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About the Journal:

The peer reviewed journal "Conscientia" is published annually to promote research in multidisciplinary fields and aims to facilitate discussions on important issues across varied disciplines, enfolding Science, Social Science and Humanities. It publishes original research papers, review works, short communication on subjects of academic as well as of popular interest. The journal also welcomes submissions on innovations in the teaching-learning process and/or learning experiences which focus on general dissemination of knowledge.

The articles reflect the findings/perspectives of the authors. The authors are exclusively responsible for the statements and opinions advanced by them. The editorial board is in no way responsible for the same.

FOREWARD

Dr. Sobhan Niyogi

Associate Professor and Officer in Charge
Krishnagar Government College

*It gives me immense pleasure to announce that volume VII of **Conscientia**, the academic journal of Krishnagar Government College is being published. Over the last 171 years this college in an uninterrupted way carries the Legacy of quality of education since the British rules to the present scenario of the development of India. Today about 3,500 students use and share the same abode of learning with the greats like D.L.Roy, Umesh Dutta,Jadunath Mukherjee,Jadunath Bhattacharjee, Lalit Kumar Banerjee, Satish Chandra Dey as illustrious students. Teachers using the podium which once used by teachers like Pandit Madan Mohan Tarkalankar, Babu Ramtanu Lahiri, Suresh Chandra Sengupta and many other names remembered with reverence. I am personally honoured to carry the Legacy of developing this Institution which has just started to celebrate the 175th years of establishment a few weeks before since 28th November 2019, following the footsteps of more than 70 eminent Principals like Roy Bahadur Jyoti Bhusan Bhaduri, Satish Chandra Dey, J.M. Sen. In less than last ten years this College has secured "A" grade twice in NAAC evaluation and very recently the University of Kalyani have declared this College as the "Best Performing College" of Nadia District. The College teachers are contributing significantly in academic research through various publications at various levels.*

*   **Conscientia,** the interdisciplinary journal of research findings launched by our College in 2011 continues to publish good quality articles since its inception. This Journal is an interdisciplinary and multilingual publication and articles include scientific research findings, socially relevant issues as well as literary contributions of humanities Departments. This volume is expected to evoke interest among various groups of readers for their academic enrichment and future thought provoking ideas.*

*   I wish to thank all the contributors from various Higher Educational Institutions for their submissions, the Editorial Board Members from our College, the Advisory Board Members from various well known Universities and Institutes of West Bengal and India for their active role for the publication of this particular volume.*

CONTENTS

ANTIBODY TECHNOLOGY: A REVIEW

Santanu Chakrabarti*

The Term "Antibody" is now very common in the period of Covid-19 pandemic. This has become so popular even in naïve discussions we can hear about antibody, its presence in our body post-infection or its protective nature. It's really good that people are being aware of their immune functions and now started caring about this crucial system of the body. Apart from such discussions we must know that antibodies are now the most rapidly growing class of approved biopharmaceutical drugs also. In this review we will explore the past, present and future of this wonder molecule of our blood and the tools and techniques that made antibody technology so lucrative as a biotechnological industry.

Discovery of Antibody

The very first antibody was discovered in 1890 by two immunologists. Emil von Behring along with Kitasato Shibasaburo discovered what was later termed antibody while researching Serum Therapy. They came across a "neutralizing substance" in blood that seemed to counter-act infection by *Corynebacterium diphtheriae*. Diptheria is a highly contagious bacterial infection of the upper respiratory tract that is spread in the air or by direct contract from affected individuals to healthy ones. In their work with diphtheria, the pair discovered that when they transferred blood serum from immunized animals to animals that were suffering from diphtheria, the sick animals were cured.

For his work in discovering the existence of this "neutralizing substance", Behring was awarded the very first Nobel prize in Physiology and Medicine. Nobel himself cited "for his work on serum therapy, especially its application against diphtheria, by which he has opened a new road in the domain of medical science and thereby placed in the hands of the physician a victorious weapon against illness and death."

Another breakthrough happened in the field of Antibodies when A. Tiselius and E.A. Kabat in 1939 suggested that antibodies reside in serum (the cell and clotting factor free part of blood). They immunized (sensitization of an animal or human with a foreign molecule known as antigen usually a derivative or part of pathogenic microbes through injection or ingestion) rabbits with ovalbumin (the egg white). Taking blood from the rabbits

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post immunization they separated the serum and divided that in to two aliquots (small amount). They electrophoresed (a biochemical technique that separates biomolecules on the basis of charge) and found four peaks. Leaving the major one as albumin they denoted the rest three as α, β, and γ globulin (a globular protein present in many biomolecules like haemoglobin). The other aliquot was reacted with ovalbumin (the antigen used to immunize the rabbits) and the precipitate formed was discarded. The remaining serum part (supernatant) was electrophoresed and showed a significant drop in the γ globulin peak. They suggested that the γ globulin portion reacted with the antigen and became precipitated as coagulant. So they identified the γ globulin as the immunoglobulin or antibody (Fig. 1). Tiselius was awarded Noble prize in 1948 for this study (1).
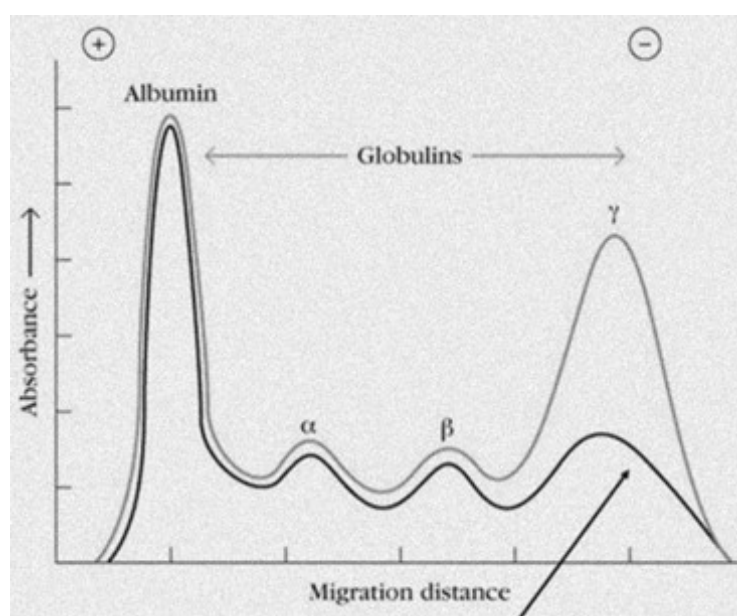
Fig1: Graphical representation of Tiselius and Kabat's Experiment, 1939

Since then lots of studies explored the structure and functions of the antibodies, most of the biochemical details and biological actions of them were elucidated and soon these molecules were targeted to cure people from dreadful infections as vaccines. It was found that human antibodies have five subclasses namely, IgG, IgM, IgA, IgD and IgE depending on the nomenclature of their heavy chain type as each antibody molecule has two heavy chains and two light chains depending on their length and molecular weight. Among them IgG remains in serum as monomer being the most potent antibody subclass (Fig 2).
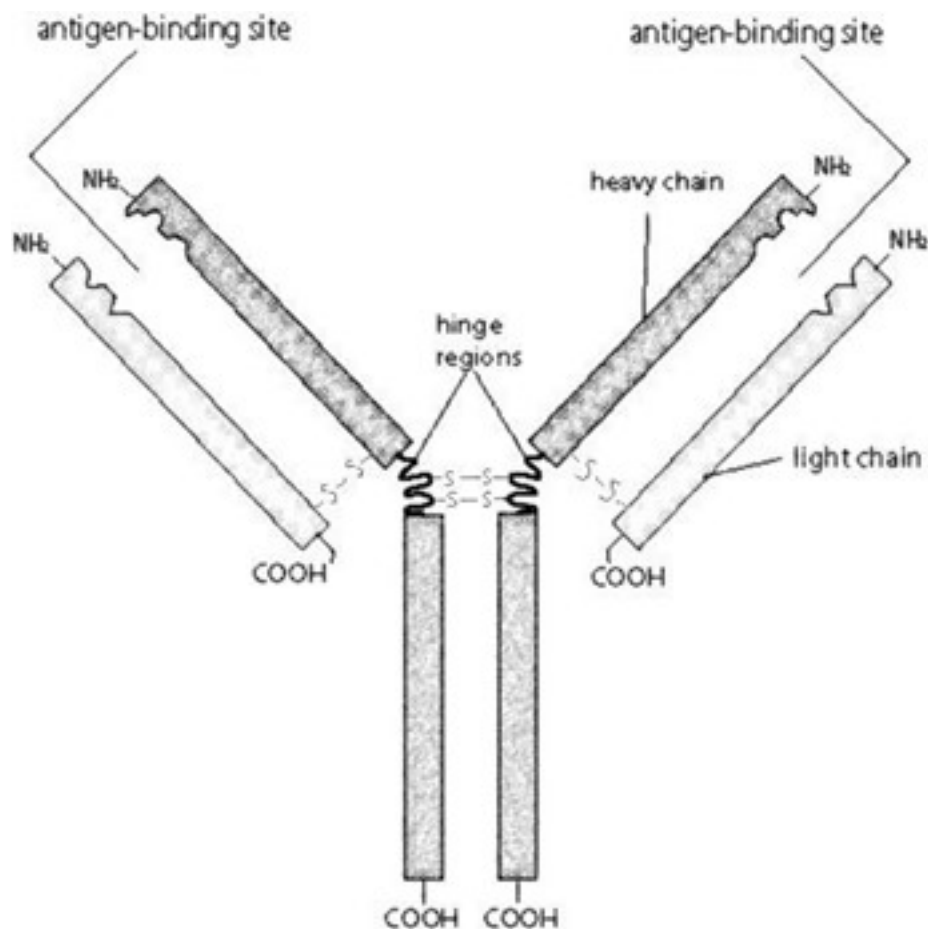
Fig 2: Structure of Antibody (Immunoglobulin G, IgG Molecule)

Polyclonal antibodies

When we have an immune response, we normally generate lots of different antibodies to different parts (antigens) of a pathogen and thus the nature of such antibody responses are polyclonal in nature where a single antibody is a product of a single cell, the B lymphocyte of blood) which may be regarded as a single clone. As lots of B cells simultaneously produce antibodies against different antigens of the pathogens, such a pool of antibodies present in our serum is regarded as polyclonal. Though this pool is protective and can eliminate pathogens by attacking them from different corners, this polyclonal nature lacks specificity. This phenomenon sometimes may cause problem as the immune system is very intricate and every action of this system is associated with many other actions and products. Inflammation may be cited as such a co-action which may or may not be favourable for the body. The most crucial weapon of our immune system may lead to difficult consequences vis-à-vis such non specific nature of serum antibodies made them useless as molecular

probes (A molecular probe is a group of molecules used in molecular biology to detect the properties of other molecules or structures). The structure of an immunoglobulin molecule on the other hand made people interested to make them as molecular probes as by action a single antibody molecule is bivalent in terms of binding antigens. So, researchers became interested in producing mono-specific antibodies which may be utilized as molecular probes as well as neutralizing specific antigens.

Monoclonal Antibodies

In the 1975, the Nobel-prize winning work of Kolher and Milstein enabled researchers to produce highly specific or monoclonal antibodies infinitely in culture using a technology called hybridoma technology (2). This key innovation paved the way for the development of numerous molecular probes as well as therapeutic antibodies. Monoclonal antibodies are unique molecules that can be used equally well in research, diagnosis and in the treatment of diverse diseases, especially cancer.

These two Nobel laureates immunized mice with antigens and taken out their B lymphocytes from the spleen (regarded as the repertoire of trained B cells) of the mice and fused them with a mouse cancer cell line to make them immortal (as *cancer cells* are considered as cells those had *forgot* how to *die). By selecting the properly fused cells, screening for antibody production against the specific antigens and by serially diluting the cell populations until a single cell stage is reached the monoclone is obtained. These cells are then preserved in low temperature (usually in liquid Nitrogen) and expressed for monoclonal antibody production whenever required eternally.*

Since then, their applications have improved the growing biotechnology industry, but the most important application concerns the proper detection and therapy of human malignancies.

Immunotoxin

Antibody therapies have become an important component in the management of cancers. Antibodies can block tumour growth factors or their receptors, activate immunological attack on the tumour, and are used to deliver payloads such as radioisotopes, cytotoxic drugs or toxins. Immunotoxins are a new class of antitumour agents consisting of tumour- selective monoclonal antibodies linked to highly toxic molecules and take the advantage of the exquisite specificity of antibodies to selectively target drug delivery and the potency of toxins to kill the target cells (3,4).

Bacterial toxins commonly used in immunotoxins include diphtheria toxin and the exotoxin from *Pseudomonas*. Plant toxins utilized in immunotoxins include ricin found naturally in castor beans **(***Ricinus communis)* and the ribosome inactivating proteins gelonin (found in *Gelonium multiflorum*), pokeweed antiviral protein (found in *Phytolacca americana*), etc.

In broad terms, there are six possible types of compound that have been linked to an antibody:

i) Small molecules, which are usually highly potent cytotoxins (e.g. maytansanoid, auristatin) to kill tumor cells

ii) Protein toxin (e.g. Pseudomonas exotoxin, diphtheria toxin) to kill tumor cells

iii) A cytolytic immunomo dulatory protein (e.g. Fas ligand) to kill targeted cells

iv) A biologically active peptide (e.g. GLP-1) to extend the pharmacological half-life of the natural peptide

v) Enzymes (e.g. urease) to modify the biochemistry of the targeted microenvironment

vi) Radionuclides (e.g. ^{90}Y, ^{111}In) for either killing or imaging of tumor cells

In 1986, the the first therapeutic monoclonal antibody for the prevention of transplant rejection was marketted. By the end of 2019, as many as 80 antibody-based drugs were approved to treat a range of autoimmune conditions, infectious diseases and cancers. Many more potentially exciting therapies are also in the pipeline including against HIV or Ebola and in coronavirus infections (SARS, MARS, etc).

With recent advances in antibody engineering technologies helping to further accelerate progress, therapeutic antibodies are set to remain a feature of the drug development landscape for many years to come.

"Humanized" Antibodies

One drawback remained in the monoclonal antibodies was the source, that is the antibody was still produced by the mice. Replacing more and more of the mouse antibody regions has led to "humanized" antibodies where the only remaining amino acids (the structural units of the proteins, in this case immunoglobulin) of mouse origin are those that make direct contact with the antigen. The latest generation of therapeutic monoclonal antibodies are fully human. These are generated either by using mice that have been genetically engineered to carry human antibody genes, or through recombinant display screening technologies that involve inserting a library of human antibody gene sequences into bacteriophage or yeast (5).

Therapeutic antibodies

Therapeutic antibodies first entered clinical studies in the early 1980s, soon after the description of the original hybridoma technology by Kohler and Milstein, but most clinical studies led to disappointments. Advancements in antibody engineering were instrumental at this stage and led to the production of chimeric, humanized, and fully human antibodies characterized by a much lower immunogenicity and the potential to interact more efficiently with effector cells of the immune system. This generation of antibodies has made great success in major commercial and therapeutic field, helped to establish the concept of therapeutic antibodies as one of the

major avenues in targeted therapies. For tuning the interaction of these antibodies with their antigens and immune receptors and leading to stronger effector cell activation or to the modulation of the antibody half-life in patients, several techniques have been developed. Today, many of the key limitations have been resolved, and antibody therapy is the most active field in therapeutics (6).

Camelid antibodies

The structure of immunoglobulin molecules composed of two heavy chains and two light chains was forever changed one day in 1989 following analysis of total and fractionated immunoglobulin G (IgG) molecules in the serum of a camel in the laboratory of Professor Raymond Hamers at the Vrije Universiteit Brussel (VUB) (7). The antibodies lacking a light chain (heavy chain-only antibodies) occurred as part of a student-run project aimed at developing a serodiagnostic test for trypanosome infection in camels and water buffalos. The preliminary data showed that besides conventional IgG1 (molecular weight ~150 kDa), two other immunoglobulin fractions (~90 kDa) were present which contributed up to 75% of all serum IgGs (Fig. 3). Comparative studies on the sera of new world camelids (*Lama glama* and *Lama pacos*) subsequently confirmed the presence of heavy chain-only antibodies, at concentrations between 30 and 50%. Following these exciting findings, it became essential to analyze the antigen-binding properties of these IgG fractions with the presence of truncated forms of heavy chain antibodies with no light chains. Such antibodies from camelids exposed to *Trypanosoma evansi* (causing sleeping sickness in animals) demonstrated strong binding activity in the heavy chain-only fractions as shown by immunoassays. Since then development of such camelid antibodies as drugs has gone through many phases mainly for the purpose of exploring their potential applications in research, biotechnology, and medicine (8). These include antibodies against blood glycoprotein to control platelet aggregation and clot formation, viral infection, venom toxins and also in the treatment of rheumatoid arthritis and the use of radiolabeled nanobodies for tumor imaging. Now in the third phase of development (2014–present), publications continue to grow and more heavy chain only antibodies have entered into clinical trials or advanced closer to the market. Ablynx and other large biophama companies, such as Merck, Boehringer Ingelheim, Sanofi,etc are ready with more than 20 preclinical and clinical programs. The first these antibody based drug, Caplacizumab, for treating rare blood clotting disorders has reached the market in 2018 (9).
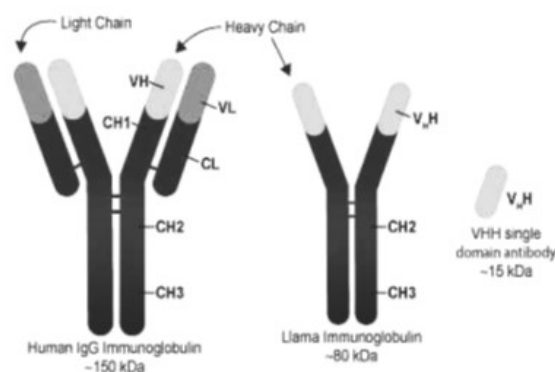
Fig 3: Structure of Camelid Antibody in comparison to human IgG

Bispecific antibodies

The concept of bispecific antibodies (BsAbs) involves combination of the antigen-binding sites of two antibodies within a single molecule (Fig. 4). Thus they are able to bind simultaneously two different epitopes (sites on antigen where the antibodies bind) and redirect effector cells toward therapeutic targets, either present on the same antigen or on different antigens. These molecules can limit complement activation (in normal situation these serum factors clear the pathogens by cytolysis but involves several side effects), which is responsible for side effects in many therapeutic settings, and profoundly enhance target selectivity. Nowadays, BsAbs are primarily produced by three methods, quadroma technology based on the somatic fusion of two different hybridoma cell lines, chemical conjugation involving chemical cross-linkers, and genetic approaches utilizing recombinant DNA technology. BsAbs can be roughly divided into two categories, immunoglobulin G (IgG)-like molecules and non-IgG-like molecules. IgG-like bsAbs keep Fc-mediated effector functions such as antibody-dependent cell mediated cytotoxicity (ADCC), complement-dependent cytotoxicity (CDC), and antibody-dependent cellular phagocytosis (ADCP). BsAbs in IgG-like formats usually have longer serum half-lives owing to their larger size. Non-IgG-like BsAbs are smaller in size, leading to enhanced tissue penetration. Bispecific antibodies have recently taken center stage as one arm of next-generation antibody therapeutics with a strong focus on effector cell retargeting and dual targeting strategies especially in cancer (10,11).
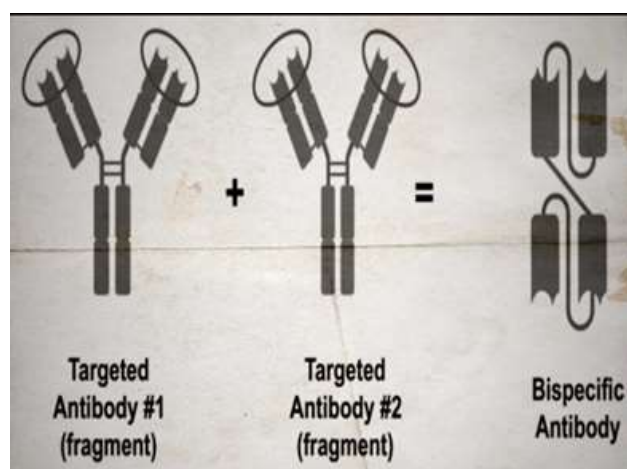
Fig 4: Bispecific antibody

Genetically Engineered Antibodies

Genetic engineering involves introduction of foreign genes of any organisms including human, in bacteria, bacteriophage viruses or yeasts and expressing them to produce molecules of medical, agricultural or other importance. This biotechnique is known as recombinant DNA technology and the products are called recombinants.

Recombinant antibodies are antibody fragments generated by using antibody coding genes as a source and display technologies which mainly contain phage display, yeast display, ribosome display, etc. This process has high reproducibility, specificity and scalability. Recombinant antibodies are reduced in size, rebuilt into multivalent molecules and fused with immunotoxins or liposomes (synthetic biomembranes made of phospholipids, often used as carriers of drugs). The emergence of recombinant technologies has revolutionized the selection, humanization and production of antibodies, superseding hybridoma technology and allowing the design of antibody-based reagents of any specificity and for very diverse purposes. Unlike common monoclonal antibodies which are produced using traditional hybridoma technology, recombinant antibodies do not need hybridomas and animals immunization in the antibody production process. Therefore, recombinant antibodies have some advantages compared with common monoclonal antibodies, which lead to various forms of recombinant monoclonal antibodies being used increasingly, mainly for therapeutic purposes. Another major advantage of this approach for generating a recombinant antibody is its speed compared to traditional hybridoma technologies. Usually it takes three to six months to generate a monoclonal antibody whereas these antibodies are generated in only one or two weeks.

Recombinant antibody engineering and recombinant DNA technology has facilitated successful expression and cloning of widespread antibody fragments in bacteria (*E. coli*), as well as mammalian (Chinese hamster ovary (CHO), or myeloma cell lines), yeast (*Pichiapastoris*), plant (*Arabidopsis*), and insect cells (*Drosophila melanogaster*) (12).

Antibody Fragment Display

Different antibody fragments are used in phage display technology: scFv (single chain fragment variable), Fv (fragment variable), Fab (antigen binding fragment) and their derivatives, V-gene domain, bispecific or bivalent antibodies, and other oligomers. Fab fragments are the linkage of V_H–C_H and V_L–C_L by disulfide bridges, and radiolabeled Fabs are used in tumor imaging. Fv is used for the construction of V_L and V_H domains or their modifications such as scFv, which is the most popular fragment. A linker molecule (made of amino acids Glycine and Serine (Gly4Ser)3 is used for the stabilization of V_L–V_H and proper antigen binding site formation without the loss of antibody affinity. Chelating recombinant antibodies (CRAbs) are scFv segments with a high binding affinity. These constructs consist of two scFv fragments specific to the identical antigen and adjacent epitopes. These fragments are connected by a short linker (up to 10 amino acids) for the dimerization and formation of diabodies. ScFv has high affinity, highly solubility, multi-domains, and high binding specificity with their target antigen and they are used for antibody engineering, biotechnology, cancer research, and biomedical applications (13).

