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# Improving gas sensor properties of encapsulated ZnO nanorods for ethanol detection using ZnO:Cr layer as an encapsulated layer

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**Abstract**

In this study, encapsulated ZnO nanorods with different amount of chromium (Cr) dopant (0-4.5 at.%) were prepared with hydrothermal method, and their sensitivities as gas sensors against ethanol vapor were investigated. Morphologies of samples were explored by field emission scanning electron microscope (FESEM) which showed that encapsulation process increased the diameter of ZnO nanorods. Existence of Cr in ZnO nanorods structures was confirmed by Energy-dispersive X-ray spectroscopy (EDX). Based on X-ray diffraction (XRD) analysis, the ZnO:Cr nanorods had wurtzite crystal structure, and adding Cr did not alter the crystal structure of ZnO. Electrical measurements revealed that current levels of samples were decreased by adding Cr, while the current level of the sample with 4.5 at.% was increased. This reduction could be attributed to the presence of $Cr^{3+}$ ions, which led to decrease of charge carriers. Besides, due to the catalytic properties of Cr and its lower ionization energy than Zn, it was observed that Cr dopant improved the detection sensitivity of samples, and decreased the optimum operating temperature of samples. Among all samples, the most sensitivity (14) was obtained based on the sample with 1.5 at.% of Cr for 500 ppm ethanol vapor at the optimum temperature (250 °C). In fact, by encapsulating the samples, they became rougher, so the appropriate places to absorb and decompose of gas molecules are increased.

**Keywords:** semiconductor, nanostructure, metal oxide, core/shell

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