Abstract

In recent years, application of photocatalysis in remediation of aquatic pollutants have been grown exponentially. In majority, wide-band gap semiconductors (like TiO_2, ZnO, which works on UV light) or the metal complexes (as homogeneous catalyst or sensitizers) have been frequently utilized in photocatalysis. As the homogeneous catalysts face the limitation of separation from the reaction medium, it is aimed to heterogenize the metal complexes on solid matrix and also to modify the wide-band gap semiconductor by surface sensitization to activate them under the visible light. In this thesis, different heterogeneous catalysts or sensitizer systems have been explored to be stabilized on suitable inorganic matrices (mesoporous silica (SBA-15) and semiconductors like ZnO, MoS_2, etc) for the photocatalytic environmental applications. The research works presented in this dissertation are divided into four chapters (**Chapter 2 to Chapter 5**). In **Chapter 2**, room-temperature photocatalytic degradation of chlorophenolic compounds by Ru(II)-complex immobilized on mesoporous silica SBA-15 in water under the visible light (95% degradation in 150 min) has been described. **Chapter 3**, discusses the heterogenization and activation of the Fe(II) complex on SBA-15 surface as visible light active photocatalyst for the removal of Bisphenol A (BPA) in an aqueous medium (~80% degradation of BPA in 120 min at pH $\leq$ 4). Further, effect of incorporation of Ru(II)-complex on the hybrid has been studied and compared under different experimental conditions (1.8% enhancement in rate of degradation at neutral pH). In **Chapter 4**, a substituted $Ru(bpy)_3^{2+}$ complex has been investigated as a photosensitizer to the UV light active ZnO. The hybrid was utilized in photodegradation of organic pollutants (2,4-DCP and 4-nitrophenol) and reduction of 4-nitrophenol in presence of a co-catalyst (trace amount of Pt(II)) under the visible light. In **Chapter 5**, MoS_2, a well-known layered transition metal dichalcogenide, has been employed for O_2 activation in degradation of two model pollutants (2,4-DCP and BPA) under the visible light. Being an indirect band gap material, MoS_2 shows very poor visible light activity and therefore, a suitable sensitizer, AgBr, has been selected and deposited on its surface to activate the hybrid under the visible light. Further, reduced graphene oxide (rGO) has been incorporated into the catalyst to achieve enhanced photocatalysis. A series of control studies was performed (in each catalyst system) to elucidate the nature of the photodegradation processes, intermediates formed, and to identify the reactive oxygen species (ROS) by different catalytic systems. Overall, we had demonstrated the syntheses of series of hybrid systems (as heterogeneous catalysts), and arrived at their suitability for the photocatalytic remediation of various organic pollutants under the visible light along with their degradation pathways.