Synthesis of Nitride Photocatalyst Materials by Ammonothermal Method

Tomoaki Watanabe[a]

[a] *Applied Chemistry, Meiji University, 1-1-1 Higashi-Mita, Tama-ku, Kawasaki-shi, Japan*

*E-mail: tomowata@meiji.ac.jp

Keywords: photocatalyst, nitride, ammonothermal

Metal nitrides and oxynitrides have received much attention owing to various applications in electronic devices because of their unusual dielectric and optical properties and ionic conductivity as well as their catalytic activity, and show particular potential as photocatalysts for the splitting of water. They have a number of other intriguing properties as well. Particularly intriguing are the recent findings that some Ta-based oxynitrides can serve as visible-light-driven photocatalysts because of their narrow band gaps. For example, Domen et al. reported recently that Ta-based oxynitrides such as TaON, Y2Ta2O5N2, and LaTaON2 show high activity for water reduction and oxidation in aqueous solutions containing sacrificial reagents under visible-light irradiation. Despite these promising findings, transition metal oxynitrides have been much less investigated in terms of syntheses, properties, and applications, than have the corresponding oxides. For example, transition metal oxynitrides are still generally synthesized by the conventional but rather difficult routes of calcining oxide or reactive oxide precursors with flowing ammonia at high temperatures. However, the products so obtained rarely exhibit the expected properties, but rather tend to exhibit low crystallinity, slow reaction rates, and significant structural defects because of the long duration and high temperature of calcination.Among the new methods for synthesizing oxynitrides, the use of supercritical ammonia shows promise. Important advantages of this method compared with the conventional methods are that it gives well-crystallized nitrides such as GaN[1] , CaAlSiN3[2] ,LaTaON2[3] ,SrAlSiN3[4] , Ta3N5[5]at relatively low temperatures and it suppresses defect formation because the reaction scheme is not so much a solid-state reaction as it is a liquid-state reaction. However, there are a few reports about the synthesis of transition metal nitrides in supercritical ammonia. Thus, in the present talk, we will demonstrate the synthesis of well-crystallized nitrides and oxynitrides at low temperature by reacting metal precursors in ammonia under supercritical conditions.

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