Phage Display

Phage display is a selection technique for recombinant fusion proteins and phage coat proteins that are expressed on the phage surface (Fig. 5). The library is developed by careful genetic manipulation. Peptide or protein coding genes are inserted into a vector fused to the phage coat proteins. The bacteria are transformed with phagemid libraries, and then infected with a helper phage to assemble phage particles that express fusion proteins on their surface. Subsequently, the displayed proteins/antibody fragments are rooted to the surface of the coat protein, and permit affinity purification with its analogous genes (14).
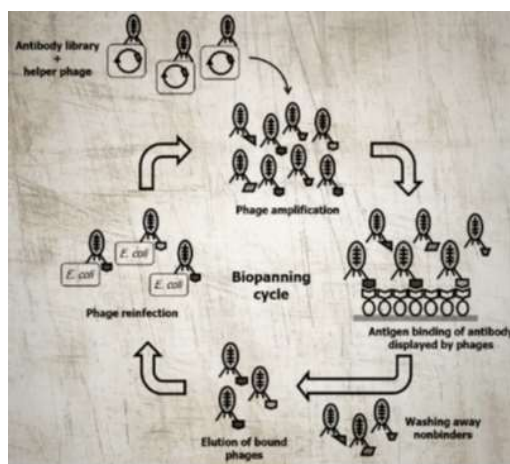
Fig 5: Phage Display technique for selection of desired humanized antibodies

Yeast surface display

Antibodies are engineered with superior properties such as binding affinity, stability, and catalytic activity by several other display tools (for example, yeast and bacterial display) for broad spectrum of biotechnology, medicine, and biomedical applications. Yeast surface display exhibit development of recombinant antibodies by displaying on the surface of *Saccharomyces cerevisiae* via genetic fusion to an abundant cell wall protein (15).

Ribosome display

Ribosome display is a cell-free display system, and a technique to perform entirely *in vitro* selection of proteins or peptides to bind desired ligand. Ribosome display consists of both prokaryotic and eukaryotic display systems. It forms stable protein-ribosome-mRNA (PRM) complexes and links individual nascent proteins (phenotypes) to their analogous messenger RNA (mRNA) (genotypes). Ribosome display allows synchronized isolation of a functional nascent protein, through affinity for a ligand together with the encoding mRNA. The encoding mRNA is then transformed and amplified as DNA for further manipulation, including repeated

cycles or protein expression. The advantages of ribosome display over other cell based methods include displaying very large libraries, generating toxic, proteolytically sensitive and unstable proteins, and incorporation of modified amino acids or mutations at distinct positions (16).

Chimeric Antibody

In 1984, Morrison firstly introduced chimeric antibody using recombinant DNA technology, joining mouse antibody variable region gene to human antibody constant region gene (17). The constructed chimeric vector was transfected into mouse myeloma cells and the cells expressed chimeric antibodies. Combining the mouse variable region with human constant region improved the monoclonal antibody humanization proportion to 70% (Fig. 6). The first chimeric therapeutic antibody Abciximab, was approved by Food and Drug Administration (FDA), USA for inhibiting platelet aggregation by binding platelet glycoproteins. In 1997, the first full-length IgG chimeric therapeutic antibody Rituximab was approved for treatment of non-hodgkin's lymphoma and rheumatoid arthritis. Chimeric formats therapeutic antibody achieved greater success than murine therapeutic antibody encouraged people to fight against cancer and autoimmune diseases by focusing on therapeutic antibody development.
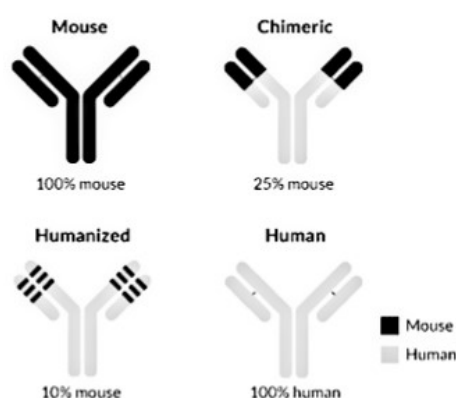
Fig 6: Chimeric and Humanized antibodies

No limits for therapeutic antibodies

Over the coming years, we are likely to see the development of new and better antibodies and more personalized treatment. In the near future, we'll have a larger armoury of different monoclonal antibodies and a better understanding of which patients to treat with which antibodies and in what combinations. In the longer term, we may remove the need to produce antibodies outside the body at all and instead introduce DNA constructs into the patients to make them on site. Researchers are increasingly excited about what the future holds for therapeutic antibodies.

The disease areas that therapeutic antibodies can target have subsequently expanded, and antibodies are currently utilized as pharmaceuticals for cancer, inflammatory disease, organ transplantation, cardiovascular disease, infection, respiratory disease, ophthalmologic disease, and so on.

Table: Some Important Therapeutic antibodies (18)

Name of the Antibody	AntibodyType	Disease	Specific Disease where used
Rituximab	Chimeric	Cancer	Bcell Non-Hodgkin Lymphoma
Trastzumab	Humanized	Cancer	Breast Cancer
Gemtuzumab	Humanized	Cancer	Leukemia
Cetuximab	Chimeric	Cancer	Colorectal, Head & Neck cancer
Panitumumab	Human	Cancer	Colorectal cancer
Bevacizumab	Humanized	Cancer	Lung, Breast cancer
Denosumab	Human	Cancer	Bone cancer
Obinutuzumab	Humanized & Engineered	Cancer	Chronic lymphocytic leukemia
Ramucirumab	Human	Cancer	Gastroesophageal adenocarcinoma
Catumaxomab	Bispecific	Cancer	Malignant ascites
Infliximab	Chimeric	Inflammmation	Arthritis, Spondylitis, Colitis
Raxibacumab	Human	Anthrax	Inhalation anthrax from *Bacillus anthracis*
Daclizumab	Humanized	Trasplantation related	Prophylaxis for transplant rejection
Abciximab	Chimeric	Heart Disease	Prevention of Cardiac ischemia
Omalizumab	Humanized	Allergy	Severe asthma
Natalizumab	Humanized	Autoimmune disease	Multiple sclerosis
Belimumab	Human	Autoimmune disease	Systemic lupus erythromatosus
Itolizumab	Monoclonal	Coronavirus	SARS & other Coronavirus infections

End Note

It is about 100 years of the discovery of the magic bullet "antibody" which helped us survive from different dreadful diseases either naturally or by elicitation through vaccination. Now it is the age of their therapeutic applications using the most important trait of these molecules, specificity. Stereo-specific targeting and recognition of antigens by these advancements of Science may help mankind to get rid of many dreadful diseases including cancer in near future.

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Giant Polyoxometalate as a precursor of nano-architecture:

Synthesis and characterization

*Rajarshi Chatterjee**

Abstract

Polyoxometalate cluster anions (POMs) control formation and morphology, and serve as protecting ligands, for structurally and compositionally diverse nanostructures. Utilizing new experimental approaches and gradual understanding of the underlying chemical processes, a great advancement is recorded in the self-assembly of inorganic and metal–organic compounds at a very fast pace over the last decades. Exploitation of unveiled information originating from initial experimental observations has sparked the development of new families of compounds with unique structural characteristics and functionalities. The first part of this research article summarizes the one pot-synthetic procedure of 3d transition metal incorporated Keggin hetero polyacid using basic chemicals without using any other derived POM as starting material. In the second part of the script, we represent use of POMs as protecting ligands for stabilizing metal nanoparticles, as well as their use as templates for the preparation of new inorganic materials. Not only that, new information concerning the structure of POM-protected metal nanoparticles is systematically developed. This detailed information is obtained by the combined use of scanning and transmission electron microscopy (SEM &TEM), FTIR spectroscopy along with thermogravimetric analysis which provides a new perspective on the formation and structure of POM-decorated nanoparticles. The purpose of this research article is not the exhaustive discussion of the broad field of inorganic and metal–organic chemical systems, but to focus on a novel representative example which demonstrates the implementation of new synthetic approach and design.

Keywords

Introduction

Polyoxometalates or POMs are metal–oxygen cluster-anions [1] which constitute a large and rapidly growing class of discrete molecular structures with applications ranging from catalysis [2–3] to functional materials [4]. These are formed by metals (addenda atoms) such as tungsten, molybdenum and vanadium in

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their higher oxidation state. POMs are composed of condensed metal-oxygen $\{MO_x\}$ polyhedral ($x = 4$ to 7). POMs can be formed mainly by vanadium, molybdenum and tungsten due to their appropriate ionic size and their ability to act as good acceptors of oxygen's electrons. The fundamental requirements for a transition metal to serve as addenda are the ability to adopt a variety of coordination modes (mainly 4 to 6) in response to acidification, have high positive charge, and are capable of p–d interactions. However, there are a few examples that deviate from this set of rules, as reported by Kortz et al (2010), where the authors demonstrated the preparation and characterization of metal oxides made of noble metals [5,6] in the presence of supporting organic or inorganic ligands. The most commonly studied POM is the heteropolyacid (HPA) best represented by Keggin [7]. The arrangement of twelve metal atoms (e.g. M = V, Mo, W) around one single heteroatom (e.g. X= Si, P, As etc.) forms a Keggin based POM, where X/M=1/12. In the Keggin structure, the heteroatom X is bonded to four oxygen atoms to form a tetrahedron and each metal atom is linked to six oxygen atoms to form octahedral. The assembly of three octahedra yields a trimetallic group M_3O_{13} which are connected to others and the common site of M_3O_{13} is linked to the central heteroatom X. In summary, there are four M_3O_{13} gathered around the central heteroatom X to form $(XO_4)M_{12}O_{36}$. In this paper, the synthesis of a mixed addenda Keggin type heteropolyacid (HPA) will be described and characterized. HPA typically has low surface area and high solubility, which makes it challenging to use them as catalytic materials in aqueous media. The cooperative chemistry of polyoxometalates (POMs) and metal nanoparticles (NPs) still remains a relatively unexplored area of nano science despite showing remarkable potential and application in fields as diverse as catalysis and medicine. Titanium dioxide (TiO_2) nanoparticles (NPs) are manufactured worldwide in large quantities for use in a wide range of applications. To make it more economically viable, different strategies are adopted. Keeping in mind the recent developments in the synthesis of nanoparticles using polyoxometalates (POMs), we have tried to bring a new synthetic line for producing TiO_2 - nanoparticles. Many procedures can be foreseen to fabricate POM-based nanostructures, but solvothermal synthesis of nanooxides is a novel method till date. Not only this, numerous examples of POM-protected metal nanoparticles syntheses and reactions can now be found in the literature, [8] but the use of Keggin POMs to prepare nano-scale analogs of binary inorganic materials like metal-oxides is completely a new pathway which can be considered as the latest development. In short, solvothermal synthetic method of nano materials from gigantic POMs is undoubtedly a pioneer work when nano synthesis is concerned.

Experimental

Materials and methods

Chemicals were readily available from commercial sources and were used as received without further purification. Disodium hydrogen phosphate (Na_2HPO_4), sodium vanadate ($NaVO_3$), sodium molybdate dihydrate ($Na_2MoO_4 \cdot 2H_2O$), titanium tetraisopropoxide$Ti[OCH(Me)_2]_4$ were purchased from Sigma-Aldrich and were used as received. Deionized water was used as the solvent.

Synthesis of phosphovanado molybdic acid (PVMA) $H_4[PVMo_{11}O_{40}]$ (1)

$NaVO_3$ (6.1 g, 0.050 mol) was dissolved in boiling water (100 mL) and then mixed with another 100 mL aqueous solution of Na_2HPO_4 (7.1 g, 0.050 mol). The mixture was cooled prior acidification by 5 mL concentrated sulfuric acid H_2SO_4 (5 mL) which gives rise to a red color solution. A solution of $Na_2MoO_4.2H_2O$ (133 g, 0.55 mol) was dissolved in 200 mL water and was added to the mixture. 85 mL conc. H_2SO_4 was then added drop-wise with vigorous stirring of the solution. Solution color transited from dark red to lighter red upon addition of the acid. The aqueous mixture was allowed to cool before being extracted with diethyl ether (400 mL). The heteropoly etherate was present in the middle layer. After separation was achieved, a stream of air was passed through the heteropoly etherate layer to free it of diethyl ether. The orange solid residue was dissolved in appropriate amount of water to obtain a saturated solution. The solution was further concentrated in a vacuum desiccator over concentrated sulfuric acid to allow for crystallization of the product. The orange crystals of phosphovanado molybdic acid (PVMA) were filtered, collected and left to air dry.

Solvothermal synthesis of $H_4[PVMo_{11}O_{40}]$ stabilized TiO_2 nanoparticles (TiO_2-PVMA)

The synthesis of POM modified nanoTiO_2 was carried out as follows: 0.2 g of $H_4[PVMo_{11}O_{40}]$ (PVMA) was dissolved in 1 mL ultrapure water. 9 mL of concentrated HCl (37%, 12M) was added and charged to a 45 mL Teflon sleeve. 0.6 mL of titanium tetra isopropoxide$Ti[OCH(Me)_2]_4$ (TTIP) was mixed with 19.4 mL of hexane and this mixture was carefully added into the Teflon without mixing with the aqueous layer. The Teflon was then sealed in a stainless-steel autoclave and heated at 170 °C for 24 h. The resulting TiO_2 was collected after cooling and washed 3 times with a mixture of 10 mL of water and ethanol (50% v/v) and dried in a vacuum oven at 40 °C for 24 h. This customized TiO_2 was dispersed into an absolute ethanol solution containing 3-Aminopropyl triethoxysilane (APTES) (1.5 % v/v) and magnetically stirred for 24 h for surface aminization. APTES is used here for covalent attaching of organic films to metal oxidetitania TiO_2. It is then centrifuged and washed with 10 mL ethanol 3 times before being dried in a freeze dryer for 24h. The surface-aminatedTiO_2 was then dispersed into 15 mL absolute ethanol containing 0.2 g of $H_4[PVMo_{11}O_{40}]$ and stirred for 24 h. The resulting POM based TiO_2 was washed until the yellowish coloration of $H_4[PVMo_{11}O_{40}]$ was no longer observable and then freeze dried for 24 h before used for further application.

Physical measurements

Elemental analyses were carried out using a Perkin–Elmer 240 elemental analyzer. Spectral measurements were made in a Varian Cary 1E UV-visible spectrophotometer with 1.00 cm glass cells. IR (400–4000 cm^{-1}) was recorded in KBr pellets on a Nicolet Magna IR 750 series-II FTIR spectrophotometer. The morphology and elemental analysis of the as-synthesized TiO_2 and PVMA modified material was analyzed by a field emission scanning electron microscope (FESEM JEOL-7600F). Powder XRD patterns were obtained by Bruker D8 advance diffractometer with monochromatic CuKα ($\lambda = 1.5418$ Å) with step size of 0.02° s^{-1}. Thermo gravimetric analysis (TGA) was performed using TA instrument TGA Q500. Temperature was ramped up from room temperature to 100 °C at a rate of 5 °C min-1, held isothermally at 100 °C for 15 mins, ramped up to 200 °C at a rate of 10 °C min^{-1}. It is then finally and ramped up to 500 °C at 10 °C min^{-1}. Sample was dispersed in ethanol and dripped onto a copper grid with holey carbon support to study the local structure

using a transmission electron microscope (TEM JEOL-2100F) at an accelerating voltage of 200 kV with a point to point resolution of 1.9 Å.

Results and discussion

Vibrational and UV-vis spectra

The synthesis of Keggin type phosphovanadomolybdic acid (PVMA) lays the foundation for the preparation and modification of materials.Using FTIR spectroscopy, the characteristic bonding in the PVMA were identified and presented in Figure 1. The characteristic peaks of the Keggin structure can be found in the range of 1100 – 700 $cm^{-1.}$. The main features are from P-O_a bonding of the centre tetrahedral, M-O_b-M corner sharing bridging oxygen, M-O_c-M edge sharing bridging oxygen and M=O_t terminal oxygen (where M = Mo or V). The characteristic bands of P-O_a, M=O_d and M-O_b-M in PVMA undergoes red shift with increase in vanadium substitution, which likely originate from the weaker metal oxygen bond due to vanadium (+5) being in a lower oxidation state that molybdenum (+6). Detailed study is illustrated below.
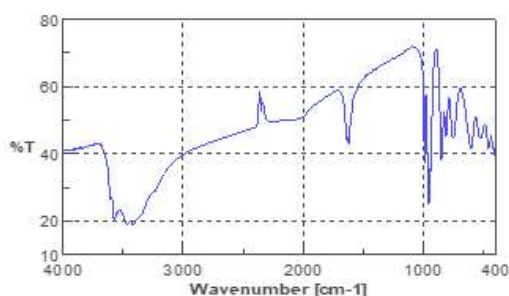
Fig-1: FTIR spectrum of complex 1, taken as KBr pellet

The IR spectra of compound (1) display the characteristic features of a Keggin-type structure as shown in Fig.1. Five strong vibration bands are indeed observed for, ν (V=O), and ν (V–O–V) at 1104.8, 1060, 957, 889, and 796.5 cm^{-1}. Apart from these, the IR spectrum of the title compound has some characteristic bands for the polyoxoanion at 510, 940, 878, 770 and 1320 cm^{-1} which are attributed to í (V=O_t terminal), ν (V–O_b-V) octahedral edge sharing) and ν (V–O_c-V octahedral corner sharing) respectively [9]. In addition, a strong broad peak observed at 3350 cm^{-1} is assigned to ν(OH) absorption along with the hydrogen bonds which proves the presence of lattice water. Again, from the UV-visible spectral point of view, it has been observed that the formation of POM stabilized TiO_2 nano-composites resulted in a red-shift as shown in UV-vis diffuse reflectance spectra of TiO_2, $H_4[PVMo_{11}O_{40}]$ (PVMA) and TiO_2-PVMA composite.
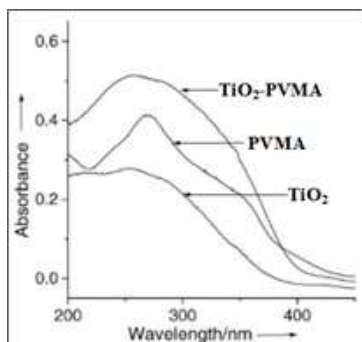
Fig-2: Comparative study of UV-vis spectra of TiO$_2$, PVMA and TiO$_2$-PVMA composite

Crystal structure

Polyoxometalates generally form ionic crystals [10] which can accommodate lattice water of crystallization and counteraction within the large interstices formed due to the size of the heteropolyanion and the requirement due to their huge ionic charge. The removal of water is easy and reversible by simple increment of temperature up to 150°C. Thus lattice water plays an important part in the crystal structure and packing of the heteropolyanion. A good example will be the different crystallographic space groups exhibited by 12-tungstophosphoric acid (H$_3$PW$_{12}$O$_{40}$). In the most highly hydrated state H$_3$PW$_{12}$O$_{40}$·29H$_2$O, the crystal structure has a cubic Fd3m space group. Further decrease in lattice water gives H$_3$PW$_{12}$O$_{40}$·21H$_2$O with orthorhombic Pcca space group.[11] Therefore, variation in the structure of polyoxometalate makes it difficult to obtain highly reproducible X-ray crystallographic information especially when powdered material is used instead of single crystal samples. That is why we prepared XRD sample mainly from single crystals.The powder XRD patterns of PVMA exhibits the diffraction peaks which show that the PVMA prepared consist of mainly a single crystalline phase. The lattice parameters of the crystals are close in values with H$_4$[PVMo$_{11}$O$_{40}$] having a=12.862Å and c=18.292 Å, with the incorporation of increasing number of vanadium atoms in place of molybdenum, the influence on the XRD peak position and intensity is minute. The small reflection peaks appearing in the diffraction patterns of PVMA are common, especially in powdered samples due to loss of water molecules which easily influence the crystal structure of PVMA.Our aim was to attain morphological control along with PVMA incorporation in the TiO$_2$ crystals. The combined XRD diffractogram given below indicates that desired incorporation of PVMA in the TiO$_2$ crystal lattice via electrostatic interaction.
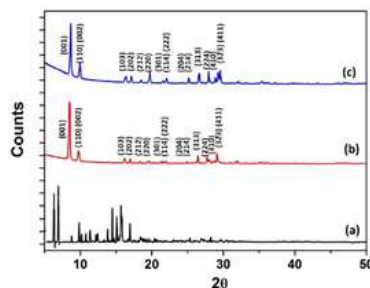
Fig-3: XRD diffractogram of (a) TiO$_2$, (b) PVMA and (c) TiO$_2$–PVMA with the characteristic reflection peaks of the Keggin structure labeled.

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Thermo gravimetric analysis

Figure 2 shows the thermo gravimetric weight loss profile of PVMA. The crystal effloresces slowly even at room temperature and the large amount of water of crystallization which are loosely attached are easily lost as temperature increases. It can be seen that the sample experiences major weight loss as the temperature increases up to 100 °C. The temperature setting for the analysis was made to hold at 100°C and 200°C so as to remove the water of crystallization completely. The 2nd derivative weight loss peak appearing around 300°C is associated with the removal of the structural water molecules holding the secondary structure of the PVMAs. The calculation from the overall weight loss reveals that water of crystallization and chemical formula of the PVM prepared to be $H_4[PMo_11VO_{40}]\cdot32H_2O$.
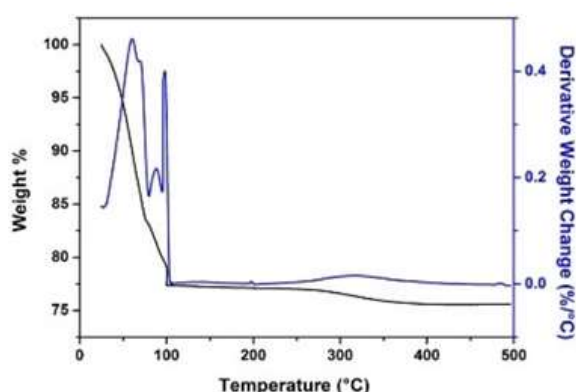
Fig-4: Thermogravimetric analysis weight loss profile of complex

Characterization of TiO_2-PVMA

With the aim of heterogenizing PVMA via immobilization, a one-pot solvothermal synthesis was designed to incorporate $H_4[PVMo_{11}O_{40}]$ into the crystal lattice of TiO_2. The desired outcome was to attain morphological control along with PVMA incorporation in the TiO_2 crystals for the final product which shows nano-plate morphology. In order to improve the coupling of PVMA with the TiO_2 surface, 3-Aminopropyl triethoxysilane APTES was employed as a coupling agent. The immobilization of PVMA on TiO_2 using a coupling agent increases the relevant elements of PVMA detected, but does not lead to formation of detectable PVMA crystalline phase. Nisar et al [12] showed that the main influence on post-modification was a decrease in the reflection intensity, which can be attributed to the reduction in reflected X-ray due to the surface modification. Further attempts to reduce the number of steps required in synthesis by introducing APTES in the organic phase during synthesis for surface modification proved to be futile and resulted in poor morphological control. This reveals that polyoxometalates are capable of stabilizing and protecting metal nanoparticles (NP) during their formation [13]. Figure 3(a) shows the SEM micrograph and (b) shows the TEM images of TiO_2 NP. Figure 3(b) also shows that the nano-plate is highly crystalline with clearly observable lattice.
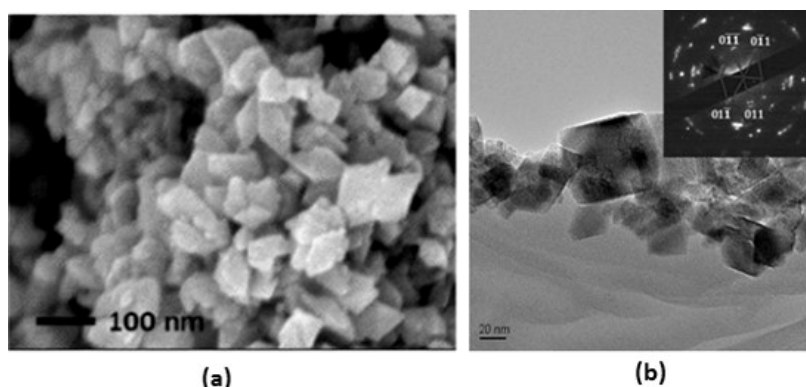
Fig-5: a) SEM micrograph of PVMA modified TiO$_2$ b) TEM micrograph of TiO$_2$ nanoparticles

Conclusion

There is increasing interest and need to develop a deeper understanding of the nature and behavior of nanoparticles in the environment. This is driven by the increased use of engineered nanoparticles and the increased pressure to commercialize this growing technology. Banerjee et al [14] in this regard tried a new doped nano crystal synthesis in accordance to green chemistry. Keeping in mind the greener side of technology, in this review we want to emphasize on a new synthetic methodology of nanoparticles from gigantic polyoxometalates. It sounds weird but we have used POM as a precursor for making nano through a solvothermal synthesis. The basic one-pot synthesis of polyoxometalate via acid condensation reaction followed by etherate extraction is neatly described. The immobilization of PVMA on TiO$_2$ NP described in this article establishes foundation knowledge and understanding of such surface modification process which also allows better consideration of the parameters in the preparation of this kind of nano-architecture [15]. In short, we have penned our investigation which is done to optimize the surface modification using high surface area titanium oxide as solid support for effective immobilization of PVMA.

