

## Ordering – Disordering Phenomena and Electrochemical Intercalation Chemistry

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The reversible intercalation/deintercalation phenomenon in a host structure is the basic reaction that occurs during the charge/discharge of almost all batteries. As far as layered structure electrode materials are used, the ordering phenomena play a major role. For a general point of view the structures can be described as a packing of  $\text{MO}_2$  slabs, with the mobile species ( $\text{H}^+$ ,  $\text{Li}^+$ ,  $\text{Na}^+$ ) intercalated in the interslab space. The ordering can concern the  $\text{MO}_2$  slab, their packing and also the intercalated species.

The cell voltage is the difference between the Fermi levels between the two electrodes. Its variation upon cell charge and discharge reflects all structural changes, whatever their origin that occur during the electrochemical reaction. In particular all ordering/disordering phenomena, which are very common in layered materials, are clearly emphasized. In this presentation a review of these various phenomena will be presented:

- Various types of packing of the slabs
- Stacking faults in relation with the electrochemical properties
- Cation ordering within the slabs
- Long range ordering/disordering in the packing of ordered slabs
- Lithium/vacancy ordering in the interslab space during electrochemical intercalation/deintercalation
- Competition between the cation ordering in the interslab space and the charge distribution in the slab : the special case of the  $\text{Na}_x\text{MO}_2$  materials

The study by X-Ray and electron diffraction of either the starting materials or the intercalated/deintercalated ones is a way to understand their structure, the effect of the electrochemical reaction and the material evolution during long range cycling of the electrochemical cell.

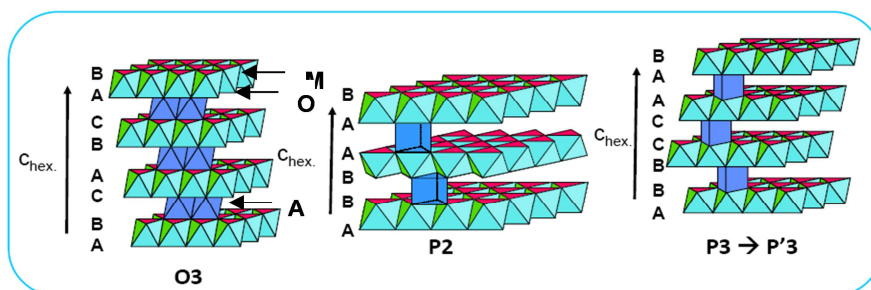
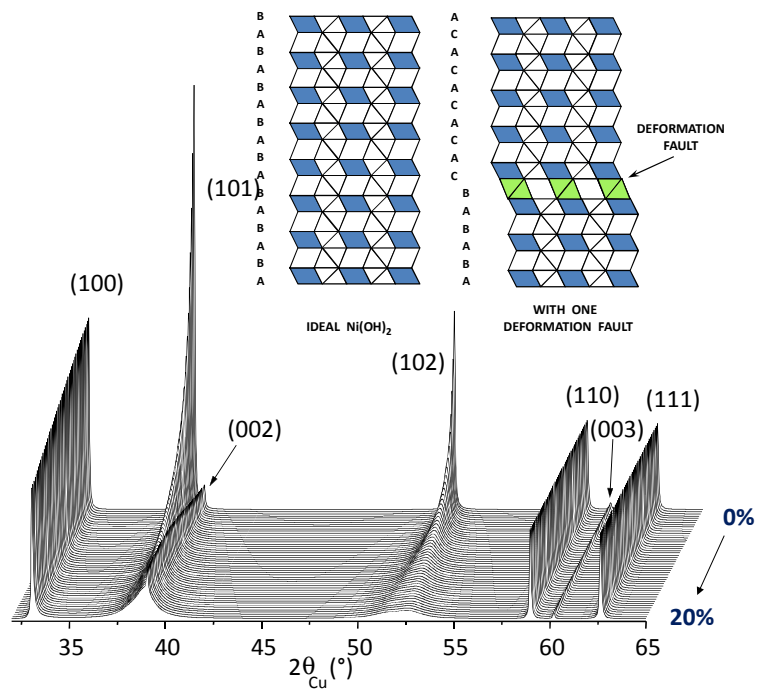


Fig. 1 The various types, of packing in  $\text{A}_x\text{MO}_2$  layered oxides



Fig; 2 Effect of an increasing amount of deformation faults on the XRD pattern of nickel hydroxide

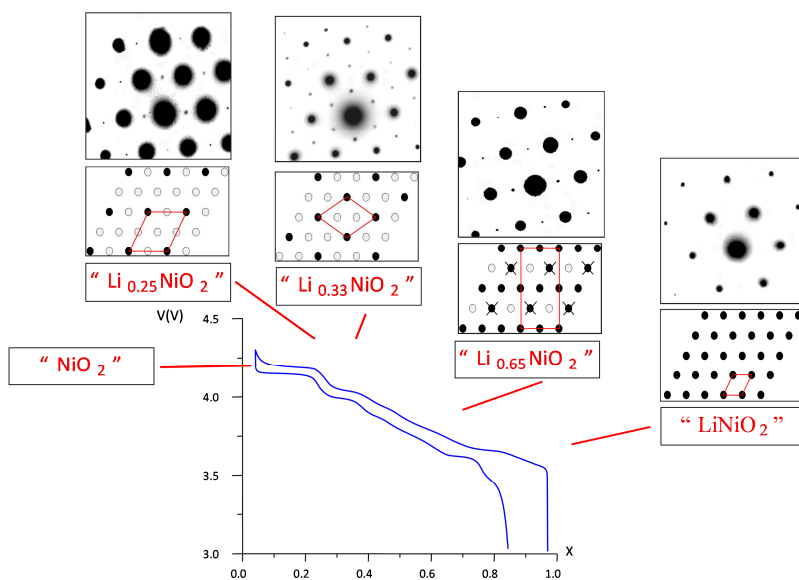


Fig. 3 Various lithium/vacancy ordering observed during the electrochemical intercalation of lithium in the  $\text{Li}_x\text{NiO}_2$  system.