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FACILE FABRICATION OF SEMICONDUCTING OXIDE NANOSTRUCTURES BY DIRECT INK WRITING OF READILY AVAILABLE METAL MICROPARTICLES AND THEIR APPLICATION AS LOW POWER ACETONE GAS SENSORS

NATO Science for Peace and Security Programme (SPS) under grant G5634
„Advanced Electro-Optical Chemical Sensors" AMOXES

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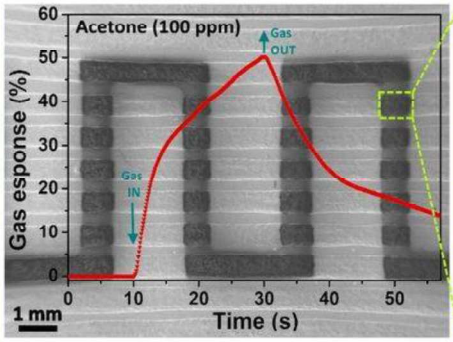
Keywords: Direct Ink Writing, Cu-Fe deposition, heterojunction, Fe_2O_3-CuO/Cu_2O/Cu, gas sensing, Transmission electron microscopy

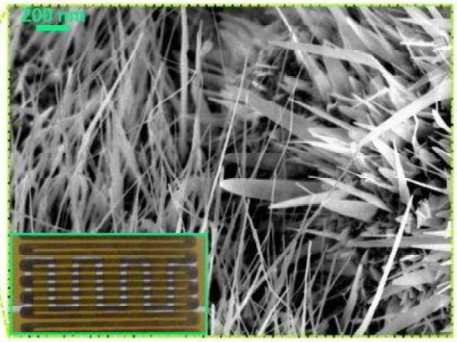
Abstract: A facile two step fabrication and characterization of 3D printed acetone sensors based on mixed semiconducting metal oxides is introduced. The devices are fabricated by Direct Ink Writing metal microparticle (MP) stripes of commercially available pure iron and copper particles onto the surface of a glass substrate, forming a bridging multi-phase semiconducting oxide net by subsequent thermal annealing. The open, highly porous bridging structures consist of heterojunctions which are interconnected via non-planar CuO/Cu_2O/Cu nanowires and Fe_2O_3/Fe nanospikes. The power consumption and the gas sensing properties showed selectivity to acetone vapor at an operating temperature of around 300 °C with a high gas response of about 50% and the lowest operating power of around 0.26 µW to a concentration of 100 ppm of acetone vapor.

Highlights:

- Direct ink writing of sensors can overcome the necessity for clean room technology;
- Mixed-metal oxide sensors can be easily fabricated by printing of common metal microparticles;
- Open porous semiconductor structure allows for sensitive VOC detection;
- High base resistance leads to a low power, energy efficient sensor.

Application: The printing of MPs in general paves the way for a new generation of printed different devices, even in "home-made" conditions, for a manifold of applications tailored such as biomedical devices, portable electronic and sensor applications by the composition and geometry of the printed MP stripes, enabled through the simplicity and versatility of the fabrication method.





References: https://doi.org/10.1016/j.nanoen.2019.104420

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