Thermoelectric ZnO Thin Films Grown with ALD

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Various oxide materials have been found to exhibit unexpectedly high thermoelectric figures of merit and with their low cost, high thermal durability and low toxicity they offer an attractive alternative to the more conventional materials being used in thermoelectric applications today. When doped with e.g. Al, ZnO is a promising n-type oxide material, and nanostructuring can be potentially used to improve its properties further. By utilizing the atomic layer deposition (ALD) thin film growth technique, films can be grown with excellent thickness control and conformality. As such, the technique is ideally suited for growing accurately doped ZnO thin films as well as for nanostructuring approaches such as superlattice and template-based structures [1].

In this work, the ALD technique was employed to grow $Zn_{1-x}Al_xO$ (x = 0-0.02) and $Zn_{1-x}P_xO$ (x = 0-0.05) thin films on glass substrates. The precursors used for the depositions were diethyl zinc (l), trimethyl aluminum (l) and trimethyl phosphate (l) for the cations, and H_2O (l) was used as the oxygen source. Growth temperatures were varied between 160 °C and 220 °C. The precursors were unheated with the exception of trimethyl phosphate, which was heated to either 40 °C or 100 °C. All the films were grown with thicknesses in the range of 90-120 nm.

Optical reflectivity measurements of the films were used to estimate the effect of the doping on carrier concentration. The effects of the Al and P substitutions on the thermoelectric characteristics were investigated by measuring the Seebeck coefficient and electrical resistivity of the films at low temperatures. Seebeck coefficient values comparable to those obtained for bulk samples in a previous work were obtained [2].

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