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

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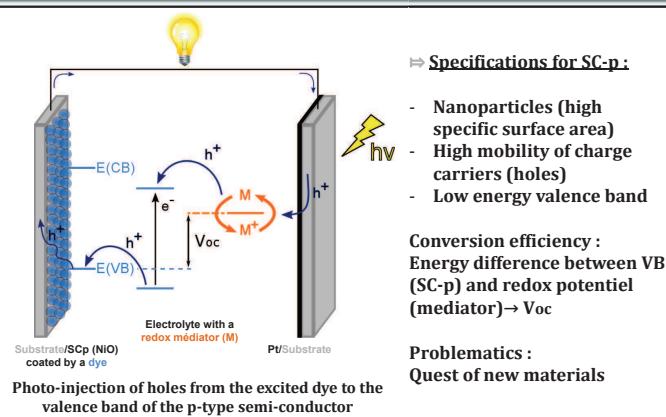
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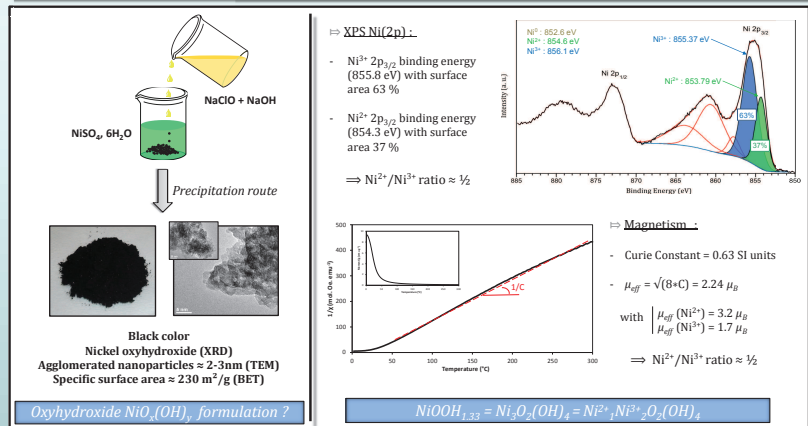
<sup>c</sup> CEISAM, Université de Nantes, France

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 <sup>[1]</sup> in 1991 a new generation of solar cells has been developed <sup>[2]</sup> 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 CuAlO<sub>2</sub>, CuGaO<sub>2</sub>, CuCrO<sub>2</sub> or NiCo<sub>2</sub>O<sub>4</sub> nanoparticles. Following our recent synthesis of N doped ZnO with stabilization of p-type charge carriers <sup>[3]</sup>, 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 <sup>[4]</sup>.

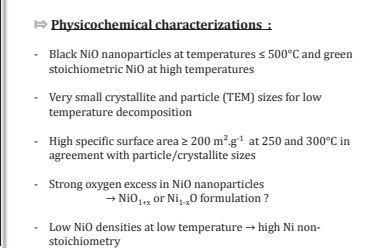
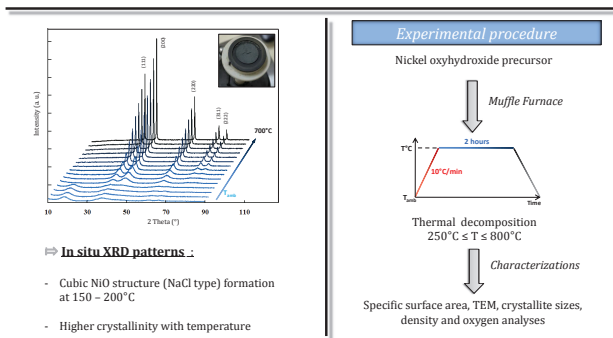
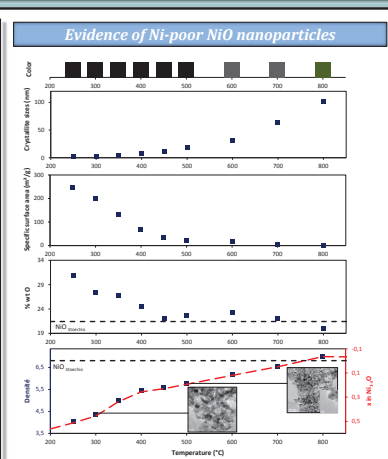
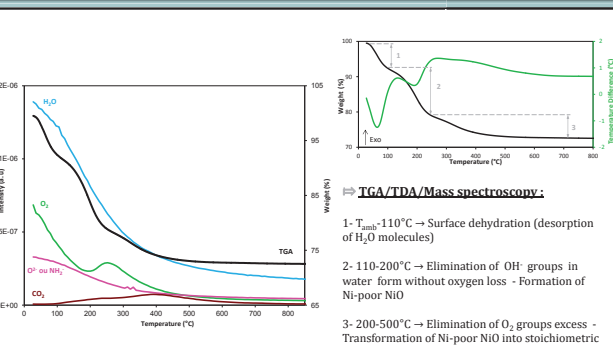
## p-DSSC performances



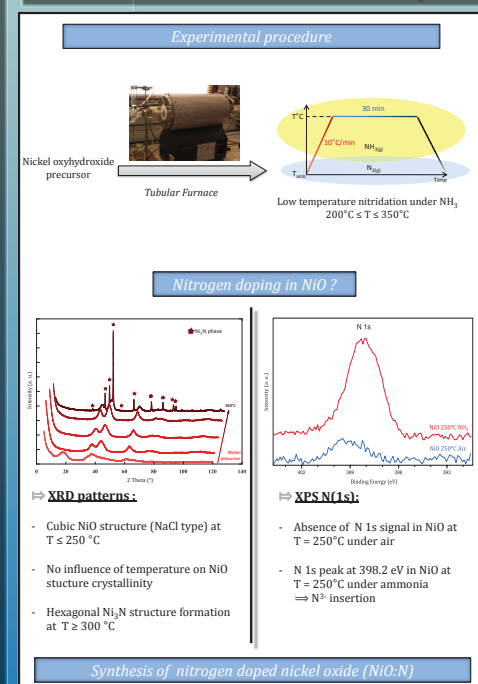
## Nickel precursor synthesis & characterizations



## Thermal decomposition under air atmosphere



## Thermal decomposition under ammonia atmosphere



## Conclusion

- ⇒ Synthesis of an original nickel precursor with very small particle sizes and high specific surface area. The determination of the Ni<sup>2+</sup>/Ni<sup>3+</sup> ratio is leading to the exact formulation Ni<sub>3</sub>O<sub>2</sub>(OH)<sub>4</sub>
- ⇒ Decomposition of Ni<sub>3</sub>O<sub>2</sub>(OH)<sub>4</sub> under air at temperature lower than 500°C forms strong non-stoichiometric NiO nanoparticles with high nickel vacancy concentration
- ⇒ Stabilization of nitrogen doped NiO by decomposition of Ni<sub>3</sub>O<sub>2</sub>(OH)<sub>4</sub> under ammonia atmosphere at 250°C
- ⇒ Characterization of Ni-poor NiO and NiO:N nanoparticles in p-DSSC in progress

## References

- [1] B. O'Regan, M. Grätzel, *Nature* **353**, 737-740 (1991).
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- [3] B. Chavillon, L. Cario, A. Renaud, F. Tessier, F. Cheviré, M. Boujtia, Y. Pellegrin, E. Blart, A. Smeigh, L. Hammarström, F. Odobel, S. Jobic, *J. Am. Chem. Soc.* **134**, 464-470 (2012).
- [4] B. Polteau, F. Tessier, F. Cheviré, L. Cario, S. Jobic, F. Odobel (2015) to be published.