Transparent conductive IZO films deposited by reactive sputtering from metallic targets

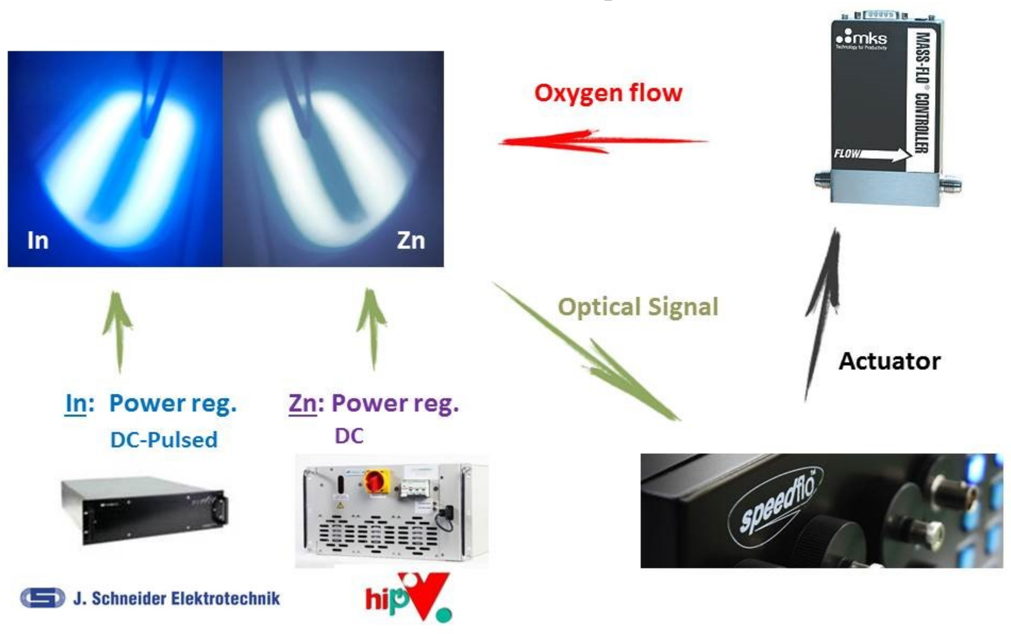
I. Fernández Martínez, A. Wennberg, Nano4Energy SL, Madrid (Spain)
O. Peña, R. González-Arrabal, ETSII-UPM, Madrid (Spain)
V. Bellido-González, Heqing Li, Gencoa Ltd., Liverpool (UK)

Abstract

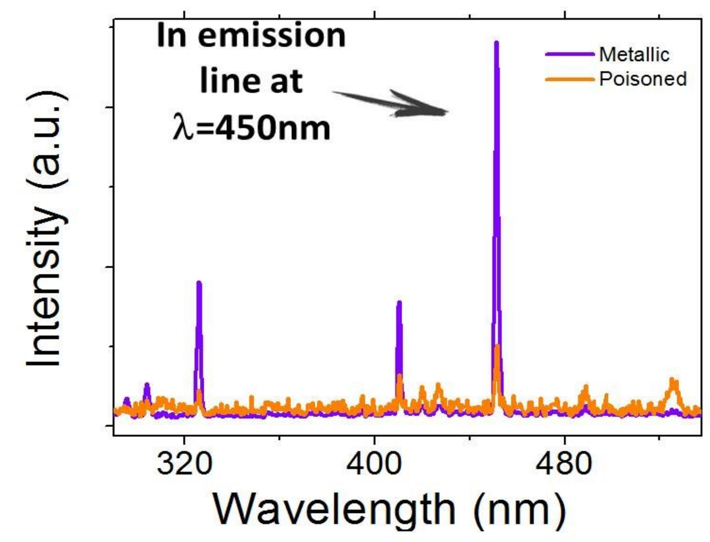
- InZnO (IZO) is an **amorphous TCO** with interesting properties such as low electrical resistivity, high electron mobility, optical transparency in the visible and near-infrared spectrum range and low surface roughness. Due to its amorphous character, it can be deposited at **Room Temperature (RT)**, which makes IZO an ideal material for flexible devices and a candidate for replacement of the ITO/glass combination.
- The primary source of carriers in IZO is the **native defect doping via oxygen vacancies** in the amorphous phase. **Precise control of the oxygen** gas amount during sputter deposition is required to optimize the oxygen vacancy concentration and hence the carrier density. The conductivity of the IZO films can be changed from electrically insulating to conductive by varying the oxygen concentration in the argon sputtering gas (less than 5%).
- The optimum oxygen content to maximize the conductivity is also dependant on the **In to Zn ratio**.
- We show the use of a **feedback control of the reactive gas** to stabilise the surface composition of the metallic targets by adjusting the reactive **oxygen flow** in response to the **plasma conditions**. The balance of metal and oxygen atoms is maintained at the optimum level for obtaining high deposition rates and accurate control of the film stoichiometry..
- IZO films with electrical resistivity in the **10-4Ohm.cm range** and average optical **transparencies of 85%** were achieved.

