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Parallel Hardware Implementation of Walsh Hadamard Transform

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The Walsh Hadamard Transform is a powerful notion in digital signal processing. This paper explains the construction of parallel hardware architecture using the mathematical concept of Kronecker product based approach to Walsh Hadamard Transform and its simulation using Verilog. This architecture is simulated here using Field Programmable Gate Array (FPGA) technology in Verilog Spartan 3e platform. Furthermore, this paper illustrates the fast algorithm and parallel computational result of both one-dimensional and two-dimensional transforms using the Kronecker product.This algorithm can be used to implement a systolic array based dedicated hardware for computation of the transform. Our proposed hardware design for the Walsh Hadamard Transform will be used in various digital signal processing applications. The systematic derivation of parallel architecture design using the concept of Kronecker product and stride permutation would depict the real time processing rather than conventional way and reducing time complexity using minimal resources is a challenging task.

Keywords: Kronecker product, Systolic architecture, FPGA, Verilog

Introduction

The Walsh Hadamard Transform (WHT) is a mathematical construct that finds wide applications in the fields of digital signal processing, data compression, and encryption.[1] It also finds application in quantum computer information processing and it is more often called Hadamard gate in this context. The transform is particularly useful in feature extraction for pattern recognition and digital image processing because of its easy implementation using simple arithmetic stages.[2] Also, the binary nature of the Walsh functions and the Hadamard matrix allow easy semiconductor-based computer implementation.[3]

The usage of the Kronecker product allows the de-implementation of WHT using an algorithm that is both recursive and parallel. For a one-dimensional input of size 2α, the algorithm completes in α clock cycles. Moreover, for a two-dimensional input of size $(2\alpha \times 2\alpha)$, the same is complete in 2α clock cycles. Thus, using this approach can significantly reduce the number of clock cycles.[4]

Kronecker product allows the decomposition of the WHT matrix into simpler arithmetic stages comprising of homogeneous recursive array block. It thus provides a parallel computation of systolic based array implementation of WHT for synchronous evaluation.[5] Decomposing the one-dimensional input into pairs and applying them to the arithmatic stages allows for parallel execution.[6] The output obtained is stride-permuted and applied back to the same arithmetic stages, continuing the execution recursively. For a two-dimensional input, we design an algorithm that works on the column-major representation of the input.[7] This representation is one-dimensional, allowing the computation similar to the above. As discussed in our previous work[8], the step-by-step development beginning from Granata's paper.[4] from the theoretical approach of expressing the DSP algorithm using the Kronecker product gives insight into developing the parallel hardware architecture.

Although the previous work had focused on modeling the FFT algorithm[3,9],which threw light onto the plethora of algorithms involving recursion that can have a similar implementation, the major constraint remains the implementation of this derived architecture for practical. This had been greatly aided

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ORIGINAL PAPER

Modeling, Simulation and Performance Analysis of Drain Current for Below 10 nm Channel Length Based Tri-Gate FinFET

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Abstract
Lambert W function-based a drain current model of lightly doped short channel tri-gate fin fashioned field effect transistor (TG-FinFET) is studied. Technology computer aided design (TCAD) simulation is used to authenticate the mathematical model. The channel length modulation (CLM), the influence of series resistance, mobility degradation and saturation velocity are involved in this drain current model. A precise drain current is obtained by adding quantum mechanical effect (QME) which also improves the efficiency of the model. The drain conductance, transconductance and subthreshold swing (SS) are derived from the drain current equation. To study the performance of the device, two dielectric materials i.e., silicon dioxide (SiO_2) and hafnium oxide (HfO_2) are separately used as gate insulating materials. The predictions of the model are validated by TCAD simulations and published experimental results.

Keywords TG FinFET · High-k · TCAD · QME · Drain current · HfO_2

1 Introduction

Shrinking the size of metal oxide semiconductor (MOS) device generates quite undesirable glitches namely short channel effects (SCEs), high SS, higher leakage current etc. These problems are profound when the channel length is comparable to the depletion width of the source and drain junction [1]. FinFET can be used to reduce these problems because of its gate around structure that produces an electrostatic shield to protect the channel from the parasitic field initiating from drain and gate [2]. The fin can be a part of the body or it can be isolated from the body to reduce the leakage current. Most importantly improved gate control demands smaller fin width. However, to achieve a higher packing density, FinFET technology faces challenges in scaling of fin width at 7 nm node. Due to its better electrical parameters, FinFET promotes an important research area in semiconductor industry. It is reported that SCEs and switching capacitance can be improved in double gate (DG) FinFET [3–7]. A TG-FinFET is more immune to SCEs and offers a higher drive current in contrast with DG structure [8–10]. According to Intel, the performance of 22 nm 3-D trapezoidal FinFET is 37% better than 32 nm 2-D planer transistor and its power consumption is half of the planer structure [11]. The n-channel metal oxide semiconductor (nMOS) TG FinFET with high-k dielectric material is recognized as a potential successor of conventional planar MOS structure in the sub-28 nm regime [12]. The restriction of scaling of SiO_2 below 1.5 nm may be minimized by replacing SiO_2 with high-k dielectric material. HfO_2 with a high bandgap (5.6 eV), high band offset (1.4 eV) and high-k value ($k = 22$) restricts the tunnelling current. The good interfacing quality with Si, excellent thermal and chemical stability, drives HfO_2, as a potential candidate of high-k dielectric material in MOSFET technology [13–17]. Generally, FinFET with fin width two-third of the gate length consists of multiple fins to drive high current [18]. Therefore, width quantization is the obvious part of FinFET and results in erratic fluctuation in threshold voltage [19, 20]. The limitation of high threshold voltage of heterojunction tunnel FETs is also overcomed by FinFET. It can reduce SS below 60 mV/decade that can enable the digital integrated circuit to operate at a supply voltage

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Exploring Virtual Learning Community in the New Normal

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Abstract

The closure of schools due to Covid pandemic posed teachers, specially those at school level, with the challenge of transforming teaching from offline to online. However, support from the main stream providers of in-service teacher education of ESL teachers in West Bengal was scarce in this regard. The authors volunteered to develop a virtual learning community for supporting member teachers develop professionally to cope with their challenges. The paper explores the trajectory of this virtual learning community in the New Normal and focuses on the learning of two founder teachers benefitting from the dialogic reflection taking place within the community.

