Effect of substrate temperature on the microstructural and optical properties of RF sputtered grown ZnO thin films

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ABSTRACT

This study investigates the effect of substrate temperature ranging from 30 °C to 150 °C on micro-structural and optical properties of ZnO thin films. RF sputtering method is used for the deposition of thin films on p- type Si substrate. The X-Ray Diffraction (XRD), Atomic Force Microscopy (AFM) and Scanning Electron Microscopy (SEM) study is used for the investigation of different micro-structural and surface morphological properties of ZnO thin films. XRD results portrays hexagonal wurtzite structure, indices (0 0 2) preferred orientation thin films. UV–VIS-NIR spectroscopy and photoluminescence spectroscopy are employed to find the optical parameters of deposited ZnO thin films. It has been observed that the deposited thin films are highly transparent with the transmittance greater than 85% and their refractive index varying from 1.75 to 2.75 as the substrate temperature changes from 30 °C to 150 °C. Various opti-cal parameters like transmittance (T), absorption (A) and their outcomes are also examined and reported. The optical band gap shows a marginal variation from 3.22 eV to 3.26 eV.

1. Introduction

Zinc Oxide (ZnO) has turned up as the most promising material among various II-VI group oxides, due to its excellent electronic, optical, magnetic and chemical properties and its potential device application in various fields. Its low cost, abundant availability in nature, wide band gap (3.37 eV), high absorption in UV region, non-toxic nature, high exciton binding energy (60 meV) [1–2], high mobility (2.5 cm^2 V^{-1} sec^{-1}), makes a solid platform for variety of applications like chemical sensors, Light Emitting Diode (LED), Thin Film Transistor (TFT), clear and flexible displays [3–5], piezo-electric nano-generators [6] and in solar cells.

Various deposition techniques like chemical vapor deposition (CVD), pulsed laser deposition, electro-deposition, sol–gel, and RF sputtering were earlier reported by researchers for depositing ZnO thin films [7–8]. In all the above methods some needs high temperature in order to prepare thin film, some other are toxic and some are complex processes. So among these all, RF sputtering is the most encouraging technique for depositing ZnO thin film because of its controlled growth process. The deposition process using RF sputtering also assures highly stable and repeatable films. Apart from this, it also ensures c-axis crystal growth and large grain size which improves carrier transport with good controllabil-ity and conformity [9].

Now a days, researchers giving considerable attention towards study and understanding of nano-dimension thin films. They are tracking the difference in the microstructural, optical and electrical behavior of the materials by switching substrate temperature. In past, researchers reported variation of functional ZnO thin film properties with thickness, pressure, substrate type and annealing temperature [10]. In order to ensure ZnO thin film compatibility for a variety of optoelectronic and piezoelectric device applica-tions, effect of substrate temperature plays a vital role. The aim of present work is to report a systematic study about the influence of substrate temperature (30 °C, 50 °C, 100 °C, and 150 °C) on microstructural and optical parameters of Zinc Oxide thin films.

2. Experimental procedure

In first step, p-Si substrate was cleaned using standard RCA method [11]. The nano crystalline ZnO thin films were deposited

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Effect of Top Electrode Materials on Switching Characteristics and Endurance Properties of Zinc Oxide Based RRAM Device

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This work reports the effect of top electrode materials, i.e., Al, Ag, and Ti on the switching characteristics of resistive random access memory (RRAM) devices based on zinc oxide (ZnO) thin film. The RRAM devices with Si/Pt/Ti/ZnO/Top electrode (Al or Ag or Ti) structure were successfully fabricated, and their switching characteristics were measured. The structural properties of ZnO metal oxide thin film were studied using X-ray diffractometer (XRD), atomic force microscopy (AFM) and scanning electron microscope (SEM). The switching characteristics of the fabricated devices were measured with the help of I-V curves, which were measured using semiconductor parameter analyzer. It has been observed that the manufactured devices have exhibited bipolar properties. The Si/Pt/Ti/ZnO/Ag structure has shown the best endurance up to 10^3 cycles. Further, the measurement of retention properties at room temperature was also done for Si/Pt/Ti/ZnO/Ag structured device, which confirms the non-volatile properties of the obtained devices. The ratio of low resistance state (LRS) and high resistance state (HRS) was found maximum for Ag top electrode up to 10^2. It has been observed that LRS and HRS currents of the device do not degrade up to 10^4 s.

