

Development of Environmental Friendly- and Earth Abundant-based Energy Harvesting Materials and Their Applications

Dr. Shin, Seung Wook

Department of Chemical Engineering and Materials Science, University of Minnesota, Amundson Hall ,421 Washington Ave. SE, Minneapolis, MN 55455-0132, USA.

The global energy supply and related environmental issues are among the biggest technological challenges confronted by researchers in the 21st century. The rate of worldwide energy consumption reached 15TW in 2008 and is expected to nearly double by 2050 due to the growing global production and population. In contrast, major energy resources still originate from limited and non-renewable fossil fuels including coal, oil, and natural gas. Furthermore, the combustion of these fossil fuels has caused a series of critical environmental problems, ranging from air and water contamination to global warming. Therefore, seeking renewable, clean, and carbon-neutral alternative energy resources is urgently needed to limit the dependence on fossil fuels. Solar energy is widely accepted as a free, abundant, and endlessly renewable source of clean energy, which could meet current and future human energy demand. Based on these issues, the harvest and conversion of solar energy into a usable energy form (electrical power or H_2) is highly desirable. Nowadays the most popular way to use solar energy is through solar cells, which could directly convert solar energy into electricity, and water splitting device, which could convert solar energy into chemical fuels. Thin film solar cells technology based on the materials such as CdTe and $Cu(In,Ga)Se_2$ (CIGS) has achieved the highest conversion efficiencies beyond 19 % and 21 %, respectively. In the other hand, noble metal and metal oxide based water splitting device show excellent performance. Although these research studies have achieved the outstanding performances, the fabrication process is limited for commercial in the solar cell and water splitting devices due to the use of toxic elements (Cd and Te), rare elements (In, Ga, Ru, Rh, Pd, Pt and Au) and use of toxic process (selenization under H_2Se gas). Considering the issues with elements and fabricating process, the development of earth abundant element based solar cells and photoelectrochemical water splitting device with outstanding performance is highly desirable. In this presentation, development of green synthesis of earth abundant element based nanoparticle, formation of thin films, fabrication of energy harvesting devices will be demonstrated and discussed.