Contribution ID: **51** Type: **Oral**

# Gas sensing optimization of NiO-SCCNTs core-shell nanostructures by atomic layer deposition

*Thursday, 20 June 2019 12:20 (20 minutes)*

Hierarchical core-shell (C-S) heterostructures composed of a NiO shell deposited onto the stacked-cup carbon nanotubes (SCCNTs) were synthesized using atomic layer deposition (ALD). By ALD technique, a precisely controlled film of NiO particles was uniformly deposited onto the inner and outer walls of the CNTs. Indeed, by varying the number of ALD cycles from 25 to 700, NiO coating of 0.80 and 21.8 nm were deposited on SCCNTs. The morphological, microstructural and electrical characteristics of the as prepared NiO-SCCNTs C-S nanostructures were thoroughly investigated. The electrical resistance measurements highlighted the large influence of the NiO thickness on increasing of many order of magnitude the baseline resistance of NiO-SCCNTs C-S nanostructures with various thicknesses of the NiO shell layers, suggesting that the conductivity of the sensors is dominated by Schottky barrier junctions across the n(core)-p(shell) interfaces.
The behavior of NiO-SCCNTs sensors was investigated for low concentrations of volatile organic compounds (VOCs) such as ethanol and acetone. The gas sensing response of the NiO-SCCNTs heterostructures towards acetone and ethanol showed a strong dependence on the thickness of the NiO shell layer. The remarkable performance of NiO-SCCNTs sensors benefits from the conformal coating by ALD, large surface area by SC-CNTs and the optimized p-NiO shell layer thickness which regulate the modulation of the electron-depletion region in the NiO shell layer. So, optimizing the NiO layer thickness, NiO-SCCNTs sensors display a response about 6 times higher than pristine SCCNTs at the operating temperature of 200 oC. On the basis of the morphological, microstructural and electrical characterization and sensing results, the sensing mechanism which account for the marked variation in the resistance during the interaction of the target gas molecules has been here discussed.

## Summary

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**Session Classification:** Session 2 - Advanced materials –Nanomaterials