INSTITUTE OF INFRASTRUCTURE, TECHNOLOGY, RESEARCH AND MANAGEMENT

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Title: Renewal energy technologies: The present and future

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Abstract

Theoretical physicists, over the years have laid out the energy roadmap of the planet. Their prediction goes as far as 100 years from now that gives us fairly decent idea about the technologies of the future. The future of energy is going to be the mix of various technologies. The foundation of several of these technologies already lies in the solid-state physics textbooks. The development of advanced functional materials for energy applications is already at the forefront of the research due to the limited availability of fossil fuels and environmental concerns. The speed of research and innovation in the field of energy is astonishingly fast. In the non-conventional sources of energy i. e. wind, solar, mechanical, thermal, hydrogen etc. one form of energy is converted into another form of energy with improved efficiency. In my lecture, I shall introduce some of these research areas and some recent results from our laboratory. The semiconductors have already revolutionized the electronic devices and solar energy harvesting areas. I will discuss in brief the overview of using semiconductor nanostructures and their hybrids with graphitic carbon for solar light harvesting where these nanowires are used as efficient electron transporting medium. We have grown arrays of highly single crystalline titania nanowires directly on FTO substrates and have constructed dye sensitized solar cells. These arrays show good promise for the photovoltaic devices. In a related research we also experimented with doped titania and titania-multi-walled carbon nanotubes for enhanced properties. The disordered titania (black composite) with integration of graphene quantum dots show a broadband absorption and could be used for water-splitting to generate hydrogen gas as well as for DSSC. We have also fabricated bismuth oxichloride nanocrystals and studied their potential applications in renewable energy. In addition, the magnetic nanoparticles could be also used for energy applications. Hard magnets are used in wind turbines, hybrid cars to generate electricity. Most of these hard magnets are based on rare earth materials. Efforts are required to replace a fraction of these materials with rare earth free hard magnets. I will introduce some latest research in this area from my group. The magnetocaloric refridgeration is also an interesting area where superparamagnetic particles holds very good promise. Moving to the other side of the materials landscape, I will introduce another area where the energy generation can take place from piezoelectric materials in which mechanical energy can be transformed into the electric energy. For that piezoelectric

materials such as ZnO and PZT etc. can be processed in various form in polymer matrix to provide a flexible substrate and mechanical energy from wind or people walking on the roads, can be tapped and converted in to the electrical energy. I will show as how using piezoresponse force microscopy, some of these materials can be characterized. At the end, I will introduce how low bandgap semiconductors such as chalcogenides could be used for thermoelectric materials were thermal energy (temperature gradient) gets converted in to the electrical energy. I will explain the basic principles and will also show the materials aspect as well as measurement procedure to get the thermoelectric figure of merit.