Keywords: RRAM, Switching characteristics, Top electrode, ZnO.

1. INTRODUCTION

Due to the recent advancements in CMOS and other semiconductor devices, semiconductor memories are in huge demand. The memory occupies a significant portion in an IC, so it should be smaller in size, power efficient and stable. Due to the scaling in CMOS technology, the size of these conventional memories is reducing and now has reached a saturation point. The scaling has also increased the leakage power in CMOS circuits. To overcome the limitations of traditional memories and to bring advancement in new technologies like IoT and big data applications, the memories should be dense, power efficient and robust [1]. Existing non-volatile memory technologies like flash memories are charge storing memories and have now reached its physical limits [2]. Hence, nanoscale memories, which do not work on charge storing like FeRAM, MRAM, PCRAM, and RRAM, have drawn a significant interest of researchers for future non-volatile memories [3-6]. RRAM is a potential candidate for future memories due to its modest components, extraordinary compactness, low power, and exceptional scalability [7]. The device structure of RRAM is a capacitor like configuration with a metal-insulator-metal (M-I-M) structure. It is observed that the resistive switching occurring in the M-I-M structure can be changed by an electrical signal applied to it [8]. Recent reports on memory arrays are focused on the metal oxide-based RRAM due to the ease of the materials and exceptional compatibility with the fabrication procedure of CMOS.

The working principle of RRAM is established on the reversible resistive switching RS mechanism between two stable resistance states, which are low resistance state (LRS) and high resistance state (HRS). This reversible switching happens in transition metal oxides with the M-I-M configuration. There are two types of switching memories related to electrical polarity i.e. unipolar and bipolar [9]. The process, which brings variation in the resistance states of the device, i.e., from HRS to LRS is called SET process, while the variation from LRS to HRS is known as RESET process. An explicit resistive state (HRS or LRS) can be reserved after the cancellation of electric stress that specifies the non-volatile nature of RRAM. Generally, in the initial resistance state of a fresh sample, a higher voltage (more than the set voltage) is required to initiate the resistive switching behavior. This process is known as forming/electroforming process.

The mechanism of switching in the unipolar RRAM device is described as the formation of conductive filament when voltage is applied, which sets the device into a LRS. The Joule heating produced is responsible for rupture back to HRS. The polarity of the applied current does not affect the Joule heating effect, but its amplitude does. This type of devices shows unipolar switching behavior. Since switching direction is dependent on the applied voltage polarity in a bipolar RRAM, different polarity is used for erasing and writing the data. To circumvent the dielectric breakdown in every switching

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An Automated Optimize Utilization of Water and Crop Monitoring in Agriculture Using IoT

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Abstract. AI Solution for Farmers is an agricultural based project, created to help farmers and to help them in increasing their productivity. Since the technologies are running the world, why agriculture must be deprived of it. Agriculture is one of the most important areas that have major impacts on the economy and society of a country. Technological developments serve as tools to share knowledge and practices of agricultural products and make more satisfactory lives for farmers, traders, policymakers, and the overall society. It is evident that knowledge has become a crucial component in production, society, food security, health, poverty, and other millennium development goals. The use of technology may provide a better approach to solve the problems arising from sowing the seed to harvest the crop. The new technologies like Machine Learning and Data Science may be great help to have an eye on the deciding factors to the growth of crop.

Keywords: IoT, Sensors, Raspberry-PI, Microcontroller, Wi-Fi.

1. Introduction

An intelligent system to utilize internet of things (IoT) to monitor a plurality of crops in an agriculture field and further enables a farmer to manage the crops and the agriculture field in real-time is provided substantially, as shown in and/or described in connection with at least one of the figures, as set forth more completely in the claims.

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Abstract:

Background and Objective: Spatial queries frequently used in Hadoop for significant data process. However, vast and massive size of spatial information makes it difficult to process the spatial inquiries proficiently, so they utilized the Hadoop system for process the Big Data. Boolean Queries & Geometry Boolean Spatial Data for Query Optimization using Hadoop System are used. In this paper, a lightweight and adaptable spatial data index for big data have discussed, which have used to process in Hadoop frameworks. Results demonstrate the proficiency and adequacy of spatial ordering system for various spatial inquiries.