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A Brief Review on Modification of Polyimides

Sobhan Niyogi[*]

Abstract:

Polyimide (PI) is an attractive dielectric material and has been widely used in the field of Electrical, electronics, aerospace, and automobiles due to its useful dielectric and mechanical properties and good chemical resistance. Polyimides of the "true types" are generally insoluble in common organic solvents. Once the polyimide is formed neither it can be moulded nor extruded by conventional thermoplastic techniques to get a product of different shape. Not only have these polyimides got a particular set of properties depending on the chemical structure of its repeat unit also the properties like wettability, printability, adhesion to metals etc. Surface properties of polyimides are very poor due to their glassy surface nature. So over the years it has been tried both in academics and industrial researches to modify the properties of polyimides to get a set of good properties. Therefore various techniques are adopted to modify the properties of polyimides for their extended use for various purposes.

Introduction:

Fully aromatic polyimides are only few in numbers and it is possible to estimate that only few can be prepared with desired properties by permutation and combination of few existing dianhydrides and diamines of aromatic nature. Therefore scientist both in Industry and Academia started to think in otherway to extend the possibility of use of polyimides for various purposes. Even a casual look of Chemical Abstract would reveal endless patents and research papers on modification of polyimides.

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From the reported work on modifications it may be observed that polyimides have been modified by the following four methods:

1. Change of polymer backbone chemical structure

2. Blending two different polyimide or other polymers with polyimides

3. Incorporating various low molecular weight compounds in the forming stage of polyimides

4. Surface treatments of preformed polyimide film by

   (a) Chemical (wet) methods

   (b) Physical (dry) methods

Change of Polymer Backbone Chemical Structure

To overcome the limitations in properties of polyimides scientists in the early 1970s became able to develop some modified polyimides with different chemical backbone structure. Few such modified polyimides are polyetherimides, polyesterimides, polyamide-imides etc.[1]. Not only these commercially developed polyimides, numerous other polyimides were developed out of various research activities where the chemical structure of both dianhydrides and diamines were systematically varied to get polyimides with better processability. Various flexible segments within the repeat unit structure such as $-O-$, $-SO2-$, $-CH2-$, $-S-$, $-C(CF3)_2-$, or bulky pendant groups etc.[2] were introduced to achieve that type of modification.

By Blending Two Polyimides or Other Polymers

Blending is a commercially attractive technique for modification of polymer properties. A detailed discussion of blends of polyimides with polyimides or other polymers are there in scientific literatures[1-10]. Polyimides may form blends with polyimides with other suitable high performance polymers. All these types of blends are suitable for various activities like gas separation where permeability and permselectivities may be controlled by changing the blend composition.

Incorporation of Low Molecular Weight Compounds in Polyimides

Incorporation of low molecular weight compounds of inorganic, organic or organometallic in nature into polymer is an attractive and sometimes necessary technique to modify polymer properties. So these compounds were also used to modify the properties of polyimides. By incorporation of those compound properties like electrical conductivity, gas permeability, thermal stability, mechanical property, surface reflectivity etc. were changed. Compounds like lithium chloride, lithium nitrate, stannous chloride, palladium salt, cobalt chloride, silver acetate, bis (trifluoroacetylacetonato) copper (II), bis amide acids or bis imides, auric acid trihydrate (hydrogen terachloroaurate (III)), á-chloro-naphthalene, o-dichloro benzene, 1,2,3-trichloro benzene etc. have been used to modify polyimides.

Khor *et al.* [11] have shown that when LiCl is doped with polyimide in its forming stage the hygroscopic nature and electrical properties are changed. Varma *et al.* [12,13] have shown that when Co^{2+}, Sn^{2+}, and Hg^{2+} chloride is used as dopant in polyimides, current-voltage characteristics of PI are altered and dependent on field and temperature. No significant increase in conductivity is observed in the presence of metallic halides. The dielectric constant of PI film increased by doping with metallic halides. The loss factor is also affected in the presence of dopants also. Sarboluki[14] has shown that when lithium chloride or lithium nitrate is used as dopant in polyimides the films show superior antistatic property. Niyogi et.al[15]. have shown that low amount of LiCl incorporation (0.5% LiCl w.r.t. solid weight of polyamic acid) during forming stage of polyimide and subsequent leaching out of that LiCl enhances the vapour permeability behaviour of polyimide film as membrane. Wang et. al.[16] have shown that LiCl doped polyimide may act as humidity sensor also. Ezzel and Taylor[17] have shown that when tin compounds like stannous chloride dihydrate ($SnCl_2$, $2H_2O$) or n-dibutyl stannic chloride [(n-Bu)$_2$ $SnCl_2$] is used as dopant in polyimides (PMDA–ODA or BTDA–ODA) surface resistivity of air side of the films decreases by 8-11 orders of magnitude. But volume resistivity did not change to that extent. They also showed that Tg of PMDA–ODA polyimide increases when $SnCl_2$, $2H_2O$ is used as dopant but polymer degradation temperature decreases for the same system. Furstch *et al.*[18] used Li_2PdCl_4 and $Pd[(CH_3)_2S]_2Cl_2$ as palladium dopant for polyimides. They showed that the electrical properties of polyimide films are dependent on the type of additive, curing environment and presence of dopant in the film material after high temperature thermal curing. Ezzel *et al.*[19] used some copper containing organometallic compound like bis (trifluoroacetylacetonato) copper (II), bis(acetylacetonato) copper (II), bis(acetylacetone) ethylenediamine copper (II), and tetrakis tri [(n-butyl) phosphine) iodo] copper (I) as dopants to polyimides.

Surface resistivity of Cu(TFA)$_2$ doped polyimide is the lowest among the various dopants used. The air side of the films became "mirror like" when cured in air. Porta *et al.*[20] have shown that the surface conductivity of Cu(TFA)$_2$ doped polyimide films increased by five orders of magnitude while cupric oxide deposited on the air side of the film. Forsch *et al.*[21] have shown that when tris (acetylacetonato) aluminium (III) is used as dopant with polyimide (BTDA- 3, 3' DABP) the adhesive strength increases to a good extent. Ramcourt et.al[22-23] have shown that when CoCl$_2$ or CoCl$_2$ –LiCl is used as dopant in polyimide the air side surface resistivity is dramatically reduced compared to that of the virgin polymer. But the thermal stability is reduced for the same films. But when CoCl$_2$ –LiCl is used as co-dopant thermal stability is further reduced. Madeleine *et al.*[24] incorporated gold to polyimide by using auric acid. They observed some metallic gold luster and the films were nonconductive. Caplan *et al.*[25] used auric acid and triethylphosphine gold(I) succinimide for the incorporation of gold in polyimides. They observed that the succinimide additive of gold is more effective in terms of higher reflectivity and electrical conductivity. But the thermal stability was lower compared to auric acid doped films. Thompson *et al.*[26] in their U. S. Pat. have claimed about the formation of a reflective polyimide film by using silver acetate as the dopant. Clair *et al.*[27] have shown that when some bisimides are used as additive for high molecular weight polyimides melt viscosity, moisture pickup, free volume, modulus and dielectric constant decreased. Makino *et al.*[28] have shown that when organic compounds like o-dichlorobenzene, 1,2,3, trichlorobenzene or a-chloronaphthalene is used along with p-chlorophenol solution of polyimides better permeability characteristics are observed in the resulting films. Chan[29] have shown that when polyimide is functionalized with ruthenium complex like bis (2, 2' : 6' 2" – terpyridine) ruthenium (II) the photosensivity of the polyimides in the visible region is increased. Yano *et al.*[30] have observed a big decrease in permeability coefficient when some clay hybrid polyimide film is prepared from saponite or montmorilonite and poly (amic acid).

Tong Zhang [31] in their effort to increase the dielectric constant of pI film successfully incorporated in-situ generated SiO$_2$ on TiC particle and incorporated the whole into poly(amic acid) for film preparation. Enhancement of dielectric property of polyimide was also observed by Xintong Li et al [32] by using Zirconia nanocrystals.

Zhang et.al.[33] became able to prepare a Polyimide / Al$_2$O$_3$ nanocomposite film with better thermal stability and corona resistance.

Surface Treatment of Polyimides:

Surface of polyimides are very smooth and inert in nature. There are also no active functional groups on the surface of most of the polyimides so that those groups may be used for further chemical reactions or may be used in other way. So it was tried to generate some functional groups on the surface of preformed polyimides so that that the surface related properties like printability, wettability, adhesion to metals may be increased. Functional group generation on the surface was achieved by wet chemical process and by some physical process like with various types of radiation.

Chemical (Wet) Methods

To improve the adhesion of a metal or polymer to the substrate polyimide film, the polyimide surface needs to be polarized and using chemicals is a very easy and cost effective way to carry out such process. Chemical method of modification mainly involves the etching of surfaces by chemicals like sodium hydroxide solution or by some amines to generate various functional groups on the surface. Now those functional groups on the surface may be allowed to react with suitable chemicals. Lindsey [34] disclosed a method in U. S. patent for etching of polyimide surfaces by using strong basic solutions of alkali metal hydroxides, quaternary ammonium hydroxides, and the like and have shown that enhancement in adhesion takes place after etching. De Angelo [35] in his U. S. patent have shown that an aqueous solution of a basic compound along with ethylenediamine makes a synergistic effect on etching. A rough polyimide surface was obtained or reactive sites on the surface were created. After this good printability and metal adhesion was observed. Redmond *et al.* [36] also used a mixture of hydrazine and a caustic material for etching of polyimide surfaces. Due to this deposition of palladium containing catalyst on the polyimide surface was favourable. Beckenbough *et al.*[37] in their US patent used hydrazine as etchant and followed by UV irradiation for surface modification of polyimide films. Dumas *et al.*[38] have used a nitrogen-oxygen containing adhesion promoting compound to enhance the adhesion of metals to polyimide surfaces. Grapentin *et al.*[39] have used a solution containing alkali hydroxide and hydrazine or a derivative of hydrazine for the modification of polyimide surfaces and subsequently deposited metal by galvanic process. Lee *et al.* [40] also used KOH solution for etching followed by acidification for the modification of polyimide film surface and observed a ten fold increase in peel strength in a particular experiment. Buchwalter *et al.*[41] also modified the polyimide surfaces by using chemical etchants and due to this type of etching various functional groups were formed on the surface of the polyimide films. These active sites were further allowed to react with epoxy, hydrazine or alcohol. Ho *et al.*[42] chemically modified polyimide film

surface by using a solution of KOH, methanol, ethylenediamine at various percentages followed by activation of the surface by some commercially available catalytic solution. After this type of surface modification copper or nickel deposition was possible. Yagci *et al.*[2] have modified the chemical backbone structure by bromination and epoxidation as a double bond was present in the backbone of the polyimide they synthesized this polymer from 6-FDA and a diamine 4, 4' –bis (p-aminophenoxymethyl)-1-cyclohexene (CHEDA).

Lu shao *et.al.*[43] showed how a ethylenediamine changes the cross linking and other inner structure of polyimide which enhances its ability for selective gas separation.

Kim et.al.[44] have carried out by coupling reaction of Upilex S polyimide film by using N,N-carbonyldiimidazole as coupling agent to enhance the adhesion property of polyimide with Copper metal. Vorobyov [45] reported that the adhesion of plated copper layer on the polyimide surface modifed with NaOH was due to the formation of the Cu–OC bond and Cu–NC bond. KMNO4 aqueous solution was used by Wang *et. al.*[46] to improve the bonding force by modifying the polyimide surface due to the formation of micro-roughness.

Park *et.al.*[47] have shown that when standard Polyimide films are treated with ethylenediamine adhesion of polyimides with copper metal enhances.

Wu *et.al.* [48] have prepared a double sided reflective and conductive surfaces of silvered polyimide films by potassium hydroxide hydroxylation of polyimide film surfaces. The films showed essential mechanical properties and very good reflectivity and conductivity.

Mu *et.al.*[49] have similarly prepared cobalt oxide layers on polyimide films via surface modification and ion-exchange technique using KOH solution.

Chung *et.al.* [50] have prepared a polyimide membrane by modifying its surface by using ethylene diamines to get favourable diffusivity selectivity and solubility selectivity between H_2 and CO_2.

Tung *et.al.* [51] have shown that upto 30% incorporation of boron nitride(BN) inpolyamic stage and subsequent polyimide film formation takes place with much higher thermal conductivity for the film.

Liu *et.al.*[52] have shown that preformed fluorinated polyimide films may be modified by carrying out cross linking at room temperature by dipping the films in p-xylene diamine methanol solution. The crosslinking takes place by opening up of the imide linkage which in turn modifies the permselectivities of various gas combinations.

Surface modification of polyimide Kapton film was carried out by Yun Jun Park *et.al.* [47] by using ethylene diamine. This treatment of polyimide surface by ethylene diamine functionalises the surface by generating

amine group from broken imides chain/gr, which in turn enhances the ability of the modified surface to adhere with deposited copper metal.

Physical (Dry) Methods

Physical methods of modification of polyimide is a very attractive way to modify surfaces of polymers including polyimides as it generates various functional groups on the surface of polyimides which is the main aim of surface modification. This is mainly accomplished by irradiation of various types of radiation or by bombardment with some ionic plasma or corona discharge etc. and a huge number of research papers have been published on this aspect of surface modification. Dorrer et al.[53] modified the transmissivity of a polyimide film by at first depositing metallic aluminium and then oxidizing that aluminium on the surface of the polyimide film. Films modified in that way shows better transmissivity. Mirtich et al.[54] improved the optical, electrical properties of the Kapton™ polyimide by treating the surface of polyimide film with an electron bombardment argon source. Jones et al.[55] modified hydroxy containing polyimides by CF_4 and O_2 plasma to facilitate metallization of polyimide surfaces. Feurer et al.[56] used high intensity proton pulses of duration 50 ns to modify polyimides. Change in optical and electrical conductivity took place due to this type of modification. Kim et al.[57] modified polyimide film surfaces by irradiation with unpolarized and linearly polarized UV light (LPUV) on previously rubbed and unrubbed samples. The modified and unrubbed polyimide surfaces showed weak anisotropy between the directions parallel and perpendicular to LPUV light's polarization direction and this anisotropy is responsible for liquid crystal alignment. Wolany et al.[58] have shown that when polyimide surface is exposed to oxygen plasma a great number of C - O and C – N active sites become available for successful metal deposition. Wang et al.[59] have structurally modified the surface of PMDA-ODA polyimide by irradiation with Yb+ and Er+ ions at room temperature. Loh et al.[60] have modified Kapton H TM film by surface grafting with various water soluble monomers. But prior to grafting film surface modification by Ar-plasma, O_2 – plasma or O_3 treatment was necessary to enhance the extent of grafting. Matsui et al.[61, 62] and Liu et al.[63] have shown that when some polyimides having crosslinkable sites are irradiated with UV light shows decrease in gas permeability but selectivity for H_2/N_2 increases. Weiss et. al.[64] and Pidduck et al.[65] have shown that when polyimide surface is rubbed liquid crystalline alignment takes place. Kirk et al.[66] modified polyimide surface by corona discharge in nitrogen / hydrogen or nitrogen / ammonia atmosphere. Due to this type of modification wettability and reception to adhesives increases. Sang Jin Cho et.al.[67] used nitrogen microwave plasma for modification of polyimide surface for deposition of electroless copper deposition for enhancement of copper adhesion. On the other hand Soo-Jin Park et.al.[68] showed that atmospheric pressure plasma treatment increases the oxygen containing functional groups on the surface of the polyimide film thereby

increasing the adhesion characteristics of polyimide film to metallic copper. In an another study Soo-Jin Park *et.al.* [69] shows that when in atmospheric-pressure fluorinated compound like CHF_3/Argon is used fluorine incorporation on the surface of polyimide takes place which in turn decreases the dielectric value. In one more study Soo-Jin Park *et.al.* [70] showed that when in atmospheric-pressure fluorine is used the same observation of decrease in dielectric value is observed.

Conclusion:

This article tries to show that during the last so many years polyimide research has reached a level when without synthesising new polyimides, mixing/blending of various organic and especially inorganic materials to standard polyimides can change the properties of those polyimides. Also surface modification by various methods can change, in most cases the properties in terms of electrical and as gas permeability nature of certain polyimides. Hence it may me concluded that modification of polyimides has been established as a very effective tool to improve certain properties and may be tailor made to have a property as per requirement. The future of this type of research is really very bright by exploring other methods of modification for the existing polyimides.

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Influence of magnetic field on pulsatile nature of flow of blood in an inclined circular tube accompanied with periodic body acceleration

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ABSTRACT

A mathematical model has been developed for studying the characteristics of blood flow in a rigid inclined circular tube with periodic body acceleration under the influence of a uniform magnetic field. The blood is supposed to be couple stress fluid. Finite Hankel and Laplace transforms are used to obtain the analytical expressions for velocity profile, flow rate and acceleration of blood. The flow velocity deviates with various parameters such as Hartmann number, gravitational parameter, body acceleration, inclination angle, time etc. and this deviation of flow velocity can be regulated by a proper use of magnetic field.

Key words and phrases: Pulsatile motion, couple stress fluid, body acceleration.

1.   INTRODUCTION

In our daily life we often face some external body acceleration, such as travelling in high velocity vehicles, aircrafts etc. Again in various sports it needs a high acceleration suddenly. These type of situations undoubtedly effects the normal flow of blood which lead to headache, vomiting tendency, loss of vision, abnormality in pulse rate etc. So we have to maintain such type of body accelerations to avoid these types of health hazards.

Various mathematical models have been investigated by several researchers to explore the behaviour of blood flow under the influence of external acceleration. Sud et. al. [1, 2] studied the characteristics of blood flow accompanied with body accelerations. Sud and Sekhon [3, 4, 5] took into account various types of body accelerations and studied different characteristics of blood flow according to the nature of accelerations.

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Chaturani and Palanisamy [6, 7, 8] studied the flow characteristics of blood under external body acceleration assuming blood as a Newtonian fluid, Casson fluid and power law fluid respectively. Chaturani and Upadhya [9] studied the gravity flow of fluid with couple stress along an inclined plane with application to blood flow. A good number of researchers [10, 11, 12, 13] investigated the nature of blood flow in an inclined channel or surface. El-Shehawey et. al [14] studied the nature of unsteady flow of blood in the presence of magnetic field through a circular pipe taking blood as an electrically conducting, visco-elastic, non-Newtonian fluid. Rathor et. al [15] have studied the pulsatile flow of blood through rigid inclined circular tubes under the influence of periodic body acceleration.

Number of researchers [16 - 20] in present day, developed various mathematical models on the effect of transverse magnetic field upon the flow of blood through arteries taking different conditions into account.

In the present paper, a mathematical model is developed to study the characteristics of pulsatile flow of blood through an inclined circular tube under the influence of periodic body acceleration in presence of transverse magnetic field. Here we consider blood as a couple stress fluid. The axial blood flow velocity is determined using finite Hankel and Laplace transforms, as these transfoms make the problems easy to solve analyticaly. The effect of magnetic field, gravitational parameter, inclination angle, body acceleration, time etc. on axial blood flow, flow rate and acceleration of blood has been discussed graphically.

2. MATHEMATICAL FORMULATION OF THE PROBLEM

Let us consider a one-dimensional pulsatile blood flow through a uniform straight and inclined rigid circular tube in presence of transverse magnetic field. Let us take the flow of blood as axially symmetric, pulsatile and fully developed. Taking blood as couple stress fluid we may write the basic equation in cylindrical polar co-ordinates as

$$\rho \frac{\partial u}{\partial t} = -\frac{\partial p}{\partial z} + \rho G + \mu \nabla^2 u - \eta \nabla^2 \left(\nabla^2 u \right) + \rho g \sin\theta - \sigma B_0^2 u \tag{1}$$

where $\nabla^2 \equiv \frac{1}{r}\left(\frac{\partial}{\partial r}\left(r \frac{\partial}{\partial r} \right) \right)$.

Here $u = u(r,t)$ is the axial velocity, ρ is the density of blood, μ is the co-efficient of viscosity of blood, η is the couple stress parameter, g is the acceleration due to gravity, B_0 is the transverse component of magnetic field and σ is the electrical conductivity of the medium. The pressure gradient $\frac{\partial p}{\partial z}$ is taken as

$$-\frac{\partial p}{\partial z} = A_0 + A_1 \cos \omega t \quad , \ t \geq 0 \tag{2}$$

in which A_0 is the steady state part of pressure gradient, A_1 is the amplitude of the oscillatory part,
$\omega = 2\pi f$, f being the heart pulse frequency. Again the body acceleration G is given by

$$G = a_0 \cos(\omega_1 t + \phi) \quad , \ t \geq 0 \tag{3}$$

in which a_0 is the amplitude of body acceleration, ϕ is the phase difference, $\omega_1 = 2\pi f_1$ and f_1 is the body acceleration frequency.

