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Cobalt ion implantation induced modification in band gap, thermal parameters and lattice strain on RF – magnetron sputter deposited Zinc Oxide thin films on borosilicate glass

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Modification of transparent conducting oxide (TCO) thin films using transition metal ion beams has received much research focus due to the possibility of developing diluted magnetic semiconductors (DMSs). DMS materials are potential candidates for application in spin based magnetoelectronic and optoelectronic nanodevices [1]. This work reports on the effects of Co+ ion implantation on band gap, thermal parameters lattice strain and grain size on radio-frequency (RF) magnetron sputter deposited zinc oxide (ZnO) thin films on borosilicate glass substrate. Zinc oxide is a direct band gap semiconductor with a large energy gap and a good exciton binding energy, which makes ZnO to be used extensively in many applications, such as in energy nanodevices and optoelectronics [1].
ZnO thin films of thickness 120 nm were implanted with 170 keV Co+ ions at different fluences ranging from 5x1015 to 5x1016 ions/cm2 using the 200 kV ion implanter at iThemba LABS in South Africa. The implanted Co+ ions were seemingly incorporated into the ZnO matrix as substitutional metallic ions. At high ion fluences, the lattice strain was observed to decrease by 10.92%, while grain size increased by 34.82%. Williamson-Hall analysis in estimation of grain size and lattice strain of implanted samples showed good agreement with the crystallite size estimated using the Debye-Scherrer method. The optical band gaps of implanted samples, from UV- visible absorption spectroscopy, showed interesting improvement. For the sample implanted to a fluence of 5 x 1016 ions/cm2, a 7.52% decrease in thermal factor was observed in comparison with the as-grown sample.

[1] Yuksel Koseoglu. Enhanced ferromagnetic properties of Co-doped ZnO DMS nanoparticles. Journal of Superconductivity and Novel Magnetism, 26:485–489, 2013.

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PhD

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