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Enhanced ethanol vapour sensing performances of copper oxide nanocrystals with mixed phases

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Abstract

Copper oxide nanostructures are fascinating nanomaterials due to their remarkable electrical, optical, thermal, and sensing properties given that their tunability and the stabilization of specific phases are uniquely possible at the nanoscale dimensions.

The present study reports on nano-crystalline copper oxide thin films via a simple synthesis from chemical solutions (SCS) followed by two types of thermal annealing, namely rapid thermal annealing (RTA) and conventional thermal annealing (TA). We report on the enhanced ethanol sensing performances of the device structures based on synthesized copper oxide nanocrystals with one and two distinctly different phases, namely Cu_2O, CuO, as well as mixed phases CuO/Cu_2O.

A gradient in phase change of nano-crystals was observed for annealed samples starting from CuO on the top to Cu_2O in their central region. RTA effects on the gas response of the Cu_xO_y nano-crystals have been identified as unprecedented selectivity and sensitivity to ethanol vapours at different temperatures. An increase in resistance value of about one order in magnitude was detected for samples treated by conventional-TA at 400 °C for 30 min at optimal operating temperature of 300 °C and RTA at 525 °C for 60 s at lower optimal operating temperature of 275 °C. It has been observed that the response and recovery times for pure copper oxide-based sensors can be significantly improved by Zn-doping, e.g. from ˜4.1 s and ˜10.5 s to about 3.3 s and 7.2 s, respectively.

The obtained results were discussed in details and it provide an exciting alternative for fast, sensitive, and selective detection of trace gases, which

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could be of several benefits in the technologies dealing with public securities and environmental monitoring applications.