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Growth of Smart Crystals from a NaCl Flux and Their Application

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Summary

One of the most important environmental problems is global warming. Global warming is caused by increases in the amounts of water vapor, methane, carbon dioxide, and other gases being released into the atmosphere as a result of the burning of fossile fuels. Therefore, semiconductor photocatalysts have attracted much attention due to their potential applications in various industrial fields. In particular, they have been studied for the conversion of photon energy into chemical energy because of their applications such as splitting of water, degradation of toxic substances, and several types of solar cells. Among various semiconductor photocatalysts, TiO_2 has been widely researched due to its high activity and stability and high photoinduction under ultraviolet (UV) light. In resent years, a variety of metal oxides such as titanates, niobates, tantalates and multi oxides have also been found to exhibit photocatalytic activity. In general, these metal oxides are synthesized via a conventional solid-state reaction or melt growth at high temperatures in excess of their melting points. These methods are not environmentally friendly. Here we report the growth of high-quality metal oxides such as titanates, niobates and tantalates from chloride fluxes (NaCl and KCl etc.) at a growth temperature much less than the melting point of each metal oxide. Furthermore, their photocatalytic properties and selective adsorption properties were also evaluated.

Highly crystalline photocatalytic crystals of sodium titanates, strontium titanates, sodium niobates, potassium niobates, sodium tantalates, potassium tantalates and strontium tanatalates were successfully grown by the cooling and evaporation of chlorides as the fluxes. Among these metal oxides, the layered $Na_2Ti_3O_7$, $K_4Nb_6O_{17}$ and $Sr_2Ta_2O_7$ crystals were transparent and colorless, and they were plate-like in form with well-developed faces. The crystal sizes were dependent on the holding temperature and the cooling rate. For flux cooling, the crystal size drastically decreased with a decrease in holding temperature and gradually decreased with an increase in cooling rate.