Keywords

Teacher learning, professional development, learning community, community of practice, collaboration, reflection.

Introduction

The 21st century has been marked for “rapid change” (Scott, 2010:20) in educational contexts necessitating a demand for change in teaching practices also. Professional development is pointed out as a key strategy “to bring positive change in practicing teachers' competence” (Borg, 2018:1). However, the year 2020 witnessed an unforeseen situation in educational contexts that expedited this change process with a sudden leap. The closure of all educational institutes during the Covid pandemic in India created a situation where teachers at all levels of education system had to shift their teaching from offline to online. The main stream providers of professional development for in-service teachers at school levels were often found ill-

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RESEARCH ARTICLE

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Autoregressive moving average based anycast with support vector machine clustering in mobile ad-hoc networks

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Abstract

Nodes in mobile ad-hoc networks (MANETs) are battery-powered, therefore, need energy-efficient techniques to cut down the cost of energy consumption. Energy consumption is directly related to route discovery, which could be reduced through anycasting. Anycast is an operation in MANETs, where the source sends messages to one particular destination node of anycast region. In general, the message transmitted is divided into certain packets, and those are transmitted continuously one after the other through selected routes. If the link from anycast source to destination breaks in between or an anycast destination goes out of the anycast region, in that case, a new anycast destination will have to be selected on a new route to the destination. This will incur huge message costs and energy. In this work, we select desirable anycast destinations based on their eligibility by using autoregressive moving average and support vector machine. Eligibility is modeled as a function of residual energy, location, the relative velocity concerning neighbors, and the number of packets successfully forwarded earlier by those neighbors' locations. Reducing the number of anycast receivers reduces the message cost of protocols significantly. We have compared our protocol's performance with the same of anycast-AODV, anycast-DSR, anycast-FAIR, and MQAR (mobility and QoS-aware anycast routing protocol) results show significant improvement. Collective improvement amounts to 89% more energy preservation and 39% delay on average.

1 | INTRODUCTION

A mobile ad-hoc network (MANET) is an infrastructure-less network where the nodes are free to move independently in any direction. Hence, no pre-built infrastructure is required for establishing it. All nodes are battery-powered, and they have to collaborate among them by forwarding each other messages selflessly.[1,2] These networks are used mainly for rescue services in natural disasters like floods, earthquakes, etc., where quick deployment and mitigation are necessary. It is also handy for communication on a battlefield, surveillance.[3] The routing protocols proposed for MANETs[4-9] can be broadly classified into proactive and reactive routing techniques. In proactive routing protocols, nodes store route information to every other node of the network in a table, even not required. This is not practical for a large MANET as this will lead to colossal storage overhead.[10] On the other side, the reactive technique reduces this overhead as this technique find route when required.[11] In these protocols, route request (RREQ) packets are broadcast when

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Influence of V_2O_5 concentration on structural and electrical transport properties of semiconducting ternary glass and glass-ceramics nanocomposite system

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ABSTRACT

The effects of V_2O_5 concentration on semiconducting xV_2O_5–(1-x) ($0.25Nd_2O_3$–$0.75ZnO$) glass nanocomposites were investigated by structural, optical, and electrical conductivity studies. The composition dependency of physical attributes like density, molar volume, bond dissociation energy, number of bonds per unit volume, etc., was established. Using X-ray diffraction and field-emission scanning electron microscopy, we identified the presence of different nanocrystallites and amorphousness. DC electrical conductivity was caused by the small polaron hopping due to the presence of V^{4+} and V^{5+} valence states, enhanced as the small polaron radius was reduced with rising V_2O_5 concentration. The non-overlapping small polaron tunnelling (NSPT) model was the preferred AC conduction process, and reducing nature of tunnelling distance enhanced AC conductivity with increasing V_2O_5 concentration. We modified the existing NSPT model to get reasonable values for fitting parameters. The scaled AC conductivity spectra revealed temperature independence and the composition-dependent conductivity relaxation process of small polarons.

1. Introduction

Glass nanocomposite systems doped with transition metal oxide (TMO) like vanadium pentoxide (V_2O_5) have different applications in electrochromic devices, thin-film batteries, chemical sensors, infrared detectors, and so on [1]. Rare earth compounds have special properties as an outcome of the presence of moderately shielded 4*f*-orbital electrons, which has attracted much attention [2, 3]. Neodymium (Nd) is one of the most important rare earth elements in the lanthanide series, with applications in a wide range of fields such as catalysts, luminescent devices, magnetic devices, protective coatings, and dielectrics [2–5]. Vanadates have attracted increasing attention as an influence of different structural arrangements like tetrahedral, octahedral, and bi-pyramidal coordination environments due to the presence of different valence states [6–8]. Due to the layered structure of V_2O_5, it possesses extraordinary optical and electronic properties [6–8]. V_2O_5 is typically composed of a VO_4^{3-} structural group, with the V^{5+} ion surrounded by four O^{2-}ions in tetrahedral symmetry [9]. It is also reported that the structure of the vanadate glass system consists of a layered chain of VO_4 or VO_5 polyhedral units [10]. Zinc oxide (ZnO) usually has a three-dimensional network made up of ZnO_4 and ZnO_6 polyhedra, sharing edges and corners [11].

In TMO-doped glassy systems, the covalent glassy network comprises oxygen atoms, resulting in new structural entities. The degree of structural alterations usually depends on the glass network former or modifier oxide concentration. Glass network structure modifications affect a variety of physical properties like density, oxygen packing density, molar volume, and so on. The density of glass is usually the most fundamental physical property that can be computed, which provides a highly informative property to determine and analyze the structure of the glass [12,13]. The glass structure can be interpreted with regard to the molar volume rather than density, as the glass former agrees with the spatial allocation of the ions forming that structure. In the glassy system, the variation of molar volume with the variation of molar composition of oxide indicates structural modifications throughout a formation or alteration process [14,15].

