Design and fabrication of gas sensors based on Metal Organic Framework membrane encapsulated ZnO nanowires

Martin Drobek*†[1], Mikhael Bechelany[1], Matthieu Weber[1], Sang Sub Kim[2], and Anne Julbe[1]

[1]Institut Européen des Membranes, Montpellier – CNRS-UM-ENSCM – France
[2]Inha University, Incheon – South Korea

Abstract

Gas sensors are of great interest for a wide variety of applications, including the detection of toxic or explosive gases, air quality monitoring, medical diagnosis or food/cosmetic control.
Recently, many research efforts have been devoted to improve the performance of semiconductor metal oxide (SMO) based sensors for gas detection.

In this work, we have developed an innovative strategy to improve the selectivity of ZnO metal oxide sensors by coating ZnO nanowires (NWs) with a MOF-based molecular sieve nanomembrane. In comparison with blank ZnO sensors, their optimized ZnO/MOF counterparts (e.g. ZnO/ZIF-8 or ZnO/SIM-1) exhibit both enhanced sensitivity and excellent selectivity towards H2 [1,2]. In addition, we recently further improved sensor performance by a strategic combination of a molecular sieve MOF nanomembrane deposited on ZnO NWs decorated with palladium nanoparticles (Pd NPs) deposited by Atomic Layer Deposition (ALD). Maximal signal responses were obtained while maintaining excellent sensor selectivity towards H2 [3].
This original MOF-membrane encapsulation strategy of SMO nanowires sensors thus opens a new avenue for the preparation of highly selective sensing devices with innovative complex 3D-architectures. Indeed, the judicious choice of the metal oxide, metallic NPs (eventually magnetic) and molecular sieve materials with tuned properties for specific molecules detection could be advantageously employed for applications requiring good selectivity towards other gas or vapour species (e.g. noble gases, NH3, H2O, COx, NOx, H2S, O2, VOC) preferably at room temperature or by self-heating systems.

Keywords: ZnO, nanowires, ZIF8 membrane, encapsulation, Pd nanoparticle, ALD, molecular sieving

*Speaker
†Corresponding author: martin.drobek@umontpellier.fr