



HAL
open science

Preparation of nitrogen doped ZnO thin films by colloidal route

Arnaud Valour, François Cheviré, Franck Tessier, Fabien Grasset, Stéphane Jobic, Laurent Cario, Eric Faulques, Tengfei Jiang

► **To cite this version:**

Arnaud Valour, François Cheviré, Franck Tessier, Fabien Grasset, Stéphane Jobic, et al.. Preparation of nitrogen doped ZnO thin films by colloidal route. E-MRS 2015 Spring Meeting, May 2015, Lille, France. hal-01277164

HAL Id: hal-01277164

<https://hal.science/hal-01277164>

Submitted on 22 Feb 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Preparation of nitrogen doped ZnO thin films by colloidal route



Arnaud Valour ^{a)}, François Cheviré ^{a)}, Franck Tessier ^{a)}, Fabien Grasset ^{b)}, Stéphane Jobic ^{c)}, Laurent Cario ^{c)}, Eric Faulques ^{c)}, Tengfei Jiang ^{c)}

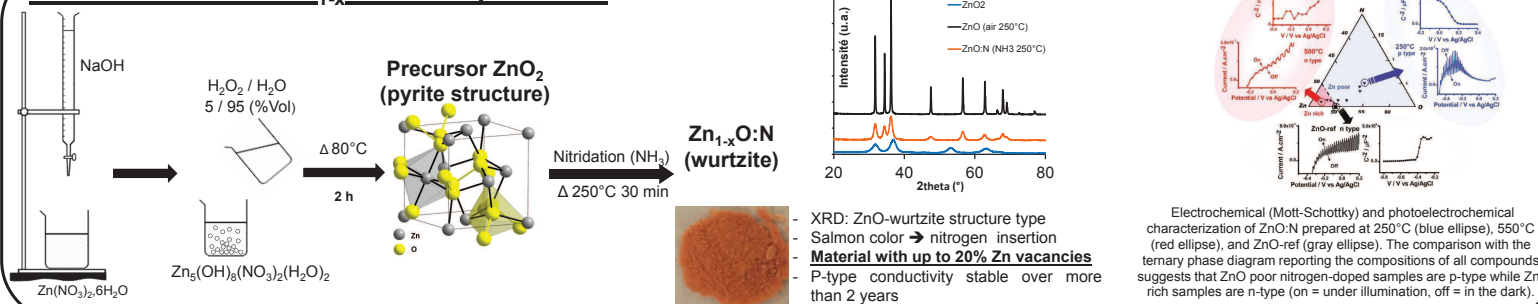
^{a)} Institut des Sciences Chimiques de Rennes (UMR CNRS 6226) – Université de Rennes 1 – France

^{b)} Laboratory for Innovative Key Materials and Structures – National Institute of Material Science (UMI 3629 CNRS/Saint Gobain) – Tsukuba, Japon

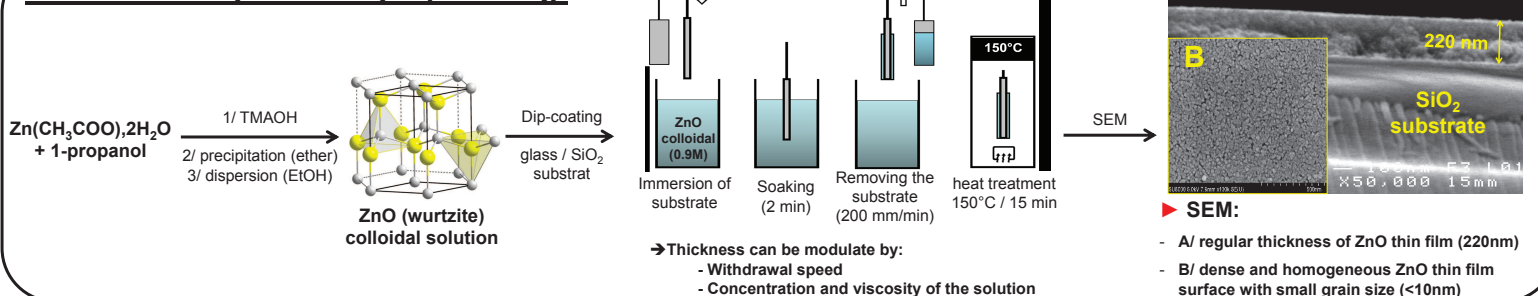
^{c)} Institut des Matériaux Jean Rouxel (UMR CNRS 6502) – Université de Nantes – Nantes, France

Zinc oxide is a material of great interest exhibiting pigmental, photocatalytic, piezoelectric, antibacterial, or varistor properties that have already been developed in many different fields of industry. Still novel applications emerge in various domains but they often require the preliminary stabilization of a p-type ZnO counterpart to the natural n-type ZnO to be stimulated. In optoelectronics for instance, the high optical transparency of ZnO thin films coupled with their high electrical conductivity and their strong room temperature luminescence could indeed open up the door to revolutionary technologies as transparent electrodes in solar cells and flat panel displays, light emitting diodes, lasers, etc. We have previously reported the stabilization of p-type nitrogen doped Zn_{1-x}O nanoparticles (ZnO:N) obtained through the decomposition of zinc peroxide (ZnO₂) at low temperature under ammonia flow. Our objective is now to extend these results to the realization of p-type ZnO thin films by colloidal route in order to achieve n-ZnO/p-ZnO:N homojunctions which would lead to various applications in optoelectronics. The aim of the present work is to prepare nitrogen doped Zn_{1-x}O thin film by thermal decomposition of ZnO₂ films obtained by chemical conversion of ZnO colloidal thin films.

