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Colour tuning from violet to blue emission stimulated by various nickel oxide nanostructures: Influence of bias voltage towards volatile organic compounds vapours

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Abstract

Propanol and benzene, toluene, ethylenebenzene and xylene (BTEX) vapours are within the volatile organic compounds (VOCs) family and are utilized in industrial and petroleum goods, are greatly toxic in human health and environment. Therefore, it is desired to fabricate the gas sensor that is sensitive and selective towards VOCs at relatively low temperature. Thus, herein, p-type NiO with various morphologies were synthesized using hydrothermal method, using different base precursors. Surface morphology analyses displayed NiO with platelets, nanoblocks, microspheres and nanorods structures, while Brunauer-Emmett-Teller surface area analyses showed surface areas of 79.19, 117.21, 70.47, and 20.98 m2/g, respectively. The colour changing from violet to blue emission with the transformation in morphology was observed from the Commission Internationale de I'Eclairage diagram. The deficiency in a material, such as nickel interstitials and nickel and/or oxygen vacancies were confirmed from photoluminescence and X-ray photoelectron spectroscopy. The performance of various NiO based sensors was evaluated in the presence of different vapours, at various bias voltages (0.25–2 V) and operating temperatures (25–150 °C). The NiO microsphere based sensor showed the best sensing characteristics towards propanol at an optimized applied bias voltage of 1 V and operating temperature of 150 °C. The NiO sensor derived from porous microspheres showed relatively maximum response values of 40 and 64% towards 60 ppm toluene and propanol vapours and rapid response/recovery times of 20 s/54 s (toluene) and 29 s/86 s (propanol) at the functional temperature of 150 °C. These findings showed that NiO sensors can be regarded as promising candidates for the identification of toluene and propanol vapours at relatively low operating temperatures with fast response/recovery times.