Preparation of nitrogen doped ZnO thin films by colloidal route

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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 ZnO nanoparticles (ZnO:N) 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 ZnO thin film by thermal decomposition 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 ZnO \(_2\) and Zn_{1-x}O:N :**

**XRD:**
- 3 ZnO characteristic peaks in the 30°< 40° area for ZnO thin film
- Conversion into H\(_2\)O\(_2\) solution leads to the presence of the two less intense ZnO characteristic peaks
- After nitridation, Zn\(_{1-x}\)O:N thin film with more crystallized ZnO characteristic peaks

**UV-Vis spectroscopy:**
- ZnO characteristic absorption band at 370 nm
- Zn\(_{1-x}\)O:N absorption band at around 285 nm
- Zn\(_{1-x}\)O:N with two absorption bands: 370 nm (ZnO) and around 450 nm (Nitrogen doping)

**Conclusions:**
- Decomposition of ZnO under NH\(_3\) at T=250°C leads to Zn-poor ZnO:N. Zinc vacancy, coupled with insertion of nitrogen is necessary to access p-type.
- Stabilization of homogeneous, regular and dense wurtzite ZnO thin film by dip-coating (thickness \(\approx 200\) nm).
- Conversion of ZnO thin film into ZnO\(_2\) by a simple chemical conversion (into H\(_2\)O\(_2\) solution) in order to obtain Zn\(_{1-x}\)O:N films by nitridation under NH\(_3\) at T=250°C

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References: