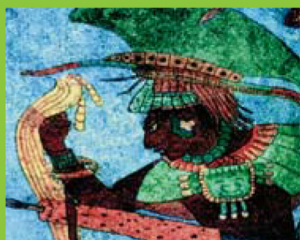
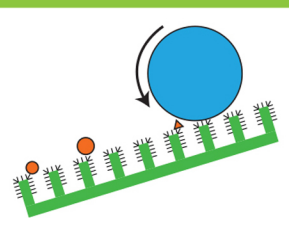


Narendra Kumar
Sunita Kumbhat

Concise Concepts of Nanoscience and Nanomaterials



Concise Concepts of Nanoscience and Nanomaterials

Dr. Narendra Kumar, former director & DRDO fellow (Min. of Defence, Govt. of India), obtained his Ph.D degree in 'Organometallic Chemistry' from Delhi University, he has a very rich experience of working on a variety of advanced materials including organometallics, liquid crystals, conducting polymers, nanomaterials together with evolving green synthetic routes for the preparation of metal salts by electrochemical, conducting polymers and nanomaterials in aqueous media and products based on some such materials even for defence applications. Dr. Kumar has published 110 research papers, including four review articles, in International Journals of repute in the areas of Nano Materials, Organometallics, Conducting Polymers, and Electrochemical Synthesis together with one Chapter in Encyclopedia on Nano Science & Technology and has 12 patents to his credit. He has co-authored two book "Nanotechnology and Nanomaterials in Treatment of Life Threatening Diseases" (Elsevier, USA, 2013) and 'Essentials in Nanoscience and Nanotechnology' (Wiley, USA, 2016). He also served as a visiting research associate of CSIR during 1992-95 and is a recognized supervisor of JNV University, Jodhpur for Ph.D. and Guided 6 students for the degree. He has delivered several invited talks on Conducting Polymers and Nanomaterials in several International and National Conferences/Seminars, Universities in Japan and USA. Recently, delivered 2nd Kalam Memorial Oration "Nanotechnology: Potential Applications in Military and for Rural Development" at DMSRDE, Kanpur.

He is recipient of 'DRDO Technology Award' for his pioneering research work on conducting polymers, DRDO Best Scientist of the Year Award, from the Prime Minister of India, for products based on conducting Polymers and nanomaterials for defence applications, and the national MRSI-ICSC Super Conductivity and Materials Science Annual prize by Materials Research Society of India. Dr. Kumar is the member of a number of scientific societies including the prestigious American Chemical Society and Material Research Society of India.

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Cover illustration : Carbon nanotube, an engineered nanomaterial as background.

‘Lotus Effect’ i.e. self cleaning mechanism in lotus leaves, represent nanotechnology in Nature. Mayan Painting made up of hybrid organic-inorganic nanocomposite of natural clay palygorskite and plant derived indigo dye, represent nanotechnology of ancient civilization.

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Preface

‘Nano’ refers to a size scale as one billionth of a meter (10^{-9} meters) and nanoscience is the study of objects/particles broadly in the size range of 1-100 nm and their unique properties. Nanomaterials and nanotechnology has been always existed in Nature in various forms both in living and non-living world. The fundamental building blocks of sustaining life, such as DNA, RNA, proteins, lipids, biomembranes are all nanostructured materials; bones, teeth, feathers, shells are beautiful examples of nature’s nanocomposite showing extraordinary characteristics. Nanoparticles found in interstellar dust, sediments, minerals, etc. are some example of nanomaterials in non-living species.

Though we have many examples of nanomaterials/ nanocomposites such as pigments, colloidal suspensions, unknowingly created by earlier generations, however the potential of nanoscale was projected by Scientific thinker like Richard Feynman (1959) and Eric Drexler (1980s) followed by National Nanoinitiative (NNI) taken up by US Government in 2001. Landmark discoveries of Scanning Probe Microscopies (Binning *et al.*, 1980s); Fullerenes (Smelly *et al.*, 1985) and CNTs (S. Ijima, 1991) gave impetus to the R & D activities in Nanoscience and Nanotechnology.

Past three decades have witnessed unprecedented growth in terms of synthesis, characterization of a wide variety of nanomaterials showing novel physicochemical and biological properties. Such properties have led to the technological applications of newer nanomaterial in diverse area concern with better health, wealth and security of mankind. Nanotechnology along with biotechnology and information technology have proved to be the cutting edge technologies of twenty first century. This is an area where different disciplines of science and technology converges while breaking their boundaries. The significance of nanoscience and nanomaterials calls for the students, budding scientists and industrialists to remain educated on fundamentals of nanoscience and updates on the recent advances in development of nanomaterials.

Present text book is an attempt to embodied the fundamental aspect of nanoscience and nanomaterials while including the latest developments in the

area. Book is divided in seven chapters; first chapter introduces the subject of nanoscience with various terms, definitions, nanoscience in nature, history and its transformation into nanotechnology. Second chapter gives comprehensive description of different categories of nanomaterials including inorganic, carbon based, organic, self-assembled supramolecular structures, nano-composites and nano-coatings. Third chapter of the book deals with the different synthetic strategies to prepare nanomaterials. Characterization of nanomaterials is spread over two chapters with an objective to generate a better understanding of newer developments in the area. Chapter four, deals with the spectroscopic and scattering techniques, whereas chapter five includes microscopic imaging techniques. Chapter six describes various physicochemical unique properties of nanomaterials evolved as a consequence of their nano size. Chapter seven deals with technological impact of nanoscience in diverse areas including consumer goods, health care, energy, information and computer technology; defence and security; environment and pollution control.

We believe that this book will generate and promote the basic understanding on the complex and revolutionary discipline of Nanoscience and Nanotechnology offered as core subjects for UG and PG courses in most of the academic Institution across the World.

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Sunita Kumbhat

March, 26, 2018
Jodhpur

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Narendra Kumar
Sunita Kumbhat

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