We can write equation (1) in non-dimensional form, by substituting

$$u' = \frac{u}{\omega R}, \ r' = \frac{r}{R}, \ t' = t\omega, \ A_0' = \frac{R}{\mu\omega} A_0, \ A_1' = \frac{R}{\mu\omega} A_1, \ a_0' = \frac{\rho R}{\mu\omega} a_0, \ z' = \frac{z}{R}, \ g' = \frac{\rho R}{\mu\omega} g$$

as (dropping the primes)

$$\alpha^2 \alpha'^2 \frac{\partial u}{\partial t} = \alpha'^2 A_0 + \alpha'^2 A_1 \cos t + \alpha'^2 a_0 \cos(bt + \phi) + \alpha'^2 \nabla^2 u - \nabla^2 (\nabla^2 u) + \alpha'^2 g \sin\theta - M^2 \alpha'^2 u \tag{4}$$

where $\alpha = R\sqrt{\dfrac{\omega\rho}{\mu}}$ is the Womersley's parameter, $\alpha' = R\sqrt{\dfrac{\mu}{\eta}}$ is the couple stress parameter,

$M = B_0 R\sqrt{\dfrac{\sigma}{\mu}}$ is the Hartmann number, R is the radius of the tube and $b = \dfrac{\omega_1}{\omega}$.
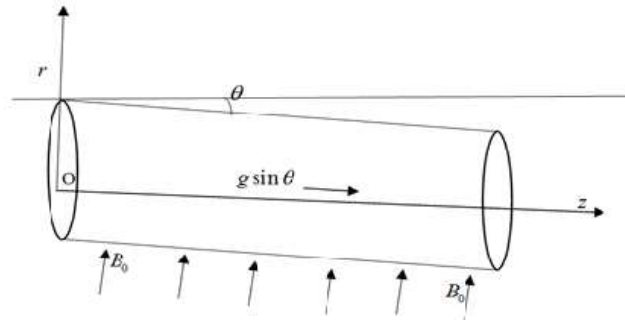
Fig. 1: Geometry of the prescribed model.

3. MATHEMATICAL ANALYSIS

We take the boundary conditions of the problem as [15]

$$u \text{ and } \nabla^2 u \text{ both are finite at } r = 0, \tag{5}$$
$$u = 0 \text{ and } \nabla^2 u = 0 \quad \text{at} \quad r = 1. \tag{6}$$

Taking finite Hankel transform of (4) and using boundary conditions (5) and (6) we obtain

$$u^*\left(\lambda_n,t\right)=\sum_{n=1}^{\infty}\frac{J_1\left(\lambda_n\right)\alpha'^2}{\lambda_n}\ \frac{A_0+A_1+a_0\cos\left(bt+\phi\right)+g\sin\theta}{\lambda_n^2\left(\lambda_n^2+\alpha'^2\right)+M^2\alpha'^2}$$ (7)

where $u^*\left(\lambda_n,t\right)=\int_0^1 ru(r,t)J_0\left(r\lambda_n\right)dr$ and λ_n are the roots of the equation $J_0\left(\lambda_n\right)=0$.

Initially at $t=0$
$$u^*\left(\lambda_n,0\right)=\sum_{n=1}^{\infty}\frac{J_1\left(\lambda_n\right)\alpha'^2}{\lambda_n}\ \frac{A_0+A_1+a_0\cos\phi+g\sin\theta}{\lambda_n^2\left(\lambda_n^2+\alpha'^2\right)+M^2\alpha'^2}$$

To solve the problem we employ the Laplace transform in equation (1) and with the help of (5) and (6) we obtain

$$\alpha^2\alpha'^2\left\{s\bar{u}-u\left(r,0\right)\right\}=\alpha'^2\frac{A_0}{s}+\alpha'^2\frac{A_1 s}{s^2+1}+\alpha'^2 a_0\frac{s\cos\phi-b\sin\phi}{s^2+b^2}+\alpha'^2\nabla^2\bar{u}-\nabla^2\left(\nabla^2\bar{u}\right)$$
$$+\alpha'^2\frac{g\sin\theta}{s}-M^2\alpha'^2\bar{u}$$

i.e.,
$$ms\bar{u}-mu\left(r,0\right)=\alpha'^2\frac{A_0}{s}+\alpha'^2\frac{A_1 s}{s^2+1}+\alpha'^2 a_0\frac{s\cos\phi-b\sin\phi}{s^2+b^2}+\alpha'^2\nabla^2\bar{u}-\alpha'^2\nabla^2\left(\nabla^2\bar{u}\right)$$
$$+\alpha'^2\frac{g\sin\theta}{s}-M^2\alpha'^2\bar{u}$$ (8)

where $\bar{u}\left(r,s\right)=\int_0^{\infty}e^{-st}u\left(r,t\right)dt$ and $m=\alpha^2\alpha'^2$

Now taking finite Hankel transform of (8) and using (7) we get

$$ms\bar{u}^*\left(\lambda_n,s\right)-m\frac{J_1\left(\lambda_n\right)\alpha'^2}{\lambda_n}\sum_{n=1}^{\infty}\ \frac{A_0+A_1+a_0\cos\phi+g\sin\theta}{\lambda_n^2\left(\lambda_n^2+\alpha'^2\right)+M^2\alpha'^2}=$$

$$\frac{J_1\left(\lambda_n\right)\alpha'^2}{\lambda_n}\left[\frac{A_0}{s}+\frac{A_1 s}{s^2+1}+\frac{a_0\left(s\cos\phi-b\sin\phi\right)}{s^2+b^2}+\frac{g\sin\theta}{s}\right]$$
$$-\left\{\lambda_n^2\left(\lambda_n^2+\alpha'^2\right)+M^2\alpha'^2\right\}\bar{u}^*$$

where $\bar{u}^*\left(\lambda_n,s\right)=\int_0^1 ru\left(r,s\right)J_0\left(r\lambda_n\right)dr$

or,

$$\left\{sm+\beta\right\}\bar{u}^*\left(\lambda_n,s\right)=\frac{J_1\left(\lambda_n\right)\alpha'^2}{\lambda_n}\left[\frac{A_0}{s}+\frac{A_1 s}{s^2+1}+\frac{a_0\left(s\cos\phi-b\sin\phi\right)}{s^2+b^2}+\frac{g\sin\theta}{s}+m\sum_{n=1}^{\infty}\frac{\gamma}{\beta}\right]$$

$$[\text{Taking } \beta = \lambda_n^2 \left(\lambda_n^2 + \alpha'^2 \right) + M^2 \alpha'^2 \text{ and } \gamma = A_0 + A_1 + a_0 \cos\phi + g\sin\theta]$$

i.e.,

$$\bar{u}^* \left(\lambda_n, s \right) = \frac{J_1 \left(\lambda_n \right) \alpha'^2}{\lambda_n} \left[\frac{A_0}{s} + \frac{A_1 s}{s^2 + 1} + \frac{a_0 \left(s\cos\phi - b\sin\phi \right)}{s^2 + b^2} + \frac{g\sin\theta}{s} + m\sum_{n=1}^{\infty} \frac{\gamma}{\beta} \right] \frac{1}{sm + \beta} \quad . \tag{9}$$

For simplicity of calculations, we rearrange (9) as

$$\bar{u}^* \left(\lambda_n, s \right) = \frac{J_1 \left(\lambda_n \right) \alpha'^2}{\lambda_n} [\frac{A_0}{\beta} \left(\frac{1}{s} - \frac{1}{s+h} \right) + \frac{A_1 \beta}{\beta^2 + m^2} \left(-\frac{1}{s+h} + \frac{s}{s^2 + 1} + \frac{m}{\beta \left(s^2 + 1 \right)} \right)$$

$$+ \frac{a_0 \beta \cos\phi}{\beta^2 + m^2 b^2} \left(-\frac{1}{s+h} + \frac{s}{s^2 + b^2} + \frac{mb^2}{\beta \left(s^2 + b^2 \right)} \right)$$

$$- \frac{a_0 bm \sin\phi}{\beta^2 + m^2 b^2} \left(\frac{1}{s+h} - \frac{s}{s^2 + b^2} + \frac{\beta}{m \left(s^2 + b^2 \right)} \right)$$

$$+ \frac{g\sin\theta}{\beta} \left(\frac{1}{s} - \frac{1}{s+h} \right) + m\sum_{n=1}^{\infty} \frac{\gamma}{\beta} \left(\frac{1}{m} \cdot \frac{1}{s+h} \right)] \tag{10}$$

where $h = \dfrac{\beta}{m}$.

Taking inverse Laplace transform of (10) we get

$$u^* \left(\lambda_n, t \right) = \frac{J_1 \left(\lambda_n \right) \alpha'^2}{\lambda_n} [\left\{ \frac{A_0}{\beta} + \frac{A_1 \left(\beta\cos t + m\sin t \right)}{\beta^2 + m^2} + \frac{a_0 \left\{ \beta\cos \left(bt + \phi \right) + bm\sin \left(bt + \phi \right) \right\}}{\beta^2 + m^2 b^2} + \frac{g\sin\theta}{\beta} \right\}$$

$$- e^{-ht} \left\{ \frac{A_0}{\beta} + \frac{A_1 \beta}{\beta^2 + m^2} + \frac{a_0 \left(\beta\cos\phi + bm\sin\phi \right)}{\beta^2 + m^2 b^2} + \frac{g\sin\theta}{\beta} - \sum_{n=1}^{\infty} \frac{\gamma}{\beta} \right\}] \quad . \tag{11}$$

Also taking finite Hankel inversion of (11) we obtain the required solution for blood velocity as

$$u \left(r, t \right) = 2\sum_{n=1}^{\infty} u^* \left(\lambda_n, t \right) \frac{J_0 \left(r\lambda_n \right)}{J_1^2 \left(\lambda_n \right)}$$

$$= 2\sum_{n=1}^{\infty} \frac{J_0 \left(r\lambda_n \right) \alpha'^2}{\lambda_n J_1 \left(\lambda_n \right)} [\left\{ \frac{A_0}{\beta} + \frac{A_1 \left(\beta\cos t + m\sin t \right)}{\beta^2 + m^2} + \frac{a_0 \left\{ \beta\cos \left(bt + \phi \right) + bm\sin \left(bt + \phi \right) \right\}}{\beta^2 + m^2 b^2} + \frac{g\sin\theta}{\beta} \right\}$$

$$-e^{-ht}\left\{\frac{A_0}{\beta}+\frac{A_1\beta}{\beta^2+m^2}+\frac{a_0\left(\beta\cos\phi+bm\sin\phi\right)}{\beta^2+m^2b^2}+\frac{g\sin\theta}{\beta}-\frac{\gamma}{\beta}\right\}]\quad . \tag{12}$$

The flow rate Q is given by

$$Q(r,t)=2\pi\int_0^1 u r\,dr$$

$$=4\pi\sum_{n=1}^{\infty}\frac{\alpha'^2}{\lambda_n^2}\,[\left\{\frac{A_0}{\beta}+\frac{A_1\left(\beta\cos t+m\sin t\right)}{\beta^2+m^2}+\frac{a_0\left\{\beta\cos\left(bt+\phi\right)+bm\sin\left(bt+\phi\right)\right\}}{\beta^2+m^2b^2}+\frac{g\sin\theta}{\beta}\right\}$$

$$-e^{-ht}\left\{\frac{A_0}{\beta}+\frac{A_1\beta}{\beta^2+m^2}+\frac{a_0\left(\beta\cos\phi+bm\sin\phi\right)}{\beta^2+m^2b^2}+\frac{g\sin\theta}{\beta}-\frac{\gamma}{\beta}\right\}] \tag{13}$$

and the fluid acceleration F is

$$F(r,t)=\frac{\partial u}{\partial t}$$

$$=2\sum_{n=1}^{\infty}\frac{J_0\left(r\lambda_n\right)\alpha'^2}{\lambda_n J_1\left(\lambda_n\right)}\,[\left\{\frac{A_1\left(m\cos t-\beta\sin t\right)}{\beta^2+m^2}+\frac{a_0 b\left\{bm\cos\left(bt+\phi\right)-\beta\sin\left(bt+\phi\right)\right\}}{\beta^2+m^2b^2}\right\}$$

$$+he^{-ht}\left\{\frac{A_0}{\beta}+\frac{A_1\beta}{\beta^2+m^2}+\frac{a_0\left(\beta\cos\phi+bm\sin\phi\right)}{\beta^2+m^2b^2}+\frac{g\sin\theta}{\beta}-\frac{\gamma}{\beta}\right\}]\quad . \tag{14}$$
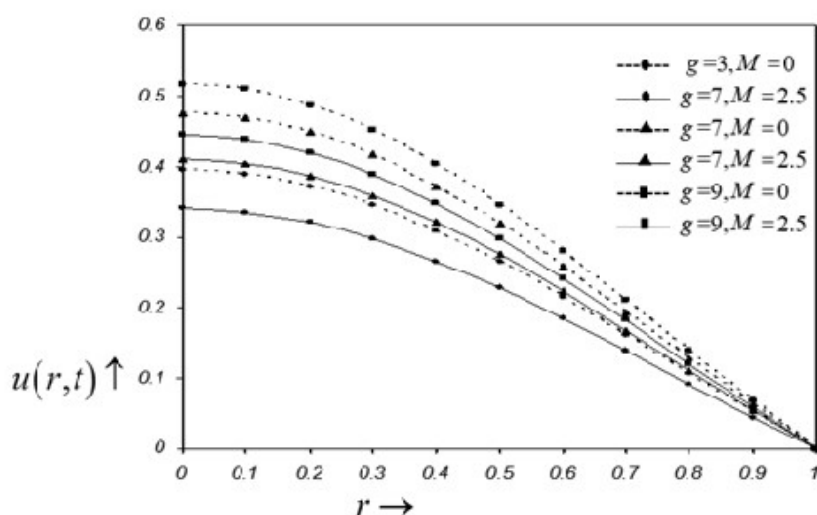
Fig. 2: Variation of velocity profile for different values of g;
taking $A_0=2.0$, $A_1=1.0$, $a_0=3.0$, $b=0.5$, $t=0.5$, $\phi=15^0$, $\theta=30^0$, $\alpha=1$, $\bar{\alpha}=1$
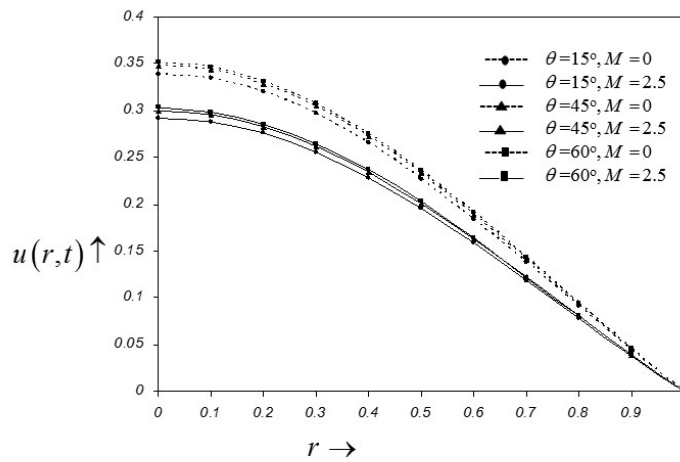
Fig. 3: Variation of velocity profile for different values of θ;
taking A_0 =2.0, A_1 =4.0, a_0 =3.0, b =0.5, t =0.5, ϕ =15^0, g = 0.5, α =1, $\bar{\alpha}$ =1
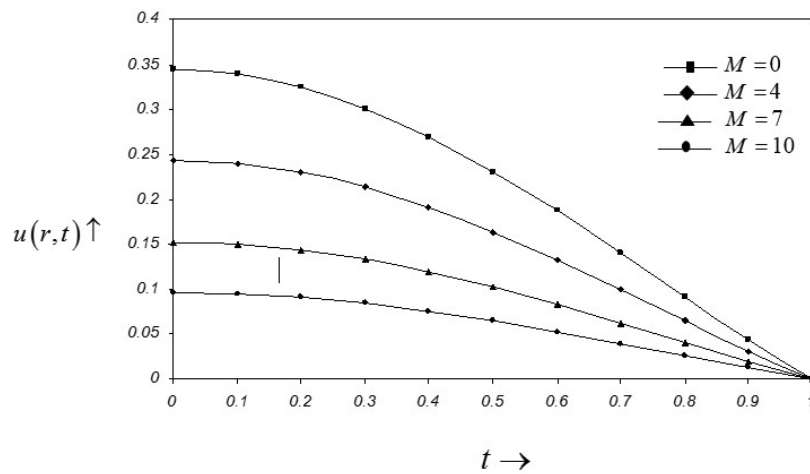
Fig. 4: Variation of velocity profile for different values of M;
taking A_0 =2.0, A_1 =4.0 a_0 =3.0, b =0.5, t =0.5, ϕ = 15^0, θ = 30^0, g = 0.5, α =1, $\bar{\alpha}$ =1
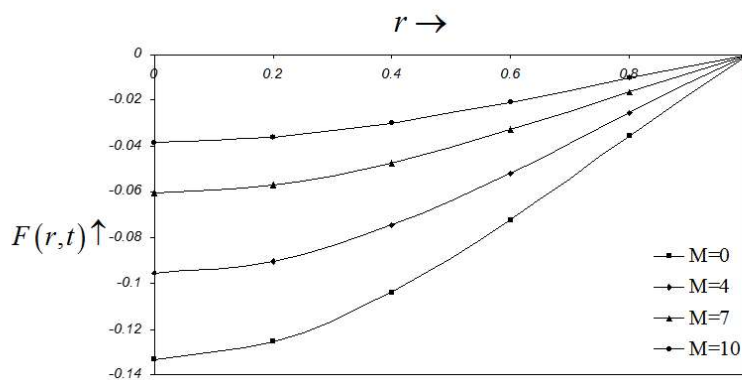
Fig. 5: Variation of acceleration of blood for different values of M;
taking A_0 =2.0, A_1 =4.0 a_0 =3.0, b =0.5, t =0.5, ϕ =15^0, θ = 30^0, g = 0.5, α =1, $\bar{\alpha}$ =1

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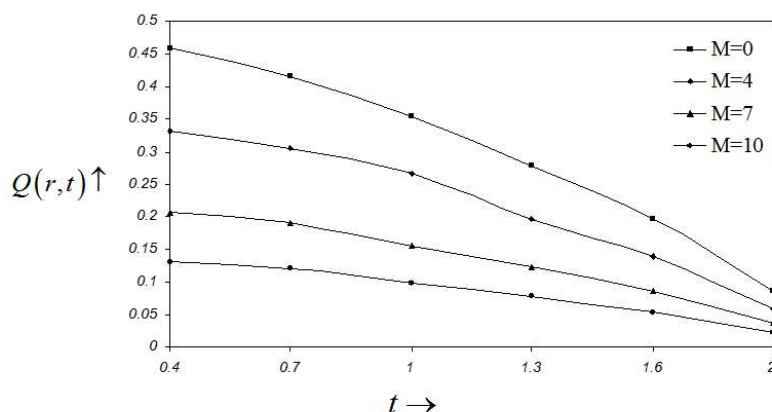
Fig. 6: Variation of flow rate of blood for different values of M ;
taking A_0 =2.0, A_1=4.0 a_0=3.0, b =0.5, $\phi = 15^0$, $\theta = 30^0$, $g = 0.5$, $\alpha = 1$, $\bar{\alpha} = 1$

4. NUMERICAL RESULTS AND DISCUSSIONS

The expression for velocity profile $u(r,t)$ obtained in equation (12) has been depicted in figures-2 and 3 by plotting r versus u in presence/absence of M , for different values of gravitational parameter g and inclination angle θ . Fig – 4 is constructed for versus r with varying Hartmann number M. Figure-5 is constructed for r versus fluid acceleration F and Fig – 6 is constructed for t versus flow rate Q.

Figure-2 shows that u increases with increasing g , but influence of M reduces the effect of variation in g. Figure – 3 shows that u increases with increasing g, but influence of M reduces the effect of variation in θ . Similarly it is possible to show that u increases with increasing a_0 (amplitude of body acceleration), A_0 (steady state part of pressure gradient), A_1 (amplitude of the oscillatory part of pressure gradient), α (Womersley's parameter), α '(couple stress parameter) respectively; but the presence of M reduces the effect of variation of those parameters. On the other hand from figure – 4 we observe that u decreases with increasing t and presence of M reduces the effect of variation of t. In figures 5 and 6 different values of M are taken to visualise the effect of M on acceleration of blood F and flow rate Q respectively, retaining all other parameters unaltered. Fig. – 5 shows that there occurs a retardation in the flow velocity $u(r,t)$ and the amount of retardation is reduced by the influence of M. In fig – 6 for different values of we observe that the flow rate Q depends largely on time t and the transverse magnetic field reduces the amount of flow rate Q.

5. CONCLUSIONS

It is clear from the above discussions that the transverse magnetic field effects largely on the axial flow velocity of blood. Again from the figures 2-9 the amount of deviation in $u(r,t)$ due to M is shown. So, by taking appropriate values of M we may regulate the axial flow velocity.

In case of arthritis, gout etc. patients are often advised to take protective pads or tractions. By applying proper magnetic field attached with those instruments we may enhance their activity. Again, in the case of magnetotherapy, by maintaining a proper magnetic field, the influence of magnetic instruments on blood flow velocity may be regulated.

In our daily life we often use several kind of electromagnetic instruments, such as cellular phones, transistors, television, computers etc. which have some magnetic field effect. This magnetic field effects the blood flow velocity leading to various kinds of health hazards such as headache, vomiting tendency, partial loss of vision etc.

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Future of Digital Higher Education in India

*Suchismita Maiti**

Abstract:

In modern era we cannot imagine a day without digital media. In all sector digitization is spreading by leaps and bounce. Education sector is not an exception as well. In recent time we have both universities offering only online courses and universities offering some online courses along with offline courses. In this paper a discussion will be done about the need, prospect, different initiatives and challenges in digitization of science learning in higher education. This online learning process is one of the important steps in digital India movement and it also ensures our primary right of education irrespective of cast, sex, age, place of living or economical condition. It also provides a wide platform of education. Till date in India it is consider as a parallel process along with traditional teaching learning process. It can be predicted that in near future it will become the primary one looking at the recent trend of education worldwide. Implementation of digital education required innovative way for evaluation and supervision over task completion and quality maintenance.

Introduction:

Education is the backbone of nation. Only education can help the nation to establish itself in the world. In traditional system of education, the education is confined in particular place and time. In traditional lecture based system teacher plays the role of performer in a scheduled time and place and students as receiver. In this process student plays passive role. But in online teaching learning process plays equal emphasis on in-class and out –class work and provide more interaction between student-teacher and student-student interaction. New generation students are technology savvy and are very much comfortable in digital media,so digitization of education specially higher education is a better choice for them.

