P. Barquinha, C. Fernandes, A. Santos, E. Carlos, R. Branquinho, A. Kiazadeh, J. Martins, A. Rovisco, R. Martins, E. Fortunato

i3N/CENIMAT, Department of Materials Science, Faculty of Science and Technology, Universidade NOVA de Lisboa and CEMOP/UNINOVA, Campus de Caparica, 2829-516 Caparica, Portugal.

pmcb@fct.unl.pt

Sustainable, multifunctional and flexible electronics platform based on oxides

Oxides are everywhere. Their amazing set of properties enables a wide range of applications from painting pigments to solid state lighting or sensors. In the field of large-area electronics (LAE), Gen10 display fabs (≈9 m^2 glass) are already using indium-gallium-zinc Oxide (IGZO) thin films as the semiconductor of the thin-film transistors (TFTs) embedded in displays, given the good compromise between performance/cost/uniformity of this oxide semiconductor compared to other thin-film technologies (a-Si or poly-Si). Despite the acceptance of IGZO thin films by LAE key players, many ideas can still be explored in the field of oxide electronics. This presentation will address four of them, based on ongoing work at CENIMAT:

- Replacement of IGZO by more sustainable oxide semiconductors, namely zinc-tin oxide (ZTO), whose performance can now be similar to IGZO in TFTs, even with processing temperatures as low as 150 °C, on flexible substrates. [1]
- Migration from sputtering to solution processing techniques. Nowadays, fully spin-coated oxide TFTs with field-effect mobility (μ_{FE}) ≈10 cm^2/Vs are being fabricated in our group at only 150 °C. [2]
- Design, simulation, fabrication and characterization of mixed-signal oxide-based thin-film circuits with a significant level of complexity (100s of TFTs), setting its range of applications well beyond the typical pixel switching and current driving in displays. One of such applications is on flexible x-ray sensors, owing to the excellent ionizing-radiation hardness of oxide TFTs (fig. 1). [3]
- Move from oxide thin films to oxide nanostructures. At CENIMAT numerous oxides, including WO_3, Cu_2O or ZTO, are already being explored following solution processing, namely hydrothermal synthesis at temperatures below 200 °C. Nanoparticles or nanowires with 10s-100s nm of diameter are now common with these materials and the first steps in integrating them in devices are now being given, for an amazing boost in device performance and functionality: in some years oxide nanotransistors can even provide computing capabilities to your transparent and flexible foil!

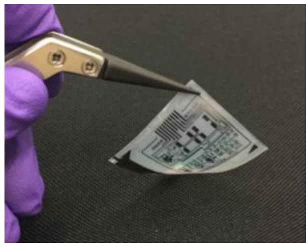

Figure 1: Flexible chip including addressing and readout electronics based on oxide TFTs for X-ray sensor (FP7 i-FLEXIS project).

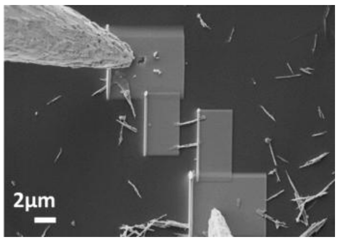

Figure 2: In-situ electrical characterization in a SEM of ZnO-based oxide nanowire transistor (ERC StG 2016 TREND).

References

[1] C. Fernandes *et al.*, Materials (2017) under publication

[2] E. Carlos *et al.*, ACS Appl. Mater. Interf., 8 45 (2016) 31100

[3] T. Cramer et al., Adv. Elect. Mater. 2 7 (2016) 1500489