ABSTRACT

Thin film ZnO (0.3-1.μm) was deposited on various substrates e.g., silicon, quartz and zinc by a modified CVD method known as spray-CVD technique. The deposition model was established on the basis of boundary layer theory. To obtain smooth, compact and reproducible quality films the deposition parameters were optimised at 260^{o}C and 350^{o}C. The growth along the c-axis ie., perpendicular to the substrate surface was preferential at higher deposition temperature (350^{o}C). From XRD analysis the formation of polycrystalline ZnO with hexagonal wurtzite structure was confirmed. Annealing in oxygen showed that 600^{o}C was the optimised temperature to obtain ZnO film of suitable crystallinity, highest particle size (26 nm) and lowest r.m.s. strain.

ESCA results showed that as-deposited film was non-stoichiometric due to excess zinc. The film annealed in oxygen at 600^{o}C was near stoichiometric at the surface and it deviated with the depth. SIMS qualitative depth profile analysis confirmed this result. Optical absorption analysis revealed a direct band gap of 3.3 eV at room temperature. The electrical resistivity of the film was found to vary between 1.0 and 150 ohm-cm depending on the annealing conditions. The film deposited at 260^{o}C and annealed in oxygen at 600^{o}C was found to show the resisitivity in the range 125-150 ohm-cm. The carrier concentration was 1.1×10^{18}- 1.5×10^{19} cm^{-3} and the mobility was 0.006-0.01 cm^{2}/volt-sec. Using such ZnO film two device structures e.g., Pd/ZnO/p-Si heterojunction and Pd/ZnO/Zn metal-active insulator-metal (MIM) were fabricated. Suitable energy band diagram of the heterojunction was constructed from the experimental data. The current-voltage characteristics of these device structures in air and with different concentrations of hydrogen (2000-20000 ppm) in air revealed that the devices can be used as the room temperature hydrogen sensors. Various sensing parameters e.g., sensitivity, time response, recovery time, series resistance and barrier potential were determined. The MIM sensors were found to show higher sensitivity and concentration at much lower operating bias. The adsorption and desorption processes on the Pd surface and subsequent gas-solid phase interaction at the Pd/ZnO interface were found to play the key role of sensing. The sensors were tested in presence of CO_2, CO and LPG at room temperature but no response was obtained. These sensors were therefore selective to hydrogen at room temperature. The stability of the devices was also studied.