Process control

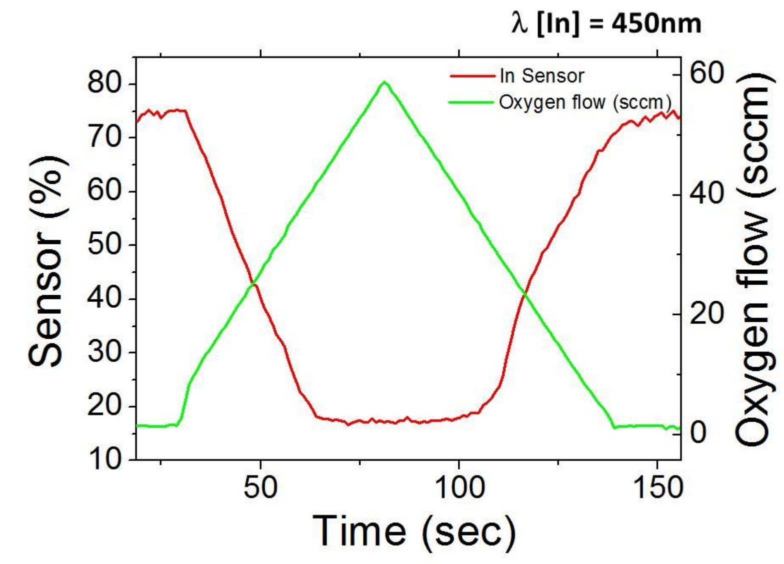
Plasma emission monitoring with feedback loop