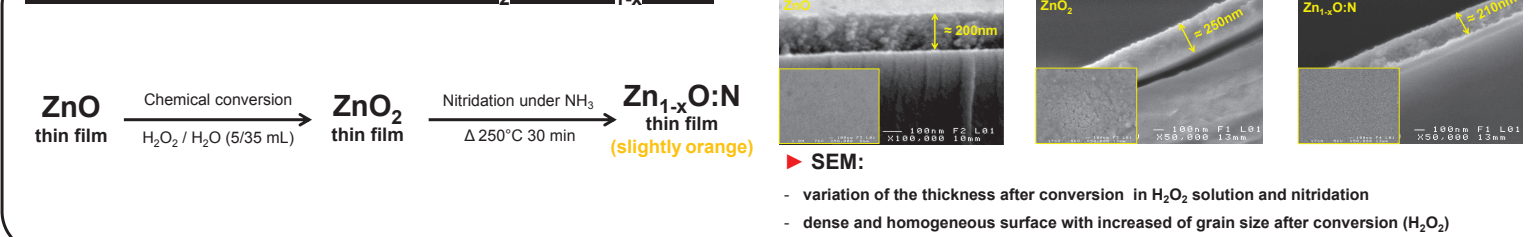
Previous work on Zn_{1-x}O:N nanoparticles:



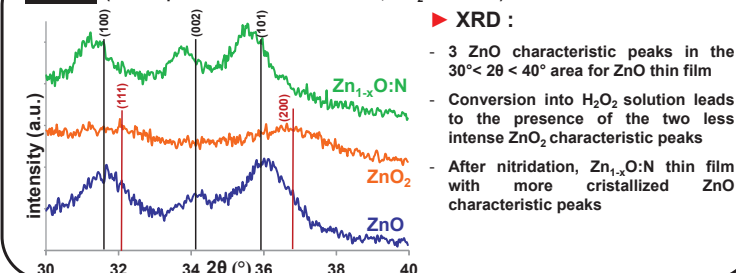
ZnO thin film synthesis by dip-coating:



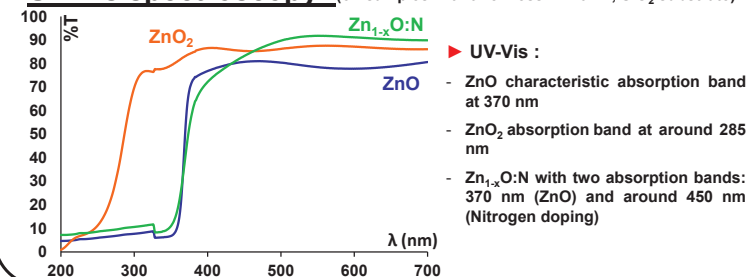
ZnO thin film conversion into ZnO₂ and Zn_{1-x}O:N :



XRD: (on samples with thickness ≈ 220nm, SiO₂ substrate)



UV-Vis spectroscopy: (on samples with thickness ≈ 220nm, SiO₂ substrate)



References:

P-type nitrogen doped ZnO nanoparticles stable under ambient conditions. B. Chavillon, L. Cario, A. Renaud, F. Tessier, F. Cheviré, M. Boujtila, Y. Pellegrin, E. Blart, A. Smeigh, L. Hammarström, F. Odobel, S. Jobic *J. Amer. Chem. Soc.* **134** (2012) 464-470

Unravelling the origin of the giant Zn deficiency in wurtzite type ZnO nanoparticles A. Renaud, L. Cario, X. Rocquefelte, P. Deniard, E. Gautron, E. Faulques, F. Cheviré, F. Tessier, S. Jobic *Scientific Reports* (2015) submitted

Conclusions:

- decomposition of ZnO₂ under NH₃ at T=250°C leads to Zn-poor ZnO:N. Zinc vacancy coupled with insertion of nitrogen is necessary to access p-typeness
- stabilization of homogeneous, regular and dense wurtzite ZnO thin film by dip-coating (thickness ≈ 200nm).
- conversion of ZnO thin film into ZnO₂ by a simple chemical conversion (into H₂O₂ solution) in order to obtain Zn_{1-x}O:N films by nitridation under NH₃ at T=250°C