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ARTICLE

Synthesis and Magnetic Properties of Antiferromagnetic Maricite-$NaFePO_4$ by Mössbauer Spectroscopy

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ABSTRACT

Sodium iron phosphate $NaFePO_4$ can be considered for certain land-based non-portable power applications, where factors such as cost, size, and weight are not critical. In this study, the crystallographic and magnetic properties of maricite-$NaFePO_4$ are characterized by using X-ray diffractometer (XRD), vibrating sample magnetometer (VSM), and Mössbauer spectrometer. The sample was prepared by solid-state reaction method. The crystal structure of sample was determined to be orthorhombic with space group of *P*nmb and the measured lattice constants are $a_0 = 6.8647$ Å, $b_0 = 8.9781$ Å, and $c_0 = 5.0420$ Å. The zero-field-cooled (ZFC) and field-cooled (FC) magnetic susceptibility curves of maricite-$NaFePO_4$ were taken with applied field of 1000 Oe. In the magnetization curve, maricite-$NaFePO_4$ showed antiferromagnetic behavior below Néel temperature ($T_N = 15$ K). In order to investigate the magnetic structure through Fe nucleus, Mössbauer spectra of maricite-$NaFePO_4$ were measured at various temperatures from 4.2 to 295 K. The room-temperature Mössbauer spectrum showed one-doublet with measured values of $\Delta E_Q = 2.19$ mm/s and $\delta = 1.04$ mm/s. The Mössbauer spectrum taken at 4.2 K exhibited asymmetrical absorption line. The obtained Mössbauer parameters were the hyperfine field of $H_{hf} = 165.97$ kOe, electric quadrupole splitting of $\Delta E_Q = 2.20$ mm/s, $\delta = 1.23$ mm/s, $\theta = 15°$, $\varphi = 10°$, and $\eta = 0.4$. While the values of H_{hf}, and ΔE_Q decrease with increasing temperature. The values of isomer shift (δ) indicate that, for all temperatures, the state of iron ions is ferrous. This suggests the reduction of strong electric quadrupole interaction which enhances the asymmetric Mössbauer spectrum below T_N.

KEYWORDS: Sodium-Ion Battery, Mössbauer Spectroscopy, Antiferromagnetism.