IBS CINAP Seminar

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Multifunctional Nanocomposites for Clean Energy Generation and Environmental Remediation

Neeraj Khare

Physics Department, Indian Institute of Technology Delhi
Hauz Khas, New Delhi-110016, India

With the ever increasing demand for energy and also due to increase in environment pollution, there has been lot of interests to develop novel materials for clean energy generation and also for cleaning environmental pollution.

Hydrogen is being considered as a clean energy fuel and using a Photoelectrochemical method is a very promising way of generating H2 by photoelectrolysis of water. We have designed and synthesized several nanocomposite material by coupling semiconductor-semiconductor, semiconductor-polymer, semiconductor-ferromagnet, semiconductor ferroelectric and semiconductor-graphene nanostructures and explored its potentiality for enhancing the PEC H_2 generation.

Organic dyes contaminated industrial waste water is highly toxic and posing serious problem to living organisms and whole eco systems. Semiconductors photocatalysts has engaged as an attractive technique to decompose the organic dyes, however the challenge is to develop visible light active, efficient and stable photocatalysts. We have developed visible light active, stable nanocomposites by combining semiconductor nanostructures of different band gaps and RGO, PANI or with appropriate ferroelectrics which exhibit much enhanced photocatalytic activity for the organic dyes degradation.

Piezoelectric and triboelectric generator can convert electrical energy directly from to be wasted mechanical energy ranging from blinking of eyes to ocean waves. We have synthesized PVDF based nano composite using ZnO, $BaTiO_3$, RGO, $NaNbO_3$ nanostructures which demonstrated much enhanced Piezo and tribo effect. The enhancement in the piezoelectric and triboelectric properties are attributed to enhanced ß-phase of PVDF, increased surface roughness and increased polorizability of the nanocomposite films.

Thermoelectric generator can directly convert thermal energy into electricity however the challenge is to develop efficient thermoelectric material to decouple thermal conductivity, electrical conductivity and Seebeck effect so that simultaneously larger electrical conductivity and lower thermal conductivity can be achieved. We have synthesized several nanocomposites such as Bi_2Te_3-CNT, Bi_2Te_3-RGO, Bi_2Te_3-CNR-R_3HT, Sb_2Te_3-RGO etc. in which presence of conductiviting interfaces are demonstrated to enhance electrical conductivity and simultaneously decreasing thermal conductivity due to enhanced phonon scattering.

The present talk will review the progress made so far in our group at IIT Delhi in the above mentioned area and will also present the main challenges.

Biography

Dr. Neeraj Khare is currently Professor in Physics Department, IIT Delhi. He received his Ph.D. (Physics) from Banaras Hindu University, Varanasi in 1986 and MSc (Physics) from Allahabad University, Allahabad. After PhD, he visited Department of Chemical Physics Application, Polytechnic of Milan, Italy as ICTP fellow (1988). Subsequently, he joined National Physical Laboratory, New Delhi in Superconductivity Group as Scientist in Dec. 1988. He joined IIT Delhi in Physics Department in Oct 2005. He had various visiting positions at Department of Materials Science & Metallurgy, University of Cambridge, UK, IBM, T. J. Watson Research Center, Yorktown Heights, NY, USA, Department of Physics and Applied Physics, University of Strathclyde, Glasgow, UK, Department of Inorganic Chemistry, Novosbrisk, Russia, Pohang University, South Korea and National University of Singapore.