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Digital learning and different methods associated with it:

Digital Learning is sometimes confused with online learning or e-learning. A digital learning strategy may include any of or a combination of any of the following: (i)adaptive learning that uses computer algorithms to get the desired effect for interaction between learner and deliver, (ii)badging and gamification for motivation of students ,(iii)blended learning is the combination of online and offline learning, (iv)classroom technologies such as electronic white board, flipped learning, (v)e-textbooks learning objects,(v) mobile learning e.g. Mobile Phones, Laptops, Computers, iPads. (vi) personalized learning that aims to customize learning according to each students' strengths, needs, skills and interests, (vii) online learning (or e-learning), (viii)open educational resources(OERs) that gives teaching-learning materials in any medium- digital or otherwise in the public domain , (ix)technology-enhanced teaching and learning is the learning that occurs through the application of electronic communication and computer based education technology, (x)virtual reality simulate the matter in three dimensional image using computer to enhance the concept, (xi)augmented reality provide a computer generated image on a user's view of the real world, (xii)learning analytics that helps understanding and optimizing learning and the environments in which it occurs . There are a plenty of tools and resources available in online (many of that are free) that can be used to create and enhance a digital learning environment. The resources and tools that 21st century teachers can use for digital learning are RSS or Social Readers through which the people can share their concept on the matter they read and receive feedback i,e interactive learning , Google+ Communities provide a platform to create a group on a specific subject to engage other user on the network with same interest, YouTube Channels help to get different learning videos and audios, iTunesU, Cloud-based Word Processors (i.e. Google Drive),File-sharing platforms (i.e. Dropbox, Evernote, Digital Pocket, Zotero), Video conferencing software (i.e. TrueConf, Zoom, Cisco Webex, Microsoft Teams) helps to create actual physical class room teaching.

 Prospect and challenges of digital education in India:

In contrary to the opinion that the digitization of education will diminish the role of teacher in teaching learning process,involvement of teacher will be more in this new process as teachers have to make more modified teaching material, always be available to students for academic consultation and always be upgraded as students has the liberty to choose his instructor or teacher. In online learning process the students can get worldwide platform of database in the form of e-book, e-journal, educational videos and virtual laboratories. In contrary to traditional education system this system provides more personalized education and more teacher-

student and student-student interaction that cannot be thought earlier. It is very much useful for differently able learner . It also helps the teacher to track student progress individually and more easily as the student can be bounded to give response after every step to progress further. Anyone can start learning about anything at any age even after performing all the household and personal responsibilities. It has been noticed that the online education increase retention of information. In online learning required less time to learn than in a traditional classroom setting because students can learn at their own pace, going back and re-reading, skipping, or accelerating through concepts as they choose. Nevertheless, the effectiveness of online learning varies amongst age groups. The general consensus on children, especially younger ones, is that a structured environment is required, because kids are more easily distracted.

 In India it is a big challenge to get good quality of learning resources and teacher in all trades in all part of the country. In this case the digital learning give opportunity to the students to choose the best teacher in any specialization and can learn and interact with teacher, co-learner at a preferable time. Age is not a barrier for the type of learning. This new age teaching learning process is more cost effective. At initial stage it requires some funds to get a computer or smart phone and good internet connection but recurrence cost or maintenance cost is nominal. Internet plays an important role in the growth of digital learning. In India internet connection covers most of the part of the country, cost of internet access decreases and free internet accessibilities increases which would broaden the opportunity of digital learning to common people.

In science due to scarcity of sufficient fund and man power laboratories in different higher education institute are not well equipped in India .Without hand on experience science learning is not being completed. In this respect digital education opens a new pathway through virtual laboratory. Through simulation in virtual laboratory one can get hand on experience and it helps in better understanding of the content. This Virtual laboratory helps differently able learner to get an hand on experience in any discipline which was not been possible in traditional system. As all the responses of learner is digitize the evaluation process will become more transparent in comparison to traditional process.

The outcome of digital learning :

The outcomes of this learning are

(i)Online has expanded access to higher education virtually anywhere , anytime – smart phone and other 'always –on' devices providing even more flexibility.

(ii)Asynchronous learning (where the instructor and students are not in classroom at same time) helps student to ask any question (even silly one) without hesitation.

(iii) Using artificial intelligence and different assessment process institution can track and monitor students engagement and effectiveness of instruction as well as specific assignment for engaging student.

(iv)Inadequacy of both good quality and quantity will not be a hindrance for digital learning [1].

Advantages of digital learning:

Global trends of learning indicate that the students will prefer the digital learning which resulting the continuous growth of online education and it will be continues in future, is a big challenge for traditional contact type classroom teaching. Not only the students but also teachers take the help of digital education for their up gradation and doubt clearance. Online accesses to similar learning resources through open education resource (OER) eliminate all type of discrimination in learning. It provides a network between the learner and teachers all over the world [2]. This is a ragging free education system which is a big challenge in traditional education system in our country. In digital learning the content are represented audio-visually and more attractively leads to more interest and fast learning of the learner. At any stage of life one can change his career and also can start his carrier after thoroughly knowing about the content of the course with the help of digital learning.

Different initiations by Government :

The government of India has initiated a hug reforms in higher education to expand the platform of education. The initiatives are

SWAYAM MOOCs portal (Study web of active learning) is an indigenous MOOCs portal that provides high quality of education through courses design by best teachers in the country and video lecture, e-reading materials, discussion forum and assessment system. For the course taken into SWAYAM portal up to 20% credit will be transfer into the academic record of the student, Till date more than 1000 courses are available and 33 lakh users are registered.

Using satellite communication under SWAYAM Prabha programme 32 DTH channels has been functional which air four hours of new content every day.

 National Digital Library(NDL) is a virtual library give access to 15 million digital books and journals with a single window search facility. 31lakh learners including all academic levels, all disciplines and also differently able learner are using this facility.

Global Initiative of Academic Network(GIAN) is an initiative to garner best international knowledge and experience into the country's higher education to enable Indian students and faculty to interact with best academics and industry experts from across the world. GIAN courses are short duration courses.

e-pathsalahas been developed by NCERT (National Council for Educational Research and Training) for showcasing and disseminating all educational e-resources including textbooks, audio, video, periodicals and a variety of other print and non-print materials. So far, 3062 audios and videos, 630 e-books(e-pubs) and 504 flip books have been made available on the portal and mobile app [3].

Limitation of digital education and steps to overcome it:

Along with the good perspective of digitization of higher education there are some challenges and limitations. This noncontact learning process eventually leaves some gaps in teaching of courses. Learning hierarchy is not maintained as total content is available at a time which leads to knowledge application in future[4] . Of course, digital learning has a unique set of challenges to go with the advantages. Many students who excel in a classroom will struggle with an online course. Even those who have no trouble mastering the material can fall behind on assignments and fail assessments. It's important for teachers to be aware of these potential obstacles. With a little foresight and planning, they can help their students get the most out of every course. To overcome the digital learning challenges following steps should be followed

1. Need for Self-Discipline: In traditional teaching-learning process there is a strict routine and schedule of the classes and student are monitored by teachers face to face. But in online system the scenario is different. It easy in online system to skip class and the assignment as teachers cannot actively check . So for some intrinsic motivation is needed to follow the day to day task given by teachers. Teachers can equip the students with tools that help them to develop the self discipline. A shared calendar for the class with reminders for due dates is a great start. An interactive syllabus can be introduced where students can check off work as they complete it.

2. Missing Social Interaction: College universities are the best time for the socialization of students as at this level their personality is also developed and parental interference is lowered. The physical class room helps in learning and lively group discussions which help to lift up all the group members and achieve the goal. But in online course as the physical presence is not there the bonding is not so hard which hamper the easy sharing of views and collaborating mentality. By encouraging the student to introduce themselves and interact with each other beyond the boundary of course this problem of online learning can be overcome. By introducing

group assignment in course fundamental collaboration between students can be started. Then by meaningful comments on student progress in completion of that assignment good result can be expected. By this way soon the collaboration take a momentum.

3. Lack of Teacher Contact: In physical campus students interact with teachers during instruction time, question answer time, before and after the class time, office hour. The students become more familiar with teacher during different cultural, sports and academic programme organized in physical campus of higher education which helps them to share any type of problem they face. It also makes the teacher student relationship strong. In online system as teachers cannot get rid of their own boundaries but by making a class-specific chat account for students and setting hours during which they can expect a prompt response , quick response of email from students, asking follow up questions, replying to all comments , answering the questions even the silly one this deficiency can be minimized.

4. Poor Time Management: This challenge is related to the self-discipline, but it deserves to be a separate point. One of the major advantages of online learning process, students can learn at desired pace, some time it results in tremendous pressure at end of the scheduled course time. So it is important to set goal and need continuous monitoring to give the student flexibility of learning progress followed by some specific time structure.

5. Technological Difficulties: Technology is the main pillar of online education system. In our third world country access to a recent –model laptop or desktop computer to all the students is a big challenge. Most of the students rely on their smart phone for all online activities so for online learning process the study materials should of the form which easily compatible with smart phone as well as computers. Virtual laboratory till now is not so developed to conduct all the science experiments online which also a big challenge to build the concept of science subject properly. Government already took some initiation to overcome this by arranging online learning equipments for students.

6. Need to arrange technology based teaching training for the teachers: Before the pandemic situation all the teacher training programme over the country emphasis on the traditional mode of teaching method and proper uses of teaching learning materials. The skill of preparation graphical and animation videos to improve the concept and understanding of subject matter was ignored. The online teaching required this type of videos.

7. Need of self discipline for student and good monitoring system: Sometime learner are destructed by technology and they mal practice in assessment process. To overcome this problem the monitoring of student response and innovation of assessment system is needed. Government should legal framework to monitor and maintain a quality level of learning resources. Otherwise once wrong or low quality resources are webbed it will ruin the effort of digital education. Security should be taken to prevent all types of malpractices.

Conclusion

There are some lacunas in teaching of courses in this new platform of teaching. There is no hard and fast rule for the learning hierarchy as total content can be made available at a time which leads to knowledge application in future. But in India it is a big challenge to consider the online teaching as only one option throughout the country for all learners as the good internet connection and computer or smart phone is not available to all and also educational institutions have no sufficient funds to conduct online teaching learning process. Teachers continued the teaching learning process in their own expenses in most of the cases. The pandemic situation made us realize that we have to improve the internet services all over the country and grant should be given to student to make computer or smart phone available. Some students can malpractice in assessment process, so the evaluation or assessment process has to be designed in such a way that malpractice can be restricted strictly. The Government should form a strict rules and judicial system regarding the quality, originality otherwise the effort of online education will become a big zero. So improvement of continuous monitoring system regarding resource quality and student progress has to be improved.

Thus at the end it can be concluded that a digital learning is an alternative way of learning and help the country a lot in pandemic situation but not the only way of learning in normal situation . Till date traditional learning process is equally significant. The best option is the blended mode of learning of these two.

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Cyclic Conformal Cosmology

Ujjwal Das*

Abstract

Although the Big Bang Model was believed to be the correct model of the universe after some experimental evidence, the laws of Physics seem to breakdown at the Big Bang singularity. So this model has some fundamental physical and philosophical problems. This review article briefly describes how the newly proposed Cyclic Conformal Cosmological Model where the Universe is an eternal succession of Aeons, tries to solve the problems of the Big Bang Model in a new way along with some of its predictions which can be verified by observation of CMBR data.

Key words: Big Bang, CMBR, Conformal Transformation, Black hole Evaporation,

Introduction:

One of the most fascinating inquiries of the human mind about the Origin and Evolution of the Universe has given birth to the branch of physics namely Cosmology. The Discovery of the CMBR in 1965 by Penzias and Wilson confirmed the prediction of Big Bang Model of the Universe as some kind of primordial explosion according to which the universe (the whole space-time) came into existence all of a sudden approximately 14 billion years ago. Since then it is believed to be the correct model of the universe by many scientists. However, there are some fundamental physical and philosophical problems as it is a day without yesterday and by this model, one cannot explore beyond the plank time era (10^{-43}second from the bang) and also laws of physics breakdown since curvature and temperature diverge to infinity (physical singularity) at Big Bang. However Einstein proposed a cyclic model (Einstein 1931) of the universe in 1931. But in 1934 Richard Tolmanraises

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objections against the validity of the model by considering the. Entropy of the Universe (Tolman 1934). In search for an alternative Cosmological Model, One of the most promising model emerged through a very recent research headed by Sir Roger Penrose is Conformal Cyclic Cosmology (Penrose 2006)—the view of the universe in terms of Conformal geometry rather than Lorentzian geometry and also without requiring any Quantum Cosmological theory

2.1.Basic Idea of Cyclic Conformal Cosmology:

According to this model, the Universe is eternal and consists of infinite succession of Aeon (phase of the universe from one Big Bang to the next which repeats itself indefinitely) from infinite past to infinite future. Fig-1 shows the space-time diagram of our universe according to Big Bang Model without inflation at the beginning. At present, our universe undergoing a phase of accelerated expansion and in far future its boundary will become infinite. Now the point of singularity at the Big Bang can be stretched out to finite boundary and infinite boundary of the far future can be squashed into finite boundary by using a mathematical trick called conformal transformation under the crucial condition that physics at these two points remains to scale-invariant i.e. insensitive to the size or scale and such a condition really hold true (arguments behind such assumption will be given below). So after the conformal transformation of figure 2 it takes the form of figure 3 and the strange observation is that the physical and geometric conditions are exactly same at the point of the big bang in the past and in the far future. Now the conjecture of Cyclic Conformal Cosmology is that the far future of this present cycle of the universe in which we are living at present can be regarded as the Big Bang of the next universe yet to be born and our big bang at the past is the far future of another universe of the past.

2.2. Our universe in the far future:

According to recent observation that our galaxy contains a black hole at its center and it will eventually swallow all the mass of galaxy and same will happen for other nearby galaxies and they will come together and merge to form a new giant black hole. In this way all the mass of the universe will eventually be swallowed up by black holes and the universe will be left with the remnant of such super massive black holes. Now

according to Hawking (Hawking 1974), a Black hole emits radiation and so its mass will decrease and it will evaporate eventually by the explosion of huge amount of radiations containing photons only.

2.3.Our universe in the past i.e. at the Big Bang:

Near the Big Bang temperature was very high and the particles of the materials at this very temperature moves with very high very velocity so the energy in their rest-mass can be neglected with respect to kinetic energy so one can consider the particles as containing almost zero rest mass. So again we are in a physical condition where the universe can be regarded as filled with huge amount of radiation only.

2.4. The condition/Scenario of Scale Invariant Physics:1. According to the general theory of relativity any space-time manifold can be best explored by its Causal structure i.e. arrangements of Light Cones at different points of the Space-time. Material particles follow the world line or trajectory through the space-time must always have to be passed inside these light cones at every points of its trajectory and the hyperbolic surface inside the cone calibrates its time scale as shown in figure 1. But photon always lies on the surface of the light cone and in principle don't experience the passing of time. Light cone in a sense represents mathematically the metric of space-time in which all the information about space-time is encoded. Metric g has total 10 components out of which 9 components uniquely specify light cone structure but the 10th component is related to the scale of the geometry and not related to photons behavior. So Photons are essentially scale insensitive.
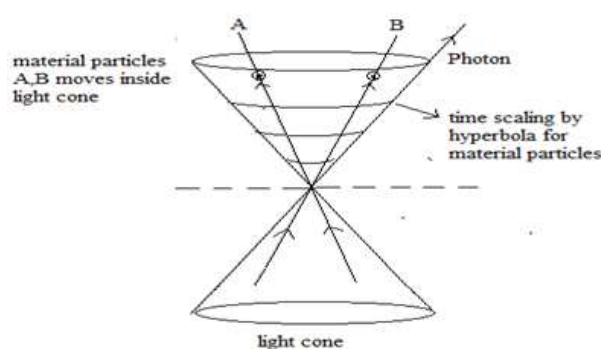
Figure 1 Material particles A,B moves always inside light cones and keep track of time .Time scaled by Hyperbolas. Photon moves on the surface of light Cones.

It follows from another different arguments: Two most fundamental equation of the 21st century are Plank formula for radiation energy: E=hv and Einstein Mass Energy Equivalence Formula: $E=mc^2$. So combining these two formula it gives $v=mc^2/h$. The physical interpretation of this formula is that every stable particle with non zero rest mass behaves as a clock with extreme high precision. (for example atomic clock). So only material particles can keep track of the time in the universe but photons does not. So when the physics of the universe can be described by radiations or photons only, it does not distinguish between largeness and smallness of time and length. This is the key feature for this cyclic conformal model. Now conformal geometry is a geometry which is independent of scale and the use of conformal geometry here changes the whole game. By conformal transformation causal structure remains invariant and infinity can be brought back to finite size (as is most popularly done in drawing Penrose diagram and nothing peculiar about it) keeping its physics essentially unchanged and also by following same line of arguments (Paul Tod 2015) initial point at the Big Bang can be stretched out to a finite boundary (Fig-2) as at that point universe contains almost zero rest mass particles which satisfy the condition scale invariance description of physics. The boundary of Big Bang of one cycle can be smoothly matched with the far future boundary of the universe of previous cycle. Similarly Boundary of the far future of a cycle can be matched to the next cycle's Big Bang which is yet to be born. This reveals the eternal picture of the Universe with succession of Aeons (Fig-3) and in one of the Aeon we live at present.
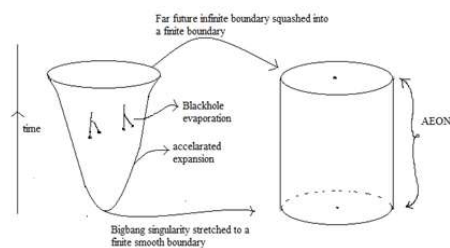
Figure 2: left figure shows our universe and right figure is obtained after conformal transformation of the left. Big Bang singularity can be stretched to finite smooth boundary and infinity of far future can be squashed to finite size.
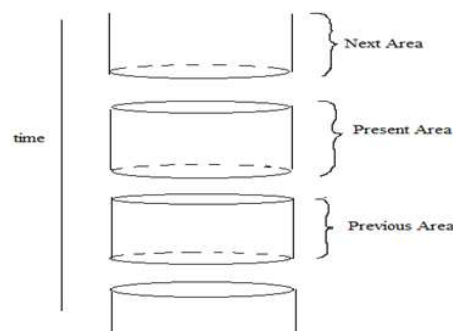

Figure 3: Big Bang in the past have same physical and geometric condition as of the far future of an expanding universe. So universe can be viewed as eternal succession of Aeon(interval between successive Big Bangs

3. Non Existence Singularity at Big Bang in Conformal Model*:*

At Big Bang singularity all components of curvature tensor remains finite except the component concerning "scale" of geometry and so it is difficult to deal with as long as we adopt Lorentzian geometric description of the universe. Now as conformal geometry is not dependent of any scaling but preserve other geometric relation so no singularity is exhibited there as in the case of Lorentzian description.

4. Resolution of Entropy puzzle*:*

In the far future of an Aeon, all the matters will be swallowed up by super massive black holes and a black hole can contain a huge amount of entropy than any other object or system in the universe. According to Sir Roger Penrose when the black hole evaporates by Hawking radiation all the entropy or information will be lost forever which to some scientific view seems to violate one of the most fundamental principle of quantum mechanics known as the Unitary Principle which is a statement regarding conservation of probability of the system. But during any measurement on the system when a system jumps to any particular state Unitary is always violated so according to Prof. Roger Penrose, Quantum mechanics may not be the complete description of Nature and there is a problem with the view that information is not conserved or totally lost from Universe as black hole evaporates. So as according to conformal cyclic cosmology far future of one Aeon is the beginning of the next or big bang of the next cycle so one can starts with zero entropy of the Universe. Starting with zero value of entropy is a stringent requirement of a cosmological model to be valid if it is to be consistent with the second law of Thermodynamics.

5. Prediction and Observational Verification*:*

(Hawking Points in the sky and possibility of detection of signal from previous Aeon). Large super massive black holes will evaporate in the far future of an Aeon by the explosion with a huge amount of radiations and when the infinite boundary is squashed down to a finite boundary it will be concentrated in some region forming a spot after conformal transformation and will smoothly pass through the cross over the surface to next Big Bang of the succeeding Aeon (Fig-4). This spot expands after Big Bang and left an imprint on CMBR with a region of the diameter of 4 degree which is the 8th times the diameter of the Moon in the Sky. This is called Hawking points (An,Meissner,Nurowskiand Penrose 2018) as it originates from Hawking

Radiation. Plank satellite data and other data of CMBR show such a spot with a very high statistical confidence level. Till date there is no other cosmological explanation except the interpretation of those spots as Hawking points which imply the existence of some previous Aeon of the Universe. However, Inflation is not required in this model as it would spoil out all the evidence from previous Aeon.
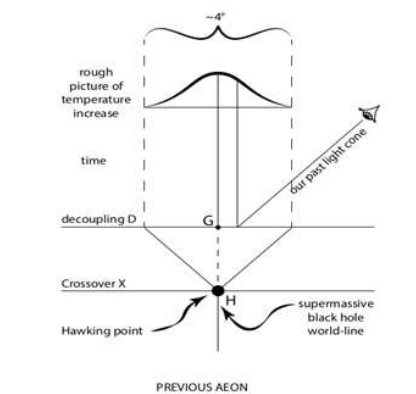
Figure 4:Signal from Hawking points transmitted through the cross over surface between Aeons and left an imprint on the CMBR as spot of 8 times the diameter of moon in the sky (4 degree).

Conclusion: This cosmological model is superior and appealing than other models as it solves two puzzling features e.g. Big Bang Singularity and Entropy Problem which are present in other known cosmological models. Also eternity of the Universe answers to some fundamental philosophical problems also. However, only the confirmed discovery of signals from previous Aeon (Hawking points, etc.) in the future can establish this model as the correct description of our Universe.

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Preparation of Cu₂O thin film grown by RF magnetron sputtering

Goutam Kumar Paul*

ABSTRACT

Cuprous oxide (Cu$_2$O) hold a very important position in the fields of materials science due to great potential in many acoustic, electric and optical applications. Cu$_2$O, a direct-gap semiconductor with band gap energy of 2.0 eV has been regarded as one of the most promising materials for application to photovoltaic cells, especially for the top cell in a tandem structure. The attractiveness of Cu$_2$O as photovoltaic material lies in the fact that constituent materials are nontoxic and abundantly available. Polycrystalline p-Cu$_2$O is grown by RF-magnetron sputtering for the purpose of application to solar cells. We are trying to improve of Cu$_2$O properties changing the growth temperature.

INTRODUCTION

Cuprous oxide (Cu$_2$O) is one of the promising direct band-gap semiconductors with band-gap energy ~ 2.0 eV. It has huge potential for application to photovoltaic cells [1-2], to be more specific for the top layer in a tandem structure. This is because of the fact that has a high absorption coefficient in the visible region. So, p-Cu$_2$O thin film provide a large area, potentially cheap, use for sustainable photovoltaic devices. This article reports fabrication of p-Cu$_2$O thin film structures by radio frequency rf magnetron sputtering technique and improvement of its quqlity in respect sustrate temperature.

