

## Design, Synthesis, and Catalytic Applications of Functionalized Metal Complexes and Nanomaterials for Selective Oxidation and Coupling Reactions

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**Abstract :** The development of functionalized metal complexes and nanomaterials has gained significant attention due to their potential in catalyzing selective oxidation and coupling reactions. These catalysts play a crucial role in various industrial and pharmaceutical processes, enhancing the efficiency, selectivity, and sustainability of chemical reactions. This research aims to design and synthesize new functionalized metal complexes and nanomaterials to explore their catalytic applications in the selective oxidation of alcohols and coupling reactions, focusing on improving yield, selectivity, and catalyst reusability. The study involves the synthesis of a nickel Schiff base complex stabilized within 41-MCM as a heterogeneous catalyst. A Schiff base ligand derived from glycine was used to create a tin (IV) metal complex characterized through spectroscopic techniques and computational analysis. Additionally, iron-based magnetic nanoparticles functionalized with melamine were synthesized for catalytic evaluation. Lastly, a palladium (IV) complex was prepared, and its oxidative stability was analyzed. The nickel Schiff base catalyst showed high selectivity in converting primary and secondary alcohols to aldehydes and ketones, with yields ranging from 73% to 90%. The tin (IV) complex demonstrated accurate structural and electronic properties, with consistent results between experimental and computational data. The melamine-functionalized iron nanoparticles exhibited efficient catalytic activity in producing triazoles, with enhanced reaction speed and reusability. The palladium (IV) complex displayed remarkable stability and low reactivity towards C-C bond formation due to its symmetrical structure. The synthesized metal complexes and nanomaterials demonstrated significant potential as efficient, selective, and reusable catalysts for oxidation and coupling reactions. These findings pave the way for developing environmentally friendly and cost-effective catalytic systems for industrial applications.

**Keywords :** catalysts, Schiff base complexes, metal-organic frameworks, oxidation reactions, nanoparticles, reusability

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