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Study of mixed modifier effect on dielectric and optical properties of zinc-phosphate based ternary and quaternary nanocomposite systems

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ABSTRACT

The influence of the incorporation of TeO_2 and MoO_3 content on optical and dielectric properties within the ZnO-P_2O_5 host glass matrix has been studied. The density values of all compositions have been estimated using well-known Archimedes principle. The temperature and frequency dependency of dielectric parameters are established. Dielectric constant, as well as the dielectric loss of the glass system, are observed to decline with increasing frequency and increase with rising temperature. The ferroelectric relaxor properties of all-glass systems are studied through modified Curie-Weiss law. A remarkable alternation has been observed in the value of dielectric permittivity for the quaternary and ternary systems, indicating the influence of the mixed modifier effect. In the spectroscopic investigation, different optical parameters like optical energy bandgap, Urbach energy, refractive index, absorbance coefficient, optical density, dissipation factor, and the VELF and SELF have been obtained and are found to be strongly influenced by the mixed modifiers.

1. Introduction

Several physical characteristics, like lower melting point, higher chemical durability, low crystallization, higher refractive index, and excellent infrared transmitivity, have been the key features of oxide glasses that contain tellurium oxides (TeO_2), which enhance the practical applicability of these glasses [1]. For phospho-tellurite glasses, low glass-forming capability, higher thermal stability, and a wide transparency area from UV to near-infrared enable their ability as a potential candidate in the field of photonic application [2]. The lack of glass-forming ability of TeO_2 requires some other oxides like glass formers, intermediates or modifiers like ZnO, BaO, CdO, P_2O_5, MoO_3, V_2O_5, etc. to form a stable glass. MoO_3 acts as a glass modifier, P_2O_5 acts as a glass-forming oxide, and ZnO stabilise glass networks. As a result, incorporating all of these oxides can significantly boost the formation of tellurite-based glass systems [3]. In MoO_3 doped phosphate glass systems, electrochromism properties and enhanced ionic conductivity lead to electro-optical applications [4]. Mo ions are found within the glass network as tetrahedral (MoO_4) and octahedral (MoO_6) structural units due to the presence of two valence states, Mo^{5+} and Mo^{6+} [5].

In the arena of solid-state electronics, the dielectric characteristics of glass play an important role. Glass dielectrics are often used in different electrical circuits and electrical insulators as capacitance materials [6]. The route of electronic or ionic transport in a disordered glass material can be found by studying frequency-dependent electrical conductivity and the dielectric constant (ε'). Localized states in glassy materials are formed by the occurrence of disorder in the atomic configuration, which can be recognized through the systematic investigation of the dielectric constant (ε'). A comprehensive examination of dielectric properties, relaxation time (τ_c), and loss tangent (tan δ) over an extensive range of temperatures and frequencies reveals the structure of glass. The insulating nature can be described by the dielectric properties and dielectric breakdown strength of glass [7].

A high-frequency dispersion of dielectric permittivity has been

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Full Length Article

A surface potential model for tri-gate metal oxide semiconductor field effect transistor: Analysis below 10 nm channel length

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ABSTRACT

In this study, an analytical model of Tri-gate metal-oxide-semiconductor field effect transistor (TGMOSFET) for short channel lengths below 10 nm is suggested and Technology computer-aided design (TCAD) simulation is used for confirmation. Two dimensional (2D) Poisson's equation is solved with symmetric and asymmetric double gate (DG) MOSFET separately and is combined using the perimeter-weighted sum approach to model the surface potential of lightly doped silicon TGMOSFET. The model is examined by varying channel length, oxide thickness, gate voltage, drain voltage and doping concentration. In this study, the ratio of channel length to width is always kept greater than or equal to two. The structure is also inspected with a high-k dielectric material. A relative study of hafnium oxide (HfO_2) and silicon dioxide (SiO_2) with identical oxide thicknesses is given to explore the effect of high dielectric material on the model of TGMOSFET. To obtain identical surface potentials, the oxide thickness of HfO_2 must be larger than SiO_2. Unlike SiO_2, the minima of surface potential remain constant with channel length for HfO_2. The outcome of the TCAD simulation is highly associated with the results of the analytical model. Therefore, to meet high packing density and low power consumption, TGMOSFET can be a potential candidate for ultra large scale integrated circuit (ULSI) technology.

1. Introduction

With the help of advanced and fast computation technology, the semiconductor integrated circuit (IC) technology drives almost all other technologies. According to Moore's law, the number of transistors integrated into an IC, doubles in every two years. The advancement of IC technology is based not only on the reduction of energy consumption, size, and cost but also on the enhancement of speed. Miniaturization was effectively carried out until 1990s [1] without facing any prominent hindrance to achieve high-performance, high packing density and low power consuming ICs. Then silicon substrate is replaced by silicon-on-insulator (SOI). It reduces the parasitic capacitance, series resistance and the size of the semiconductor device. IBM successfully employed SOI in 2000 and subsequently, it becomes the substrate of next generation IC technology. A huge number of research works have been carried out to overcome the adverse effects of miniaturization. Degradation of subthreshold slope, reduction of threshold voltage, increased leakage current, poor $I_{don}/I_{doff,}$ are the prominent outcomes of miniaturization that degrades the device's performance. Hence, short channel effects (SCEs) impose limitations on the scalability of the device's physical dimensions. For example, the insulator thickness lower than 1.5 nm introduces high tunnelling gate current which increases the power dissipation and generates surplus heat and these may damage the device [2,3]. Therefore, scaling of insulator thickness (SiO_2) is restricted due to tunnelling current. This problem can be handled by using high-k gate dielectric materials. It reduces the leakage current and increase the gate capacitance. Hence incorporation of high-k material as an insulator is one of the key solutions [4]. HfO_2 has been considered as a potential candidate of high-k material due to its decent electrical interfacing quality with Si. It has very good thermal and kinetic stability. The high-k value (22), large bandgap (5.7 ev) and the conduction band offset (1.4 eV) with respect to Si are the other important factors for choosing HfO_2 as an insulator in Si technology [5–7]. Recent trends of IC technology explore the use of multi-gates that can manage the SCEs more precisely.