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EXPERIMENTAL

Polycrystalline p-Cu_2O was grown by means of rf magnetron sputtering [3] on Corning 7059 glass substrate using a Cu target of 99.99% purity, and Ar as sputtering gas. Oxygen was introduced during the growth of Cu_2O through a nozzle whose end was placed near the substrate. We prepared two sets of samples for Cu_2O, with various oxygen flow rates 140 ml/m with various substrate temperatures Sample I: 400 K, Sample II: 500 K, The thickness of each layer was 800nm. The hole concentration of Cu_2O was in the around $10^{16}cm^{-3}$. The atomic arrangement of Cu_2O is shown in Fig. 1.
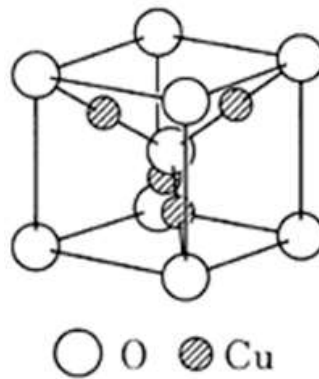
Figure. 1. Atomic arrangement of Cu_2O.

The XRD profiles in θ-2θ mode to know the structure and crystallinity of the films were analyzed by a X-ray diffractometer (Philips model PW1730) using Cu K^∞ radiation. The microstructure of Cu_2O samples investigated using atomic force microscope (AFM) for average grain-size determination. The carrier concentration of the Cu_2O samples (400^0C and 500^0C) was measured using Hall–voltage measurement technique.

RESULTS AND DISCUSSION

The structural properties were studied by X-ray diffraction (XRD) in the θ-2θ mode using Cu-K$_\alpha$ radiation. The XRD profile in θ-2θ mode using Cu-K$_\alpha$ radiation of the heterostructure is shown in Fig.2. Diffraction peaks of (111), (200) and (220) planes of Cu_2O are observed. The crystal quality may also be improved at higher deposition temperatures, and grain size seems to play an important role in improving device performance.
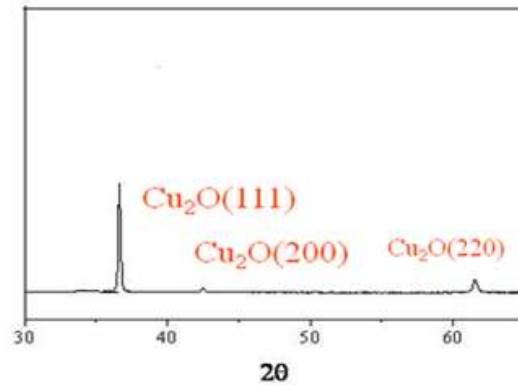
Figure 2. XRD profiles of p-Cu$_2$O

Fig. 3(a) shows atomic force microscope (AFM) images of samples with Cu$_2$O deposited at 400^{0}C. The average grain size is around 25 nano meters. As the deposition temperature was increased for substrate at 500^{0}C the increasing grain size Fig. 3(b)

(a)   (b)
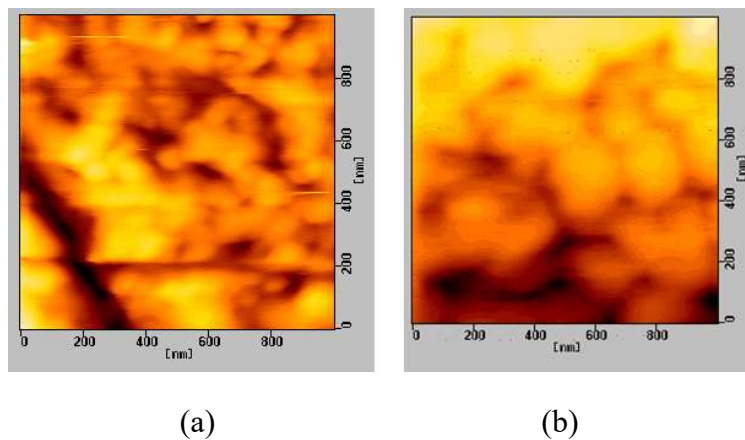
Figure 3. AFM images of samples. The deposition temperatures of Cu$_2$O are (a) 400^{0}C (b) and 500^{0}C.

We measure the Hall mobility and calculate carrier concentration from this. The carrier concentration is increased with increasing substrate temperature shown in Fig. 4. This result is reasonable since the carrier scattering is enhanced by ionized acceptors. These results indicate that the substrate temperature is very effective in controlling the electrical properties in p-type conductivity. The crystal quality may also be improved at higher

deposition temperatures, and grain size seems to play an important role in improving thin film performance.

The grain size and carrier concentration are given in Table 1
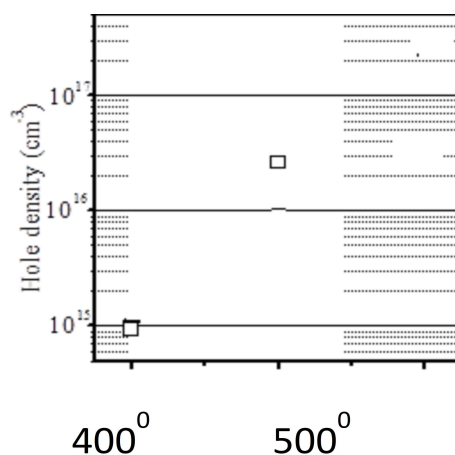
Figure 4. Carrier concentration with substrate temperature

Table 1

Sample	Grain size	Carrier concentration
Sample 1	25 nm	$0.2 \times 10^{15}/cm^3$
Sample 2	45 nm	$1.4 \times 10^{16}/cm^3$

CONCLUSION

In this article we have reported a study of p-Cu_2O thin film prepared by rf magnetron sputtering and subsequently subjected to various substrate temperature, clearly showing the enhancement of carrier concentration properties with increasing substrate temperature.

ACKNOWLEDGMENT

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Effects of Electromagnetic Fields on Bone Formation: Short Review

Nirmalendu Hui*

Abstract

It is now established that, time varying magnetic fields of various configurations can produce physiologically beneficial effects for conditions as diverse as recalcitrant bone fractures, osteoporosis, spine fusion in orthopedics and various types of tissue wound healing. Electromagnetic (EM) field therapy is non-invasive and a no-touch treatment process having marginal side effects and free from after-therapy hazards. Some maiden studies on animals employed microampere level of DC currents delivered via implanted electrodes which produced the remarkable results of new bone formation particularly around the cathode. Later, it became clear that the new bone growth resulted from the chemical changes around the electrodes was caused by electrolysis. Exploration revealed that pulsed electromagnetic field (PEMF) can stimulate calcification of the fibro-cartilage between bone segments. Its effects on ionic calcium channels to increase blood supply have been implicated as a source of improved bone healing. Further soft tissue healing has been reported by the use of direct electrode coupled devices generating EM-waveforms of low frequency. Cells involved in wound repair are electrically charged and endogenous direct current & exogenous PEMF may facilitate cellular migration to the wound area. However, the lack of precise understanding regarding the mechanism of healing in all the above cases of ailments is hindering wider applications of EM-field-healing technologies. In the future endeavors systematic understanding about healing process mechanism would have to be taken up. This could be done by theoretical modeling of healing process, detailed analysis of the model and implementing the predictive results from the analyses.

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Introduction

The matter of bone fracture and wounds inflicted in the tissues of various internal organs in human physique are truly very common phenomena. These phenomena have, from time unknown, caused health related worries in human, more so when the fractures or tissue wounds are of severe magnitude. Although humankind, with its intellect and analytical mind, always tried successfully to heal such fracture and wound related disorders, but till the recent past only very classical and painfully invasive procedures have been applied for such healing. However in the last few year quest of humankind towards non-invasive and painless procedures for fracture and tissue wound healing have produced remarkable result, which could mainly be attributed to immense technological development in the electromagnetic research pertaining to the subject area of physics.

Exploration towards repair of bone fractures or ailments relating bone-degradation took off more than half a century ago with the pioneering discovery of two Japanese scientists. During the fifties of twentieth century, Yasuda & Fukuda [1] showed that electrical voltage could be obtained upon deforming the dry bone in animals. And, by now it is established that exogenous EM fields of extremely low frequency [2] can have profound effects on a large variety of biological systems. It has become increasingly clear that weak, non-ionizing electromagnetic fields exert a wide range of athermal effects when energetic patterns and "bio-targets" are properly matched. As a result, a critical re-examination of weak field interactions with the charge and other physical characteristics of many biochemical species is in progress (e.g., ligand-receptors, phase transitions, and co-operativity, among others). Simultaneously, a new approach to medical therapeutics is emerging, one in which abnormal cell behaviour is modified, beneficially, by inductive coupling of selected, externally applied, extremely low frequency (ELF) magnetic fields.

Pulsed electromagnetic fields (PEMF) (a subset of ELF em- fields), displays frequencies at the low end of the electromagnetic spectrum [3], from 6Hz-500Hz. It is being observed in clinical research that time varying PEMF with high rate of change (Teslas /sec) could induce significant biological currents in tissues, which in turn enable such field to have greater biological effects, provided the biological effect is dependent on the magnitude of the induced current [4]. The wave forms associated with PEMFs can be asymmetric, biphasic, and quasi-rectangular or quasi-triangular in shape though most ELF sources of electromagnetic-field stimulation produce a sinusoidal waveform. In 1979 The United States Food and Drug Administration (FDA) approved both quasi-rectangular and quasi-triangular waveforms as safe and efficacious forms of treatment of disorders associated with fractures [3].

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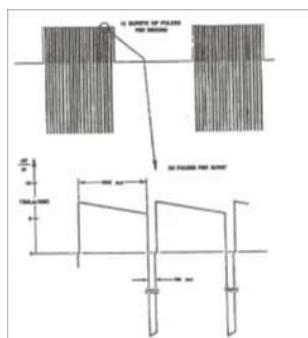
Figure 1 The original signal for treatment of non-union fractures proposed by Bassett et al. [18]

Further, extremely low-frequency EMFs can also stimulate bone tissue giving vent to remodelling of the bone itself. This feature has been widely applied in the treatment of skeletal diseases such as osteoporosis, tendonitis, osteonecrosis, fracture and non-union. The success of treatment with EMFs depends on accurate diagnosis and selection of physical parameters of the applied fields. The complex picture of the processes that take place in bone marrow stem cells (BMSCs) as well as in the bone tissue were supplemented by recent studies of EMF-therapeutics, which show a correlation between the presence of EMFs gradients and the inflicted cellular reactions. Thus, research on EMF- therapeutics from the view point of experimental biology as well as the currently applied clinical therapies, may now have the chance to explain the link between the clear-cut causal explanations of physics and the observed cellular and organic changes in bone and tissues.

PEMF as well as low frequency EMF stimulations can be applied non-invasively to biological systems following two different methods: capacitive coupling or inductive coupling. Capacitive coupling does not involve any contact with the body (in contrast of direct coupling that requires placement of opposing electrodes in direct contact with the skin surface surrounding the tissue of interest [5]. Rather time changing magnetic field of the PEMF induces an electric field, which in turn produces a current in the body's conductive tissue. Inductive coupling too does not require the electrodes to be in direct contact with the skin. Both electric and electromagnetic devices are observed to have demonstrable effects on the process of healing in fresh fractures [6], delayed healing and non-unions in fractures [7], osteoporosis, spine fusion [8] in orthopedics and for the treatment of chronic and acute wounds [9]. There is no discomfort or known risk associated with PEMF and EMF stimulations, these are non-invasive, and treatment costs are substantially reduced as compared to the cost of surgery [2].

In this review, to begin with, the early development in the area of PEMF-therapeutic application in bone formation, soft tissue healing and allied treatments, have been discussed. Then I moved to discuss effects of PEMF on different cellular and molecular organisms involved in bone formation. Finally a brief summery has been presented.

To end this introductory narration, it may not be out of place to claim that, with the advent of new and more effective electromagnetic (field) signals, the scope of applying pulsed and otherwise EM fields to varied types of bone repair and tissue wounds repair would definitely be expanding multifold with the passage of time.

Understanding Achieved

In the pioneering endeavor, Yasuda, Fukuda & others showed that electrical voltage could be obtained upon deformation of dry bone. Afterwards, several research groups reported the generation of electrical potentials in wet bone on mechanical deformation [10, 11]. All these observations established the fact that EM fields can have influencing effects on bones. Analogous properties are observed to be manifested in collagen and cartilaginous tissues [12, 13] in animals. The important conclusions from these studies have been that the bones and tissues could respond to electrical signals in a physiologically useful manner. This ultimately led to the use of EM fields to modulate bone repair and to heal tissue wounds.

Exploration revealed that EM fields can stimulate secretion of certain growth factors (such as insulin-like growth factor-II) after a short duration of trigger stimulus [14]. It follows that induced electric fields act as a triggering mechanism which modulates the normal process of molecular regulation of bone repair mediated by the mentioned growth factors. The maiden studies on animals employed micro-ampere level of DC currents delivered via implanted electrodes which produced the remarkable results of new bone formation particularly around the cathode [15]. As these studies progressed, it became clear that the new bone growth resulted from the chemical changes around the electrodes caused by electrolysis [16]. Further, it has been shown that a mechanical thrust also plays role in DC bone stimulation [17]. Subsequent studies on the effects of EM fields on bone and tissue related ailments, concentrated mainly on the direct effects of such EM fields, led researchers to produce non-invasive and no-touch means of applying electrical/mechanical signal to cell/ tissue targets. Therapeutic use of these technologies (generating EM signals) in orthopedics have, by now, approved by regulatory bodies worldwide for treatment of recalcitrant fractures, spine fusion [18, 19, 20] and the osteoarthritis of knee [21].

Studies revealed that, EMFs have many physiological effects on cells and tissues, including the up-regulation of gene expression of collagen type II, [22] the preservation of extracellular matrix (ECM) integrity of cultured explants, and the increase in prostaglandin E2, vascular endothelial growth factor (VEGF) and tumor growth factor-β3 (TGF-β3) cytokine levels in an experimental model of decalcified bone matrix-induced stem cell ossification. [23, 24]. In addition, investigators also measured the effects of cell exposure to EMFs on mRNA expression of the bone morphogenetic protein (BMP) family by reverse transcription polymerase chain reaction[25]. Expression of RANK mRNA with EMFs application was significantly higher than that in the sham group and mRNA levels of alkaline phosphatise, α1(I) procollagen, and osteocalcin (OC) increased. EMFs enhanced osteogenesis of mesenchymal stem cells (MSCs) in the presence of an inductive stimulus and increased BMP and VEGF expression.

Cellular effects of EMF:

It has been observed by experiments of EMF healing of various bone related problems that EMF can stimulate secretion of certain growth factors (such as insulin like growth factor-II) after a short duration of trigger stimulus. It follows that the induced electric fields act as a triggering mechanism which modulates the normal process of molecular regulation of bone repair mediated by growth factors. These concept/modalities give vent to a working model where EMF is observed to have effects on Ca^{+2} ion transport [26], moderate increase in cell proliferation rate [27], five-fold increase in *IGF-II* release and increase in *IGF-II* receptor expression in osteoblasts [28,29]. PEMF is observed to have stimulating effect on *TGF- βmRNA* in a bone induction model for rat [30], probably implying that PEMF induces cartilage differentiation. Upregulation of *TGF- βmRNA* by 100% as well as collagen and osteocalcin synthesis in human osteoblast-like cell line *MG-63* has been observed to be induced by PEMF [31].

Based on above observation it has been suggested by researchers that EMF (specific PEMF & PRF as well as weak static mag.-fields) acts through Kalmodulin –dependent pathway such that it modulates Ca^{+2} binding to CaM by a twofold acceleration in Ca^{+2} binding kinetics in a cell-free enzyme preparation [32]. The above signifies a ion-binding target pathway which has also been confirms in studies using static mag.-fields [33,34]. PEMF has also been observed to increase considerably the angiogenesis in an endothelial cell culture [35] as well as increase in vitro & in vivo angiogenesis in endothelial release of *FGF-2* [36].

Here are two methods by which PEMF stimulation can be non-invasively applied to biological system: capacitive or inductive coupling. In capacitive coupling technique external skin electrodes placed on opposite

side of fracture site and sinusoidal waves of 20-200 kHz are employed to induce 1-100mV/cm electric fields in the repair site [38]. In inductive coupling technique PEMF time varying electric fields are induced at the repair site by applying time varying magnetic fields via one or two electrical coils. Typically peak time varying mag.-fields of 0.1-20G including 1-150mV/cm peak electric fields in 3cm diameter target are being used presently [38].

· **Models of EMF –therapy**

Existing EMF -therapeutic models are

a) Inductively coupled clinical EMF wave forms: Electric field induces via time varying mag.-field wave form is directly related to the electrical characteristic of the coil and the current wave form applied to the coil. Induced EMF is proportional to the rate of change of current in the coil $\left(\dfrac{di_{coil}}{dt} \right)$ that produces the desired shape of induced electric field. Here

$$I_{coil}(t) = \frac{V_0}{R_{coil}}\left(1 - e^{-\frac{t}{L}R_{coil}} \right)$$

where V_0 =driving voltage of the inductor, L = coil inductance and R_{coil} =effective coil resistance.

So
$$\frac{dI_{coil}}{dt} = \frac{V_0}{L} e^{-\frac{t}{L}R_{coil}}$$

Above equation shows that a rectangular type induced wave form is achievable for a linear rise in coil current with the time constant $\tau = \dfrac{L}{R_{coil}}$ sufficiently large. The induced electric field here can be considered to be used as EMF therapeutics. Depending on the characteristics of bone fractures and tissue wounds EM fields of desired frequency and desired pulse shape could be considered to be generated through this model. Improvisation of this devise would be necessary to generate EM fields of specific desired characteristic (pulse, shape and frequency range).

b) Ion cyclotron resonance model (ICR): This device is driven frequency specific combination of dc and ac magnetic-field and is observed to increase ion-mobility near receptor site and/or through ion channels. The practical problem with ICR is that it also gives vents to thermal noise. However minimizing such short comings

clinical devices are created on basis of ICR models which are in use currently for recalcitrant bone fracture. Clinical results from these devices appear to be equivalent to those for inductive and capacitive couple devices [38,39]. The device consists of an external pair of coils oriented parallel to one another. The alternating 40μT sinusoidal mag.-field at 76.6 Hz (a combination of Ca^{+2} and Mg^{+2} resonance frequency) is applied. The static dc parallel mag.-field of 20μT is also applied.

There also exist some other models named as the Larmour precession model, the dynamical systems model, the cell array model and so forth.

Effect of Pulsed Electro-Magnetic Field on Bone Formation

PEMF stimulation has been shown to have an effect on bone repair via a number of different mechanism. Firstly, PEMF has been shown to stimulate calcification of fibro-cartilage in the space between the bony segments. Second, the increased blood supply that arises due to PEMF's effect on ionic calcium channels has been implicated as a source of improved bone healing. Thirdly, PEMF has been suggested as having an inhibitory effect on the resorptive phase on wound repair, leading to the early formation of osteoids and calluses. A fourth mechanism by which PEMF is thought to have an effect on bone repair throughits influence on increasing the rate of bone formation by osteoblasts[40].

PEMF treatment of osteoblasts in the active proliferation stage accelerated cellular proliferation, enhanced cellular differentiation, and increased bone tissue-like formation. PEMF treatment of osteoblasts in the differentiation stage enhanced cellular differentiation and increased bone tissue-like formation. PEMF treatment of osteoblasts in the mineralization stage decreased bone tissue-like formation. In conclusion, PEMF had a stimulatory effect on the osteoblasts in the early stages of culture, which increased bone tissue-like formation. This stimulatory effect was most likely associated with enhancement of the cellular differentiation, but not with the increase in the number of cells.

- **Studies on animal:**

In general experimental models of bone repair in animal show enhanced cell proliferation , calcification and increased mechanical strength even with direct currents (field produced by suitable arrangement of devices) [41]. Studies with PEMF also show increased calcification and enhanced mechanical strength in healing bones [18,42]. Truly, experimental observations reveal that mechanical strength of late phase osteotomy-gap healing in case of dog is nearly 35% stronger in PEMF treated limbs [42]. PEMF produced a 10% increase

in the diameter of arteriolar micro vessels in rat muscle from which the authors suggested increased local blood flow could play a role in the PEMF acceleration of bone repair [43]. On the clinical site EM stimulation modalities have been in use to treat fresh fractures, osteotomies, spine fusion and delayed and non-union fracture. Various trials with EMF and PEMF stimulation so far for treating the mentioned bone oriented disorders have been observed as successful.

• **Soft tissue application:**

In the recent past EMF stimulation has been observed to have considerably clinical application in wound healing. Soft tissue healing has been reported by the use of direct electrode coupled devices delivering wave form of range mentioned earlier [44]. In such healing process injury currents which develop in the presence of dermal wounds are considered to play significant role. Cells involved in wound repair are electrically charged and endogenous direct current may facilitated cellular migration to the wound area [45]. Analogous to bone repair, exogenous PEMF signals may also enhance the endogenous electric signal to accelerate wound repair. Both dc and PEMF have already been reported to reduce edema, increase blood circulation, modulate unregulated growth factor receptor, enhance neutrophil and macrophage attraction and epidermal cell migration as well as increase fibroblast and granulation tissue proliferation [45]. Wounds originating from arterial and venous skin ulcers, diabetic ulcers, and pressure ulcers as well as surgical and burn causes may also get healed by dc and PEMF modulation.

Summery

The above discussion leads us to say with conviction that, time varying EM-fields of various configurations, can produce physiologically beneficial effects for pathological conditions as diverse as bone fractures, non-unions in fractures, osteoporosis, osteotomies, recalcitrant fractures, various bone disorder related pains and all types of tissue wounds including that of internal organs. All these beneficial effects could be achieved with low intensity, non-thermal and non-invasive time varying EMFs, having many configuration over a broad frequency spectrum. Out of all the benefits mentioned above, non-union pathogenesis is now well accepted as a potential feature of fracture recovery. The data from recent studies conclusively demonstrate that EMFs could stimulate angiogenesis, migration, proliferation, and differentiation of stem cells from the mesenchymal tissues adjoining the affected injury-areas, into cartilage- and bone-forming cells [46]. It is to be noted here

that pulsating ultrasound and intermittent mechanical loading are also observed to modulate considerably the process of bone repair and bone-remodeling [47].

To be content with the discussion so far, it must be mention that, bio-electromagnetic research faces the difficulties to reproduce and replicate the work in other laboratories. Therefore, renewed endeavor in research is necessary to concretize the various mechanisms of action regarding the multi-faceted EMF-therapeutics. Finally, to conclude, the wide applicability of EMF-therapeutics in fracture healing and tissue-wounds-repairing has been emphasized throughout in this review with the leads taken from the stretch of existing research literature, mechanisms pertaining to bone formation has been discussed and directions about further research in this potential field has been explored.

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Information and Communication Technology as an Educational Tool: Past, Present and Future

*Hemen Biswas**

Abstract:

According to an approach of behavioural science, educational technology encompasses the application of appropriate scientific and technological methods based on the established thoughts in sociology, linguistics, communication, psychology and other allied areas in order to develop both the teaching and learning processes. This technology based method incorporates the development, application, and evaluation of systems, techniques and aids in the field of education. Different technological media are being widely used by teachers, educational instructors and learners to facilitate a wide range of co-related learning and teaching experiences even in a very remote geographical area within a short period of time that could not be possible in a traditional "information giving" education system held in a physical class room. Thus, the proper implication of educational technology can enable towards dynamism of the education system in particular and reinforce and strengthen the social, national and global development in general.

