The study on intercalation of nano - sericite

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ABSTRACT

The sericite mica is an endemic mineral produced at Shiayang, Taitung County of Taiwan. It is also one of the most valuable industrial minerals of Taiwan. Preparation of nanometer-scale sericite will endow numerous developmental potential. The present literatures point toward an ion-exchange of interlayer potassium ion so as to weaken the interlayer bonding force and allow achieving of a swellable condition is the most promising intercalation approach in the preparation of nanosericite. This study was carried out in 3 stages. In the first stage, variables of sodium intercalated swellable sericite were examined. Hydrothermal and molten salt methods were applied to exchange the interlayer cations. Heating conditions, sodium hydroxide dosages, temperatures, and heating time of different treatments were examined for their modification effects on crystal lattice changes, specific surface areas, and cation exchange capacities (CECs) of the sericite, and to establish the optimal conditions of intercalating sericite with sodium. In the second stage, the best sodium intercalation process was established. Using the results of the first stage, mass production of sodium intercalated sericite could be formulated. .Using CEC, X-ray diffraction (XRD) of crystal lattice, and SEM techniques to evaluate the transformation rates of sodium intercalated sericite. In the third stage, the intercalated sericite was turned into nanosericite. A cationic surfactant, cetyl dimethyl betaine (CDB) was applied to organically intercalate the sericite layers, causing the exfoliated nanosericite to stably disperse. Zeta potential changes of the nanosericite were observed to investigate the variables affecting its stability. XRD was also used to investigate the changes in crystal lattices of the nanomaterial, as well as conducted SEC observation of the dispersion. The results indicated that hydrothermal method to swell the sericite entailed the best result at 7.5 M NaOH concentration and 200°C for 2 h which increased the CEC of the original sericite from 11.6 meq/100 g to 33.7 meq/100 g. The XRD results suggested that new diffraction peaks were observed at 2θ angles of 14, 24.4 and 43.5 ° ; whereas the original diffraction peaks were mostly disappeared. For the molten salt method, adding 3 g of NaOH and heating to 400°C for 1 h caused CEC of the original mineral to increase from 11.6 meq/100 g to a high of 51.2 meq/100 g. Even treatments at lower temperatures also showed marked CEC enhancements. XRD of the molten salt intercalated sericite showed disappearance of the original peaks while there as no new peak formed. The second stage experiments found that at sericite to NaOH (S/N) ratio of 1/1.5, and a temperature of 240°C for 4 h, higher CEC was achieved at 85.9 meq/100 g, which possessed the same diffraction peaks as those observed for hydrothermally produced intercalated sericite. Henceforth, this condition was used to sodium intercalation sericite for mass production. In the third stage, the intercalated sericite was acidified with nitric acid to a pH < 2, which turned the intercalated sericite into a transparent solution state. Then the CDB cationic surfactant was applied to organically intercalate the sericite layers. Zeta potential measurements indicated at pH 4~5, the isoelectrical poit of CDB was achieved. FTIR analysis results showed that new absorption peaks appeared at 2972, 1650, and 1216 cm-1, which correlated with the absorption peaks of CDB. These confirmed that CDB intercalated the sericite successfully. SEM observations suggested that adding CDB could effectively reduce the particle diameters of the nanosercite, with the nominal diameter of nanosericite to reduce from 4 μm to 1 μm for the 5% CDB intercalated nanosericite.

Keywords : sericite、molten salt method、hydrothermal method、organic intercalation、swellable、cationic exchange capacity

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