PROGRESS REPORT FOR AINGRA07011

PROJECT TITLE: Structural characterisation of ternary alloys: TCO and MAX phase thin films

INVESTIGATOR(S)
Chief Investigator: Professor Marcela Bilek
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Students: James Stokes, Myles Cover
ANSTO Investigators: Ken Short, Peter Evans and Mihail Ionescu
Specialist Committee: N

SCIENTIFIC OBJECTIVES
We will synthesise technologically important transparent conducting oxides and MAX phase materials as thin films. A range of advanced deposition techniques, in particular a pulsed cathodic arc as well as a high powered pulsed magnetron sputtering system will be used to synthesise the materials of interest. These discharges are unique in allowing fine control of composition due to highly reproducible plasma pulses containing sub-monolayer amounts of depositing ions. The generation of pulses is computerised, allowing unprecedented control of composition for ternary alloys. We will study the composition, microstructure and properties of the alloys produced and relate them to the fundamental deposition conditions.

PROGRESS REPORT and RESEARCH OUTCOMES
ZnO is increasingly becoming an important TCO material due to its growing potential for technological applications. The performance of this material is strongly affected by the microstructure and its chemical composition and these are strongly correlated to the deposition conditions.

We have also studied the electrical behavior use the van der Pauw technique of three samples which was deposited using a cathodic arc at floating potential (sample 1), pulsed biased at 5kV (sample 2) and substrate heated to 220°C (sample 3). Transmission electron microscopy studies of the microstructure have revealed very distant differences of the grain size and shapes between the three samples. RBS analysis performed at ANSTO showed that the chemical compositions for sample 1 (figure 1a) and sample 2 (figure 1b) are Stoichiometric with equal amount of Zn and O. This hydrogen content is often a difficult element to quantify and for the case of ZnO, the concentration of H can greatly affect its performance. Elastic Recoil Detection Analysis showed that in all our films, the hydrogen content was very minimal, in most cases, less than 1% (figure 2)
Sample 1
Layer 1: Zn=50; O=50;
Thickness=2,380 ML
Layer 2: Si=33; O=67;
Thickness=3,750 ML

Sample 2
Layer 1: Zn=50; O=50;
Thickness=3,100 ML
Layer 2: Si=32; O=68;
Thickness=2,100 ML
Layer 3: Si=33; O=67;
Thickness=1,600 ML
Figure 2
We are currently conducting further experiments and analysis which will involve making more samples to study this interesting observation. Some of our initial findings are currently in preparation for publication.

**PUBLICATIONS / REPORTS arising as a result of your work.**

**PhD STUDENTS** For each student involved with the project, please indicate the date or anticipated date of conferment of a PhD or other award, and give the title of the thesis.