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Synthesis of Ni-poor NiO nanoparticles for DSSC-p applications

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Over the last decade, p-type semiconductors (SC) have known a renewed interest. Indeed these materials may have potential applications for light-emitting diodes, transistors, solar cells, etc. Since the achievement of the first Dye Sensitized Solar Cells (DSSC) by Grätzel [1] in 1991 a new generation of solar cells has been developed [2] where the n-type SC is replaced by a p-type one. This leads to the photo-injection of holes instead of electrons in the circuit. To date nickel oxide (NiO) is the reference p-type semiconductor. However yields are still far from those of n-DSSC and many studies aim to replace NiO by other systems such as CuAlO2, CuGaO2, CuCrO2, or NiCo2O4 nanoparticles. Following our recent synthesis of N doped ZnO with stabilization of p-type charge carriers [3], we focus now on the preparation of N doped NiO nanoparticles to improve the p-type conductivity of NiO. We study here the chemical reactivity of a nickel oxyhydroxide precursor under air and ammonia that conducts to nanostructured Ni-poor NiO [4].

p-DSSC performances

Nickel precursor synthesis & characterizations

Thermal decomposition under air atmosphere

Thermal decomposition under ammonia atmosphere

Evidences of Ni-poor NiO nanoparticles

XPS NiO2 (C1s)

Spectra: 
- Ni 2p1/2 binding energy (E1/2) = 855.37 eV
- Ni I 1s binding energy (E1/2) = 856.1 eV

XRD patterns:
- Cubic NiO structure (NaCl type) at T = 250 °C
- No influence of temperature on NiO nanoparticles crystallinity
- Hexagonal Ni2O3 structure formation at T > 300 °C

Synthesis of nickel doped nickel oxide (NiO: N)

References