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# Two-terminal Metal-IGZO-Metal devices

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Oxides materials combine a unique ensemble of properties presenting great potential to meet the diverse requirements for developing modern electronic technologies. These properties are the driving force for oxide films nowadays being employed in transparent and flexible Thin Film Transistors (TFTs), with amorphous In-Ga-Zn-Oxide (a-IGZO) being of the most celebrated. Yet, despite the significant research activity, there is only limited information available on two-terminal devices for large area electronics. High quality Schottky diodes based on oxide semiconductors would offer additional functionalities such as high frequency applications and development of structures like Metal Semiconductor Field Effect Transistors (MESFETS). Moreover two-terminal metal-oxide devices are currently under scrutiny for exhibiting the memristive effect, i.e. the ability to store a multitude of non-volatile resistive states[1]. These Resistive Random-Access Memories (RRAMs) have brought new exciting prospects via novel applications in neuromorphic and reconfigurable systems, yet haven't found a clear role in large area electronics. RRAM cells typically require Schottky contacts and an electroforming process for exhibiting resistive switching. Thus two terminal semiconductor devices and RRAMs should be studied in parallel.

This work presents an experimental proof of concept study highlighting that by using appropriate electrode materials, room temperature deposited IGZO thin-films could be used for supporting such functionalities. To this end, 30 nm thick IGZO films were deposited by a HiTUS[2] system on top of 10 nm thick Pt bottom electrodes. Four different combination of stacks were fabricated by depositing 20 nm thick TiN, Pt, Au and 4 nm $AlO_x$ and Pt at the top interface. TiN and $AlO_x$ were sputtered while Pt and Au were deposited via e-beam evaporation. Electrical characterization was performed in the temperature range of 300K to 350K with a bespoke memristor characterization platform, Arc ONE™, revealing excellent stability and high reproducibly for all devices. The prototypes comprising a Pt/TiN combination resulted in clear Schottky contact formation, while all other combinations resembled the behaviour of back-to-back Schottky stacks[3] that support bipolar switching.

**References**

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[3] L. Michalas et al. 2018 J. Phys. D: Appl. Phys. 51, 425101.

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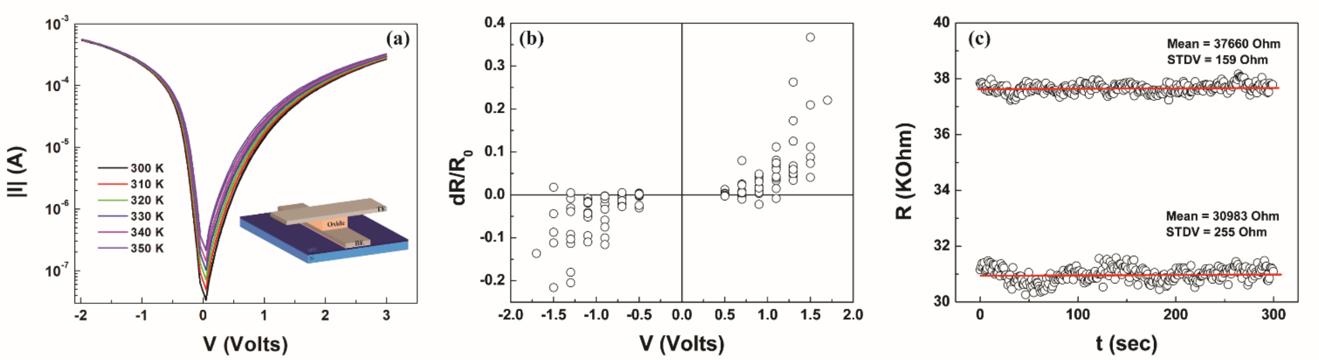


*Figure 1. Depending upon the employed electrodes, two-terminals IGZO devices can operate as Schottky diodes (Pt/TiN) (a) or exhibit bipolar resistive switching (b), between discrete stable resistive levels (c) (Pt/Pt)*

**Biography**

Loukas Michalas is a Senior Research Fellow within the Zepler Institute for Photonics and Nanoelectronics at the University of Southampton, working on the development and characterization of metal-oxide based technologies. Previously he was a "Marie Curie" Research Fellow with the IMM-CNR, Rome, Italy and a Research Associate at the University of Athens, Greece. He holds a PhD in solid state electronics.