Effect of precipitant on the morphology of magnesium hydroxide nanosheets and magnesium oxide nanoparticles synthesized via chemical precipitation

Kamaluldeen, A.[1]

[1] Murdoch University, Australia

Magnesium oxide is an auspicious metal oxide that has superior performance in a range of scientific applications. Magnesium oxide nanoparticles (MgO NPs) are a noteworthy functional material with significant physicochemical properties. The mineral Magnesite is the primary material used globally for the production of MgO. Alternatively, unconventional materials such as sea water and sea bittern are sustainable and promising sources for the production of MgO. This study outlines some morphological variation of MgO NPs prepared from sea bittern using two types of precipitants, namely NaOH and NH_3. Two samples of sea bittern were treated with each precipitant to precipitate magnesium hydroxide nanosheets (MHNS) that are used as precursors for the synthesis of MgO NPs. The two MHNS samples were dehydrated by a heating program with three intervals over seven hours up to 650 ^oC.

The morphological characteristics of the synthesized MgO NPs and their precursors were primarily investigated using a Zeiss 55VP scanning electron microscope (SEM). The SEM images showed larger MHNS in the precursor prepared using NH_3 compared to their counterparts precipitated by NaOH, Fig.1(a and b). Similarly, the MgO NPs also had varying particle size and morphology. SEM images revealed a significant variation in the particle morphology of both products. Apparently, the MHNS precipitated by NH_3 produced semi-integrated nanoparticles of MgO. More precisely, these particles seem to be interconnected to form porous-like nanosheets, Fig. 2(a). On the other hand, the precursor prepared using NaOH gave finely disintegrated nanoparticles of MgO following the same heating treatment, Fig. 2(b). This variation was also investigated using FEI Titan transmission electron microscope (TEM), and the TEM micrographs confirmed the SEM morphological observations, Fig. 3(a to d). The results of this study revealed the possibility of changing or sustaining the morphology of the precursors precipitated by NaOH and NH_3 in their synthesized MgO NPs respectively, both agreeing [1] and disagreeing [2] with previously reported works.

The MgO NPs were characterised for their mineralogy using a Panalytical Empyrean XRD. The crystallographic data of XRD and TEM (SAED and HRTEM) were in good agreement. The XRD data were refined using the Rietveld method and analyzed according to Williamson Hall analysis to find out the crystallite size, strain, stress, energy density, the crystal structure, and crystal plane orientation. Particle morphology is very important and can direct the possible applications of the MgO NPs. An example of that, well dispersed spherical nanoparticles are ideal as a bactericidal agent, and their activity is enhanced as the particle size is reduced [3], while porous and porous-like nanosheets are more preferred for the adsorption of heavy metals and the removal of dangerous impurities [4].

Reference

[1] S. Yousefi, et al., Journal of Alloys and Compounds 711 (2017) 521-529.
[2] W. Jiang, et al., Powder Technology 191 (2009) 227-230.
[3] M. Bindhu, et al., Materials Letters 166 (2016) 19-22.
[4] T. Wang, et al., Materials Letters 116 (2014) 332-336.

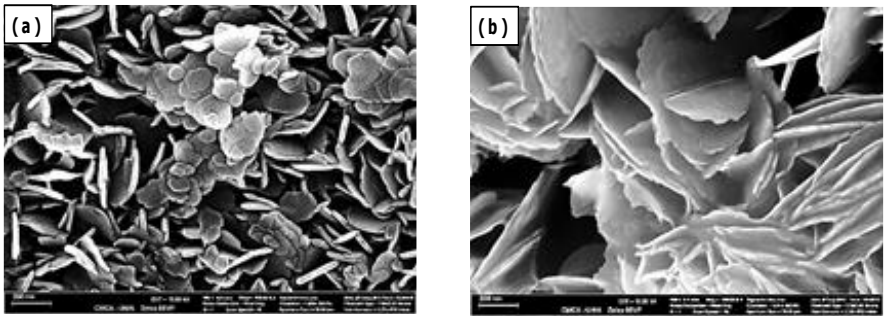

Fig. 1: SEM images (a) small size-MHNS precipitated by NaOH and (b) Large size-MHNS precipitated by NH3