Methods: In this section, the different type of approaches are used which helps to understand the procedure to develop an efficient system by involving the methods like efficient and scalable method for processing Top-k spatial Boolean Queries, Efficient query processing in Geographic web search engines. Geographic search engine query processing combines text and spatial data processing technique & Top-k spatial preference Queries. In this work, the implementation of all the methods is done for comparative analysis.

Results and Discussion: The execution of algorithm gives results which show the difference of performance over different data types. Three different graphs are presented here based on the different data inputs indexing and data types. Results show that when the number of rows to be executed increases the performance of geohash decreases, while the crucial point for change in performance of execution is not visible due to sudden hike in number of rows returned.

Conclusion: The query processing have discussed in geographic web search engines. In this work a general framework for ranking search results based on a combination of textual and spatial criteria, and proposed several algorithms for efficiently executing ranked queries on very large collections have discussed. The integrated of proposed algorithms into an existing high-performance search engine query processor and works on evaluating them on a large data set and realistic geographic queries. The results shows that in many cases geographic query processing can be performed at about the same level of efficiency as text-only queries.

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Low-cost novel designed receiver heat exchanger for household solarized cooking system: development and operationalization

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Abstract

Solar energy is widely regarded as the most promising renewable energy source available, and it is used for a variety of purposes. Out of various applications of solar energy, it has predominantly been suggested for cooking in the last three to four decades. High cost and non-customer focus design of the solar cooker is predominantly suggested as it acts as a barrier to actualization of solar cooking as a usual cooking practice. To keep in mind, this paper presents a proposed part design of a custo̶m̶i̶z̶e̶d̶ ̶s̶o̶l̶a̶r̶

Study on some aspects of adoption of Solar Cooking System: A review

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Abstract

In developing and under-developed nations, the cooking industry is one of the most energy-intensive industries. Although cooking methods have been vastly improved, society has depended heavily on biomass for its kitchen needs since the dawn of civilization. Innovative cooking technology (methods) is now becoming progressively common because of the negative effects and energy wastages in traditional biomass cooking systems. Because of our reliance on rapidly depleting fossil fuels, we have been pressured to turn to alternative energy sources, and solar energy is often the best solution due to its

Optical gain characteristics of GaAs based type-II AlAsSb/InGaAs/GaAsSb nanoscale heterostructure for near infrared applications

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In this work, a nanoscale-heterostructure with composition layers AlAsSb/InGaAs/GaAsSb is designed on a GaAs substrate. The associated wavefunctions, dispersion profile, behavior of dipole transition matrix elements and optical gain have been evaluated. The heterostructure is modeled using 6 band $k \cdot p$ method by solving the 6 × 6 Luttinger-Kohn Hamiltonian. At room temperature, the optical gain of around 6500 cm^{-1} is obtained at the 1460 nm wavelength for injected carrier concentration of 5 x 10^{12}/cm^2. The effects of the externally applied strain and temperature are also investigated for the possible tuning of optical gain and wavelength in the NIR range.

1. Introduction

In today's technological landscape, optoelectronic devices such as LASERs, LEDs, optical waveguides and directional couplers are playing a major role in the field of optical communication [1, 2]. Semiconductor lasers are based on semiconductor gain media, where stimulated emission is used to achieve optical gain under the effect of large carrier density. In semiconductor lasers, the foremost concern is a very large effective mass of valence band due to the high asymmetry between the lower and upper conduction band mass of III-V semiconductors which essentially must be as small as possible [3]. Semiconductor lasers can be designed by using heterostructures which involve quantum confinement, varying alloy compositions and mismatching of strain so that one can achieve diverse optical and electronic properties. The laser using the heterojunction i.e. junction of two different materials was first suggested by a German-born physicist Herbert Kroemer [4]. He suggested that using heterostructure the population inversion can be enhanced for stimulated emission. In semiconductor physics, the effective mass approximation is widely used for parameterization of bulk crystals using well known time-independent Schrodinger's equation. Band structure calculations can be done on alloy compositions and strained layers to improve the performance of the device for their application in optical communication. So far, theoretically and experimentally numerous research works have been done in order to develop highly efficient lasing heterostructures based on the type –I (straddling gap) and type-II (staggered gap) energy band alignments. The

