Title:	Nanostructured Materials for Electrocatalytic Applications
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Abstract:	Deteriorating environment, elevated carbon di oxide emission and diminishing fossil fuels have increased the thirst for renewable energy sources and popularise various electrochemical technologies such as electrolysis process of water, production of fuel using solar sources and metal air batteries . Although these forms of energy has somewhat succeeded in solving the existing issues related to energy but still they fail to deliver satisfactory performance due to problems associated with their inefficient technologies , availability of sources and geographical errors. Hydrogen is an excellent fuel which has ability to replace the fossil fuels. It is clean fuel and contributes least in emission of greenhouse gasses. Currently steam reforming and coal gasification are two developed industrial techniques used majorly production of hydrogen. The main loopholes of these techniques are firstly they produce low quality of hydrogen and secondarily they are dependent on deteriorating fossil fuels. Therefore a new strategy should be looked upon for the production of hydrogen using simple, eco-friendly and efficient approach. Electrochemical Water splitting is one such method which produces pure quality of hydrogen using water as a raw material. Hydrogen evolution reaction and oxygen evolution reaction are two important half-cell reactions of electrochemical water splitting. Nobel metal based catalyst based on Pt and Pd are considered as state of art catalyst for hydrogen evolution reaction due to optimum binding energy and highest exchange current density in acidic as well as alkaline medium. But high cost and scarcity of these metals limits their applications on large scale. Therefore new materials based on non-noble metals which are abundant in nature should be designed and synthesized to replace the high cost noble metals catalysts for hydrogen evolution reaction. Oxygen evolution reaction on the other hand is more complex process as compared to hydrogen evolution reaction. The kinetic barrier associated with each step raises the overall potential required for driving the reaction. The oxides, hydroxides of Ir, Ru and Rh are the most popular and efficient catalyst for oxygen evolution reaction yet their applicability is restricted due to high cost of these precious metals. Thus it is highly desirable to synthesizenew catalytic materials based on non-noble metals and their composites for both oxygen evolution reaction and hydrogen evolution reaction that show superior activity comparable to benchmark catalyst as well as good stability when used for longer durations. Carbon supports based on graphene and its derivatives are considered as integral parts of these catalytic systems. They play an important role in holding the nanoparticles together as well as serve the purpose of activity enhancer either by boosting the interaction or participating in reaction mechanism. Based on above concerns the present thesis is dedicated to synthesis and fabrication of new catalytic nanomaterial for oxygen evolution reaction and hydrogen evolution reaction both based on metal oxides, hydroxides, metal nitrides and phosphides of earth abundant non-noble metals. It also focuses in devising a new methodology for synthesis of reduced graphene oxide using a unique approach as compared to traditionally available chemical reduction and mechanical exfoliation methods.
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