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1-D ZnO/PANI and ZnO/PPy composites based photoluminescence sensor for detection of acetic acid involved in cultural heritage deterioration

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Cultural heritage is seriously threatened by the presence of low concentrations of destructive gases and VOCs from indoor air at museums. Typically, primarily responsible of artefact degeneration are composed of acetic acid and NO/NO_2. Thus, a device that can detect those gases and O_2 simultaneously would be most beneficial in preservation of the cultural heritage. In this study, we are aimed to develop a sensor array, within the NEMOSINE project GA760801, composed of three sensing module to detect acetic acid, NO and O_2 simultaneously. At the first stage, 1D ZnO nanorods and nanowires were synthesized and conducting polymers of polyaniline (PANI) and polypyrrole (PPy) was formed by solution polymerization method. Interaction between ZnO nanoparticle and conducting polymers has been studied using X-ray diffraction (XRD), SEM and PL spectroscopy. The ammonia gas sensing behaviours of the ZnO/PANI and ZnO/PPy composites were examined at various ambient conditions. Newly designed chamber was used to hold sensing layer, excitation light and detectors. The acetic acid sensor, changes its photoluminescence when the sensing film adsorbs or desorbs acetic acid in gas status. An optical fibre is employed to measure variations in photoluminescence of the ZnO-conducting polymer in the presence of acetic acid vapour. Experimental results show that the sensitivity of the acetic acid is about 0.4 ppm at operating temperatures ranging from 25 to 40°C in air with a linear range 0.5-100 ppm. The response time was very short, which was 3.5 s when the target gases switched from 0 ppm to 1 ppm, and 10 s for regeneration of initial signal for subsequent measurements. Comparatively, we assembled complementary metal oxide semiconductor substrate (CMOS) composed of metal oxide semiconductor (MOS) nanostructures as a resistive type sensor integrated with a readout circuit and heater on a chip for monitoring the presence of VOC samples in the air. The results suggest that this novel ZnO/PANI composite based nanosensor and complementary miniaturized CMOS sensor shows great potential in the field of mobile environmental air monitoring and could also be modified by different sensitive materials to detect various molecules or ions in the future.

Recent Publications

1. Turemis M et al., (2018) Optical biosensor based on microalga-paramecium symbiosis for improved marine monitoring. Sensors and Actuators B: Chemical 270:424-432.
2. Turemis M et al., (2017) A novel optical/electrochemical biosensor for real time measurement of physiological effect of astaxanthin on algal photoprotection. Sensors and Actuators B: Chemical 241:993-1001.
3. Viter R et al., (2014) Application of room temperature photoluminescence from ZnO Nano-rods for Salmonella detection. IEEE Sensors Journal 14:2028-2034.
4. Viter R et al., (2016) Bioanalytical system for detection of cancer cells with photoluminescent ZnO nanorods. Nanotechnology 27:465101.

Biography

M Turemis received his MSc degree in Biochemistry from Ege Universitesi, Izmir, Turkey in 2010 and a PhD degree in Biotechnology from the Università della Tuscia of Viterbo within ITN Marie Curie project. Currently he is working as an experienced researcher at Biosensor S.r.l. His research interests focus on the development and characterization of biosensors and their applications in the field of medicine, water treatment, and biotechnologies.

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