energy efficiency of heterostructure lasers can be optimized under the effect of external electric field, temperature and pressure [5-11]. The band alignment and the optical gain calculation for nanoscale In$_{0.3}$Ga$_{0.7}$As/GaAs$_{0.4}$Sb$_{0.6}$ heterostructure has been examined and it has been shown that the optical characteristics of the heterostructure can be altered under the effect of external uniaxial strain due to changes in the effective mass of the valance band [12]. H.K. Nirmal et al. [13] also reported the tunability of the optical gain and emission wavelength with the uniaxial pressure of 2, 5 and 8 GPa respectively. The emitted light polarization TE/TM modes are also sensitive to the external tensile strain due to change in the symmetry of wavefunctions and the possible photonic momentums in the quantum wells [14]. Baile Chen et al. [15] reported that at room temperature addition of Bi composition into InGaAs/GaAsSbBi can extend the lasing wavelength without affecting the peak gain value. Consequently, different approaches for the extension of detection wavelength have been presented which includes strain or pressure effect, by changing the compositions of quantum well layers and by changing the quantum well thickness for MWIR (3–8 μm), SWIR (1.5–3 μm), and NIR (0.75–1.5 μm) applications. A quantum well structure operating in the NIR region finds application in the field of optical fiber communication [16], spectroscopy [17], routine analysis of agricultural and food products for quality control [18], medical science for diagnosing diseases [19] etc.

In this paper, a novel type-II nanoscale heterostructure of AlAsSb/In$_{0.59}$Ga$_{0.41}$As/GaAs$_{0.53}$Sb$_{0.47}$ composition is proposed on GaAs substrate for near-infrared emission.

Electrical transport properties of thermally stable n-ZnO/AlN/p-Si diode grown using RF sputtering

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Abstract

The temperature dependent electrical transport properties of n-ZnO/AlN/p-Si heterojunction diode fabricated by RF sputtering system have been investigated over a wide temperature range of 303 K–413 K. The AlN buffer layer in-between ZnO and Si lowers the mismatch in thermal expansion coefficient/lattice constant for improved electrical and structural characteristics. XRD pattern and FESEM confirm the crystalline nature and good quality of ZnO thin film with uniform grain size and crack free structure respectively. As measured from the temperature

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A hybrid cluster technique for improving ....

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A hybrid cluster technique for improving the efficiency of colour image segmentation

Ankit Kumar   , Linesh Raja   , Pankaj Dadheech   , Manish Bhardwaj

Abstract   PDF

Abstract

Image segmentation is a wide area for researching, and in many applications, segmentation is applied for finding the distinct group in the feature space. It separates the data into different regions or clusters, and each one is homogeneous. The current algorithm, which is proposed approach for noise reduction, eliminates most of the noise from the input image. This noise concerns to cut boundary of the noise full image. The result shows that it is very efficient in segmenting the image and reduces the time complexity. The proposed algorithm can be used in object deduction or in object analysing in image processing. The segmentation of image proceeds by using combination of different segmenting approach in 3-D RGB colour-space. Clarity of the output segmented image is better in comparison to other segmentation techniques of the image. Clarity of the output image is depending on the number of clusters used.

Keywords: data mining, image processing, classification, image segmentation, clustering, k-mean cluster

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- Manish Bhardwaj

ON CERTAIN FRACTIONAL KINETIC EQUATIONS INVOLVING LAGUERRE POLYNOMIALS

DEEPIKA JAIN AND ALOK BHARGAVA[1]

ABSTRACT. The purpose of the following paper is to calculate the solution of the fractional kinetic equation pertaining to Laguerre Polynomials. We obtained their solutions in expressions of the Mittag-Leffler function and interpreted their pictorial representation to discuss the nature.

1. INTRODUCTION

In recent years, we have been used distinct patterns of fractional kinetic equations in describing and solving essential questions of science. The time-dependent quantity $N(t)$ is an absolute response, then we can work out the rate $\frac{dN}{dt}$ by the following expression

$$(1.1) \qquad \frac{dN}{dt} = -D + P,$$

where D denotes the destruction rate and P denotes the production rate of N. Normally, D and P depend on $N(t)$ themself: $D = D(N)$ and $P = P(N)$. But this dependency is complex as the destruction or production at time t not only depends on $N(t)$ but also by the past research, i.e., $N(\omega), \omega < t$, of variable N. This can be explained through the mathematical expression:

$$(1.2) \qquad \frac{dN}{dt} = -D(N_t) + P(N_t),$$

Design and modeling of InGaAs/GaAsSb nanoscale heterostructure for application of optical fiber communication system

