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3D-Printed Chemiresistive Sensor Array on Nanowire CuO/Cu_2O/Cu Heterojunction Nets

Leonard Siebert,1
Oleg Lupan,1,2,*
Mattia Mirabelli,1
Nicolai Ababii, 2
Maik-Ivo Terasa,1
Sören Kaps,1
Vasilii Cretu,2
Alexander Vahl, 3
Franz Faupel, 3
Rainer Adelung,1,*

1 Institute for Materials Science – Functional Nanomaterials, Faculty of Engineering, Kiel University, Kaiserstraße 2, D-24143 Kiel, Germany
2 Center for Nanotechnology and Nanosensors, Department of Microelectronics and Biomedical Engineering, Technical University of Moldova, 168 Stefan cel Mare Av., MD-2004 Chisinau, Republic of Moldova
3 Institute for Materials Science – Chair for Multicomponent Materials, Faculty of Engineering, Christian-Albrechts-University of Kiel, Kaiserstraße 2, D-24143 Kiel, Germany

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Abstract

In this work, the one-step three-dimensional (3D) printing of 20 nm nanowire (NW)-covered CuO/Cu_2O/Cu microparticles (MPs) with diameters of 15–25 μm on the surface of the glass substrate forming an ordered net is successfully reported for the first time. 3D-printed Cu MP-based stripes formed nonplanar CuO/Cu_2O/Cu heterojunctions after thermal annealing at 425 °C for 2 h in air and were fully covered with a 20 nm NW net bridging MPs with external Au contacts. The morphological, vibrational, chemical, and structural

investigations were performed in detail, showing the high crystallinity of the NWs and 3D-printed CuO/Cu_2O/Cu heterojunction lines, as well as the growth of CuO NWs on the surface of MPs. The gas-sensing measurements showed excellent selectivity to acetone vapor at an operating temperature of 350 °C with a high gas response about 150% to 100 ppm. The combination of the possibility of fast acetone vapor detection, low power consumption, and controllable size and geometry makes these 3D-printed devices ideal candidates for fast detection, as well as for acetone vapor monitoring (down to 100 ppm). This 3D-printing approach will pave a new way for many different devices through the simplicity and versatility of the fabrication method for the exact detection of acetone vapors in various atmospheres.