Preface

Every industry, including engineering, medical, food safety, transportation, energy, and environmental science, is being revolutionised by new age nanoparticles and being made better. It is necessary to review the developments and difficulties in the field to ensure that companies fully capitalise on the prospects offered by new age nanoparticles.

Keeping this in mind, the book *Diversity and Applications of New Age Nanoparticles* discusses the creation of novel materials, synthesis techniques, and cutting-edge research in this area while taking into account recent advancements and applications of nanoparticles. This authoritative reference work is perfect for business professionals, computer scientists, policymakers, engineers, pharmacists, medical professionals, researchers, scholars, practitioners, instructors, and students. It covers important topics like antibiotics, thin films, battery technologies, and composites.

The book presents voice of editors and author from across the world. Everyone has attempted to present cutting edge latest research in the file of nanoparticles. There are thirteen chapter in the book catering various filed of nanoparticles such as eco-friendly and sustainable development, intelligent sensing using nanoparticles, nano-sized splines ferrites and its applications, bioactivity investigation of silver nano-particles, photo catalytic application, futuristic scope of Yttrium iron garnet, synthesis of nanoparticles from bio-waste, CdTe thin film development, carbon nanoparticles for energy applications, radiation shielding applications, commercialisation of piezoelectric nanoparticles, new age nanoparticles for health monitoring and development of quantum dots from waste.

Finally, all editors are grateful to team of IGI-Global team. The editors are grateful to all authors, across the world, for their outstanding contributions not only to this book, but also to the Development & Advancement Of Nanoparticles.

ORGANIZATION OF THE BOOK

Chapter 1: Application of Nanotechnology for Eco-Friendly and Sustainable Economic Development

Nanotechnology is the study of sub-micron particles (nm). Nanotechnology is today's most advanced technology. Nanotechnology has a favourable impact on sustainable development and global warming/climate change. Recycling garbage and removing pollutants from soil and water are two further uses. Bio-based nanoparticles have replaced synthetic chemicals and hazardous metals in industry. The in-

creasing digitalization of the economy is driving demand for ecologically sustainable 0D, 1D, and 2D nanomaterial microchips. Nanoparticles have a high surface-to-volume ratio and can communicate different properties. Nanotechnology can help achieve Zero Hunger, Good Health and Well-Being, Clean Water and Sanitation, Affordable and Clean Energy, Responsible Consumption and Production, and Climate Action.

Chapter 2: Intelligent Nanoparticles for Antibiotics Sensing – Nanoparticles for Sensing

Nanosensors are acquiring expanding consideration because of the need to identify and quantify synthetic and actual properties in hard to arrive at natural and modern frameworks that are in the nanoscale locale. The overviews of different sensors based on nanomaterials, arranged into three expansive categories: mechanical, electromagnetic, and optical nanosensors. Nanotechnology has led to the synthesis of nanostructures having unique properties like morphology, conductance, and optical properties. Nanostructures provide increased surface for reactivity and transduction signal due to increase in surface area to volume ratio. Herein we are discussing different nanomaterials; composites which is applied for exceedingly selective detection of analytes. The detecting ideas and their comparing benefits are talked about concerning their applications.

Chapter 3: Nano-Structured Spinel Ferrites and Their Applications as Antimicrobial Agents, Gas Sensors, and Dye Adsorbents

Ferrites–the electro-ceramic materials have been considered highly important magnetic materials for more than half a century. The crystal structure of ferrimagnetic oxides falls into one of the following categories: spinel, magnetoplumbite (hexagonal), garnet, and orthoferrite. The development of spinel ferrite nanoparticles (SFNPs) has become more popular owing to their fascinating properties, such as their potential adsorption properties, superparamagnetic behaviour, high stability, high value of resistivity, saturation magnetization, coercivity low power losses, and ease of functionalization. These advantageous features make them suitable for use in various applications. This chapter aims to discuss the structure, general properties, and some recent applications of spinel ferrites. Commonly used synthesis techniques for nanocrystalline ferrites are discussed. The applications of nano-structured ferrites like antimicrobial activity, gas sensors, and dye degradation are discussed.

