Gas sensor for food industry and agriculture based on ZnO nanoparticles and nanorods

Andrey Ryzhikov, Pierre Fau, Myrtil Kahn, Katia Fajerwerg, Bruno Chaudret, Philippe Ménini*, Chang-Hyun Shim*, Alain Gaudon**

Laboratoire de Chimie de Coordination, 205 route de Narbonne, Toulouse, France;
*LAAS-CNRS, UPS, Université de Toulouse; **Alpha MOS
andrey.ryzhikov@lcc-toulouse.fr

Semiconductor gas sensors can be widely used in food industry and agriculture. Measurements of ethylene concentration in vegetable stores and greenhouses allow the control of fruit ripening, whereas detection of H_2S, mercaptans, amines may be used to control of meat, fish and vegetable freshness. In this work we present a new generation of semiconductor gas sensors based on the combination of micromachined silicon substrates [1] and highly sensitive layer of ZnO nanoparticles. ZnO nanoparticles displaying 3 different morphologies (cloudy-like structures, size controlled isotropic particles and nanorods (Fig. 1)) were obtained through the controlled hydrolysis reaction of an organometallic precursor, namely the biscyclohexyl zinc, in the presence of various levels of long-chain amines surfactants [2]. ZnO nanopowders were deposited by a generic ink-jet method on low power consumption silicon substrates. High quality and micron thick layers have been obtained with a low defect level (no cracks, no delamination). The sensor responses to reducing gases (CO, propane, ammonia, ethylene, and acetaldehyde) have been studied in relation with the morphology of ZnO nanocrystals. Cloudy-like ZnO sensors showed a high response to ammonia vapors (20 ppm), whereas isotropic nanoparticles possessed the highest response to acetaldehyde gas (10ppm) and nanorods based layers displayed a higher sensitivity to ethylene (50ppm). These variations can be associated with the different ratios of crystalline faces exposed to reactive gases. These results open the route to the fabrication of a multisensor system based on pure ZnO nanoparticles with different shapes for the detection of reducing gases in complex mixtures.

References

[1] Ph. Ménini et al., Eurosensors XXII proceedings, 2008, 342.
[2] M. Monge et al., Angew. Chem. Int. Ed., 2003, **42**, 5321.

Figures

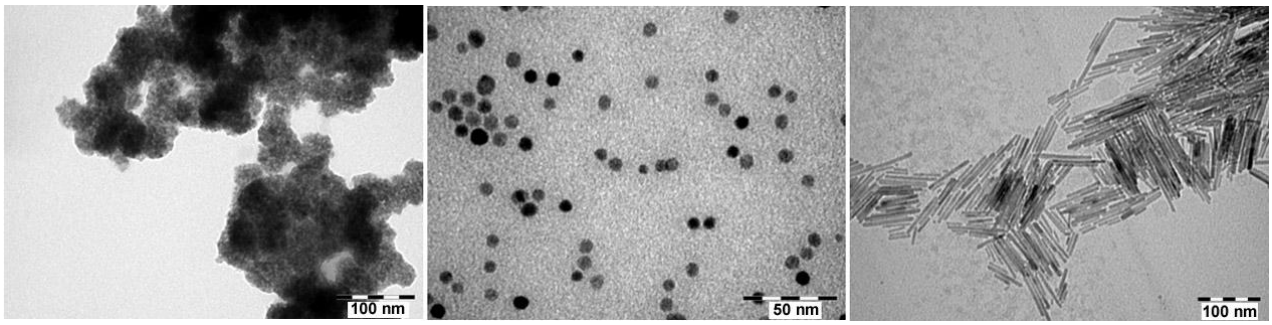

Fig. 1. ZnO cloudy-like structures, isotropic nanoparticles and nanorods