Introduction:

As a branch of science, educational technology is growing at faster rate for making new comers in teaching profession into verily successful and proficient ones by providing them with hands on teaching expertise and excellence of innovative teaching and learning. In the recent past, educational technology has revolutionised in terms of modern methods applied at various strata of teaching. Modern methods have remarkably increased the importance of teacher education and established student centric educational goals and objectives leading to an engrossing, useful and highly determined target oriented educational practice.

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A synergy between traditional and modern approaches of teaching and learning is really needed as because nowadays teaching methodologies are touching new bench marks due to modernisation and assemblage of interdisciplinary curricula which are required to understand by present day teachers and future teachers.

In wider perspective, educational technology tends to adopt knowledge of technology to advance education as a whole. In a normative context, this drive triggers with the synthesis of learning, ascertainment of experiences of the students and utilisation of these experiences along with evaluation of the learned experiences.

Origin, Development and Progress of Educational Technology and ICT:

Several types of educational technology were used in education. In the long past, different materials were written out in longhand and copied with hard labour to make them available to the readers.

At the dawn of printing technology, many masters were oppressed as because lectures became generally available.

Now, audio visual recording system has given rise to get a useful way to educate learners who do not need to be present in a classroom. Telecommunication system facilitates to bring together all the learners present in different places and teacher will deliver lectures from a classroom Mishra (2013).

Communication, collection and utilisation of information have become imparted with human civilisation. Ancient people lacked means and devices of far reaching communication way. So, they used to convey information by oral dialog, memorise them and transfer information to the recipient by oral method. Introduction of writing paper and ink has given rise to revolution in ICT. It was Gutenberg who revolutionised the print media in 1438 in Germany (Mangal, 2016). The following technological developments and advancements have shaped the runway of modern day's Information and Communication Technology (ICT).

- S. F. B. Morse invented telegraph in 1837.
- Daguerre and Talbot invented photography in 1849.
- A. G. Bell invented telephone in 1876.
- G. Marconi invented radio in 1895.
- A. R. Graffin introduced photostat in 1900.
- J. L. Baird invented television in 1925.
- C. F. Carlson invented xerography in 1938.
- J. B. Dancer and R. Dagran made micrography in 1940.

- T. Maiman invented laser technology in 1960.

- Magnetic video camera, video disc, computers were advanced in the 20th century.

- Telecommunication satellites, cable transmission and facsimile transmission (Fax) technology were researched and developed in the 20th century.

Under the scientific regulation, the process of information and communication was furnished with the modern system of information collection, storage, retrieval, transmission and exchange facilities in the late 19th century. Information and communication technology in the name of "information science" was started in the U. S. A. in 1950 when exchange of scientific information among the scientist was initiated.

That time such information science services aggregated the indexing system, abstracting, translating in a purposeful way. Several initiatives were held for developing and advancing methods like mechanised systems through which scientific information could be procurable to the users.

At the primary stage, ICT had the thrust of fundamental focus of operating bibliographic records and text based scientific information. After that, ICT was used in industries in the 1960s. Then computer aided techniques and systems improved for enabling for more feasible information and communication purposes. Then the use of ICT has been ramified in management, medicine, health care, banking, education, government sectors, police, defense, law and judiciary, entertainment, etc. Nowadays, ICT has made an effective teaching and learning process in classrooms, on-line modes of education, distance education, virtual classroom teaching, formal, informal and non-formal education.

Synthesis of Traditional and Modern ICTs:

The traditional forms of ICT include text books, reference books, resource books, news, magazines, journals which collectively constitute the print media. Interchange of oral information, thoughts can be possible among teachers, instructors, peers, patents and other persons of our surroundings. Photographs, maps, charts, posters, diagrams, etc. also include the conventional ICT forms. Specimens, mock up, puppetry are categorised under ICT. Radio, television, overhead projectors, slide projectors, movies, videos, audio-video recording system, tape recorder and other teaching forms comprise traditional ICT tools.

Unlike the traditional ones, modern ICTs frame multiple technologies. There is an assemblage of hardware and software, media and delivery systems which have undergone comprehensive digitalisation with the help of handful of tools and devices like personal computers (desktop, laptop, notebook, tab, etc.), digital video cameras, video card, web camera, use of application based softwares namely PowerPoint, word

processing, speed recognition, etc. Metropolitan area network, local area network, wide area network have the huge capacity to build up modern ICTs. Multimedia projection is being used to teaching and learning in a mass. CD-ROM, DVD, data processing unit, stored database, digital libraries, email, World Wide Web, hypermedia, hypertext, and computer oriented audio-video conferencing, virtual class room, virtual reality, interactive remote instruction, tele-texting; video texting, interactive video texting and interactive video disk have given rise to the modern ICTs.

Though modern ICTs have contributed a lot to extend different teaching and learning modes, but still tradition ICTs are the bases of educational technologies. So, an amalgamation between traditional and modern day's ICTs is showing the actual pathway of educational technologies in a complimentary manner (Mangal, 2016).

ICT Based Teaching-Learning:

e-learning includes ICTs which are serving as instrumental techniques for teaching as well as learning. It is admitted that learning becomes effective and retentive by listening and seeing simultaneously. Multimedia resources, productivity and analysis tools, streaming video, student web publishing, web based resources (e-books, e-journals, e-tutorials, etc.), computer oriented assessments, e-libraries and databases, interactive white board, conferencing systems are the prime ICT tools which are enhancing the faster way of teaching and learning throughout the world (Mishra, 2013).

Uses of ICTs in Teacher Education:

There are several means by which ICTs can be used in teaching-learning processes. These include diagnostic testing, online examination and evaluation, teaching, construction of virtual laboratory, online instruction, psychological testing, online tutorial, online assignment, online feedback, promoting reasoning and thinking, framing of instructional materials, remedial teaching, etc.

There are three types of ICT based education:

1. Online Distance –Learning Courses:

In this type, most of the instructions are given online. This type does not need face-to-face interactions between the learners and instructors. These courses may be held either in classrooms through online audio-video mode. It is an e-learning method.

2. Hybrid Courses:

These courses amalgamate the components of online distance courses and traditional ones. The instructor may replace online avenues or web based tasks in to a part of traditional classroom teaching. It is also called blended learning.

3. Traditional Courses Combined with Technology Components:

In these types, the instructors/teachers conduct courses mostly in traditional methods, but once in a while they use ICTs like multimedia simulations, web based actions, online evaluation, e-laboratory, etc. sometimes, this technique is known as e-enhancement.

In the 21st century, it is evident that the catalysis of reality based transition of educational contents and pedagogical goals is dependent on the proper utility of ICTs. Well designed ICT based educational methods have immense aspects in patronising the acquisition of knowledge and skills that will enhance the all round development of the learners. Computers and telecommunication technologies provide the teachers and students forcible and operative way, as because ICTs contain relevant problem solving methods in concerned curricula (Sampath, 2013). This results in shifting a teacher centric pedagogy to a learner centered strategy that brings about innovations in modern day's education system.

Edublogging:

In this web based technology, websites are hyperlinked to web pages by means of logging. In online journals, blogs are popularly used. Basically blog contains a website where frequently posts are sent. Blogs are characterised by automatic archival aspects, personal writing, hyperlinked post structure and open domain with free access to the public. In 1997, J. Barger first used the term "Web Blog".

When a person writes about education and its various aspects it is called edublog. Students and teachers are offered the favour for exchanging their ideas and various opinions enabling individuals to socialise and configure knowledge. Spreading of knowledge by endorsing learners to retrospect their achieved posts, gleam on their past writings and the comments put by their peers and teachers is possible in edublogging. In several ways, acquisition of knowledge, enhancement of skills and development of attitudes are equipped by edublogging. There are several types of thinking like analytical, critical and reflective ones which are directly and indirectly developed by using edublogs. Conventional teaching-learning systems and present evaluation methods may be replaced by edubloggings in some specific cases (Sharma, 2018).

India and EduSat:

India is a large country where various languages and different cultures have been successfully grown up. In our country, there are huge geographically distant areas where human settlements have been historically established. So, proper and effective education needs to be augmented in remote and rural locations across the country. This act is quite difficult in conventional education extension programme.

Satellite based ICT can enable our country to educate millions of people. High quality innovative ICT coupled with an open and flexible educational arrangement can have the power to show the actual pathway of mass education programme. ICT enabled educational delivery modes include TV broadcast, interactive TV via phone-in technology, video conferencing, interactive TV with computer support plus mails, computer conferencing, web based instructions, etc. Today, all these tasks have been possible on account of launching the EduSat by ISRO.

Successful INSAT based education services were possible since October, 2002 when ISRO adopted the EduSat projects for nationwide education programme. This interactive satellite based distance education system was specially installed to meet the increasing demands of education in national level as well as regional levels. The EduSat dependent education deserves efficient A-V medium by configuring highly qualified Direct-to-Home (DTH) broadcast.

The EduSat is used in interactive radio and television programmes i. e.; phone-in, video on, etc., teleconferencing and computer conferencing, data exchange system, web based education programmes and so on.

EduSat has set a number of objectives namely teacher's training programmes, intervention in community services, making available support to formal, informal and non-formal education missions, enhancing potential access to class resource persons and extending education to far reaching corners of the country (Sharma, 2018).

Paradigm Shift from e-learning to M-Learning:

In M-learning, learners are not remained confined in a static and preset spatial position and learning process takes place with the access of useful mobile technologies. Wireless transmitting devices like personal digital assistances (PDAs), mobile phones and palmtops provide the advanced facilities to the beneficiaries. M-learning broadens and widens the learning arena and delimits the location and boundaries of knowledge

centric field. So, M-learners can get in touch with peer groups, instructors and teachers in many places where physical reaching to the learners is difficult. Educating, learning, fostering communications, collaborating among members of the group, conducting assessment and evaluation, providing access to support and knowledge system, collecting feedbacks from the learners, increasing the students' participation, fruitful discussions between students and teachers, making learning communities, receiving different learning resources, augmenting self directed and self motivated learning, etc. are various positive characteristics of M-learning (Sampath, 2013).

Paradigm Shift from M-learning to U-Learning:

U-learning defines itself as learning everywhere while being connected through internet and item which follows the people around. Anytime, anywhere and any context may be available to access in this method of learning. U-learning provides the circumstances or surroundings of diffusive learning/education measures named as ubiquitous learning environments. It denotes that learning process is occurring all around a learner, but he or she may not even be recognizant of the on-going learning process. U-learning has evolved through e-learning and M-learning through the period of time. U-learning is equipped with ubiquitous computing systems and plasticity of mobile technology through Wi-Fi devices. U-learning provides a learning environment characterised by freedom of learning. So, this environment brings about the adaptability to the individual need, learning uniqueness of the students, pliancy of extending and discreet computing systems. U-learning is growing at a higher pace and it is becoming the future of next generation teaching-learning strategies.

Shortcomings of ICT:

Though ICT has orchestrated into education in general and upheld quality education, inclusion policy and universal access systems in particular, still it is limited to the following shortcomings.

- In India, there are a large number of higher educational institutes mostly colleges which are situated in remote and suburban localities where ICT facilities are not abundant till today. These colleges do not have purchase affordability, maintenance funds and provisions of allied expenditure to enable ICT based education.
- In institutional capacity, some teachers are quite indifferent to use the ICT technologies. They feel free to conduct teaching-learning activities in the conventional methods.

- Learners also may have less interest to undergo the transition phase from traditional way of learning to ICT enabled methods. Their anxiety and fright to the utilisation of technology may give rise to frivolity and scarcity of educational instruction for the usages and awareness in them.

- In some parts, teachers, heads of the educational institutes, authorities of academic planning bodies do not patronise to introduce ICT centric curricula at large scale.

- Teachers and instructors do not have structured provisions for pre-service and in-service training on ICT in terms of computer literacy, internet use and interactive audio-video media operation.

Objections on ICT:

- Scarcity of proficient e-materials
- Abasement
- Scarcity of technically sound and efficient/skilled instructors
- Copyright issues
- ICT based innovative teaching methods demand a huge spending of time for synthesising knowledge and sometimes these methods are devoid of applications in real situations. This leads to decrease in teaching time and increase of imbalanced workloads.
- Plagiarism evokes an ill practice to incorporate one's writings and pass those off as another's own
- Teachers and instructors may not feel their own motivation to know innovative teaching ideas and skills
- Poor amount and bad quality of available resources like old and low configured computers, browsing devices, etc
- Lacunae in pro-educational ICT policy of a country

Some Ideas for Future Consideration:

For augmentation of quality teaching-learning enabled through ICTs, the following ideas are put forward in order to consider for future development.

- To appoint all kinds of teachers in higher educational institutions (HEIs), knowhow and dohow of ICTs may be compulsory in near future.

• Training on ICTs is very basic in shaping ICT based teaching. So, the premier higher education regulating bodies like AICTE, MCI, CIET, NCERT, SIET and UGC-HRDCs are to carry out orientation training programmes and capacity building courses for the in-service teachers. This will result to eradicate their antipathy to techno centric ambiences in their own work places. Any modern trend in ICTs can be introduced in training courses at a regular basis because; ICT may modernise its own technologies according to the future demands.

• Learners are to abide by the reading practice through e-resources by means of computers and allied devices. It will result them to give up their dismay on computer interfacing and encourage them to active learning.

• In future India, computer literacy mission, internet browsing and web based learning/e-learning are to be required as a crying need particularly in rural and sub-urban areas. This will endorse the goal of expansion of education to the mass.

• Teacher education institutions like NCTE will have an important role to play to effectively incorporate ICT oriented knowledge and skills during conducting teacher education programmes across the country. This will foster other vertex organisations to optimise the ICT lesion in framing their own course curricula.

• Technology and e-resources must be equitably distributed to all geographical locations irrespective to economic parameters, socio-political backgrounds. This action will enlighten the pathway of digital unite in lieu of digital divide. For this, government intervention is essential to make ICT based infrastructure most available even in the most under privileged part of our country.

• Teachers might be motivated in short of "reward system" while using e-tools in teaching. This will help to create an academic atmosphere where traditional "chalk and talk" method may be abstained whenever needed. Teachers' professional development has to be flourished by introducing incentives for those who are undergoing ICT course at a regular basis either nationally or regionally. ICT will create different educational social media where teachers will engage themselves for participating in community services at grass root levels. This will bring about social responsibility to the people as a part of their professional development.

• Successful e-learning significantly depends on supportive and relevant e-study materials which are to be constructed with high standard curricula competent with stable and well facilitated teaching-learning ambiences. e-study materials will have a universal format which will be compatible to access at different ICT oriented avenues.

• Several low price and open access technological formats like cloud computing have to be popularised for creating an impactful technocratic teaching-learning platform. This cloud computing includes a centrally placed server on the internet unlike on a client computer. Mobile phones/smart phones,

laptops, web browsers, iPods which are provided with internet connections may be used in cloud computing. Indian education system has ample potentials for using this technology. In one way, it will reduce huge financial load to the nation and on the other way, e-resource based services will be speeded up and academic collaboration among the HEIs will be geared up without losing valuable time. It will also decrease physical and spatial constrains, optimise storage and processing requirements and amplify operational skills.

• In ICT based teacher education programmes, techno centric teaching skills and e-materials/ instruction manuals should be so many users friendly that those are to be formed, accommodated and shared very easily. In this area, there are enough provisions for future research and development.

• Free Wi-Fi facilities in the HEIs are a prime need for making education open to the learners.

• The future ICT will have more provisions for teaching, learning, communicating, sharing knowledge, researching on common man's problems, formulating innovative thoughts, solidifying multidisciplinary arrays, inducting cooperation, promoting flexibility, sharing vision and mission and tendering reliability.

• Shaping the future society gives rise to the principal accountabilities for creating a knowledge based nation. To materialise the same, our higher educational institutions have to take the advantages of improved ICTs by making available ICT based tools and devices in classrooms, libraries, laboratories, training courses, workshops, etc. ICT must modernise the education system coupled with tradition and heritage of our country. For this mission, a comprehensive synthesis of goals, values, transmission system of knowledge in entire education field is a pre-requisite.

Conclusion:

ICT can form an effective and proper teaching-learning activity in the educational sphere. It can resolve a number of educational cruxes like quality education, interactive learning, drop outs and stagnation, learning disabilities, flaws and absenteeism. Thus, this technology has the power of forcibly overthrowing the conventional education system and replacing it by a machine dependent new way of teaching and learning in spite of both these processes involving an emotional attachment which can never be governed by machines.

ICT has been helpful to the educational policy makers, teachers, instructors, councilors, researchers and students at larger scale. Still the role of ICT in education as a whole is not undisputed. Rather it often becomes debatable among academicians and educated personalities. It is evident in many pedagogical findings that instructor's outlook and adoption to the cutting edge technology is the key to the reproducing educational utility of ICT.

Undoubtedly, teachers are very important part of any educational system and are the forerunners to forward value based quality education which may be refined with the successful and continous pro-active involvements of the teaching community. A competent educational ambience certainly depends on the teachers who are supposed to provide structured, pro-academic learning expertise to their target groups (students) by blending the conventional teaching-learning practices with the ICT enabled innovative strategies which proclaim the needs of the 21st century.

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The Plague as a Representative of Plague Literature

Niladri Tikadar*

Abstract

Plague literature denotes the writings centred around the plague which depict its horrors and the human response towards it. *The Decameron* by Boccaccio or *A Journal of the Plague Year* by Daniel Defoe are good examples of this kind of literature. The former is a collection of tales by a group of young adults fleeing the plague while the latter deals with the Great Plague of London of 1665. Albert Camus' novel *La Peste(The Plague)* is also a notable example of plague literature. My paper is an attempt to explore the novel as an example of both existentialist and plague literature.

Albert Camus, the French Nobel Prize Winner in Literature in 1957, had published a collection of philosophical essays titled *Le Mythe de Sisyphe(The Myth of Sisyphus)* which convincingly demonstrated the condition of modern man. In the essay by the same name he compared modern man to Sisyphus, endlessly destined to fruitless existence. In order to understand the implications of the essay it is important to know a thing or two about Sisyphus.

Sisyphus, son of Aeolus and Enarete, is a figure from the Greek myth. He was the founder of the city of Corinth. He was considered the most cunning of men. He saw the seduction of the nymph Aegina by Zeus which he disclosed to her father, a river-god in return for water for the city. Zeus sent Death after Sisyphus but he chained him up in a dungeon. As a result mortals stopped dying. The gods in some alarm sent Ares to release Death who in turn came for Sisyphus. Sisyphus then instructed his wife to leave his body unburied and

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make no offerings to the gods. Because of this he was released from the Underworld and returned to Earth to live to a great age. When he finally died the gods devised for him the punishment of rolling a rock to the top of a hill which would always roll down again as it neared the summit. Human existence, in the opinion of Camus, is like the fate of Sisyphus. Man is unimportant in the cosmic scheme and in a meaningless world devoid of any divine power, should seek recourse to the elemental pleasures of living. Camus imagines Sisyphus to be an existential hero who wills his fate and is thus superior to the inanimate rock.

In *The Plague* the chief protagonist is the plague which elicits and modulates the response from the other characters as the novel progresses. The setting of the novel is Oran, a real town in North Algeria, invaded and afflicted with bubonic plague where the drama of human existence is played out. It is interesting to note the accuracy with which the author describes the various symptoms of the disease. He also describes with quite an accuracy the mental state of the inhabitants and the measures taken to deal with the disease-the disbelief, the panic, the hoardings, official slackness and quarantine procedures. In the face of almost certain death these modern Sisyphuses strive to find the significance of living.

The Plague, with all its grotesqueness, dominates the greater part of the novel. Clinical and vivid description is given of the step-by-step progress of the disease. The death of the rats is described in realistic detail:

> "At night, in passages and alleys, their shrill little death-cries could be clearly heard. In the mornings the bodies were found lining the gutters, each with a gout of blood, like a red flower, on its tapering muzzle; some were bloated and already beginning to rot, others rigid, with their whiskers still erect"(Camus, "The Plague" 13).

Later on in the novel when the bacillus spreads to the humans, death appears in all its horrors. One may take the case of the city magistrate M. Othon's son, a boy. The author minutely portrays his torture in the last hours before death. Yet the boy is not alone in his sufferings. Hundreds of Oranians die in this fashion and towards the end of the novel mass burials take place.

Camus does not merely leave with the spectacle of death and suffering. He portrays the absurdity of human existence. Man wishes to be important to some guiding force in the Universe. But in its absence there is nothing but the sea, the sun-warmed silence. Man, cut off from nature, lives life indifferently and selfishly till crisis time like the plague. He must, according to Camus, learn to live responsibly and in sympathy with his

fellow men despite or more so because of the meaninglessness of existence. This belief or philosophy behind Camus' writings is also known as "atheistic humanism". Camus propagates this view through the surgeon-narrator Dr. Bernard Rieux when at one point in the novel he says; "What's natural is the microbe. All the rest-health, integrity, purity(if you like)-is a product of the human will, of a vigilance that must never falter"(Camus, "The Plague" 242).

The novel may also be read as an allegory in which the plague may stand for any kind of oppression or injustice such as dictatorship. The novel was conceived by Camus as early as 1939 but begun after France's defeat and occupation by Germany. He was writing the novel in a homeland occupied by enemy forces. The early symptoms of the disease correspond to the symptoms of war which were not taken seriously by the French populace. Only when it arrived at their doorstep did they start mobilization but then it was too late.

During the occupation years there was destruction, death and suffering similar to the ravages of the plague. But a small section of the populace known as The Resistance fought back just like the Oranians such as Rieux, Tarrou and Rambert. In fact this novel urges the readers to fight back the cruelties and injustices facing them without recourse to the Almighty or any Supernatural Power and thus discover the fullness and potential of existence.

The predicament facing the characters of the novel is also true for the world population facing the menace of COVID-19 and that is why it is so pertinent today. Whereas the fictitious epidemic leaves hundreds dead in the novel, the global pandemic has left millions dead across the globe. But the message of the novel seems to be clear. Without human effort, mere recourse to Fate or the Almighty, will not get the human race anywhere, much less contain the disease.

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The Concept of Marginalisation of Refugees in Dina Nayeri's *The Ungrateful Refugee: What Immigrants Never Tell You* and Abbas Khider's *A Slap in the Face*

Debdatta Saha*

Abstract:

Marginalisation is a concept which does not merely confine itself to caste, class, race and gender, but extends to include several other parameters like ethnicity, language, region, politics, etc. The aim of this paper however would be to look at the concept of marginalisation from the perspective of refugees. Refugees are born out of world conflicts or environmental factors that force them out of their living places in order to survive. Refugee literature is literature by and for refugees that narrate their experiences and sufferings. The refugees constitute a group of uprooted people subjected to humiliation, discrimination and dehumanization. This paper would aim to explore the marginalisation of the refugees through two works, namely *The Ungrateful Refugee: What Immigrants Never Tell You* (2019) by Dina Nayeri and *A Slap in the Face* (2016) by Abbas Khider. These novels explore the oscillations of the refugee lives between invisibility and over-visibility and vilification or criminalization of refugee lives. The novels employ some of the more popular tropes of refugee literature like waiting, time and language to present the theme of marginalisation of refugees. The refugees are stripped off their individual identity and imposed a preconceived collective or group identity. They are expected to fit into demeaning stereotypes of identity. Both the novels investigate how the West perceives the refugees and also the West's self-constructed role of a saviour.