Chapter 4: Plant Extract-Based Silver Nanoparticles and Their Bioactivities Investigations

Green synthesised nanoparticles are a new source of inspiration for clinical research, as this method uses natural materials such plant-derived materials for synthesis. Green nanoparticle synthesis using plant extracts is simple, inexpensive, chemicals, resulting in biologically active shape- and size-dependent products with no contaminants or by-products. Silver nanoparticles (AgNPs) have unique physiochemical properties and promising biological applications. To assess AgNPs' functionality, they must be characterized. Natural compounds found in plant extracts reduce and stabilise AgNPs. Green synthesis

is more environmentally friendly than conventional methods, but many questions remain. To understand the plant-mediated process, many studies are needed. This proposed book chapter examines the synthesis, characterization, and bio activities of green-synthesised AgNPs. The goal is to provide an overview of green AgNP synthesis and their bioactivity assessment.

Chapter 5: Smart Nanomaterials for Photo-Catalytic Applications

Smart nanomaterials are grabbing more significant attention. Photocatalysts are catalysts that can be stimuli by light with an appropriate wavelength. Photocatalysis is deemed to be a promising approach for the utilization of photo energy and has been extensively studied for many processes. Therefore, the synthesis of nanomaterials with tailored-made catalytic characteristics, are of great importance. For applications using visible light and hence solar energy, the modification of photocatalysts can occur via the formation of heterojunction nanocomposites by inhibiting the recombination of charge carriers. These applications are driven by solar energy, which is conducive to the sustainable development of energy resources with no impact on the environment. This chapter will include recent enhancements in the smart nanomaterials for photocatalytic applications, especially in the fields of removing environmental pollutants, self-cleaning surfaces, water splitting for hydrogen production to provide clean fuel resources, selective alcohol oxidation and CO2 reduction in the environment.

Chapter 6: Yttrium Iron Garnet (YIG) – A Nanomaterial for Tomorrow

A cluster of silicate minerals known as garnet is widely used as abrasives and gemstones, has now find an application as smart nonmaterial. The garnet possesses a unique feature of having different chemical composition with similar crystal form and physical properties. Yttrium iron garnet (YIG) also popularly known as iron yttrium oxide, is an example of lab grown garnet. It can have chemical composition of Y3Fe5O1 or Y3Fe2(FeO4). The YIG exhibits a ferrimagnetic nature. with a Curie temperature of 560 K. The chapter focuses on the research around YIG with a mention on fabrication methods and applications.

Chapter 7: Synthesis Nanoparticles of SiO2 From Rice Husk and Its Industrial Application

Rice, which provides a major source of food for billions of people, covers 1% of the surface of the earth. Rice husk (RH), the outer covering of paddy rice, is an important by-product during the milling process and residue ash is generated after the burning of RH and the ash is called rice husk ash (RHA), which is a primary waste material in the agricultural industry. The main components in RH are lignin, cellulose, and hemicellulose, which are generally named lignocellulose. RH also contains ca. 15 to 28 wt% of silica. The high content of silica in RH presents opportunities for the preparation of value-added silicon-based materials. Since the 1970s, various silicon-based materials, including silica, silicon carbide, silicon nitride, silicon tetrachloride, zeolite, and silicates, have been successfully synthesized using RH as the silicon source. This field of research has been significantly advanced and expanded in the past decade spurred by the global attention on sustainable and renewable resources.

Chapter 8: Development and Characterization of As-Deposited CdTe Thin Films in a Non-Aqueous Medium

Cadmium telluride (CdTe) is a binary II-VI direct band gap semiconducting material. Cadmium telluride is a promising electrochemical and photovoltaic material for thin film solar cells. It shows both p and n type conductivity. A nanocrystalline thin film of CdTe was deposited on nickel plate by chemical bath deposition method containing 0.01M Cadmium acetate and 0.02M tellurium dioxide. The Structural, Compositional and Optical analysis were studied by X-ray diffraction (XRD), Energy-Dispersive X-ray Spectroscopy (EDS), Scanning Electron Microscope (SEM), Fourier Transform Infrared Spectroscopy (FTIR) and Photoluminescence (PL).The diffraction peak observed at 2=23.59° with (111) plane indicate the crystalline phase of CdTe film. The average crystalline size is measured to be 7nm.Compositional analysis reveals the presence of both Cd and Te elements. The EDS Spectroscopy shows the ratio of Cd and Te is1:2 in case of as deposited film. The Photoluminescence peak is observed at 471nm.

