Magnetic gas sensing exploiting the magneto-optical Kerr effect on ZnO nanorods/Co layer system

R. Ciprian,*[,a‡] C. Baratto,[b] A. Giglia,[c] K. Koshmak,[c] G. Vinai,[c] M. Donarelli,[a,b] M. Ferroni,[a] M. Campanini,[d] E. Comini,[a] A. Ponzoni[b] and G. Sberveglieri[a,b]

[a] SENSOR Lab. & University of Brescia, Dept. of Information Engineering, Via Branze 45, 25133 Brescia, Italy.
[c] CNR-INO, SENSOR Lab. & University of Brescia, Dept. of Information Engineering, Via Branze 45, 25133 Brescia, Italy.
[c] CNR-Istituto Officina dei Materiali IOM, s.s. 14 km 163.5, 34149, Basovizza, Trieste, Italy.
[d] Istituto Materiali per l'Elettronica ed il Magnetismo IMEM-CNR, Parco Area delle Scienze 37/A, 43124 Parma, Italy.
‡ Present address: Elettra Sincrotrone di Trieste, s.s. 14 km 163.5, 34149, Trieste, Italy

*email: roberta.ciprian@unibs.it

Supplementary Information

Experimental Details

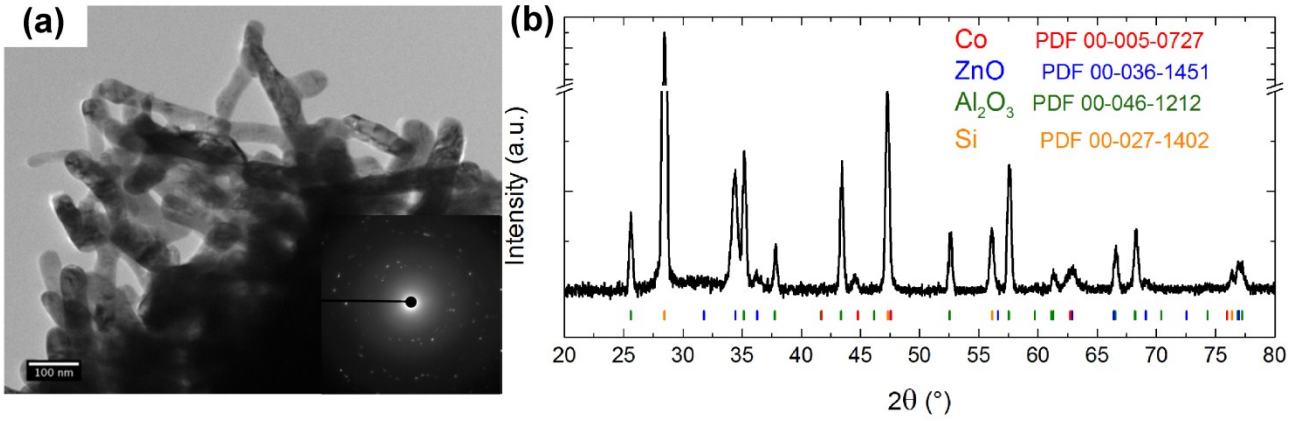
Micro-Raman and micro photoluminescence (PL) spectra have been collected using a modular HORIBA system with a single monochromator (iHR320) coupled to a Peltier-cooled Synapse CCD. He-Cd laser has been used as excitation source. The incident light has been focused on the samples by a fibre-coupled optical microscope. The excitation light wavelength for Raman spectroscopy was 442 nm. The Raman spectra have been acquired with a grating of 1800 $g \cdot mm^{-1}$, 60 s acquisition time and a 100× magnification objective, in the 170-1300 cm^{-1} Raman shift range. A wedge filter gets right of Rayleigh light. The excitation light wavelength for PL spectroscopy was 325 nm, the signal has been collected using a 600 $g \cdot mm^{-1}$ grating, with 1 s acquisition time and a 40× UV objective.

X-ray diffraction (XRD) data have been recorded using a Philips X-Pert diffractometer with Cu-Kα radiation (λ = 1.5406 Å). The morphology has been observed by field-emission scanning electron microscopy (FE-SEM) Leo 1525, with an accelerating voltage ranging between 3 and 5 kV. Cross-sectional analyses have been carried out in order to evaluate the thickness of the layers and the ZnO NRs.

