Preparation, characterization and photoactivity of modified perovskites

ABSTRACT

Perovskite-type materials such as $KTaO_3$ or $KNbO_3$ are especially useful as photocatalysts because of their high stability and unique structure containing TaO_6 or NbO_6 octahedra which facilitates migration of photogenerated electron-hole pairs. However, these perovskite-type materials can be excited only by ultraviolet light due to their wide band gap. Therefore, it is important to develop effective modification methods of $KTaO_3$ and $KNbO_3$ to enhance their photoactivity especially under visible light, which allows to utilize wider spectrum of sunlight as renewable energy source.

The aim of the research work was to prepare new group of photoactive materials based on perovskites ($KTaO_3$ and $KNbO_3$) modified with quantum dots or reduced graphene oxide, investigate the influence of chosen parameters of perovskite modifiers on the physicochemical properties and photocatalytic activity of composites and better understand photocatalytic mechanism of obtained composites. The PhD dissertation describes the research results for three series of photoactive materials: (i) $KTaO_3$ decorated with CdTe quantum dots with different sizes and types of stabilizing ligands, (ii) $KTaO_3$ modified with different amounts of reduced graphene oxide, (iii) $KNbO_3$ modified with CdS or Bi_2S_3 quantum dots and co-modified with CdS/Bi_2S_3 or CdS/rGO.

Deposition of quantum dots on the surface of wide band gap perovskites and $KTaO_3$ modification with reduced graphene oxide allowed for efficient irradiation utilization and enhancing photoactivity of obtained materials in photocatalytic degradation of phenol in aqueous phase under visible light (λ>420 nm) or in toluene degradation process in the gas phase under LEDs light irradiation (λ_{max} = 415 nm). It was demonstrated that the type of bifunctional linker, size and type of quantum dots as well as content of modifiers were important parameters which influenced surface properties and photoactivity of modified perovskites. Based on the obtained results the excitation and photocatalytic reaction mechanisms in the presence of perovskite-based composites were proposed.