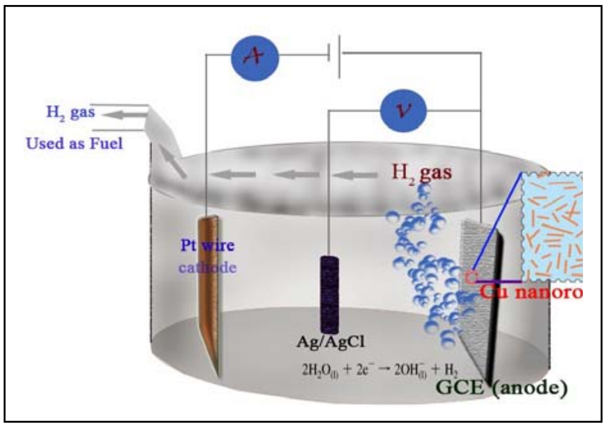
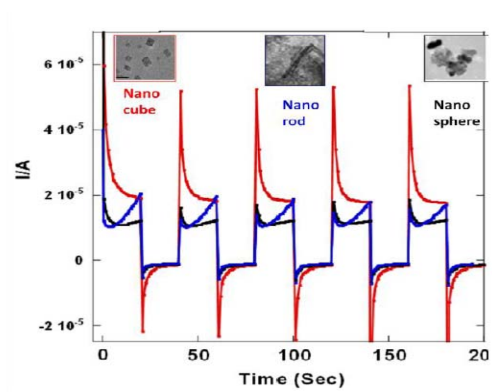
Recent Research Highlights from Prof. A. K. Ganguli's Group

Nanostructures as electrocatalysts for Hydrogen Evolution Reaction (HER)

Microemulsion-based techniques have been developed and have been used for synthesizing nanostructures with controlled morphology (nanorods, nanocubes, nanospheres and core-shell) by choosing appropriate surfactants and co-surfactant. Efficient electrocatalyst based on Cu, Fe-Co alloys have been designed using the above methods. Hydrogen evolution catalyzed by nanostructures (Fig. 1) from aqueous solutions is 5-10 times higher compared to bulk Cu (and around 100 times in the case of Fe-Co). They are also shape (copper cubes are more efficient than Cu rods and particles) and composition dependent ($FeCo_2$ is more efficient than Fe_2Co) (Fig. 2).





Core-Shell (CS) Nanostructures for Entrapment of toxins and for photovoltaic applications

Using microemulsions core-shell nanostructures with multifunctional properties (combination of optical, magnetic and non-magnetic) with precise shell thickness have been designed (Co_3O_4@SiO_2, Mn_3O_4@SiO_2, Co_3O_4@TiO_2, Ag@TiO_2, CdS@TiO_2 etc.). Further the crystalinity of shell has been controlled. HRTEM and EDX mapping clearly shows the formation of uniform core shell nanostructures (Fig. 3). TheseCS nanostructures have been designed to tune the magnetic and optical properties of the core materials. Further, hollow shells have been obtained for trapping organic pollutants like benzene, methyl orange and other dyes (Fig. 4). This would be of use in