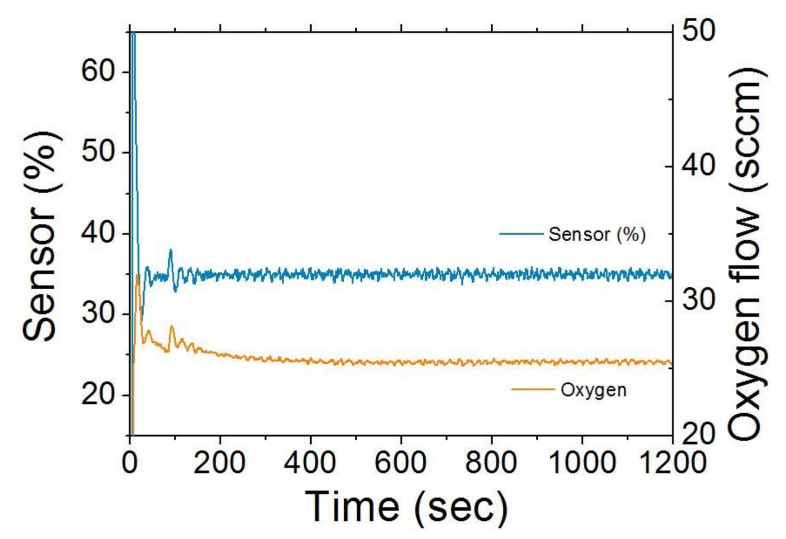
Plasma emission process control

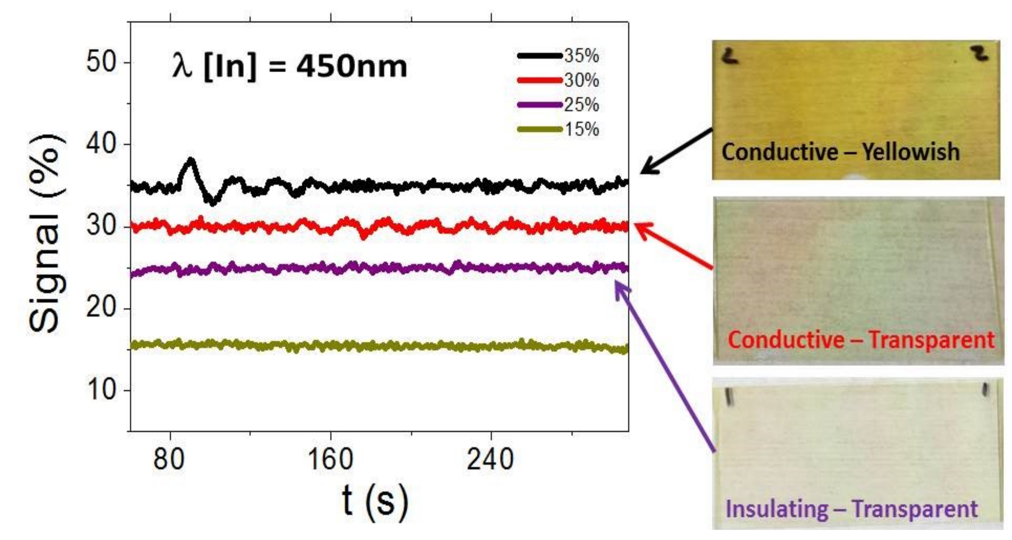


Process conditioning hysteresis loop

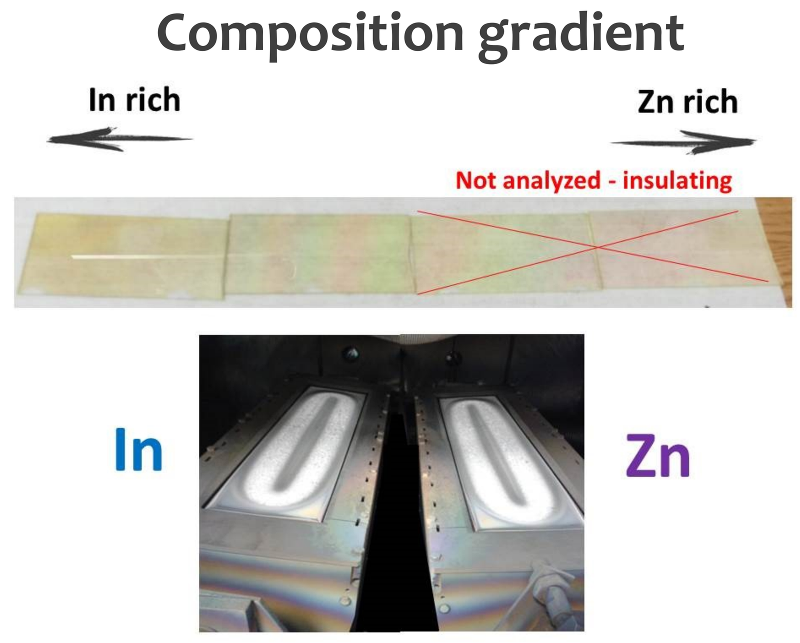


Feedback control for process stabilization

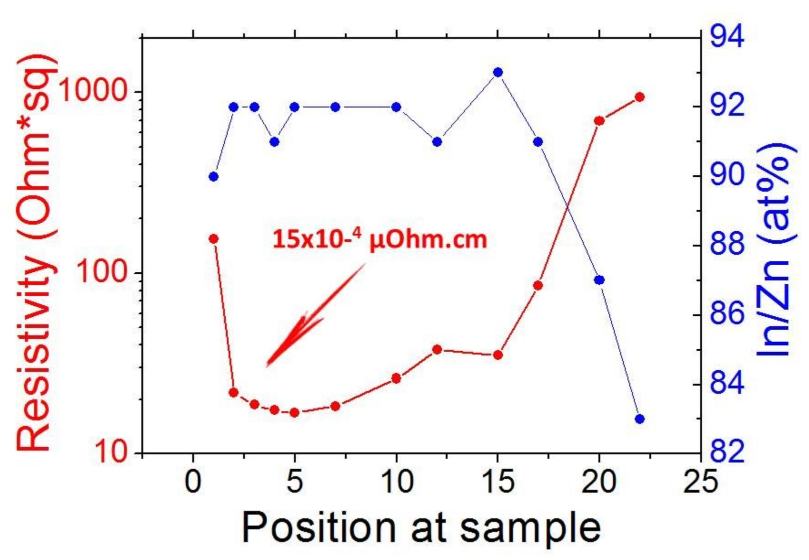




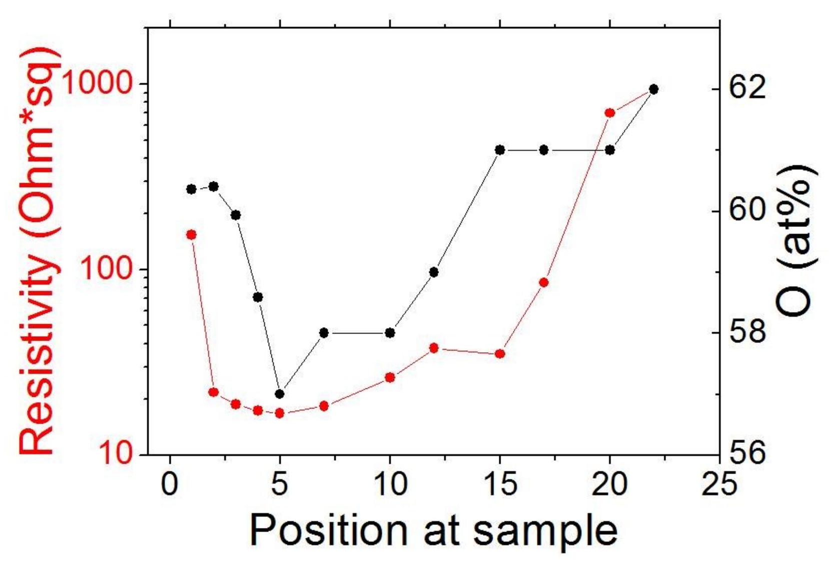
Composition gradient



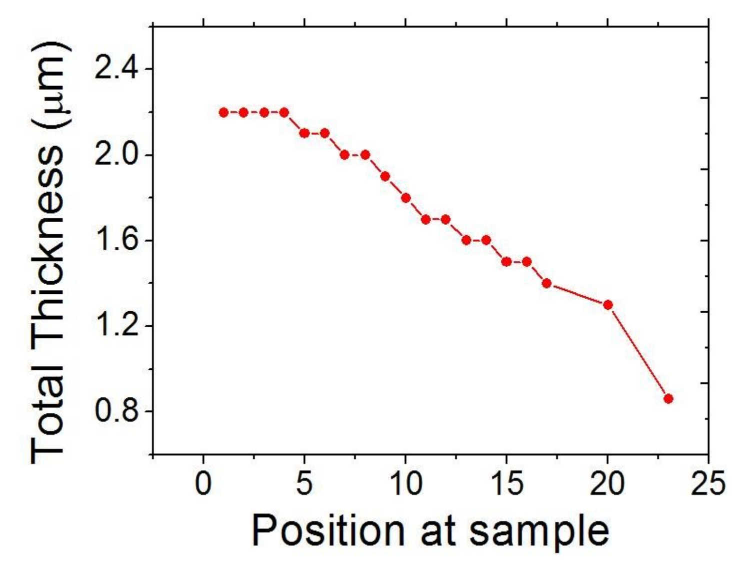
Resistivity vs composition



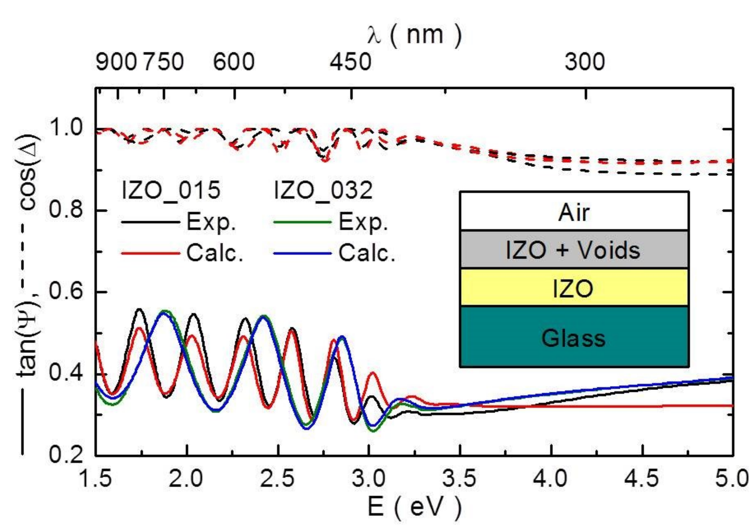
Resistivity vs oxygen content

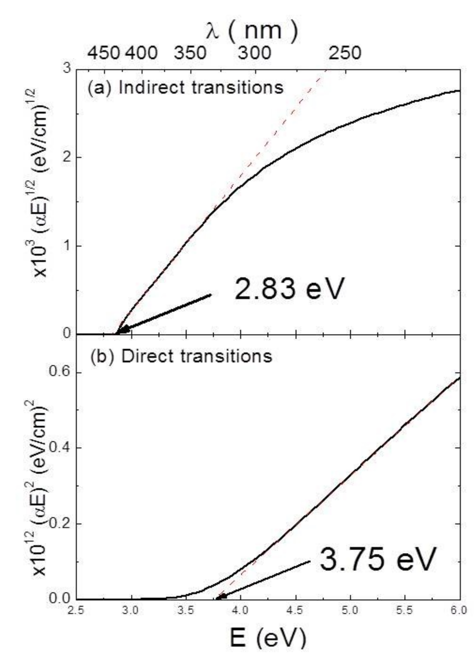


Film thickness

