
Experiment Title Determination of the stoichiometric composition of InN and ZnO using RBS(Rutherford Backscattering Spectroscopy)

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Short presentation of the scientific project

Determination of the stoichiometric composition of InN and ZnO using RBS(Rutherford Backscattering Spectroscopy)
In the research and development of materials with new physical and electrical characteristics, indium nitrate (InN) is of interest for the realisation of electro optical devices, due to its semiconducting behaviour.The semiconductor behaviour of InN is correlated to the impurities introduced into the lattice. In fact, this material is in the form of a nearly 2 dimensional structure placed on different supports (substrates), where the layer thickness, its composition and the substrate has influence of the behaviour.
In this context, it is evident that in order to establish an appropriate production technology, it is vital to be able to analyse structure and elemental composition of individual (production) probes and RBS is one of the suited analysis methods, to do that.
The samples which are thin films of InN deposited on YSZ (Yttria Stabilized Zirconia) and ZnO were prepared at INOE(National Institute for Optoelectronics), in the speciality literature these structures were also deposited on different substrates like glass, Al2O3,Pt, Si, kapton. These thin films of InN and ZnO were obtained using a reactive magnetron discharge. The instalation used is AJA ATC ORION 5 UHV which can utilise up to 5 pulverization sources in confocal geometry DC (750 W maximum) or RF (300 W maximum). The substrates temperature was in the range of 350 – 450 0C , the pressure of the working gas (nitrogen and argon mixture) was kept constant in the deposition process.
Nowadays to increase the performance of electronics and optoelectronics devices there are a lot of reaserches on thin layers of type AIII-BV and especially on those which present a series of unexplained phenomena. Such thin layers of InN fall into this category. In InN thin layers with thicknesses of hundreds of nanometers, the study of phenomena associated with the emission current is very promising, i.e the absorption of electromagnetic radiation, including a broad range of solar radiation field.
The thin layers of InN, are in the focus of researchers in the field because of its outstanding properties: forbidden band in the 0.7 - 1.9 eV, high electron mobility, although there is much controversy in the literature regarding these values. Despite the relatively high number of defects, one can modify the forbidden band by impurification (doping) using ternary compounds such as InGaN and InAlN.
InN has received much attention in recent years because of its potential applications in high speed electronic devices, and its alloy with GaN and AlN cover continuously the near-infrared to ultraviolet spectral range, suitable for fabricating full color displays and solar cells based solely on nitrides.
The presence of impurities in this material may have undesirable effects on electrical properties, mechanical and chemical properties. Because of this situation, analytical techniques of ion beam energy of the order of MeV based on nuclear physics processes have been developed to obtain quantitative elemental analysis. The technique of Rutherford

Backscattering Spectroscopy (RBS) is very useful and powerful because it is a non-destructive analysis of thin layers up to thicknesses of less than 1μm. Because RBS is a fully quantitative method (no need for standards) and data analysis is relatively simple: spectrum acquired and related software what we want to obtain is:
-measure composition and thickness of thin films, it was found that electrical and optical qualities of InN can be improved by increasing film thickness (H. Lu, W.J. Schaff, J. Hwang, H. Wu, G. Koley and L.F. Eastman, Appl. Phys. Lett. 79 (2001), p. 1489; A. Yamamoto, K. Sugita, H. Takatsuta, A. Hashimoto and V.Y. Davydov, J. Cryst. Growth 261 (2004));
-concentration of elements in the sample and the presence of impurities associated with the fabrication method. In order to obtain InN and ZnO type structures with properties as close to the requirements of material producers we also seek to determine possible impurities (magnesium, yttrium, oxygen), which is the utmost importance because the presence of these impurities change the properties of such materials.(S.M. Durbin, P.A. Anderson, A. Markwitz , J. Kennedy, Oxygen uptake of InN thin films as determined by ion beam analysis, Thin Solid Films 515 (2007) 3736–3739).
-the elemental ratios in the thin layer;

The nondestructive, quantitative, and rapid IBA measurements are very useful to develop and optimize growth protocols in respect to film thickness, stoichiometry, and especially in regard to hydrogen and oxygen impurities for group III-V nitride and ZnO thin films prepared by various growth techniques.

We estimate for each sample an acqusition time of about 2 hours, taking into account that we don’t have a multi-target RBS chamber at least 30 minutes are wasted for each sample. We have to analyze 20 samples which goes to a total time of about 2 days.
Resulting data will be reported in the third stage of a National Partnership Grant. (PNCDI2 72-191, acronym NUCNANO) where IFIN-HH is the project coordinator and also in the National Partnership MInNA where IFIN-HH is a project partner. Deadline for the 4th stage of NUCNANO project is 27 October 2010.
The results will be also presented in a conference which will take place in Fall 2010 at Berlin, Germany. This conference is hosted in a COST action „Composites of Inorganic Nanotubes and Polymers” (COINAPO) (End date: May 2013) – MP0902. IFIN-HH is part of the romanian team involved in this project

Beam time request(unit=8 hours) : 6 units
Desired Period : 20 september- 15 october 2010

Desired beam properties

Type : He
Energy(MeV) : 4,5
Intensity(p/nA) : 5 nA
Vacuum Requests : 10-6 torr

Special requirements for detectors, electronics,aquisition system
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Minimal information needed for the radiological risk evaluation:

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a)Source activity :
b)Use of open sources :
c)Estimate of the residual activity as a result of iradiation :
d)Means of storage/transportation for iradiated targets :