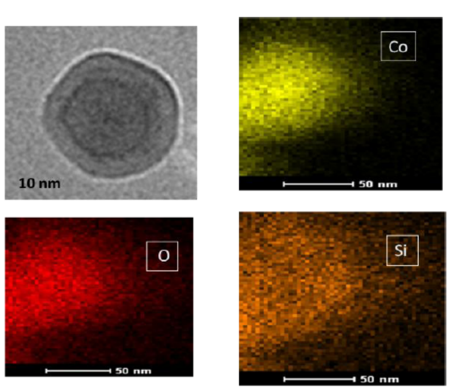


Fig. 3 Cobalt oxide@SiO2 CS nanostructures with elemental mapping

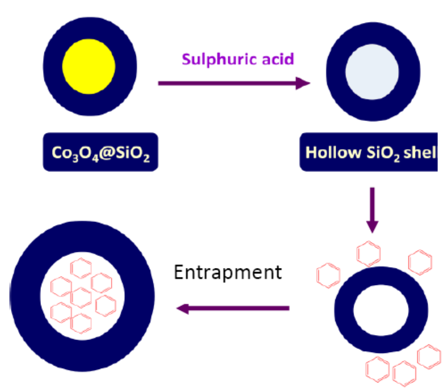


Fig.4. Hollow silica shells used to trap organic pollutants

Several efficient semiconductor photocatalysts (TiO_2, ZnO) work in the UV region. We have designed suitable core-shell nanostructures to tune the band gap of the core material such that it would be useful for applications in the visible region. In addition, to enhance the efficiency, anisotropic CS nanostructures have been obtained. We achieved these nanostructures by a two step method. First, nanorods of the core material by a soft chemical technique which was then functionalized with polyhydroxy acids and then carried out further reactions to form the required semiconductor shell to tune the band gap and shift it to the visible region. An example of ZnO@Ag2S core shell nanorods leads to a shift in the band gap from 3.3 to 2.9 eV (Fig. 5).

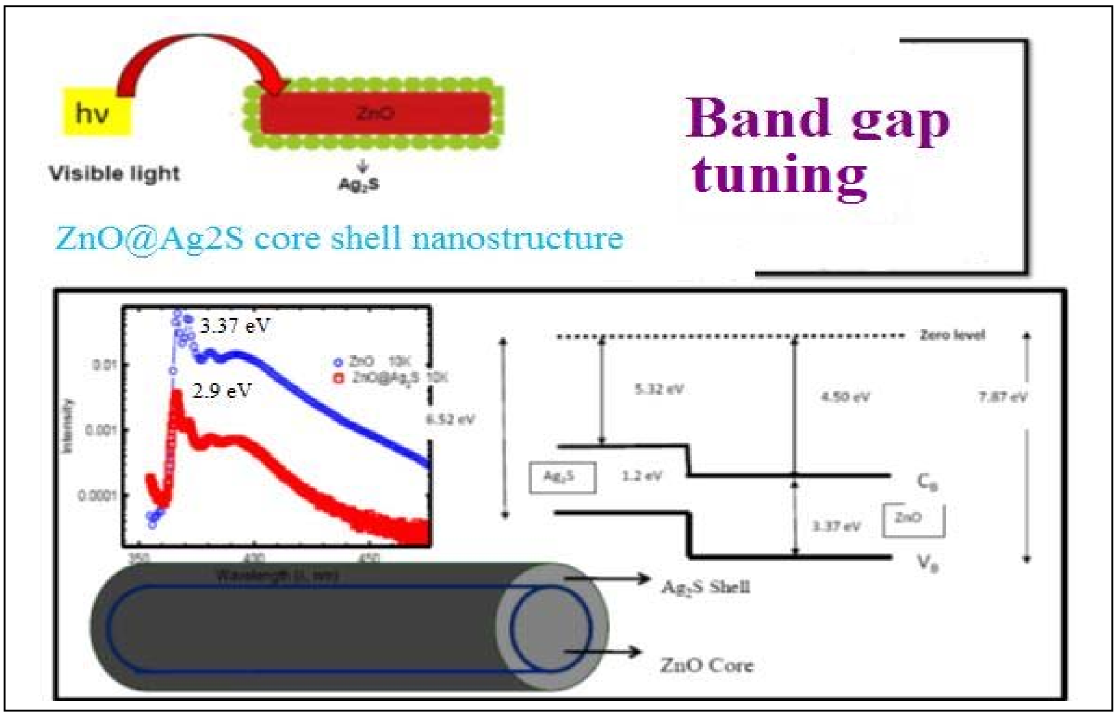


Fig. 5 PL data showing the shift in band gap of ZnO on forming CS type ZnO@Ag2S

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