Chapter 9: Effect of Carbon-Based Composites in Fast-Charging Battery Technologies

The need for electric vehicles and other portable devices globally, advancements in charging technologies, are inflection points in the evolution of upcoming batteries. The proper engineering of electrodes is essential for stability, lifetime and cyclability. Several materials have high theoretical capacity, i.e., Na, Al, Li, are desirable for next generation fast charging batteries. However, there are some drawbacks such as low columbic efficiency, dendrite growth and volume expansion restricting their practical applications. We organized many schemes and strategies for the engineering of these metal electrodes and electrolytes. The effect of many composite structures was found to improve the stability and cyclability. The carbon derivatives specially graphene, graphene oxide, carbon nanotube's, carbon fibre, graphite and their composites were studies and found to be the most suitable candidates for making the anode composite for better electrochemical performance of fast charging batteries.

Chapter 10: Nanoparticles as Fillers in Composites for X-Ray and Gamma-Ray Shielding – A Review

In last few decades, nanomaterials have gained enormous attention in scientific industry due to their tunable physico-chemical and biological properties with enhanced performance over their bulk counterparts. In particular, nanoparticles, have been extensively investigated for their usefulness in X-ray and gamma-ray shielding applications. Various elements and compounds, with high atomic number and effective atomic number respectively, have the potential to form nanoparticles that offer remarkable enhancement in the shielding performance. Composites, obtained by doping different nanoparticles into structural matrices (concrete, glass or polymers), not only possess striking thermo-mechanical properties but also are effective shielding materials to replace conventional lead shields. This review is an attempt to throw light on various aspects of nanoparticles and their influence on shielding effectiveness. We also summarize the experimental findings so as to highlight the potential underlying the radiation-matter interaction mechanism in nanostructured systems.

Chapter 11: Piezoelectric Smart Materials and Commercialization

This chapter provides an exhaustive review of piezoelectric smart materials and their applications for commercialization with the addition of recent research and breakthroughs. Piezoelectric smart materials convert electrical signals into mechanical stresses and vice versa. They are remarkably used in energy harvesting from different processes and diverse human activities. Piezoelectric materials are convenient, readily available, adaptable, and have a speedy recurrence reaction time. Smart piezoelectric actuators embedded into adaptive structures are significant. Recent progress in their applications is evident in the versatile smart wings present in an aircraft since they correlate with the overall effectiveness. In addition, a wide range of industrial applications, for example, diesel fuel injectors, quick responding solenoids, optical lenses, mechanical technology, vibrational damping, etc., utilize piezoelectric actuators. Further, this chapter aims to address the latest improvements in piezoelectric materials in connection to the realm of nanotechnology.

Chapter 12: Structural Health Monitoring by Electrical Resistance Change Method – Using Nanoparticles

Structural health monitoring (SHM) is widely used to examine the structural integrity of a structure to improve safety considerations, minimize maintenance cost, and avoid sudden breakdowns that might occur under various loadings under service conditions. Fiber reinforced polymer (FRP) composites are widely used in aerospace, automotive, marine, energy, infrastructure, Armor, and biomedical applications due to their high specific stiffness and strength, high degree of dimensional and thermal stability, and good resistance to corrosion. Thus, SHM of the damages developed in FRPs during service conditions is very crucial. However, traditionally used sensors for SHM in composites provide limited sensitivity and might negatively affect the structural integrity. Therefore, a self-sensing approach by evaluating the electrical resistance change (ERC) of FRPs have been successfully used by many researchers. The purpose of this chapter is to describe the ERC techniques using various nanoparticles such as graphene, carbon nanotube, expanded graphite, and carbon black.

Chapter 13: Synthesis and Characterization of Carbon-Based Quantum Dot From Rice, Sugar, and Aloe-Vera

Carbon quantum dots (CQDs), a novel class of zero-dimensional carbon nanostructures with diameters below 10 nm, have recently come into existence. Here, we have synthesized and analysed carbon-based quantum dots from aloe-vera, rice and sugar. The characterization of these quantum dots is done via UV-Visible spectrophotometer. The quantum dots which are made from chemicals are toxic and are harmful to both humans and animals. However, the carbon quantum dots (CQD) which we have synthesized in this research work are bio- compatible, less toxicity and has the property of high aqueous dispersibility. CQDs are being used in various fields of applications such as bio-imaging, medical diagnosis, bio-sensing, chemical sensing, photo catalysis, and photovoltaic devices etc. This study helps the scientific

community to understand the nature of carbon quantum dots and gives a brief idea of suitable materials that create CQD.

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