Hence, scaling as well as multi-gate structure must be incorporated to enhance the device's performance in ULSI technology. To include both of these features the planar technology is transferred to vertical packing arrangement that can integrate a greater

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An Efficient DOA Estimation and Jammer Mitigation Method by Means of a Single Snapshot Compressive Sensing Based Sparse Coprime Array

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Abstract

With an identical number of physical sensors, a coprime array provides a greater number of degrees of freedom (DOFs) and virtually offers a larger array aperture compared with the conventional uniform linear array. A larger array aperture enables greater resolution and stronger interference suppression capabilities. Thus, a coprime array has appropriate uses in real-time applications with reduced computational complexity. On the other hand, the development of compressive sensing theory has effectively enabled solutions to an underdetermined system of linear equations. In this paper, the estimation of the

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ORIGINAL PAPER

An Accurate Drain Current Model of Dual Material Double Gate Metal Oxide Semiconductor Field Effect Transistor

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Abstract
This article is an unique representation of drain current analysis for double metal double gate (DMDG) device structure of MOSFET. A comparative study of drain current varies for high-k dielectric and SiO_2 as the insulating substances is also discussed. The threshold voltage rolls off with the decrease in channel length which means at a small channel length dimension the device triggers on at a very low voltage. As a result enormous amount of current will flow. High-k substance like HfO_2, diminishes the short channel effects (SCEs) which are produced due to downsizing the device dimensions. Modeling has been structured depending on several benchmarks like channel length, channel and oxide thicknesses, temperature changes, and drain and gate source voltages. A rich reflection can be realized how the drain current varies and measures to overcome the flow of huge current generated due to SCEs. Transconductance and drain conductance are also described. The device with high-k material exhibits better performance than the conventional one in case of small scale dimension. Very good agreement has been noticed between analytical model and TCAD simulation output.

Keywords DMDG · Drain current · High-k · Hafnium oxide · TCAD

1 Introduction

Silicon-on-insulator (SOI) metal-oxide-semiconductor-field-effect-transistor (MOSFET) technology has become the mainstream integrated circuit (IC) design technology for many years. In the recent past few years the technology is going through the immense process of scaling down. Gordon. E. Moore predicted in 1965 that the number of technical modules in commercial IC industry would become twice with every two years [1]. High speed and the high configuration combination of a computer can be found within 18 months with paying lesser amount. As a result of reduction of device dimension the very-large-scale-integration (VLSI) MOSFET industry is opting for MOSFET devices below 20 nm gate lengths. It increases two types of SCEs which are threshold voltage roll off composed with drain induced barrier lowering (DIBL) effects [2, 3]. It introduces new challenges to the scientist to generate a new 3D MOS structure with immense tolerance to SCEs. The SCEs enhance uncontrolled movement of carriers in the channel as a result of which enormous leakage current is accounted. Most parts of these leakage currents are not measurable. The quantum tunneling phenomenon increases with scaling down the insulator thickness below 1.2 nm range (approximately). A large value of gate leakage current flows through the channel [4, 5] as a result the oxide material cannot act as an insulator.

SOI MOSFET is a bulk semiconductor 3D device structure which has become the basic component of IC technology generally used for switching and amplifying circuits and can be manufactured in a single chip. Normally the structure has four terminals but for simplicity it can be used as three terminal orientations by combining gate and body. The substrate is isolated by an insulator form the gate and acts like a capacitive terminal.

Double gate (DG) MOSFET can minimize the SCEs and offers high drive current [6, 7]. The channel is fully covered by double gates [8–10]. The channel region becomes inverted

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ORIGINAL PAPER

An Accurate Model of Threshold Voltage and Effect of High-K Material for Fully Depleted Graded Channel DMDG MOSFET

Himeli Chakrabarti [1,2] · Reshmi Maity [1] · S. Baishya [3] · N. P. Maity [1]

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Abstract
In this study, an accurate model for threshold voltage of graded channel dual material double gate (GCDMDG) structure metal-oxide-semiconductor (MOS) has been established and a comparative explored by using SiO_2 as well as HfO_2 materials. The threshold voltage roll-off and drain-induced-barrier-lowering (DIBL) have been explored. The effect of different device parameters like temperature, oxide thickness, film thickness, etc. on device performance has been evaluated to check the figure of merit over the DMDG structure. It is found that the value of threshold voltage is higher in GCDMDG structure over its counterpart but the roll-off nature is quite small. The main purpose is to reduce the short channel effects (SCEs), that has been generated due to the miniaturization of the device. For the confirmation of the model, the results have been affirmed by TCAD.

Keywords Threshold voltage · GCDMDG · High-k · Interface charge · TCAD

1 Introduction

The threshold voltage (V_{Th}) is an important device characteristic of MOS device. This is the minimum value of the gate to source voltage of the MOS-field-effect-transistor (MOSFET) that is needed to create a conducting path from the source to the drain terminal [1, 2]. It is a significant scaling factor to sustain power efficiency at which the device turns on and starts to conduct. When the gate voltage is above this value, the "enhancement-mode" transistor is turned on [3, 4].

The double gate silicon-on-insulator (SOI) MOSFET (DG SOI MOSFET) has become the most encouraging device architecture in past few years. Small scale device dimension generates several SCEs and hot-carrier-effects (HCEs) in the device and as a result, a huge amount of current will flow through the channel [6]. This huge amount of current easily damages the device. On the other hand, according to Moore's law, the device dimension will be half on every two years [7, 8]. Nowadays the personal computer has become so small that it can be easily fit into a pocket. Not only that, some additional functions, like speed, also has included within that at the same cost. The double gate structure covers the device channel from top to bottom level. It gives full coverage over the channel by the gate [9]. Another model that helps to recover over HCEs is multi-materials gate electrode engineering. Here gate electrode consists of several materials with dissimilar work functions. Generally, different poly-silicon materials have been used. Several studies have been reported of dual material and triple material double gate structure [10].

