# Exploration of Na-Mn-O system: toward new cathode materials for sodium-ion batteries?

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**Abstract**

Today, society is increasingly dependent on electricity. In response to climate change, governments around the world are promoting the development of green mobility (electric and hybrid vehicles) as well as the production of electricity from renewable sources (hydraulic, wind, solar, etc.). However, the drawback of this type of production is its dependence on weather conditions. To smooth out production when it exceeds demand, or vice versa, the use of electrochemical storage is necessary. Currently, this market is largely dominated by lithium-ion (Li-ion) technology. The lack of real alternatives is causing strain on raw materials (lithium, cobalt, and even graphite). In response to the challenges related to resources, sodium-ion (Na-ion) batteries, which rely on a much more abundant element than lithium, represent a promising alternative. In addition, manganese oxides are of great interest because of manganese's abundance, low toxicity, and cost-effectiveness. For these reasons, we embark on developing a new cathode material based on sodium and manganese oxides.

The Na-Mn-O system includes numerous phases, with many compositions reported in the 70's primarily as single crystals for the most part. To date only two compositions have been explored as cathode materials for Na-ion batteries: NaxMnO2 and Na2Mn3O7 phases. Among all the known compositions, the phase Na10Mn4O9 attracts our interest for several reasons: the high theoretical capacity assuming the reversible extraction and insertion of 8 sodium ions; and its original layered structure built of (MnO4) tetrahedra and (MnO3) isolated trigonal planar units.

Thus, this work focuses on the solid-state synthesis of Na10Mn4O9 as well as a range of various characterizations, including X-ray diffraction, scanning electron microscopy, electrochemical behavior in sodium batteries, post-mortem analysis, etc.

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