

# Crystal Structure and Magnetic Properties of Sodium-Iron Phosphates $\text{NaFe}_{0.9}\text{Mn}_{0.1}\text{PO}_4$ Cathode Material

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(Received 13 November 2018, in final form 22 November 2018)

The sodium-iron phosphate maricite- $\text{NaFe}_{0.9}\text{Mn}_{0.1}\text{PO}_4$  was synthesized using the ball mill method. The crystal structure and magnetic properties of the prepared materials were studied using X-ray diffraction (XRD), vibrating sample magnetometer (VSM), and Mössbauer spectroscopy. Structural refinement of maricite- $\text{NaFe}_{0.9}\text{Mn}_{0.1}\text{PO}_4$  was analyzed using the FullProf program. From the XRD patterns, the crystal structure of maricite- $\text{NaFe}_{0.9}\text{Mn}_{0.1}\text{PO}_4$  was found to be orthorhombic with the space group  $Pmnb$ . The lattice parameters of maricite- $\text{NaFe}_{0.9}\text{Mn}_{0.1}\text{PO}_4$  are as follows:  $a_0 = 6.866 \text{ \AA}$ ,  $b_0 = 8.988 \text{ \AA}$ ,  $c_0 = 5.047 \text{ \AA}$ , and  $V = 311.544 \text{ \AA}^3$ . Maricite- $\text{NaFePO}_4$  has an edge-sharing structure that consists of  $\text{FeO}_6$  octahedral. Under an applied field of 100 Oe, the temperature dependences of zero-field-cooled (ZFC) and field-cooled (FC) curves were measured from 4.2 to 295 K. Mössbauer spectra were also recorded at various temperatures ranging from 4.2 to 295 K. We thus confirmed that the Néel temperature of  $\text{NaFe}_{0.9}\text{Mn}_{0.1}\text{PO}_4$  ( $T_N = 14 \text{ K}$ ) was lower than that of maricite- $\text{NaFePO}_4$  ( $T_N = 15 \text{ K}$ ).

PACS numbers: 61.05.cp, 75.60.Ej, 76.80.+y

Keywords: Sodium-iron battery, Mössbauer spectroscopy, Antiferromagnetic

DOI: 10.3938/jkps.73.1863