DMDG is a new structural concept. In this concept, two different work functioned poly-silicon has been used as a gate material [11]. This structure provides high transconductance [12] and low leakage current and drain conductance. Researchers also included some added features with the DMDG concept [13]. Instead of using constant doping substrate, they used a graded doping substrate [14]. This feature added some extra feathers to the DMDG structure. In this paper higher concentrate substrate region is used at the source side and a lower concentrate region is used at the drain [15]. For the dual-material gate, there are two threshold voltages [16]. But at the small scale dimension threshold voltage become roll-off in the DMDG structure, which again helps to increase some short channel effect. This problem can be

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Compositional dependence of structural, physical, and, in particular, optical parameters of $Se_{50-x}Te_{30}Sn_{20}Sb_x$ chalcogenide glassy systems

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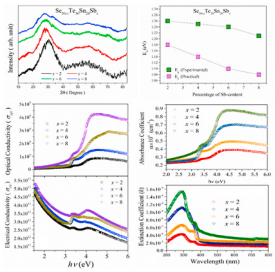
HIGHLIGHTS

- Quaternary chacogenide glassy system have been prepared by melt quenching method.
- Compositional dependence of several physiochemical, structural and optical properties are studied.
- Tauc-plot method has been deployed to determine optical band gap energy.
- The location shift of the CB and VB potential have been studied and discussed.
- Compositional dependence of Transition temperature has been observed.

GRAPHICAL ABSTRACT



ARTICLE INFO

Keywords:
Quaternary chalcogenides
Topological assessment
Chemical bond approach
Optical bandgap energy
VB and CB potential

ABSTRACT

Through this paper, we describe the compositional dependency on physical, structural and optical properties of $Se_{50-x}Te_{30}Sn_{20}Sb_x$ ($x = 2$, 4, 6, and 8) chalcogenide bulk glassy systems, synthesized via the melt quenching method. X-ray diffraction patterns of all the samples conspicuously confirm the formation of the amorphous structure. Various structural parameters like density, molar volume, compactness, atomic density and other associated parameters have been evaluated and the effect of Sb incorporation within the network has been discussed. The studied glass is rigidly connected, as suggested by the gradual increment in the values of estimated average coordination. Tauc's extrapolation method has been employed to determine optical bandgap energy from UV–Vis spectroscopic data, which reveal that optical bandgap energy decreases as Sb content increases. The bond distribution within the glassy network has been studied and discussed. The Mean bond energy and cohesive

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ORIGINAL PAPER

A Compact Drain Current Model for Graded Channel DMDG Structure with High-k Material

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Abstract
This article depicts the drain current for a graded channel double metal double gate (GCDMDG) device in a unique way. This work offers a thorough examination of the drain current differences between the high-k as well as SiO_2 oxide material. The high-k material HfO_2 reduces the short channel effects (SCEs) caused by device downsizing. The model's structure is influenced by a number of parameters, including channel length, film thickness, oxide thickness, temperature changes, and the voltages of the drain and gate sources. So, a clear reflection of how the drain current is fluctuating with various parameters created by SCEs can be observed. In all circumstances, high-k materials improve transfer characteristics and minimise SCEs in a controlled manner, which are mostly generated as a result of device structure reduction. The transconductance and drain conductance described in this article also show that in the situation of short scale dimensions, using high-k material performs superior than the traditional one. A lot of similarities have been found among the analytical model and the TCAD outcome.

Keywords GCDMDG · Drain current · Hafnium dioxide · High-k · TCAD

1 Introduction

The device current conduction capability can be expressed as drain current. All the device performances like transconductance, voltage gain, switching capability, etc. can be depicted with the help of drain current. The channel is fully inverted at threshold voltage, and the drain current begins to flow due to free charge particle movement. It is a function of both the gate-source and drain-source voltages. Initially, at linear region the current increases with the increasing value of drain-source voltage. The current becomes saturated after certain drain voltage and does not rise with increasing drain voltage. This is referred to as the saturation region [1–3]. However, as the gate voltage is increased, the drain current increases, and the saturation voltage changes as a result. Before saturation, the channel current is same as the drain current. With reducing device dimension, nonlocal phenomena such as channel length modulation, velocity overshoot, and DIBL become more effective and have a considerable impact on the drain current model. In drain current model, the most significant implication is velocity overshoot, which is linked to the transconductance created by SCEs [4–7]. For a duration less than the energy relaxation time, the electron velocity exceeds its saturation value due to the step function formed in the electric field. Over the past few years, the scaling factor has become a challenge to the conventional MOSFET technology. However, to achieve high speed, packing density and for better performance, the device dimension has to shrink according to scaling law [8, 9, 10, 11, 12]. With the scale down, the charge sharing between source and drain increases that helps to reduce the gate controllability over the channel depletion region. So the reduction of device dimension specifically declining channel length increases several SCEs like DIBL, hot carrier effects, threshold voltage roll off, channel length modulation, etc. Reduction of channel width also increases the electric field at the field isolation edge which helps to decrease the current drivability and hot carrier induced degradation [13–18].

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The effect of transition metal and heavy metal incorporation on the structural, optical and electrical properties of zinc-phosphate ternary glassy system: A comparative study

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HIGHLIGHTS FOR REVIEW

- A comparative study was performed on zinc-phosphate glass matrix doped with V_2O_5, MoO_3 and TeO_2.
- XRD patterns revealed the formation of nanocrystallites over the amorphous glassy network.
- Different optical parameters were affected by the dopant oxides.
- V_2O_5 doped sample showed the highest electrical conductivity.

ARTICLE INFO

Keywords:
Ternary glass nanocomposite
XRD
TEM
Optical properties
Electrical conductivity

ABSTRACT

The present communication reports the effect of the addition of different dopant elements in the zinc-phosphate host glass network having chemical composition 0.30A–(0.55ZnO–0.15P_2O_5) (A = V_2O_5, MoO_3, and TeO_2) that have been prepared through melt quenching technique. The X-ray diffraction patterns reveal the formation of nanocrystallites superimposing over the amorphous glass matrix of all the studied glassy systems, which is also verified by TEM micrographs. The physical characteristics like density and molar volume are examined and discussed in relation to their structural modifications. The FTIR spectra reveal a significant number of distinct characteristic absorption bands owing to different phosphate, molybdate, and vanadate groups. Depending on the different dopant elements, the variations in optical bandgap energies are observed and analyzed. The variations in the bandgap energies from 4.8 eV to 5.79 eV have been measured from the extrapolation of Tauc's plot. Various optical parameters like refractive index, optical density, optical conductivity, dissipation factor, skin depth, and optical basicity have been studied for all glassy systems. The DC and AC conductivity analyses conspicuously reveal that the V_2O_5 doped sample possesses the highest conductivity among all the investigated glassy systems.

