Studies on Preparation of Novel Materials as Highly-Pertinent Heterogeneous Catalysts using Solvothermal Method

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Introduction

The intelligence of humans understood the phenomena around them partially, which led to the development of society and a gain in living standards at the cost of environmental degradation. These have concerned intellectuals and researchers throughout the globe and alarmed the need to develop technologies for a sustainable future.

Catalysts play an important role in the synthesis of chemicals for various purpose and with sheer knowledge, understanding of science and green chemistry practices; stable and highly-pertinent catalysts can be developed for environmentally benign chemical processes. Also, hydrothermal/solvothermal techniques have tremendously contributed towards development of stable, functionalized materials with excellent reproducibility and high purity.

In this thesis, I have focused on the preparation of stable and functionalized materials under hydrothermal or solvothermal conditions and have studied them to explore their catalyses.

Results and Discussion

In ***Part I***, stable catalysts are prepared hydrothermally using inexpensive transition metals for viable applications in bio-refineries. First I have developed a stable magnesia-supported copper catalyst prepared in the presence of cationic surfactant with excellent activity for chemical upgradation of glucose to lactic acid (LA) in the presence of NaOH and formic acid (FA) in the presence of 30% H_2O_2. The catalyst drastically decreased the energy requirement to achieve high yields of LA and FA. Thorough characterization revealed the presence of novel copper oxide species, which inspired my further research. Thereafter, various surfactants were employed for the hydrothermal preparation of supported copper catalyst. I found that the type of supported Cu_xO_y species could be preferentially controlled by the mere control of type of surfactant employed and synthetic parameters, which have been illustrated in detail in the related chapter. The successful control of supported monometallic species, motivated me to extend the synthetic techniques for the bimetallic catalyst. A bimetallic CoPd catalyst was prepared in the presence of three capping agents and investigated for the facile utilization of FA as a hydrogen source. The catalysts were characterized minutely to observe the electronic/geometric changes caused by alloying of Co and Pd in the presence of capping agents. Further, from the viewpoint of bio-refinery the processes developed in this part were clubbed for the direct utilization of inedible-biomass-derived glucose as a hydrogen source.

In ***Part II***, the focus have been shifted to design of highly-efficacious catalysts with desirable properties for the industrially exploited petro-refineries based modern organic transformations. I have designed an easily accessible palladium grafted amino-functionalized organozinc coordination polymer as a robust heterogeneous catalyst for Suzuki-Miyaura coupling (TON = 2,106,720), Mizoroki-Heck and hydrogenation reactions under mild conditions. The catalyst characterization revealed the successful implementation of desired properties in the prepared catalyst.

Conclusion

A facile synthetic approach to control and design desired supported catalytic species have been demonstrated in this thesis for efficacious catalysis. This study will contribute to further design of highly-pertinent materials with desirable properties for useful applications in an environmentally-benign manner.

Keywords: Solvothermal synthesis, Heterogeneous catalyst, Biomass, Organic reactions, Catalyst characterization.