ABSTRACT

Pristine nanoparticles (NPs) have numerous applications in catalysis owing to their clean surface devoid of any capping agents. The deposition of these pristine NPs on conducting low-dimensional carbon surfaces such as graphene or CNT results in the development of interesting composite materials. These novel composite materials hold unique catalytic behavior.

At the start of this thesis, for the first time, capping agent free nanocomposites of gold on graphene and gold on carbon nanotubes have been synthesized using laser ablation. Gold graphene composite has been tested for catalytic dye decolorization to highlight the unmasked catalytic efficiency. In case of Methylene blue dye decolorization, the rate of reduction is 17000 times faster than uncatalyzed reaction. Furthermore, Rhodamine B dye decolorization, the reduction rate with the composite is nearly twice faster than that of commercial citrate capped gold NPs of similar size.

These composites are also tested for surface sensitive electrocatalytic hydrogen evolution reaction and their unmasked catalytic activity has been found to be superior to the capped variants. The capped variants chosen for this study as experimental control are citrate capped gold NPs of 20 nm size and plant based gold NPs synthesized from the stem extracts of Breynia rhamnooides. The enhanced activity with the composites is clearly evident from their low onset potentials, low charge transfer resistance and low total impedance values compared to the capped experimental controls.

In the latter part of the thesis, studies to understand the relationship between the reaction intermediates and capping agents during electrooxidations has been carried out. For the first time, an electrochemical Tafel slopes based model has been developed, to explain the fouling of an electrocatalyst surface due to the intermediates, which is further enhanced by the presence of capping agents. This understanding has been achieved with the use of Pd and Pt based electrocatalysts, in the presence and absence of capping agents. This model has wide spread applications in accessing the stability and response of any electrocatalyst with a special focus on alcohol fuel cells.