1. Introduction

In recent times, zinc-phosphate glasses have become a matter of interest for researchers owing to their low ultraviolet cut-off wavelength, high chemical durability, thermal stability, and high electrical conductivity [1,2]. Phosphate as a promising glass host material attracts many researchers due to its fascinating properties like low-temperature melting, high ultraviolet transmission, high thermal expansion coefficient, and low optical dispersion, which enable them to be suitable candidates for different optical applications [3,4]. It is well known that

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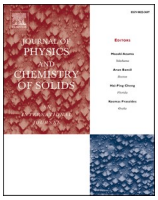

Microstructure and defects of $0.1P_2O_5$–$0.65ZnO$–$0.25(xTeO_2$–$(1\text{-}x)MoO_3)$ quaternary glass nanocomposites using positron annihilation and correlated experimental methods

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ARTICLE INFO

Keywords:
Defects and vacancies
Positron annihilation
Quaternary glasses
Transmission electron microscopy
X-ray diffraction

ABSTRACT

This study reports the spectroscopic examination of positron annihilation to characterize structural defects in glass nanocomposite systems of $0.1P_2O_5$–$0.65ZnO$–$0.25(xTeO_2$–$(1\text{-}x)MoO_3)$, consisting of two ternary ($x = 0.0$ and 1.0) and several intermediate quaternary ($x = 0.05$, 0.1, 0.2, 0.3, 0.4, 0.6, and 0.8) samples prepared by the melt quenching process. The lifetimes of the positrons, the relative intensities, and the parameters of the Doppler-broadened lineshape of the positron annihilation gamma ray spectra indicated porous-type defects inside the amorphous glassy matrices formed in samples of $x = 0.05$–0.2 and free volume defects in interfaces of the newer nanocrystallites at higher stages of modification ($x \geq 0.3$). The results of X-ray diffraction confirmed the amorphous character of the samples and transmission electron micrographs confirmed the formation of the nanocrystallites. Selected area electron diffraction patterns revealed that the nanocrystallites were superimposed on the amorphous glass matrices. The spectra of energy-dispersive X-ray analysis revealed the presence of elemental constituents of the nanocomposites according to the required stoichiometries. A detailed Rietveld analysis of the X-ray diffraction patterns was used to identify the dispersed nanocrystallites and ascertain their stoichiometries. The work here is important in the context of developing technologically relevant glass nanocomposites from metal oxides with suitable physical characteristics. However, defects like vacancies that are formed during preparation may play a crucial role in determining their physical properties as well as the formation of free volumes and new nanocrystallites, where the latter were adequately dispersed over the glassy network. This can help transform the material into novel archetypes.

1. Introduction

The phospho-tellurite glassy system constitutes a class of materials that have recently been applied to optoelectronics and photonics [1,2]. Tellurium oxide (TeO_2)-doped glassy systems have been widely considered to be highly suitable candidates in this context owing to their nonlinear optical properties and chemical stability [3–5]. Pure TeO_2, a conditional glass modifier, does not form glass on its own but requires glass-forming oxides, known as modifiers, and intermediaries like Bi_2O_3, MoO_3, ZnO, CdO, and BaO to form glasses [1–5]. TeO_2-doped glass is difficult to synthesize in high concentrations due to the likelihood of rapid amorphization and phase separation on cooling. Thus, TeO_2--doped glass may be formed with different types of defects during the melt quenching process. The glass-forming ability can be improved with the addition of metaphosphate within the tellurite glassy network [3,6]. Thus, for example, TeO_2-doped glass can be synthesized by using a melt quenching process after being doped with P_2O_5 as glass former, MoO_3 as glass network modifier, and ZnO as glass network stabilizer [7]. The glass-forming ability and structural characterization of ternary glassy systems have been reported [8,9], and one study has examined the

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Microstructural and defects characteristics of xV_2O_5–(1-x)(0.35MoO_3–0.65ZnO) glass nanocomposites utilizing positron annihilation spectroscopy and correlated experimental methods

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ARTICLE INFO

Article history:
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Keywords:
Glass nanocomposites
XRD
TEM
Defects and Vacancies
Positron annihilation lifetime

ABSTRACT

One binary and a few ternary glass nanocomposite systems of the general composition formula xV_2O_5–(1-x)(0.35MoO_3–0.65ZnO), where x varied from 0.0 to 0.95, were prepared via the melt quenching technique and characterized through Transmission electron microscopy and X-ray diffraction method. Positron annihilation lifetime and coincidence Doppler broadening spectroscopy techniques were also utilized to detect various types of defects formed within the samples. The patterns of the X-ray diffraction method revealed distinct diffraction peaks specifying the formation of nanocrystallites in x = 0.0, 0.15 and 0.35 samples. While for x = 0.55, 0.75 and 0.95 samples, significantly broadened patterns were observed, indicating predominant amorphous characteristics. Different shapes and sizes of so-formed nanocrystallites were also confirmed and measured by Transmission electron microscopy images. Moreover, selected area electron diffraction patterns revealed a few bright spots superimposed over diffuse rings, specifying the presence of nanocrystallites over the amorphous glass matrix. Positron annihilation lifetime measurements for x = 0.0, 0.15, and 0.35 samples revealed that positrons were trapped in the intermediate gaps around the nanocrystallites and vacancy types of defects. Positrons were trapped within the porous type defects inside the amorphous glass matrix and in vacancy clusters for x = 0.55, 0.75, and 0.95 samples. Further, coincidence Doppler broadening studies established the formation of vacancy types of defects due to cation non-stoichiometry and amorphousness of the glass nanocomposites.

Selection and peer-review under responsibility of the scientific committee of the Material TECH 2022 (Second International Conference on Materials and Technologies).

