Advanced Materials for Energy Storage: Laboratory to Pilot Scale Voyage

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Energy demand increases with the growing world population and the popularation of portable electronics and electric vehicles that stimulates the development of energy storage devices such as batteries and supercapacitors from high power and energy density, which significantly relies on the research and development of advanced and unique materials. In the meantime, these materials play a vital role in the efficient, green, and versatile use of energy and are crucial for exploiting renewable energy. Therefore, energy storage materials are gaining tremendous attention and research interest due to the rising concern on the sustainable development of energy. This study is presented advanced materials and processes used in perovskite solar cells, ceramic supercapacitors, and lithium-based batteries.

Firstly, the synthesis and processing of lead-free perovskite solar cells are discussed. Lead-free perovskite solar cell thin films were obtained compact titanium oxide layer for both compact and mesoporous layer, which was characterized by x-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Ultra-violet spectroscopy (UV), and solar simulators. Electronic properties, bandgap, and phases of the selected composition of targeted cell components were calculated theoretically. Photovoltaic properties were measured with standard characterization methods.

Secondly, Octacalcium phosphate (OCP) is demonstrated the capacitive behavior as electrode material in supercapacitors for the first time in the literature. OCP powder was synthesized by solution precipitation in the presence of succinic acid. X-ray diffraction (XRD), FE-SEM, Raman spectroscopy, and potentiostat were performed for detailed characterization. The electrochemical impedance spectra (EIS) of the OPC materials confirmed their significant capacitive performance, which may be valuable for future medical electronics such as biocompatible energy storage and harvesting microdevices.

Lastly, high power and high energy density Lithium Oxyhalide Reserve Battery has been developed to provide electrical energy for military land, aircraft and surface ship applications. The successful scale-up from the development laboratory into the pilot plant for this batter type will be presented

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