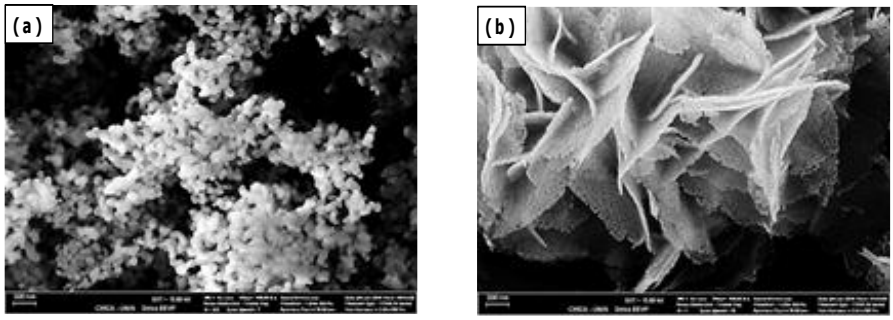

Fig. 2: SEM-Morphology-magnesium oxide nanoparticles (a) Disintegrated MgO NPs-NaOH (b) interconnected MgO NPs-NH3

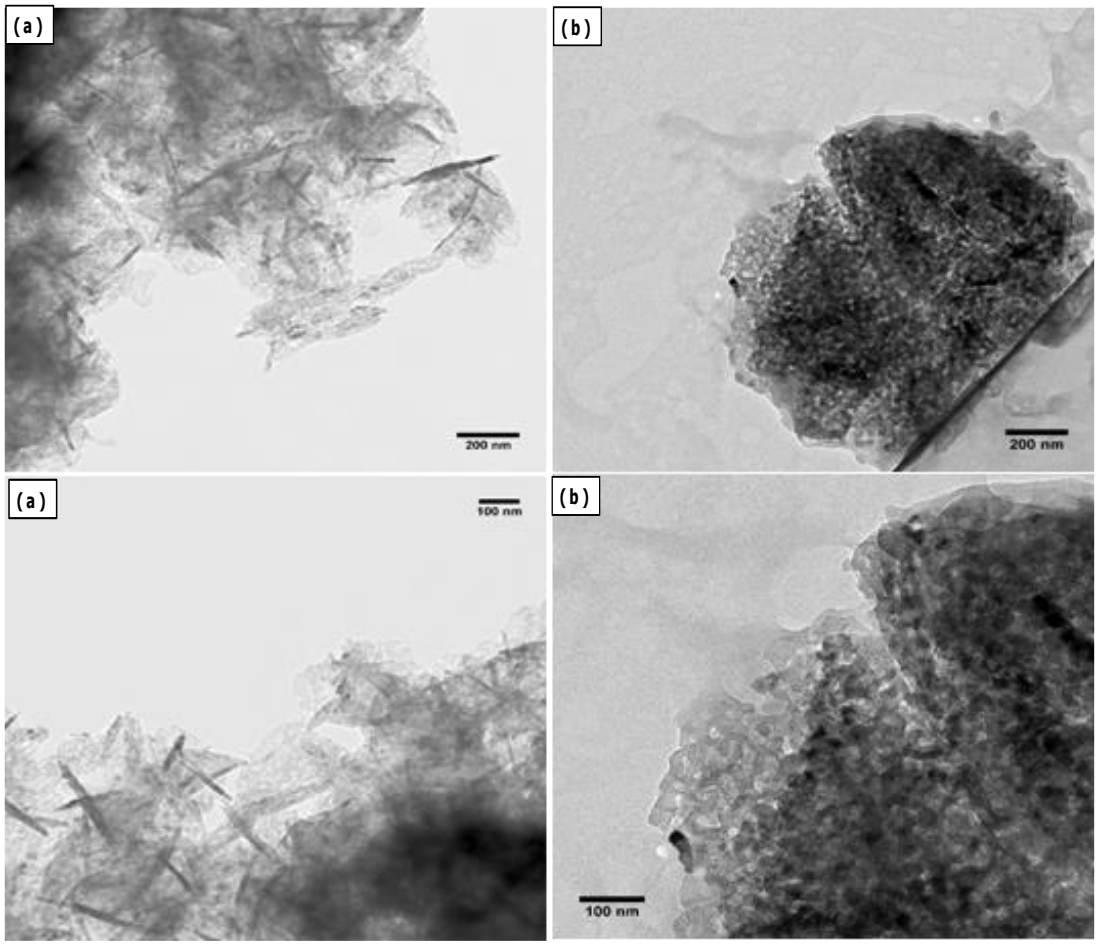

Fig. 3: TEM micrographs of magnesium oxide nanoparticles synthesized from precursors precipitated by (a) NaOH-Disintegrated MgO NPs and (b) NH3-Interconnected MgO NPs.