Marginalisation is a concept that encompasses various aspects like caste, class, creed, gender, race, religion, nationality, deformity, etc. Marginalisation is a social, political, cultural and economical phenomenon of exclusion and denial and a condition of being relegated to the margins or fringes. It is a phenomenon of assigning a

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subordinate position to someone and causing a disruption in the unitary vision of State. This paper, however, exclusively focuses on the marginalisation of refugees. Refugees are born out of "world conflicts, which force people out of their living places in order to survive" (Gallien, *Refugee Literature* 723). In the modern concept of nation-state, the issue of refugees often emerges as something disturbing, especially to the Western world. The Western nations present the issue as threatening, as if being assailed by a crisis. However, the real scenario is often quite the reverse as pointed by Claire Gallien in her article *Forcing displacement: The postcolonial interventions of refugee literature and arts*:

> The so-called "refugee crisis" in Europe then appears as a term coined by politicians and the media with little or no connection to the reality of the migrants who are confronted with the violence of war, the inhuman conditions of their journeys towards "Fortress Europe", governments' unwillingness to provide for an effective new start, and the xenophobic or Islamophobic attitudes and discourses. (736)

Refugee literature is an emerging field of study that highlights the predicament, the experiences and the plight of the refugees. Refugee literature "is not simply a record of forced migrations; rather, it dramatizes the ways this predicament is part of a shared world" (Stan 797). It articulates feelings of loss, up-rootedness and trauma. A post-colonial critique of refugee writings intends to highlight the "violence and unevenness of the current world order" (Gallien, *Refugee Literature* 722). It aims to strike a balance between invisibility and over-visibility. The refugees are submerged in a life of uncertainty, constant shifting and a state of flux. According to sociologist Ramon Grosfoguel, the refugees are placed in a "zone of non-being" (qtd. in Gallien, *Forcing Displacement* 736). The refugees are stripped off their identity and individuality, they are often deprived of their basic social, political and human rights. They are considered as superfluous and their treatment by the Western world is often inhuman. The Western world presents the refugees as a crisis, a threat to the national integrity, however, it must be remembered that "By engaging in wars abroad, participating in the destruction of entire regions and societies, exploiting cheap labour and natural resources, and supporting autocratic and authoritarian regimes, these democracies create the very refugees that they then reject" (Gallien, *Forcing Displacement* 736). The refugees are treated as outsiders and imposed a denigrated status.

The two novels chosen highlight the predicament of the refugees, the differentiating treatment they receive, the ordeals they have to go through and the prejudices they have to face. *The Ungrateful Refugee: What Immigrants Never Tell You* was published in 2019, written by Dina Nayeri and *A Slap in the Face* is

written by Abbas Khider and published in 2016 . Dina Nayeri is an Iranian- American writer and Abbad Khider , presently a citizen of Germany but he is of Iraqi descent. Both the authors entered their respective nations of residence as refugees and thus their novels contain their first-hand experiences of life as refugees. The two novels explore how the refugees are stripped off their individual identity and imposed a preconceived collective or group identity. The host countries carry some pre-conceived notions about refugees coming from other countries, depending on their home countries' prevailing social, political, cultural and even economic conditions. The refugees are expected to fit into pre-conceived and demeaning stereotypes of identity.

The refugee narratives employ certain common tropes, and the factor of journey is one of them. This implies a state of constant movement and Statelessness. Dina Nayeri in her novel *The Ungrateful Refugee: What Immigrants Never Tell You* highlights this state, "Without a State to say, 'Yes, we will be responsible for you,' we were so unmoored it was hard to fathom a next step" (12). The refugees lack the protection of a State, no authority to account for them. This very helpless condition of the refugees dehumanizes them and commoditises them. Abbas Khider in his novel *A Slap in the Face* describes in detail the business that thrives around refugees, how smugglers profit out of their condition. Khider writes in *A Slap in the Face* "When I arrived in Germany I thought I was in France because that where my father had paid them to take me. He'd given a smuggler in Baghdad five thousand dollars to arrange my journey to Paris" (32). We are introduced to another aspect of commoditisation in Nayeri's novel *The Ungrateful Refugee: What Immigrants Never Tell You.* The young narrator in the novel goes on referring to herself as cargo, for instance "I am rescued cargo; therefore, I am enchanted" (Nayeri 16). The narrator herself admits "I programmed myself with chants: I am rescued cargo" (18). The refugees were supposed to be burdened with gratefulness at being rescued, at the prospect of being inducted into the Western world "As recipients of magnanimity, they can be pitied" (Nayeri 18). The refugees have to willingly make themselves the subjects of pity. The refugees are always the subjects of suspicion. A refugee has no right to create or define one's own identity, "But now, my first category had been assigned: refugee not native-born" (Nayeri 21). The refugees are not allowed to be anything else; they have to sever all ties with their previous selves and accomplishments, they can only be refugees. Nayeri very explain the condition as:

> And while we grumble over what we are owed and how much we get to keep, the displaced
> wait at the door. They are painters and surgeons and craftsmen and students. Children. Mothers.
> The neighbour who made the good sauce. The funny girl from science class. The boy who can

really dance. The great uncle who always turns down the wrong street. They endure painful transformation, rising from death, discarding their faces and bodies, their identities, without guarantee of new ones. (20)

For the refugees their narrative of escape defines their fate and identity. They have to make their fear convincing to others for seeking asylum and acceptance, it is as if for seeking mercy from the native-born and avoid labelling like "opportunism...motivation...drive"(Nayeri 19).

The natives, on the other hand, are always eager to re-construct the identity of the refugees, to impose upon them their preconceived notions. The refugees are always expected to remain grateful to the new nations and their natives for the charity. The natives consider that the West is the only opportunity for the refugees for having a "better life" (Nayeri 16), deeply convinced by the fact that the refugees lived a life of economic scarcity and deprivation and thus, are lured by the Western world. The narrator gives a befitting reply to such pre-conceived notions of the Western world:

> I thought I'd pass out- a better life? In Isfahan, we had yellow spray roses, a pool...life in Iran was a fairytale. In Oklahoma, we lived in an apartment complex for the destitute and disenfranchised. Life was a big grey parking lot with cigarette butts baking in oil puddles...I dedicated my youth and every ounce of my magic to get out of there. A better life? The words lodged in my ear like grit. (Nayeri 17)

This attitude implies the inability of the Western people to understand the true predicament that propels the refugees to leave their own nation "A tortured mind, terror of a wasted future, is what enables you to abandon home...No one who has lived under a dictatorship, who has scooped up their children and run to a bomb shelter, doubts the fear" (Nayeri 18). This highlights the chasm existing between the natives and the refugees. The refugees live under the obligation to differentiate themselves from the economic migrants "But if you are born in the Third World and you dare to make a move before you are shattered, your dreams are suspicious. You are a carpetbagger, an opportunist, a thief. You are reaching above your station" (Nayeri 18). The natives perceive the economic migrants as threats and hence doubt them but consider the refugees as subjects of pity. The refugees, thus, desperately try to avoid being labelled as economic migrants, "they can't acknowledge a shred of joy left behind or they risk becoming migrants again" (Nayeri 19). The refugees at every moment have to endure the burden of their great debt to the nation for uplifting them, they have to be submissive and "Often, they are so broken, they beg to be remade into the image of the native" (Nayeri 18).

The prejudice that the natives carry against the refugees run deep and they often consider the refugees as alien creatures. Such prejudice often gives rise to cruelty towards the refugees. Dina Nayeri records in her novel the cruelty that was meted out to her in an English school when she was six years old, how they mocked her "they followed me in the playground and shouted gibberish, laughing at my dumbfounded looks" (38). The tortures escalated as they became physical when one day "a boy grabbed my hand and shoved it into the doorjamb. Another boy slammed it shut and I heard a sickening crunch" (38-39). Such cruelties arose from a sense of difference and distance which left a deep impact on a child of six years. In an article written by Dina Nayeri for *The Guardian* entitled *The ungrateful refugee: 'We have no debt to repay'*, years later reminiscing about the incident she wrote, "At first, the children were welcoming, teaching me English words using toys and pictures, but within days the atmosphere around me changed. Years later, I figured that this must have been how long it took them to tell their parents about the Iranian kid".

The novel *A Slap in the Face* by Abbas Khider further stands as a testimony to the discrimination and dehumanizing treatment meted out to the refugees. The entire novel takes place in a small office meant for refugees which evokes the claustrophobic life of refugees. The title of the novel is also quite suggestive of the suppressed anger of the refugees that they want to vent out against the authorities for their inhuman attitude. The 'Face' in the title represents the oppressive face and unsympathetic attitude that the Western world bears towards the refugees. The novel aims to reverse the position of the interviewer and the interviewee or in this case, the asylum seeker and the authority; it questions the God like attitude of the host nations, "You, Frau Schulz, are one of those who decide how I may or should live. Imagine for a second that you were in my position. Wouldn't you want to know what this godlike figure's first name was? The person with the power to make your life heaven or hell" (Khider 3). Waiting forms an integral part of refugee life. The refugees are forever meant to dwell in the shadow of uncertainty, their fate depending upon the pen-strokes of the officers, as Karim Mensy the narrator in the novel says to the officer, "You kept waving your sharp-nibbed fountain pen around in the air as if you are stabbing flies, crushing people's hopes with the weight of your oversized stamp" (Khider 3). The asylum seekers are nothing to them but mere flies or a mere number, as Karim Mensy points out, "For you I was asylum seeker 3873 or something. Worth no more than the numbers I had to take, and then sit and wait" (Khider 4). They are entirely at the mercy of the authority, stripped of all identity and they are merely a number.

Khider in his novel highlights harassment meted out to the refugees in the name of official formalities. The trope of waiting is pointed out which is again used as a weapon of denigration against the refugees. Such

attitude reveals the cold and condescending attitude towards the refugees. The natives remain completely indifferent to the plight of the refugees, oblivious to their situation. Mensy highlights this,

> No one ever contemplates what my life might be like now. The difficulty of getting a residence permit, the torment at the foreigners' registration office, the harassment by the federal crime agency, the embarrassment caused by the intelligence services or the trivial details of constitutional protection. (Khider 11)

The above lines very aptly summarise the plight, the sufferings of all the refugees, irrespective of their background. Both the novels effectively highlight the narrative surrounding the refugee lives consisting of subjugation, humiliation and a sub-human behaviour. Both the novels are written from the perspective of refugees which brings into focus the world as seen through the eyes of the refugees and their perception of the host nations. The marginalisation of the refugees is a pertinent issue that has to be dealt on humanitarian grounds with due consideration given to dilution of the rigid conception of boundaries and a respect for basic civil rights.

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In consonance with Open and Distance Education-Addressing the claim of technology in this facet of Higher Learning

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Abstract:

The Indian education system being one of the most expanded one is also characterised by even more expanding paradigms and perspectives to cope with continuous systematic changes. Open and Distance learning is yet another protrusive issue of recent times in the field of higher learning. The present attempt focuses on the importance of this mode of learning and address the claim of technology in this sphere of higher education.

Introduction

The Indian education system, being one of the most expandedand specialised systems in terms of its institutions, social, economic and cultural backgrounds of the givers and the recipients, the sources of financing etc., leaves an indelible impression on the life and support system of a nation. In addition, the fast changing technolgical trends coupled with the process of globalisation is revolutionising the pedagogical practices and the way teaching –learning as a process is organised within the four walls of the classroom. Thus any country has to overcome the twin challenges of increasing the diversity and technological modifications to enhance the learning outcomes and thereby augment quality of its labour force. It assumes all the more importance since education plays a significant role in economic progress and social development of a nation.

India's higher education system ranks as the third largest in the world, United States and China being at the preceding positions and the system is undergoing continuous methodical changes. Conceptualisation of its

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paradigms, patterns, perspectives, is far from static and changes are inevitable. Response to this change becomes one of the major concerns of higher education today. Globalisation, privatisation, and technologically digitalised advancements are the prime factors forcing the convergence of all the modes of higher education in India. Likewise Higher Education has to react to some of the educational issues which are emergent in nature. Among these the Choice Based Credit System (CBCS),Equalisation of Educational opportunities, Inclusive Education, Education for Women Empowerment, Education for Peace and Values, Education under the ambit of intercommunication between Equity, Equality, Quality teaching, are the prominent ones(Mondal, Ajit and Narul, Manju,2018).Another projecting issue of the recent times is that of Open and Distance learning.

Indeed Education has always been relying on certain tools and modes as these were pencils, books, chalk and boards, to deliver content, in previous years. As the technology involves and impacts, the environment gets changedfor learners and facilitators. The concept of traditional classroom teaching environment has heightened to virtual online learning environments which are in synchronous and asynchronous modes. The tool of education list has grown to include Information and Communication Technology such as smart classroom which have computers connected to internet and more recently, online platforms such as MOOCs (Massive Open Online Courses)

At present, information and communication technologies (ICTs) have been integrated into teaching and learning to support a variety of tutoring during the last three decades of the 20th century. Thus open access to open educational resources, along with open online courses, today there is growing impetus among institutions to participate in this "open" movement. The present episodein a way focuses on thisnascent issue of Open and Distance learning and links its treatises with theinescapabilityfrom the application of technology. But before we proceed onto this, a brief discourse on Open and Distance learning becomes necessary for convenience of understanding.

Distance Education-The concept

 Distance learning is a form of instruction exemplified by the physical separation of teacher from students where teaching and learning is not limited within the four walls of conventional institutions. (Meena Rahul, 2015). Many new dimensions like computer, internet and satellite have provided freedom of access to high

quality technical and other courses, where materials of teaching reach the learners at a considerably low cost, within a short span of time. Massive Open online courses (MOOCs) in current time deserves a special mention in this context, for these are considered as game changer (Broadhurst and Haywood, 2012), with a minimum technological requirement of that of regular access to acomputer with reliable and affordable broadband internet connectivity.

Application of technological facility (MOOCs) in Distance Education:

MOOCs (Massive open online courses) is aimed at unlimited participation and open access via the web. In addition to traditional course materials, MOOCs provide interactive courses with user forums to support community interactions among students, professors and teaching assistants as well as immediate feedback toquick quizzes and assignments.MOOCs is a recent and widely researcheddevelopment in distance education, first introduced in the year 2006 and by 2012 emerged as a popular mode of learning (Masson.M, 2014). It represent a global cost effective, flexible and sustainable model to massify higher learning (Kumiko Aoki, 2012).

MOOCs is offered from various stands such as EdX, Udacity etc. The option of MOOCs provides an opportunity for students to be in a golden age, characterised by near-universal access to the highest quality teaching and scholarship at a minimal cost (Harden, 2013). MOOCs are considered a 'disruptive technology' (Bower and Christensen, 1995) that will change higher education landscape forever. MOOCs may become a common phenomenon, challenging and changing existing conventional system of education through a wider adoption of communication technologies, especially internet technologies. The MOOCs can be offered by a traditional university, by an existing MOOC provider or in partnership with any of the providers. The response to MOOCs indicates that despite non-conformist voices, the MOOCs process is maturing, expanding and deepening and is spreading to new areas and countries. In fact MOOCs are heading to become a significant and possibly a standard element of credentialed university education, exploiting new pedagogical models of learning, discovering revenues and lowering costs (DBIS, 2013).The phenomena of MOOCs are described, placing them in the wider context of open education, online learning and the changes that are currently taking place in higher education at a time of globalization of education and constrained budgets (Bates, A.and Poole,

G,2005). MOOCs take education to an altruistic level as it turn higher education into a public good on a global scale. The desire to share one's knowledge is innate in many educators but MOOCs makes it more exciting that of teaching tens of thousands of students all around the world.

Open universities in a nutshell cater to three types of learners- digital natives, digital immigrants and digital illeterates.The challenge before the Open and Distance learning is to meet with and satisfy these groups of learners with varying digital literacy. Learners rather than simply receiving and memorizing information from texts are now increasingly demanding education and training through more entertaining and engaging means. Therefore lectures or texts alone does not give the learners, the actual feel of the subject ,whereas e-content delivered digitally having audio, video and animation, can provide a multi-sensory perspective in vivid learners who in turn experience their subject in a manner which is more engrossing, enriching and rewarding. In a whole these new digital formats allow a great degree of interaction and user control over the content. On the one hand learning has become more collaborative and on the other hand information can be gathered from various sources. Each Open learning system should have its own dynamic websites with a dedicated Learning Management System (LMS) for each programme offered by it.

Challenges in the aspect

It is highly imperative to bring change in the existingsystem where the society, its needs are changing, but the education sector and its functions are still old fashioned. Aspiration of good life has increased the demand for higher education. The open universities are offering conventional programmes through distant modes with a very few innovative and skill oriented programmes. The open learning systems need to revisit all their programmes and modify the curricula in tune with the industry's requirements, employability, being one. Further the curriculum of the new generation programmes should be re-designed and improvised inconsensus with the concerned industry, so that the programmes change from being purely theoritical to being more practise and application oriented and above all need based, with clear cut avenues for placement of learners in the industry on acquisition of the knowledge, skill and competency.

An academic revolution has taken place in higher education particularly in past half century marked by paradigm shift in scope and opportunity but one of the main reasons for India's performance for being not that encouraging was due to suboptimal investment on higher education in the recent past.(https://

www.worldwidejournals.com/international-journal-of-scientific-research-) With an unprecedented growth of knowledge typically in the area of information and communication followed by globalisation shrinking the world into a global village, competitiveness has become a decisive force of growth. Moreover over the years Information and Communication technology (ICT) has been emerging as a potential alternative to ensure greater accessibility to higher education beyond geographical and political boundaries, Open and Distance learning being such a mode of imparting education with a noble mission is worth mentionable in this regard. With all its advanced tools such as teleconferencing, e-mail, audio-conferencing etc., through broadening the international dimension of educational services to greater and expanding meaningful collaborations with internationally acclaimed global players in higher education, Open and Distance learning shaking hands with ICT can make higher educationeasily accessible, affordable and qualitatively improved, leading to the upliftment of the socio-economic conditions of the nation and its nationals.

Conclusion

To sum up, it can be said that Globalisation being a market phenomenon has impacted the education across all countries. Hence the educational policies across the globe started to be dominated by the economic policy of the nations. As the education slowly and steadily started gearing upto demands of the corporate world and knowledge, information and skilled human force started reflecting the same, as well as skilled human force started replacing capital and energy in newly developing knowledge economy under impact of globalisation. In view of all these, to reinforce a healthy higher educational level in India and to enhance the quality of education imparted here, thepolicy makers should bid farewell to the 'ivory towers 'andbe oriented towards community development whereby adaptation of new dispositions of knowledge, Open Distance learning coupled with adoption of MOOCs, being a strong mode, can potentially strengthen the arms of cognitive development of this large populous.

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Manuscript style-guide for authors and editors

Below are the main elements of the formatting style that the authors are requested to follow while preparing their research paper. That will help faster and error-free processing for publication.

1. General guidelines

- The entire text should in *Arial* font with font size *11* and line spacing 1.5.

- The length of the original articles and review articles should not exceed 4000 words and 6000 words, respectively.

- The writers should provide full details for correspondence together with their current affiliation.

- All submissions should be accompanied by an abstract of a maximum of 200 words.

- Authors will also provide four to six keywords for their papers.

2. Headings and Labels

- Title of the paper should use title-case, with 14 font size, bold and centred.

- The name of the author should be in 11 font size bold, in italics, and right-aligned.

- The official designation of the author(s) should be mentioned as a footnote at the bottom of the first page

- Other sections of the paper should use sentence-case.

- In order to maintain the hierarchy of headings, please keep it to a maximum of three levels. For example,

> **4 Economic Development (Level 1)**
>
> **4.1 Family Income (Level 2)**
>
> **4.1.1 Education (Level 3)**

- Kindly restrict yourself to two levels of headings; it is advisable to avoid the third level if not absolutely necessary.

3. Tables and Figures

- Please cite each table or figure in the main text. Below are examples to be followed.

- Column labels should be centred.

- Graphs and charts should be prepared in MS Office and not in jpeg or other formats.

- All sources of information in the table and/or figure should be mentioned below the respective table/figure.

> The production of paddy was 52 million tonnes in 2001 compared to
>
> 41 tonnes in 1993 (Table 3).
>
> Production rose from 6800 light and medium vehicles in 1978-88 to
> more than 10,000 a year by 1998-99 (Figure 1).

4. In-text citations

(a) Author-date

- All author-date citations will go in the text, with full references in the bibliography.

- Please do not use ibid. or op.cit. In case of repeated citations, all such citations must follow the author-date citation approach.

> The studies revealed that advanced medicinal knowledge rarely
>
> reached the community. (Barua, 1993).
>
> Barua (1993) revealed that advanced medicinal knowledge rarely
>
> reached the community.

(b) Page numbers

The author and date should be provided, followed by a colon and the specific page number.

> According to Basu's analysis, self-development is related to
>
> education. (1986: 74).
>
> Theories on sustainability should consider environmental aspects.
> (Banerjee 1998: 19–27).

4. Citations and References

(a) Article in a scholarly journal

Author(s) (Year): "Title of article," Title of journal, Volume, Issue, pages - this sequence and style should be followed.

> Chatterjee, A. (1993): "From Hegemony to Counter Hegemony: A
>
> Journey in a Non-imaginary Unreal space", *Economic & Political*
>
> *Weekly*, Vol 23, No 5, pp 41–50.

(b) Government publications

- The ministry, committee, agency or any subdivision that served as the author needs to be cited first.

- Next should be the date, title, place, and publisher.

> Committee on Irrigation and Water Resources (1981): "Debate on the Water Policy," Monsoon session, 1981, Lok Sabha, New Delhi: Government Press.

(c) Books

For a book citation, the style should be - Last name, First name (Year of publication): Title of book, Place of publication: Publisher.

(i) Book with one author

> Beck, George (1974): *Society: A New Perspective*, New York: Penguin.

(ii) Book with more than one author

- First author name will be written with last name/ surname first;

- Subsequent author names will be written with the first name first and then the last name/surname.

> Fisher, Henry and Adams Joe (1995): *Sustainable Development*, Boston: Academic Corp.

(iii) Two or more books by the same author

A long dash should be used for the author's name after the first entry. The books should be listed according to the year of publication.

> Bhowmick, Bikash K. (1941): *Struggle for Independence: A Social Narration*, Good Earth: Southern London University Press.
>
> — (1947) *New Independent India*, Denver: Academic Press

d) Online citations

- Providing only the URL is usually not sufficient.

- The author, title of the text, date, title of the website, the electronic address, and the page numbers should be mentioned.

- Also the date when the source was accessed must be mentioned.