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Carbon Mineralization into Nesquehonite-Based Building Materials.

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Carbon dioxide sequestration (CCS) is considered to be the future for the reduction of the industrial carbon emissions (Baena-Moreno *et al.*, 2019). Nesquehonite synthesis has been proposed as a promising permanent storage of CO_2 emission under low pressure conditions, with competitive properties as building material.

In this work, we study the cementitious characteristics of nesquehonite synthesized in high alkaline environment and under low-pressure conditions by reaction of gaseous CO_2 with Mg-chloride solution, as following:

$$MgCl_2 \cdot 3H_2O + CO_{2(g)} + H_2O \rightarrow MgCO_3 \cdot 3H_2O_{(s)} + 2H^+$$

A saturated Mg^{2+} solution was used for its synthesis, at a temperature of 25°C and pH 9.3. During the reaction, since the pH tended to reduce, a continuous input of NH_3 solution of high concentration (35%) was required to keep the pH in alkaline values (Ferrini *et al.*, 2009). The NH_3 solution didn't react with the products and was easily separated by using a vacuum pump. Nesquehonite synthesized herein was subsequently studied by means of X-Ray Diffraction, optical microscopy (Fig. 1), scanning electron microscopy (Fig. 2), FT-IR and Raman spectroscopic methods. Synthesized nesquehonite forms elongated fibers, exhibiting transparent to translucent diaphaneity and vitreous luster. FT-IR and Raman spectroscopy revealed the presence of OH^- and CO_3^{2-} in the crystal structure of nesquehonite.

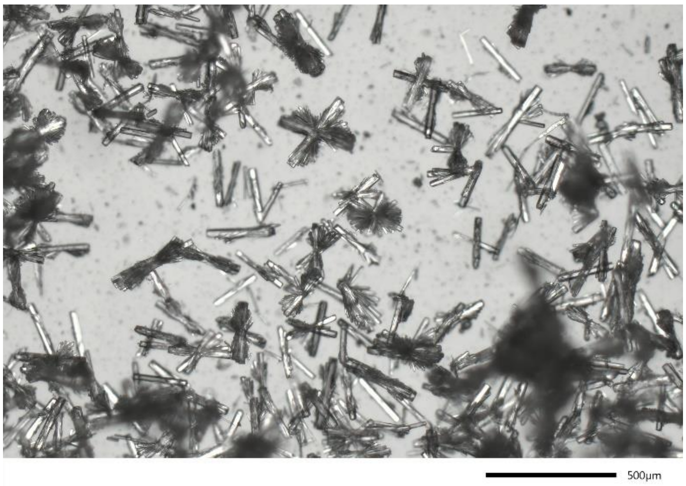

Figure 1. Photomicrograph of nesquehonite synthesized herein under transmitted polarizing light.

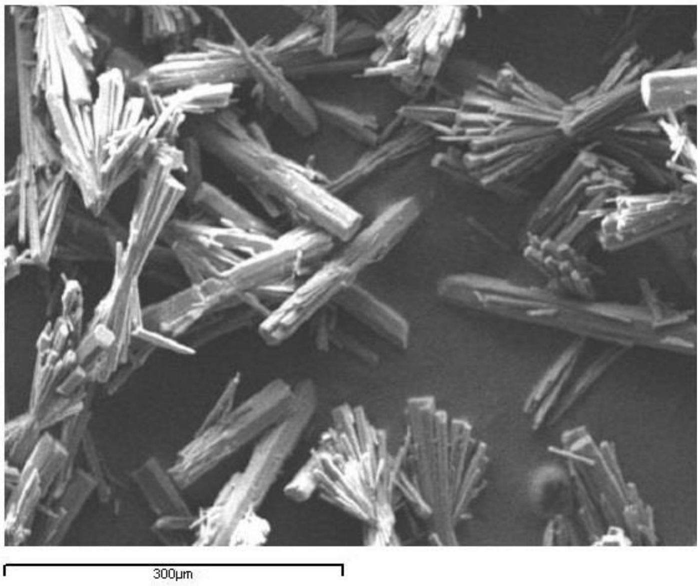

Figure 2. Secondary electron image of nesquehonite synthesized herein.

After being synthesized, nesquehonite was examined for its cementitious characteristics, by mixing it with reactive magnesia, standard aggregate sand and water to create a mortar. The new mortar was cast into 5x5x5 silicone mold and cured in water for 28 days (Fig. 3a). The sample achieved a compressive strength of 14 MPa after 28 days (Fig. 3b). Subsequently, it was studied by means of X-Ray Diffraction and FT-IR spectroscopy. XRD results indicated the presence of Mg(OH), which was formed after reactive magnesia hydration. FTIR study revealed the stability of CO_3^- in the binder of the mortar.

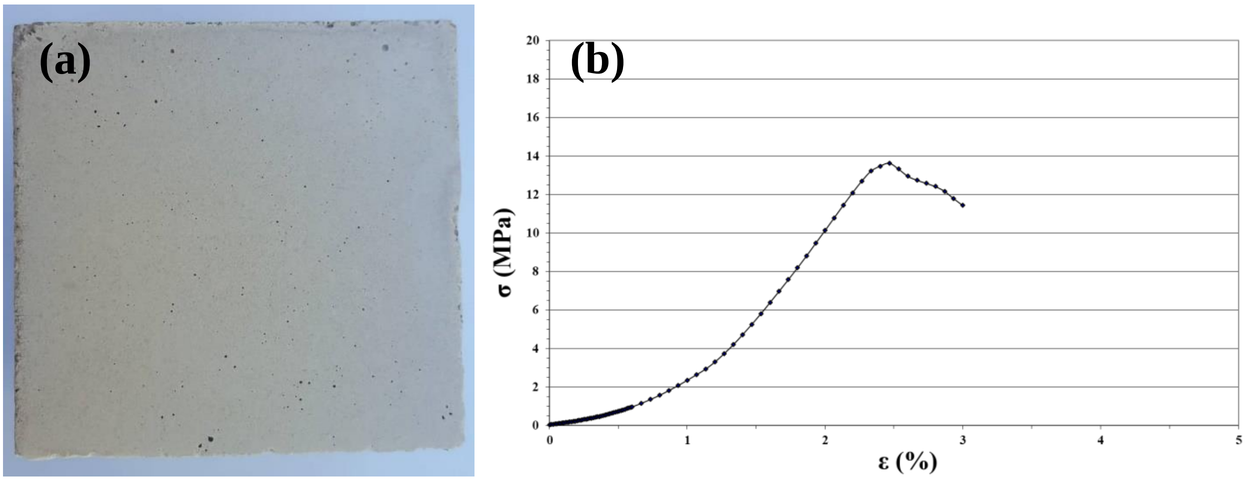

Figure 3. (a) Photomacrograph of the mortar sample and (b) comprehensive strength of the sample achieved herein.

As shown, a permanent storage of CO_2 might be achieved by CO_2 mineralization into a new nesquehonite-based "green" mortar with competitive properties. This method might be a part of Carbon Capture, Utilization, and Storage (CCUS) technologies to remove CO_2 from the flue gas and from the atmosphere by providing a safe, permanent and useful storage option.

References

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