Preparation of Zirconia Nanosheet Structures by Using Ionic Liquids

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Abstract: Recently, ionothermal has attracted attention as a new material synthesis method. The ionothermal method has three advantages: i) materials can be synthesized at ambient pressure, ii) toxin isn't released in air, and iii) ionic liquid acts as template to synthesize materials with morphology control. In this study, we tried to synthesize zirconia nanosheets by ionothermal method. Butyl-2,3-dimethylimidazolium tetrafluoroborate was used as ionic liquid. $ZrOCl_2 \cdot 8H_2O$ and hexamethylenetetramine were put into the ionic liquid, and it was stirred for 30 min. The solvent was heated at 200°C for 1 h. After ionothermal treatment, a white precipitation was obtained. The crystalline phase in the samples was identified using XRD. The surface morphology was observed by SEM and TEM. The chemical composition of the white precipitation was $NH_4Zr_2F_9$, and it had an interesting morphology with hexagonal plate structure. ZrO_2 was obtained by heating at 400, 600, and 800°C. The hexagonal plate structure was maintained. The morphology of the sample heated at more than 600°C after washing the remained ionic liquids was changed to a porous hexagonal plate like structure [1]. It is considered that NH_4ZrF_9 was decomposed with releasing F_2 and NH_3 during heating and porous ZrO_2 hexagonal plate was formed. On the other hand, ZrO_2 nanosheet was obtained without the washing process [2]. The thickness of the nanosheet is about 3 - 9 nm. The nanosheets are single crystal and spread to [011] and [111] directions. The present method is considered to be very effective for the synthesis of zirconia nanosheets and these synthesized zirconia nanosheets could be applied as fuel cell electrolytes, oxygen sensor, coatings, gate dielectric and catalysts.

References: [1] T. Yamada et al., *Dalton Trans.*, 44 (2015) 8247-8254. [2] T. Yamada et al., *submitted*.