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MS-14-P-5858 Microstructural characterization of Na0.44MnO2 nanorods as a cathode material for Na-ion batteries

KAYA P.[1], DEMIREL S.[2], OZ E.[2], ALTIN E.[3], ALTIN S.[2], BAYRI A.[2], AVCI S.[4], TURAN S.[1]

[1]Department of Materials Science and Engineering, Anadolu University, Eskisehir, Turkey, [2]Physic Department, Inonu University, Malatya, Turkey, [3]Scientific and Technological Research Center, Inonu University, Malatya, Turkey, [4]Department of Materials Science and Engineering, Afyon Kocatepe University, Afyon, Turkey

Email of the presenting author: pkayamse@gmail.com

Rechargeable batteries are essential components for powering ever-more demanding portable electronic devices such as laptops and smart phones [1]. Over the last years and decades, the intercalation-based lithium ion battery (LIB) technology has been at the center of this research, due to its high power density and capacity [2]. However; due to high cost and limited Li sources; research has recently also focused on alternative energy storage technologies and sodium ion batteries are one of the promising candidate instead of lithium ion batteries [2, 3]. $NaMn_2O_4$ nanorods were synthesized by using conventional solid state method. Na_2O_2 and Mn_2O_4 were mixed in agate mortar and then sintered at 750°C for 24 h under oxygen atmosphere. After sintering, the powders were pressed into pellets and the pellets were heat treated at 250-900°C for 24 h under oxygen atmosphere. The samples were characterized by employing XRD, SEM and TEM techniques. XRD patterns of the samples were recorded by automated Rigaku Ra_{dB} Dmax x-ray difractometer with $Cu_{K\alpha}$ radiation was used for the XRD analysis. Sintering the sample at 250°C and 450°C is not enough to from the $Na_{0.44}MnO_2$, since it still contains Na_2O_2 and Mn_2O_4 (MnO_2) phases as the main phases. During the next step of sintering at 650oC for 24 h, the $Na_{0.44}MnO_2$ phase starts forming (Figure 1). Scanning electron microscopy (SEM) investigations were carried out by using a Schottky emitter field emission gun (FEG) SEM (Zeiss SUPRA 50 VP) equipped with in-lens, back scattered (BS), electron back scattered diffraction (EBSD) and energy dispersive x-ray (EDX) detectors. For transmission electron microscopy (TEM) analysis, powder sintered at 750°C for 24 h was chosen and dispersed in 2 -propanol and then suspension was dropped on the copper grid. TEM studies were conducted by using 200 kV field emission TEM (JEOL™ JEM-2100F) equipped with STEM high angle annular dark field (STEM-HAADF) detector (Model 3000, Fischione), parallel electron energy loss spectrometer (PEELS) and energy filter (Gatan™ GIF Tridiem), and energy dispersive spectrometer (EDS) (JEOL™ JED-2300T). According to microstructural characterization results, the length of the rods reach to ~500µm, while their widths range between ~100 nm – ~2 µm (Figure 2).

References

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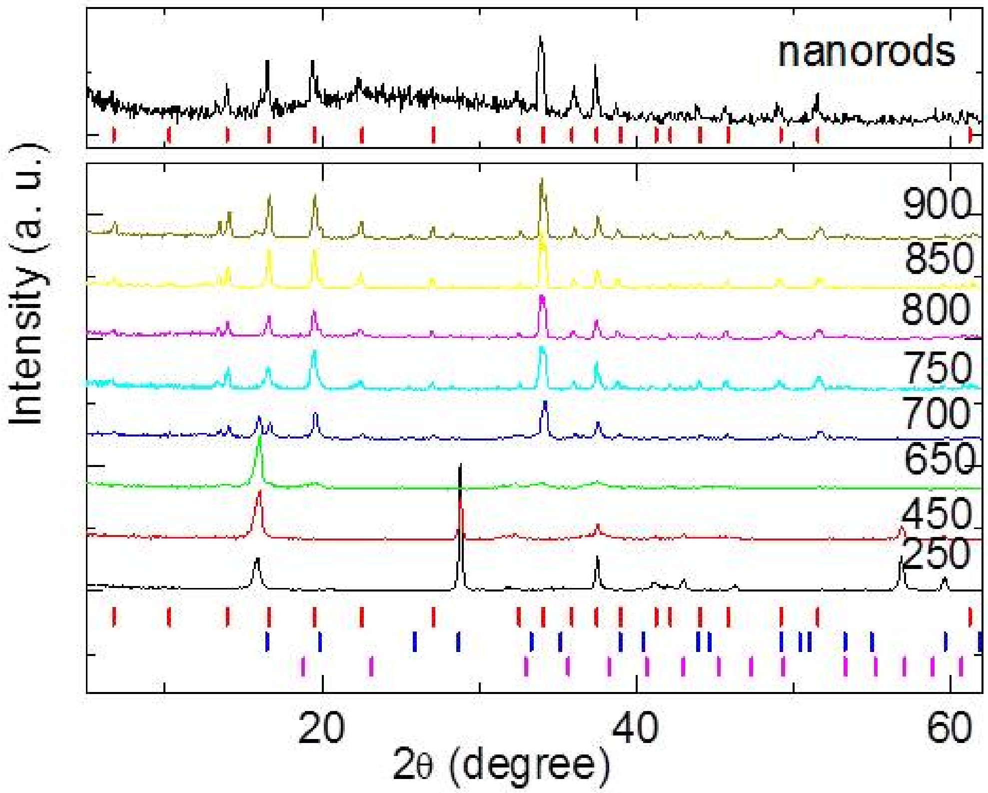

