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I-CReST 2025: 101-067– Effect of High-Energy Ball Milling on the Phase, Morphology and Crystallite Size of Cr-Doped Al_2O_3 Materials

*[1,2]Nurhanna Badar, [1,2]Hanis Mohd Yusof, [3,4]Kelimah Elong

[1]Faculty of Science and Marine Environment, Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia.

[2]Advanced Nano Materials (ANoMa) Research Group, Faculty of Science and Marine Environment, Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia.

[3]Center for Functional Materials and Nanotechnology, Institute of Science, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.

[4]School of Chemistry and Environment, Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

*E-mail: nurhanna.badar@umt.edu.my

ABSTRACT

Al_2O_3 compounds are known for their large crystal size and high stability, making it difficult to reduce their crystallite size. Doping with Cr further increases the hardness and stability, which makes the synthesis of Cr-doped Al_2O_3 nanomaterials even more challenging. One way of reducing the crystallite size of the materials is by using the high-energy ball milling method. The ball-milling method is carefully controlled to avoid unwanted chemical reactions that may change the phase and stoichiometry of the materials. In this work, pure and single-phase micron-sized $Al_{2-x}Cr_xO_3$ (x=0.1, 0.2, 0.3) materials were successfully obtained via the self-propagating combustion (SPC) method. These materials were then subjected to a simple milling process to reduce the crystallite size. This milling process was used to produce $Al_{2-x}Cr_xO_3$ nanomaterials from its microcrystalline powder. The comparisons between the micron-sized and milled samples in terms of their phase, morphology and crystallite size were discussed. The XRD results reveal that all the milled samples were pure with no impurity or other phases present. SEM results show a gradual decrease in crystallite size with increased milling time to 72 hours from around 1500 nm to ~40 nm. The milled samples consist of mainly well-formed spherically shaped crystals without any planar blocks like in the micron state. It was found that the ball-milling method has been successfully done to reduce crystallite size without the change of phase of the materials. Thus, the materials' stoichiometries are maintained.

Keywords: Al_2O_3; $Al_{2-x}Cr_xO_3$; Doped; Combustion; Ball-milling