1. Introduction

Transition metal oxide (TMO)-doped glass-nanocomposites have attracted considerable attention because of several applications like electrochromic devices, gas-sensing elements, memory switching devices, switching, optical devices, etc. [1–3]. According to the literature review [4–7], the thermal, physical, and electrical transport mechanisms of glass nanocomposites are known to be strongly reliant on their structure. The physical and other properties of the glassy system can be altered or improved due to the formation of new nanocrystallites that provide flexibility in various technological applications. The configuration of the vanadate glassy system can also be modified by varying network formers and network modifiers [8,9]. Despite the importance of such research in understanding the short-range order has already been reported [8,9], the characteristics of various kinds of defects present inside TMO-doped glass nanocomposites have never been thoroughly investigated.

Through this paper, we report the study of the evolution of several types of defects formed in glass nanocomposite systems, along with their microstructural characteristics. Conventional experimental techniques like X-ray diffraction (XRD), Transmission electron microscopy (TEM) have been utilized to get information on the macroscopic aspects. The outcomes of XRD and TEM are used to explain the structural modifications that occur during the incorporation of V_2O_5 at different stages. However, a defect-specific and highly-sensitive investigative tool, positron annihilation spectroscopy (PAS), is used to recognize and observe the evolution of various kinds of defects within the structure. PAS is a non-

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Review article | Published: 16 July 2021

An Analytical Review on Rough Set Based Image Clustering

Krishna Gopal Dhal, Arunita Das, Swarnajit Ray, Kaustav Sarkar & Jorge Gálvez

Archives of Computational Methods in Engineering **29**, 1643–1672 (2022)

Abstract

Clustering is one of the most vital image segmentation techniques. However, proper image clustering has always been a challenging task due to blurred and vague areas near to concerned object boundaries. Therefore, rough set based clustering techniques like Rough k-means (RKM) has been employed in image clustering domain because rough set concept can handle the overlapping clusters to a great extent. RKM shows the performance in image clustering domain as a similarity based clustering model like K-Means and Fuzzy C-Means. Therefore, this paper presents an up-to-date review on rough set based image clustering approaches with their merits and

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A convolutional neural network-driven computer vision system toward identification of species and maturity stage of medicinal leaves: case studies with Neem, Tulsi and Kalmegh leaves

Gunjan Mukherjee, Bipan Tudu & Arpitam Chatterjee

Soft Computing **25**, 14119–14138 (2021)

Abstract

Medicinal plants are used to cure different common and chronic diseases in different Asian countries including India. The easy availability and planting possibility make them popular resources for alternative medicinal practices like Ayurveda. These medicinal plants possess proven healing potential without causing any side effects. The biochemical constituents of the medicinal leaves are the fundamental reasons of their healing power which considerably vary with maturity. The existing practices of maturity detection are largely based on chemical analysis of leaves through different

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TECHNICAL ARTICLE

Induction Welding of 304L Stainless Steel and Copper in Vacuum Environment

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Welding of dissimilar metals like copper and 304L steel which is very difficult to achieve, was successfully carried out by induction welding in partial vacuum condition. Microstructural and spectroscopic analysis suggests a sound, crack and pore-free joint with diffusion of Fe and other alloying elements of steel in Cu side. Microhardness distribution suggests enhancement of copper microhardness near the interface. The interface microhardness and ultimate tensile strength of the joint as well as the elongation are improved with increase in current and load. The results indicate that the vacuum environment is beneficial in terms of tensile strength of the welded joints. Within the range of the present study, maximum tensile strength of about 97.92% of the un-welded copper is obtained for welding with 650 A and 2.5 kg load.

Keywords copper, induction welding, microhardness, microscopy, steels, tensile, vacuum

1. Introduction

The possibility to achieve sound welding between dissimilar materials provides design flexibility in many engineering applications. High thermal and electrical conductivity of copper and good strength of stainless steel make their combination very efficient in nuclear and power generation industries. Various welding techniques have been adopted over the years to obtain proper welding between copper (Cu) and stainless steel (SS). Fusion welding of these two materials may lead to crack formation due to huge difference in thermal expansion coefficient of the materials (Ref 1, 2). Laser beam heating, which is often used for surface treatment (Ref 3), is found to be the most successful technique in the field of dissimilar joining. However, the requirement of offset heating (Ref 4), edge preparation (Ref 5) and grain growth in Cu side (Ref 6) are some familiar aspects in laser beam welding (LBW) of copper and steel. Tosto et al. (Ref 7) obtained sound joint of copper and stainless steel without any microfissuring or porosity by using electron beam welding (EBW) technique. In another study, porosity at the copper side and microfissures in between steel and fusion zone were identified, while EBW of copper alloy and stainless steel of different grades (Ref 8). Ballistic impact joining (Ref 9), electromagnetic impact welding (Ref 10), diffusion welding (Ref 11), explosive welding (Ref 12), friction welding (Ref 13), tungsten/metal gas suspended arc welding (Ref 14) and TIG-MIG double-sided arc welding (Ref 15) are some recent nurturing joining processes used for Cu-SS welding. Although those processes were able to produce high strength joint, porosity at weld interface was unavoidable.

Induction welding of steel pipes is a widely used technique from past years (Ref 16). The research on application of induction heating is mainly focused on brazing of dissimilar metals (Ref 17, 18) or welding of polymer matrix composites (Ref 19). More recently, a few researches were carried out to incorporate the induction heating technique in composite fabrication field. Chen et al. (Ref 20) employed induction heating to fabricate CNT-reinforced microelectrodes. Mitschang et al. (Ref 21) presented a comprehensive study on the spot welding of metal/CFRPC joints by induction welding. However, literature on welding of dissimilar metals without any filler material by induction heating is very limited. The induction welding of copper and steel resulted in moderate joint strength due to the presence of porosity at the welding zone (Ref 22, 23).

Katayama et al. (Ref 24) performed LBW of A5083 and 304 stainless steel in vacuum environment and found that porosity was entirely eliminated at the welding zone by increasing the vacuum pressure. Also, the more was the vacuum pressure, the more was the depth of penetration (Ref 24, 25). Moreover, during laser welding of copper in vacuum, porosity and inner weld defects were reduced by reducing operating pressure to 0.2 hPa (Ref 26).