Fig. 1: Bottom panel: XRD patterns showing the evolution of Na0.44MnO2 phase after various heat treatments. Top panel: XRD pattern for the nanorods scratched from the surface of the main matrix.

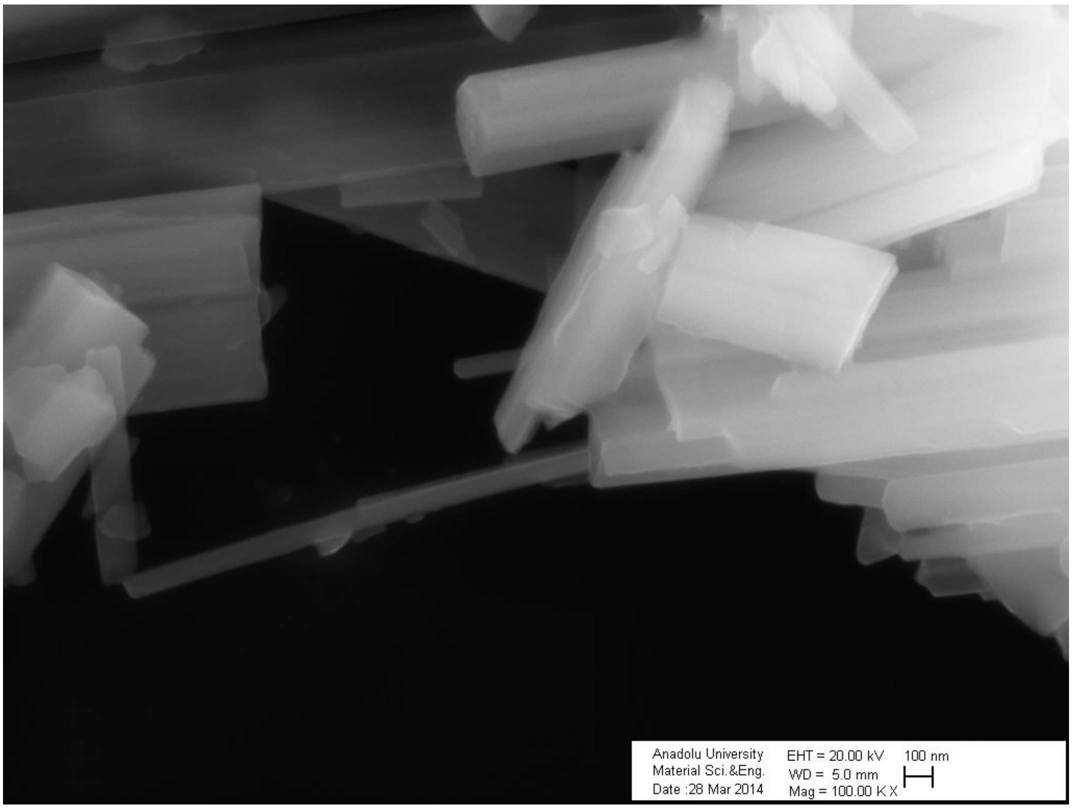

Fig. 2: SEM image of the samples sintered at 700 for 24 h taken by using INLENS dedector.