X-ray absorption spectroscopy (XAS) and x-ray magnetic circular dichroism (XMCD) at the $L_{2,3}$ edges of Co were performed at RT at BEAR Beamline of the Elettra synchrotron (Trieste, Italy). The spectra were acquired in total electron and fluorescence yield mode, TEY and TFY respectively, and normalized to the incident photon flux I_0, measured on a grid placed at the

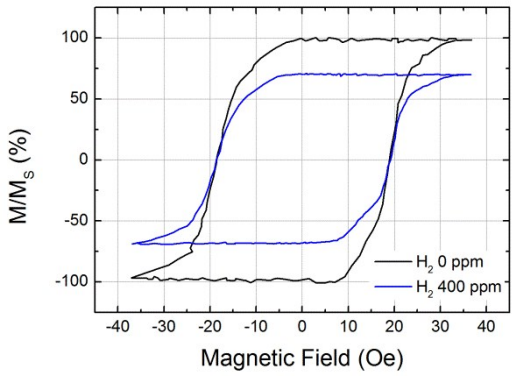
experimental chamber. The light was circularly polarized with 75% of polarization degree, and the beam was impinging at 45° with respect to the surface normal. The XMCD spectra were measured on the sample in its remanence state after applying an in-plane magnetic field pulse of about 200 Oe.

Figure SI.1



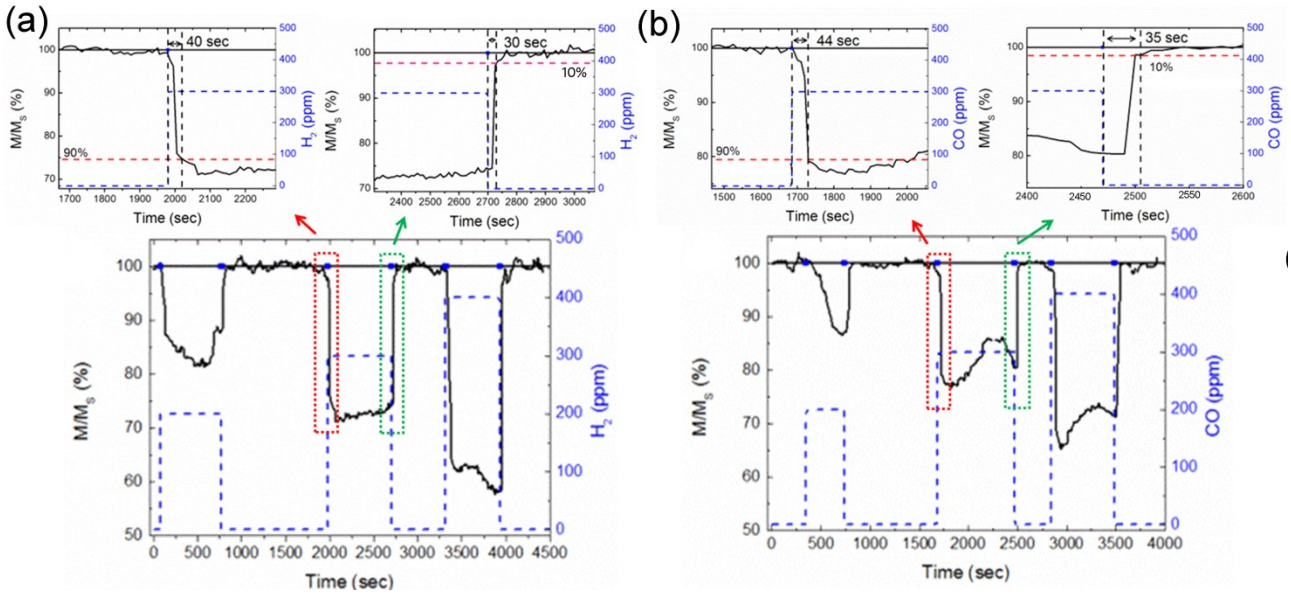
(a) TEM bright-field image and SAED pattern (inset) of the crystalline ZnO NRs. (b) XRD pattern measured with the Cu Kα radiation.

Figure SI.2



Comparison of the hysteresis loops measured at RT in longitudinal geometry for the sample in its as-prepared state (black line) and during the reaction with 400 ppm of H_2 (blue curve).

Figure SI.3



Room-temperature magnetic gas sensing properties performed using a MOKE magnetometer and different concentrations of (a) H_2 and (b) CO. The top panel shows the magnified pictures of the corresponding dashed red and green areas, respectively the response and recovery curves.

For the response time we considered the time that the sensor needs to reach the 90% of the final signal, while for the recovery time we considered the time that the sensor needs to recover 10% of the initial signal.