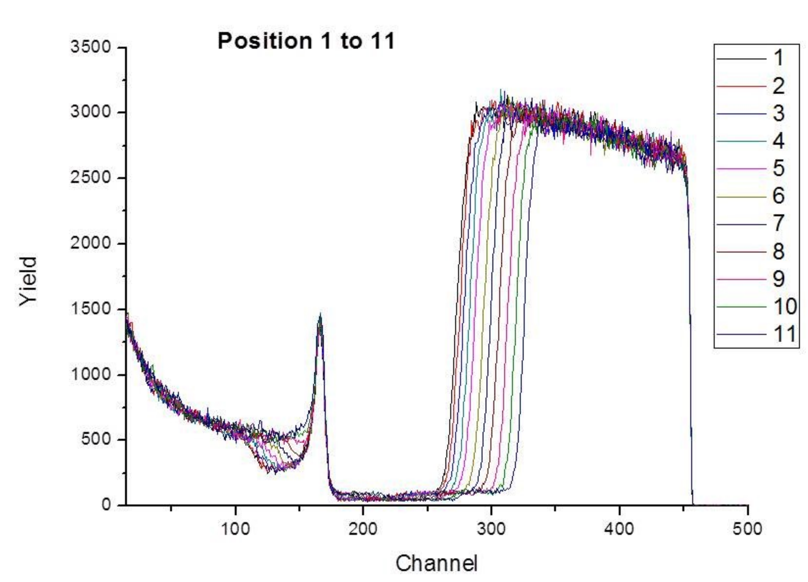


Optical properties: Ellipsometry





Composition [at%] - RBS



Conclusions

The level of **control** shown in presented results using the optical plasma monitoring control system enables a new possibility to finely adjust the stoichiometry in amorphous thin film TCO's such as IZO. The control is maintained at large scale, enabling an increase in efficiency for industrial scale production.

Acknowledgments

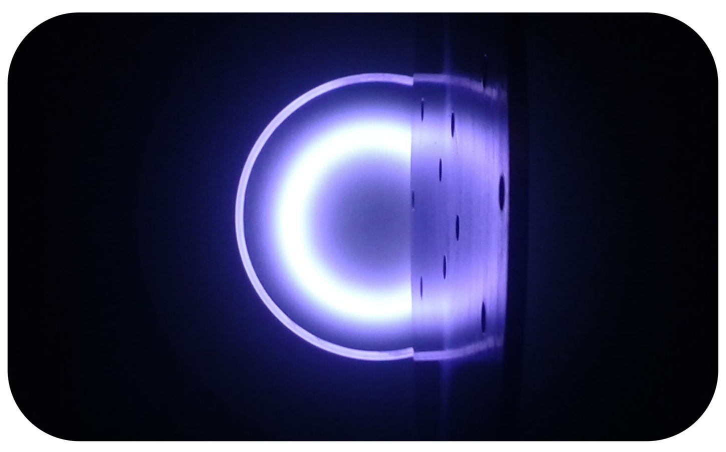
Nano4Energy would like to acknowledge the ICEX for travelling support through the Icex-Next program

