Gas sensor based on ZnO film/ silica nanopillars
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Silica nanopillars are used as substrate for Zinc oxide (ZnO) gas sensor for the first time. The nanopillars with the large surface ratio can increase the quantity of sensitive material and the gas adsorption surface, which can improve the gas sensing performance obviously. Silicon nanopillars are fabricated by Cesium Chloride (CsCl) self-assembly lithography and inductively coupled plasma (ICP) dry etching as substrate, after oxidation, the ZnO film is deposited on the nanopillars surface by RF magnetron sputtering using ZnO ceramic target (Fig.1). XRD patterns of the silica nanopillar and planar substrates after ZnO film covering indicate that all the deposited films are polycrystalline.

Fig. 1. SEM images: (a) silica nanopillars and (b) ZnO on silica nanopillars surface.

With this method, the nanopillar based gas sensor has higher gas response, shorter response and recovery time than the planar one under the same test conditions with different working temperatures, different gas concentrations for both ethanol and acetone. Fig. 2 shows the gas sensor performance exposed 1520 ppm ethanol at 300 °C. Compared with the planar based gas sensor, the gas response of the nanopillar based one increases from 22.81 to 28.20. The average response time of the nanopillar based gas sensor is shorter than the planar one from 55.4 s to 51.0 s, which is shortened by 7.9%. The average recovery time of the nanopillar based gas sensor is shorter than the planar one from 92.0 s to 168.7 s, which is shortened by 45.5%.

Fig. 2. Five cycles of response-recovery curves for (a) planar and (b) nanopillar based gas sensor for 1520 ppm ethanol at 300 °C.

Compared with the planar gas sensor, the nanopillar one has the following advantages: (1) the nanopillars substrate has large surface radio, which is covered by more sensitive material than the planar one. (2) The nanopillar substrate has larger surface to contact with air and target gas. (3) The ZnO film on nanopillars has more defects than that on planar surface, and these defects make the ZnO more possible to react with O2 and reducing gas molecules. Therefore, the nanopillar based gas sensor has the better gas sensitive characterization.