Structure-Property Relationship and Effect of Interlayer Alkaline Metal Ions in Ion-exchangeable Layered Inorganic Materials

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Summary

The effect of ion exchange on crystal structure, photoabsorption, and photocatalytic activity of layered titanates and tantalates was studied to elucidate their structure-property relationship. The interlayer distance of the dehydrated phases of these materials was strongly influenced by ionic radius of interlayer alkaline metal ions. The photocatalytic activity of layered titanates for H_2 evolution from CH_3OH/H_2O mixtures under UV-irradiation was enhanced by protonation in accord with a red shift of absorption edges and corresponding decrease of band gap energy. The similar effect was also observed in tantalates with layered perovskite type structure. The layered tantalates developed in this study showed larger band gap energy and the high catalytic activity for decomposition of H_2O to produce stoichiometric mixtures of H_2 and O_2 in the absence of sacrificial agents. These results suggest that alkaline metal ions in the interlayer play a key role in controlling the photoabsorption and photocatalytic activity. Alternatively, it was also found that the ion exchange of the alkaline metal titanate could be promoted under photo irradiation.