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
A WAY TO MAKE EUROPE

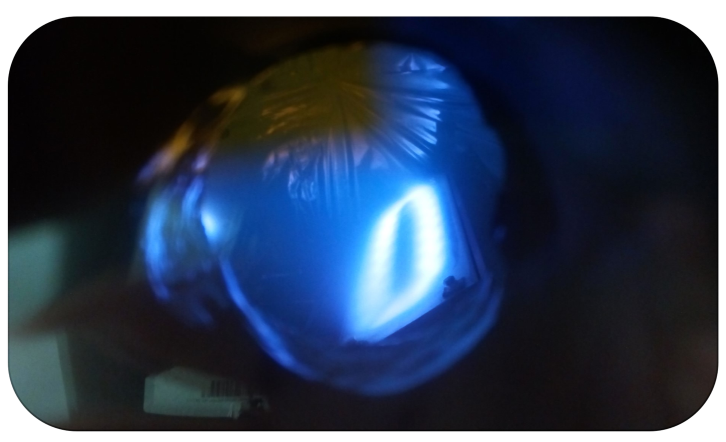
*We want our customers to share our **excitement** of improving the **performance** and quality of their processes and products by developing advanced deposition techniques beyond the current **state of the art**.*

Innovation in surface technology

Nano4Energy is an advanced technology R&D company in the area of **thin film surface engineering,** funded in 2010. We are devoted to innovation, research and development in the area of surface modifications particularly by **vacuum plasma processing.**



We offer partnership in the whole R&D process for development of new technology for your specific needs in order to maximise the always so important **quality** and value for money.



Nano4Energy also offers and develops **innovative** products for plasma processing making your production more **efficient** while increasing quality.

Nano4Energy SLNE
C/o Escuela Técnica Superior de Ingenieros Industriales (ETSII-UPM)
C/ José Gutiérrez Abascal 2
Madrid 28006
Telephone: +34 609923662
+34 622305290
info@nano4energy.eu