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ABSTRACT

In this paper, we have designed and theoretically analyzed InGaAs/GaAsSb nanoscale heterostructure, where InGaAs is quantum well material and GaAsSb is the barrier material. The proposed design is modeled using the 6 band k.p. method to find the wave functions and optical gain. An optical gain of 6220/cm is obtained at 1550 nm wavelength. The entire structure has been modeled on the GaAs substrate at room temperature 300 K. Due to the low attenuation of silica made optical fiber at 1550 nm wavelength, the designed heterostructure can be used for fiber optics applications.

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1. Introduction

In today's era, optoelectronic or optronics devices such as LEDs, laser diodes, directional couplers and photodetectors are enhancing themselves in fields like telecommunication, biomedical, pollution monitoring tools, etc [1,2]. Optronics devices are designed and fabricated for applications in SWIR (short-wave infrared), MWIR (mid-wave infrared) and NIR (near-infrared). Hence, the choice of material and the bandgap have a prime part in the emission of light for a particular wavelength. The material bandgap adaptation can be possible by the use of compound semiconductors, the use of quantum well structure and the use of strain layer epitaxy [3–5]. The reason to use ternary and quaternary compounds is to form lattice-matched heterostructure. Heterostructure can be formed with the interface and junction that take place between the layers of different bandgap semiconductors. The semiconductors involved in heterostructure have different bandgap energy. Heterojunctions can be formed with precise control on layer thickness using the molecular beam epitaxy and chemical vapour deposition technologies. Now a days, heterostructures based devices are finding its application in designing and fabrication of advanced electronic devices like resonant tunneling devices, optronic devices like optical sources and optical components like waveguides and mirrors.

In semiconductor physics depending on the bandgap, semiconductors are characterized as direct and indirect bandgap. To understand this (E, k) diagram is used. In a direct-bandgap semiconductor, the conduction band to valence band transition of the electron is shortest on the same propagation constant (k). Whereas, in indirect-bandgap semiconductor, the lowest conduction band energy and top of valance band energy lies at different values of k. For the designing and manufacturing of optoelectronic devices, direct-bandgap semiconductors are used due to the favorable recombination of the charge carriers [6]. In Fig. 1, the bandstructure diagram of a general semiconductor is shown. The valence band of a material comprised of three bands heavy-hole band (HHB), light-hole band (LHB) and split-off sub-band (SOB). Here we recognize the sub-bands on the basis of their effective mass. The effective mass of the heavy hole is higher than the light hole sub-band. Also, light hole bands have a larger energy slope compare to heavy hole bands. The split-off band is present far below the conduction band and is of less concern as the energy associated with split off-band is very small and can be neglected.

The main problem with semiconductor lasers is the high effective mass of valence-band. In semiconductors group III-V, this issue is common due to a high imbalance in the effective mass of charge carriers in valance and conduction bands. Recently, it is observed

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Mechanical and Durability Performance of Concrete Made with Waste Marble and Fly Ash

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ABSTRACT

In recent years, cement and marble industries have raised concerns regarding the adverse impact on the environment due to the release of carbon di-oxide and disposal of marble sludge, respectively. The amalgamation of marble sludge (fines) and cement-based products is favorable in the manufacturing of sustainable concrete. In this study, marble powder (MP) obtained from nearby cutting and polishing marble industries is used as a partial replacement for sand. Fly ash (FS) used as a partial substitute for cement is acquired from a nearby situated plant of ready mix concrete, Jaipur, Rajasthan, India. MP was added with an interval of five percent as 5%, 10%, 15%, 20% and 25% by weight of sand. FS was added in a percentage range of 0-50% with an interval of ten percent by weight of cement in the concrete blend. Mechanical and durability parameters in terms of slump, density, compressive strength, flexural strength, splitting tensile strength, water absorption, permeability and rapid chloride penetration test (RCPT) were evaluated for control and blended mixes. Scanning electron microscopy (SEM) was also performed for microstructure analysis for control, MP, and FS added to concrete. The results indicate that 10 % MP and 20% FS were the optimum percentages of replacement for sand and cement, respectively. Significant outcome obtained from the results will have a potential impact on the manufacturing of sustainable concrete with a solution to an environmental problem.

