Title:	NANOSTRUCTURED MATERIALS FOR ENERGY APPLICATION
Authors:	Gaur, Ashish
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Abstract:	Recently, a new climate prediction was issued by World Meteorological Organization (WMO), stating that, “There is a ~20% chance that one of the next 5 years will be at least 1.5°C warmer than pre-industrial levels, but the chance is increasing with time.” The heat stress due to high surface temperature in the coming days would reach extreme affecting human health, productivity, and mortality in many places on Earth Rising levels of CO_2 in the ocean causing huge proliferation of toxic algae, which is a potential threat to marine life, coastal communities, aquaculture and fisheries and of course human health. The ocean absorbs CO_2 at a rate of 22 million tons per day as revealed by the National Oceanic and Atmospheric Administration. Increased acidity of the ocean’s surface water resulting in the dissolution of shells and skeletons causing the extinction of numerous species. An effort to obtain sustainable and clean energy, using electrocatalytic hydrogen generation reactions and oxygen evolution reactions could be potential solutions towards environmental degradation. In this regard the present thesis is focused on the formation of transition metal based heterostructures of metal phosphide, nitride, sulphide, oxide, single-atom catalyst (SACs), Metal-organic organic framework (MOF) and MOF-derived materials for hydrogen evolution reaction (HER), oxygen evolution reaction (OER) and oxygen reduction reaction (ORR). The first heterostructure we worked on is Co@NC@MoS_2 for oxygen evolution reaction (OER) in which the synergistic effect between Co@NC nanoparticles and MoS_2 nanosheets enhances the catalytic activity. The catalyst exhibit the overpotential of 297 mV at 10 mA cm^{-2} of current density. Moving forward we worked on transition metal oxide heterostructures and we developed CuO- NiO, Co_3O_4 -NiO heterostructure for OER with overpotential of 231 mV and 311 mV and $NiWO_4$ -NiO heterostructure for HER with overpotential of 71 mV. Further, taking the advantage of high electronegativity of metal fluorides we fabricated the metal fluoride and metal nitride heterostructure (Co-Ni_3N/CeF_3). This heterostructure exhibit the overpotential of 180 mV at 10 mA cm^{-2} of current density. This ultralow overpotential was obtained due to the interfacial charge transfer from Co-Ni_3N to CeF_3 results in the augmentation of valence state of Ni and Co which enhances the adsorption of intermediates on the catalyst surface. Further we move on to explore the pristine MOF for oxygen evolution reaction. the bimetallic Co, Ni based ultrathin metal-organic framework Page XV
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