Nanotechnology bullet train has the power to take us to magical places we have barely even dreamed of, and the increased understanding of both its potential benefits and dangers will retain it on track allowing the journey toward newer discoveries to continue. Studies which contribute to this area by design paradigms enable the scientists to design innovative functional materials, and thus broadening the fields to address major societal needs and challenges. Among various nanostructures, Nano Titania possesses numerous unique features such as low cost, non-toxicity, good stability, favorable band edge positions, and facile preparation routes with diverse morphologies. The uniqueness in each lattice structure of titania bestows it with multifaceted physico-chemical and opto-electronic properties and thus provide different functionalities for their performance in various applications. Accordingly, synthesising crystalline titania with tunable phase/particle size/morphology has opened the grand research avenue. All the functional applications of \( \text{TiO}_2 \) fall in the scope of energy, environment and health, which are undeniably considered as the three important and challenging themes human race faces which are to be addressed in the present scenario.

Here we have attempted to synthesise five nano titania structures with different morphologies; namely multishelled titania hollow nanospheroids, titania nanotubes, titania nanobelts, mesoporous assembled titania nanocuboids and titania nanoparticles. Analysis of physico-chemical characteristics and formation mechanisms of these
nanostructures provide a good understanding of morphology, crystal phases, porosities etc. The applicability of the systems in photocatalytic and biological fields has to been investigated.

Thesis consists of 6 chapters

The first chapter comprises general introduction on the topic with special emphasis to nanotitania, crystal structures, synthesis, applications etc; An exhaustive review of literature in this area has been provided in this section. Second chapter discusses the experimental aspects of synthesis, characterisation and application studies of titanium dioxide nanostructures. Titanium dioxide nanostructures with diverse morphologies are prepared by adopting different synthetic routes. Modification of the high surface area nanostructures with copper and silver has been done. For biomedical applications, modifications are trialed with folic acid along with the incorporation of an anticancer drug 5-Fluorouracil [5FU]. Fundamental aspects of characterisation tools, X-Ray Diffraction (small and wide angle), Electron Spectroscopy (TEM, HRTEM, SEM,FEG-SEM), Nitrogen adsorption study (surface area and pore size distribution), Fourier Transform Infra-Red (FTIR) spectroscopy, UV-Visible Diffuse Reflectance Spectroscopy (UV-Vis DRS), Photoluminescent spectroscopy (PL) and Dynamic light scattering (DLS) are briefly explained. The utilization of these techniques for the characterisation of the prepared nanostructures and its modified analogues are also discussed.
A detailed analysis of various characterization techniques of the five nanostructured systems are presented in chapter 3. A brief description related to formation mechanisms of the nanostructures is also provided. The fourth chapter discussing the applications is divided into two sections. First section deals with the photocatalytic removal of organic pollutant using the synthesized nanostructured photocatalysts. The antibacterial as well as antifungal properties of the systems as well as superhydrophilicity character of titania surface is also investigated, so as to examine the applicability of the system as a self-cleaning material. In the second section, photocatalytic watersplitting reaction to produce Hydrogen has been discussed using catalysts modified titania nanostructures.

The fifth chapter comprises the invitro cytotoxic studies of the synthesised nanostructures towards MCF-7 Cancer cell lines. Also cytotoxicities of anticancer drug encapsulated systems are compared with those systems which are functionalised with folic acid to support the targeted drug delivery. Further the intracellular mechanisms leading to cell death is assessed using a selected system. Chapter 7 summarizes the major results and outcomes of the present study. The scope of future aspect of the work based on these studies is also provided.