KEYWORDS: Marble powder, Fly ash, Mechanical properties, Durability properties, RCPT.

INTRODUCTION

Concrete is an amalgamation of aggregates, cement and water and an admixture that is extensively used in production industry (Gautam et al., 2014). Limestone is a major source in the production of cement. Approx. 0.90 ton of carbon di-oxide is produced in the environment due to the construction of one ton of cement (Woodson, 2012). Manufacturing industries produce around 500 Million tone (Mt) of concrete per year in India (Pathak, 2009). The mandate of cement is probably to accelerate with the petition of concrete in upcoming years. The annual production of cement in 2017 was around 366 (Mt) in India (IBEF India, 2016). CO_2 production due to the manufacturing of cement is of

great concern and can be overcome by using mineral admixtures (Naik, 2008). Waste marble causes health and environmental issues due to the emission of $Ca(OH)_2$ in the environment (Yang et al., 2015). In India, production of marble waste is around 3 million metric tons and out of this, 20-25 % is available as waste after quarrying and polishing (Montani, 2016; Aliabad et al., 2014; Aruntaş et al., 2010). Previously, investigators have considered marble waste as an alternative additive for cement in concrete mixes for construction works and building materials (Gesoğlu et al., 2012). The concrete casted with 10% diatomite as sand and 5% MP as partial replacement of cement showed an improvement in compressive strength (Shirazi, 2007). The use of marble dust as a cementitious material in self-compacting concrete showed an improvement in the workability of the blended mix (Ergün, 2011). Investigated use of 10 % of MP as a
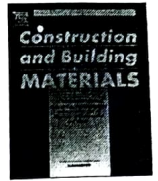
Durability performance of waste granite and glass powder added concrete

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HIGHLIGHTS

- Effect of waste granite and glass powder on durability of concrete was investigated.
- Waste granite powder was used as a partial substitute for sand.
- Glass powder was used as a partial replacement for cement.
- Combined effect of glass and granite indicated better durability performance of concrete.

ARTICLE INFO

ABSTRACT

Across the world, a large amount of waste is spawned from various industrial activities. Out of this huge quantity of waste, a little is recycled and rest is dumped in open lands. This paper deals with the use of potential solid waste in concrete, particularly granite powder originating from granite industries and discarded soda-lime glass powder obtain from waste glass bottles. Experimental study conducted in this research work examines the durability of blended concrete mixes, incorporating waste glass powder and granite powder at various substitution levels. The glass powder (GP) in 5%, 10%, 15%, 20% and 25%, and granite powder (GrP) in 10%, 20%, 30%, 40% and 50%, were added in the concrete mixes as a partial supplement of cement and sand, respectively. Durability performance of a series of blended mixes was evaluated for water absorption, water permeability, acid attack, sulphate attack, and rapid chloride penetration test (RCPT). Scanning electron microscope (SEM) and X-ray diffraction (XRD) were carried out for microstructure analysis. A significant improvement was observed in durability properties of concrete containing 15% GP and 30% GrP in place of cement and sand respectively. Results indicate improvement in water permeability and water absorption of glass granite blended concrete. Response of blended mix against sulphate and acid attack was quite better than control concrete mix. Value of RCPT was also encouraging for blended mixes.

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1. Introduction

Concrete is widely used for achieving strong and durable infrastructure, which helps in improving the quality of life of common people. For economic production of concrete, it should essentially be durable and sustainable. Durability aspect of concrete is directly connected with its long-term behavior against aggressive surrounding exposures. Keeping the issue of solid waste management in mind, which is of great concern in today's world, concrete produced utilizing such waste, will add to the benefit of society. These benefits will include, economical concrete production, reduction of landfill burden, improved air quality, riverbed protection due to excessive sand excavation, environmental issues related to manufacturing of cement and much more.

Available literature reveals that several solid wastes (stone industrial wastes, slag industrial wastes, paper industrial waste, agricultural wastes, plastic wastes) were used as cement [1], fine aggregate [2], coarse aggregate [3], filler [4], mineral admixture [5] and pozzolanic material [6] in concrete. These findings were recorded on various concrete performance parameters [1–6] and found better or comparable with traditional concrete mix. Long term behavior of concrete prepared with granite, silica sand, marble waste, and basalt, was better than traditional concrete

AusPat

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