Metal oxide composites in organic transformations

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17.1 Introduction

Composite material has a grouping of two materials with dissimilar physical and chemical properties. When they are combined, they create a material that is specialized to do a certain job, for instance, to become stronger, lighter, or resistant to electricity. They can also improve strength and stiffness (Mishnaevsky et al., 2017). Several examples of composites are known, which are used in daily routine, including reinforced concrete and masonry, ceramic matrix composites, metal composites, fiber-reinforced polymers, fiberglass, and so on (Masuelli, 2013). Composite material gives surprising or better properties than its individual counterparts, for example, carbon fiber-reinforced composite is five times stronger than 1020 grade steel while having only one-fifth of the weight. In addition, the composite material of graphene and copper is 500 times stronger than copper (Jafarian et al., 2021; Song, 2017). Similarly, a composite of graphene and nickel has 180 times greater strength than nickel (Arciniegas Jaimes et al., 2020; Güler & Bağcı, 2020). Composites have several different applications in chemistry and material science. In the last few decades, composites of metal oxides with other materials are gaining a lot of interest. In the literature, composites of metal oxides are found with other metal oxides, inorganic materials like g-C_3N_4, RGO, organic compounds, polymers, and so on. Composites of metal oxides have different applications in material science and chemistry, which includes photocatalytic degradation (Al-Rawashdeh et al., 2020; Sutar et al., 2020, 2021), solar cells (Xuhui et al., 2014), drug delivery (Park et al., 2016), water splitting (Zhu et al., 2020), organic transformations, and so on (Chaudhary et al., 2020).

Among these applications, composites of metal oxides are relatively less explored for organic transformations. Generally, homogeneous catalysts or liquid reagents have been used to perform organic transformations. Homogeneous catalysts include several catalysts such as Bronsted acids, Lewis acids, superacids (such as H_2SO_4, HCl, HNO_3, HF, $HClO_4$, H_3PO_4, $AlCl_3$, SbF_5), hydrogenation catalysts (such as palladium chloride, Wilkinsons catalyst), metal complexes, and so on (Denisov et al., 2003; Leeuwen et al., 2003; Patil et al., 2011; Reddy & Patil, 2008; Regan, 1995). In homogeneous catalysis, degree of interaction between catalyst and reactants is very

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