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Fine crystallization of layer double hydroxides with silica nanoseeds and high activity for base catalysis

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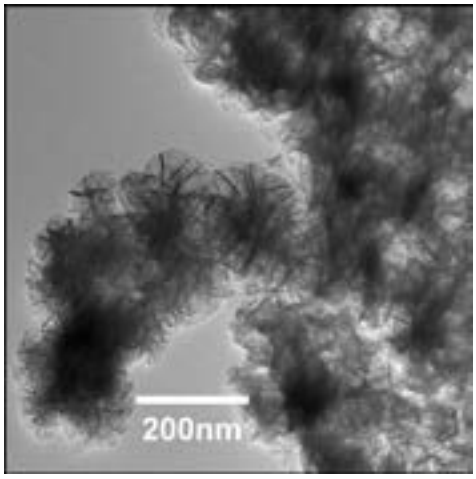
Layer double hydroxide (LDH) clays are one of the highly-attractive nanomaterials because of their high potentials on adsorption capacity, cation-exchange ability of the Brucite layer, anion-exchange ability of the interlayer space, and tunable basicity of the surface. Therefore, various synthetic approaches have been investigated in previous reports for difference purposes [1-3]. Herein, we challenged the preparation of fine-crystalized LDH materials with silica nanoseeds and evaluated its catalytic performance for Knoevenagel condensation as a model reaction. The main idea of this approach is the utilization of small-size SiO_2 seeds to prepare the fine crystals of LDHs, and which afford higher activity for the conventional LDH-catalyzed organic transformations as not only Knoevenagel condensation, but also epoxidation, transesterification, isomerization, etc. Size effect of silica seeds was compared between 250 nm and 40 nm in SiO_2@Mg-Al LDH (Si/(Mg+Al) = 5, Mg/Al = 3). The LDH crystalline sizes prepared with 40 nm SiO_2 at (003) and (110) directions were much smaller than that of 250 nm, determined by XRD. The ratio of Si-O-Al and/or Si-O-Mg conjugations estimated by Si NMR in the former case gave higher values than the latter. These results suggested that utilization of smaller SiO_2 seeds would gave stronger impact to control self-assembly of LDH during *in-situ* co-precipitation procedure. In particular, the reactivity of SiO_2(40 nm)@Mg-Al LDH gave higher activity for the model reaction than conventional Mg-Al LDH prepared with co-precipitation method without seeds [4]. According to our recent study, the effect of Si/(Mg+Al) ratio is strongly contributed to both crystal size of LDH and the reactivity for the Knoevenagel condensation; the highest activity was obtained at Si/(Mg+Al) = 0.17. Details of these correlations and characterization data would be discussed in the meeting.



TEM image of SiO2(40nm)@ Mg-Al LDH

Biography

SN is the Senior Lecturer in Japan Advanced Institute of Science and Technology (JAIST). He has completed his PhD in Materials Science at the age of 28 years from JAIST in 2011, supervised by Profs. K. Ebitani and S. Maenosono. His research interests lie in the development of highly-functionalized nano-structured catalysts by mechanistic approaches, especially heterometallic nanoparticle catalyst for facile transformations. So far, he has published 50 refereed papers, 6 reviews/book chapters, 10 conference proceedings, and 14 patents application. He received the 2016 JAIST President's Award (Research Activity Award) in September 2016, and the Monthly Journal Award of the Bulletin of the Chemical Society of Japan (BCSJ) in March 2012.

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