Literature study indicates that copper and stainless steel were welded by induction welding technique in ambient condition. However, the welding can be conducted in vacuum condition in order to enhance the joint properties. Hence, in the present study, induction welding of AISI 304L stainless steel and copper was carried out in partial vacuum condition. The joint morphology and constituents in the interface were studied. The weld quality was examined by means of ultimate tensile strength (UTS) and microhardness. The effect of process parameters on mechanical properties of the joints was examined.

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Characterization of novel molybdenum disulfide and cerium dioxide reinforced hybrid aluminum matrix composites fabricated by friction stir processing

Charakterisierung neuartiger molybdändisulfid- und ceriumdioxidverstärkter hybrider Aluminiummatrix-Verbundwerkstoffe, hergestellt durch Rührreibverfahren

P. Maji[1], S.K. Ghosh[1], R.K. Nath[1], P. Paul[1], R.K.B. Meitei[1]

Aluminum matrix composites are widely used for making structural components in the aerospace and automobile industries. In order to sustain the operational demand, excellent anti-wear and corrosion resistance properties are required in the composites. To achieve this, molybdenum disulfide and cerium dioxide reinforced hybrid aluminum-based composites are fabricated by friction stir processing at different rotational speed and number of passes. Due to grain refinement and better particle distribution at high rotational speed and 2 pass, tensile strength and microhardness improves by sacrificing ductility. However, deterioration of mechanical properties than the as-received alloy is evident in all the composites due to dissolvement of strengthening precipitates. With increasing tool rotational speed, severe adhesion type of wear shifts to abrasion wear and the wear resistance also improves. All the composites show similar corrosion behavior as the unprocessed alloy. However, the corrosion parameters such as corrosion potential and corrosion current density were influenced by processing conditions. The composite produced with 1500 min^{-1} and 2 pass exhibits highest wear and corrosion resistance.

Keywords: Metal matrix composites **/** friction stir processing **/** mechanical behavior **/** wear **/** corrosion

Schlüsselwörter: Metallmatrix-Verbundwerkstoffe **/** Rührreibverfahren **/** mechanisches Verhalten **/** Verschleiß **/** Korrosion

1 Introduction

With increasing demand of weight reduction in engineering materials, composites are gaining constant attraction since last few decades. Powder metallurgy and stir casting are some very popular conventional composite fabrication techniques [1–6]. However, existences of some common defects such as porosity, poor distribution of particles, grain growth and presence of intermetallic at matrix-reinforcement interface etc. in the composites are extensively observed in earlier literatures [1–8]. Friction stir processing was initially developed for grain refinement in alloys. The intensity of grain refinement is controlled by the degree of recrystallization which depends upon the amount of heat generation and cooling rate of the processed specimens [9–11]. However, recently this process has

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An Overview on the Development and Research Work on Coconut Shell as an Aggregate

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Abstract: ***Different waste materials such as fly ash, silica flumes, blast furnaces slag are used in concreting. Aggregate is a major ingredient for making concrete, occupy almost 70 - 80% part of concrete[1]. Conventionally crushed rocks are used as coarse aggregate and river sand used as fine aggregate. Due to rapid growth of construction activities, conventional aggregate sources are depleting very fast leading to significant increase in cost of Construction. This has necessitated research for alternative cost effective materials in construction. The paper aims about the partial replacement of crushed coconut shells as a substitute of conventional aggregate. It may help to produce concrete economically and at the same time also will help to reduce its disposal problem.***

Keywords: coconut shell, concrete, coarse aggregate, compressive strength, waste disposal.

I. INTRODUCTION

Infrastructure development across the world created demands for construction material. Concrete is the premier civil engineering material. Concrete manufacturing involve consumption of ingredients like cement, aggregates, water & admixtures. Among all the ingredients, aggregates form the major parts. In addition, concrete is the 2nd most consumed substance in the world-behind water. About 7.23 billion tons of concrete is produced every year. Annual production represents one ton for every person on the planet [2].
The large scale production of concrete in construction activities using conventional coarse aggregate such as granite immoderately reduces the natural stone deposits and affecting the environment hence causing ecology imbalance. Increasing demand of natural aggregates show that crushed stone demand will be 2050 million metric tones in 2020[2]. In this contemporary world civil engineering construction, using alternative materials in place of natural aggregate in concrete production makes concrete as sustainable and environmentally friendly construction material.

II. COCONUT SHELL AS AN AGGREGATE

Coconut is grown in more than 93 countries. India is the third largest, having cultivation on an area of about 1.78 million hectares for coconut production. Annual production is about 7562 million nuts with an average of 4248 nuts per hectare[3]. The chemical composition of the coconut shell is similar to wood 4248 nuts per hectare[3]. The chemical composition of the coconut shell is similar to wood. The chemical composition of the coconut shell is similar to wood. It contains 33.61% cellulose, 36.51% lignin, 29.27% and ash at 0.61%. Concrete obtained using coconut shell as a coarse aggregate satisfies the minimum requirements of concrete. Coconut shell aggregate resulted acceptable strength which is required for structural concrete. Coconut shell may present itself as a potential material in the field of construction industries. The coconut shell is compatible with cement and no need to pre-treatment for using it as an aggregate. Because of the smooth surface on one side of the shells presents better workability and also shows good impact resistance. As compared to conventional aggregate water absorbing and moisture retaining capacity of coconut shell is more. The presence of sugar in the coconut shell, does not affect the setting and strength of concrete because it is not in a free sugar form. It is found that wood based materials being hard and of organic origin, will not contaminate or leach to produce toxic substances once they are bound in concrete matrix.

III. RESEARCH FINDINGS

A few studies are done on coconut shells and the outcomes of the researches are as following:-
Olanipekun (2006) carried out the comparative cost analysis and strength characteristics of concrete produced using crushed, granular coconut and palm kernel shell as substitutes for conventional coarse aggregate. The main objective is to encourage the use of waste products as construction materials in low-cost housing. Crushed granular coconut and palm kernel was used as substitute for conventional coarse aggregate in the following ratios: 0%, 25%, 50%, 75% and 100% for preparing of mix ratios 1:1:2 and 1:2:4. Total 320 cubes were casted, tested and their physical and mechanical properties were determined.

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