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Growth of Smart Whiskers from a NaCl Flux

Katsuya Teshima, Shuji Oishi

Department of Environmental Science and Technology,
Faculty of Engineering, Shinshu University

Summary

Micro- and nanostructural materials have attracted much interest for their novel properties that differ from those of bulk materials. One-dimensional materials, such as whisker, tube and fiber, are of importance for various applications in electronic, mechanical and chemical engineering because they exhibit unique properties. In particular, $Na_2Ti_6O_{13}$ whiskers have thermal durability, chemical resistivity and dispersibility. Furthermore, many kinds of alkali metal titanates including $Na_2Ti_6O_{13}$ have been studied for potential use as photocatalysts for the degradation of toxic substances and decomposition of pure water and for oxygen electrodes in potentiometric sensors for O_2 and CO_2. The crystals of sodium hexatitanate, $Na_2Ti_6O_{13}$, are monoclinic with the space group *C2/m*. $Na_2Ti_6O_{13}$ has been reported to have lattice parameters of a = 1.512, b = 0.374 and c = 0.916 nm, β = 99.3º, and a density of 3.51 g cm^{-3}. Sodium hexatitanate has a melting point of 1,300 ºC. In a viewpoint of crystal structure, $Na_2Ti_6O_{13}$ has a unique structure, which is a tunnel structure consisting of three vacant spaces where one vacant space corresponds to removal of a TiO_6 unit (perovskite type unit). Several properties of the $Na_2Ti_6O_{13}$ whiskers are attributed to their unique crystal structure (tunnel structure). The present study describes the growth of high-quality $Na_2Ti_6O_{13}$ whiskers from a NaCl flux and evaluation of their adsorption and photocatalytic properties.

Highly crystalline $Na_2Ti_6O_{13}$ whiskers were readily grown by cooling of a NaCl flux. The $Na_2Ti_6O_{13}$ whiskers were transparent and colorless. The whiskers were hexagonal prisms bounded by well developed faces. The crystal forms and average sizes obviously depended on the cooling rate and the solute concentration. Furthermore, they exhibited photocatalytic activity for decomposition of organic materials. From these results, it should be possible to prepare highly active photocatalysts because the crystallinity of photocatalysts appears to be important for high activity. Finally, NaCl was found to be a very suitable flux for an environmentally friendly growth of $Na_2Ti_6O_{13}$ whiskers.