Combinatorial Development of Active Materials for Energy Storage and Conversion

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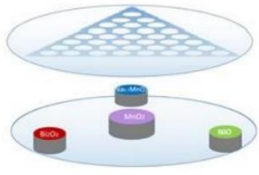
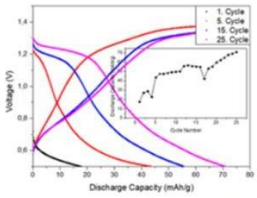
Active material development in energy storage and conversion as in similar development other fields of materials research have largely followed Edisonian approach of focusing on one material composition at a time. The approach requires a careful pre-consideration in selecting the material composition and the success depends largely on the suitability of the initial choice made for the material. Combinatorial approach is an alternative method whereby a large number of samples each with different compositions are produced simultaneously. They are then screened in a fast manner to single out the material(s) with best performance. The materials selected are then fully characterized as is customary for the conventional method. The combinatorial approach is more efficient in terms both time and effort and yield more fruitful.

In this work, we describe a sputter deposition system which we specifically designed for combinatorial material development The system designed could incorporate up to 6 sputter targets 2 inches in diameter plus the central one in 3 inches which would provide the base composition.



Combinatorial geometry for fabrication of thick film material library for Zn-MnO2 batteries. Three peripheral targets are in triangular geometry, substrates above mimicking the position of targets underneath.



Charge-Discharge profiles at selected cycles for $Bi_{0.06}Na_{0.34}Ni_{0.17}Mn_{0.44}O_x$, Insets showing the cyclic discharge capacity

In this presentation, following a brief review of the previous achievement, we concentrate on combinatorial development of cathode material for Zn-MnO_2 battery. This is a low-cost battery, with limited rechargeability, mostly used as primary battery. There is, however, considerable interest in this chemistry to make it truly rechargeable, preferably with two electron exchange, i.e. Mn4+⟶ Mn2+. We therefore modified MnO2 in quaternary configuration, where MnO2, was modified with other oxides, namely Bi2O3, Na0.7MnO2 and NiO Fig.2. A total of 36 cathodes were deposited on nickel substrate typically 2.5 mm thick each with a different composition. The results show that thick film cathodes are largely amorphous in as-deposited state but upon chargedischarge the structure rearranges into crystalline form into layered d-MnO2 structure. Two regions were identified as potential cathodes one region was close to NiO corner. and the other regions had moderately large Na content.

Acknowledgements

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