ABSTRACT

Nanotechnology involves the synthesis and/or manipulation of materials at the nanometer scale either by scaling- up from single groups of atoms or by refining or reducing bulk materials. Comprehension of metal nanoparticles exotic physicochemical and optoelectronic properties, and organization of nanoscale structures into predefined superstructures promise to play an increasingly important role in innovative technologies.

Recently, biological methodologies are considered highly promising for nanomaterial synthesis because of eco-friendly approaches alternative to the usual chemical methods. The biomimetic and biomineralization procedures, besides following the green chemical regulations for nanoscale material synthesis are supposed to yield novel and complex structural entities as compared to the conventional methods. Until now, researchers have been successful in obtaining a number of inorganic metal nanoparticles using microorganisms quite efficiently and to some extent started gaining access to design strategies to develop protocols to obtain nanomaterials of desired shape and size. Researchers also started deciphering the mechanistic aspect of formation of inorganic metal nanoparticles which are atleast easy to follow during their course of reaction with microorganisms such as gold nanoparticles. Despite all these efforts in the direction of biological synthesis of nanomaterials, one area which is still least explored or seldom encountered in literature is the green synthesis of oxide nanoparticles. Currently physico-chemical protocols for the synthesis of oxide nanomaterials involve high temperatures, toxic chemicals and harsh environmental condition, thus proving eco-unfriendly, whereas their biological counterparts have shown a great promise to overcome all these deficits.

The present investigation details the study of such biosynthetic routes/protocols for the synthesis of natural protein capped, water dispersible and biomedically important oxide nanoparticles such as Gd_2O_3 and CeO_2 using the fungus *Humicola* sp. Protein capped Gd_2O_3 nanoparticles were then functionalized and conjugated to the anticancer drug taxol and this nano-bioconjugate has shown an enhanced potency in killing cancer cells when incubated with THP-1 cell lines rather than taxol alone, thus creating new avenues in nanosized drug delivery applications. Another mesophilic fungus *Fusarium oxysporum* was then used to obtain silica (SiO_2) nanoparticles through bioleaching of waste material such as fly-ash. *Humicola* sp. once again was

employed to obtain TiO_2 nanoparticles using top-down approach. The fungus *Humicola* sp. not only showed a great potential in biomilling of bulk TiO_2 to nanosize TiO_2 but was also able to biotransform the shape and phase of TiO_2 nanoparticles. Finally, in the last working section of the thesis an attempt has been made for the elucidation of mechanism of formation of gold nanoparticles. Sulphite reductase enzyme and organic capping molecule were purified to homogeneity from an actinomycete *Thermomonospora* sp. and employed for the *in vitro* synthesis of gold nanoparticles. Sulphite reducatse enzyme has been shown to reduce gold metal ions resulting in the subsequent formation of gold nanoparticles whereas the capping molecule has been shown to provide stability to gold nanoparticles without which nanoparticles tend to aggregate.