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Annealing effect of SnO_{2-x} thin films grown by oxygen ion assisted deposition

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Tin oxide (SnO_{2-x}) thin films were deposited by ion assisted deposition (IAD) at various ion beam voltages (V_I) onto amorphous SiO_2/Si substrate at room temperature. Tin oxide thin films deposited at V_I=300 V (Film B) and at 500 V (Film C) with a fixed discharge current of 0.4 A were of stoichiometric composition. The SnO_{2-x} films showed various crystallinity and fine grain size after annealing at 500 ℃ for one hour in atmosphere. The annealed Film B showed preferred orientation along SnO_2 <110> axis in XRD study, but the annealed Film C showed a degradation in crystallinity. X-ray photoelectron spectroscopy study showed that the main peak of Sn3*d* in all samples even for some samples with N_O/N_{Sn}=1.71 and 1.51 were similar to the binding energy of Sn^{4+}. For the Film B, refractive index was 2.0 and the estimated porosity was 5.2 %. From temperature dependence of conductivity, the activation energies of Film A (V_I=0 V), B, and C at the low temperature between 323 and 373 K were in an inverse proportion to the refractive index. The activation energies ranged between 0.330 and 0.357 eV at temperatures 373 ~ 523 K. The transition temperature of conductivity in Film A, B, and C were observed around 523 K. The propane (C_3H_8) and methane (CH_4) gas sensitivities of SnO_{2-x} devices were determined with various V_I at the substrate temperatures of 100 - 500 ℃. Tin oxide thin films can be successfully fabricated by IAD as with nonstoichiometric/stoichiometric composition, the good crystallinity, and refractive index of bulk.