Characterization of sol-gel derived Nb doped ZrO_2 thin film

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Amorphous high-k dielectrics such as HfO_2 and ZrO_2 are now utilized in advanced Si-MOSFETs as gate insulator and major concerns for these films are dielectric constant and leakage current. The addition of rare earth elements, such as La Gd, Dy and Er, is reported to stabilize the phase of ZrO_2 at high temperature.[1] In this work, fundamental properties of niobium (Nb) doped zirconium oxide thin film was studied. A sol-gel process is applied to prepare the film with an annealing temperatures of 500~990 ℃ in air (N_2:O_2=3:1) atmosphere. The Nb-doped ZrO_2 was deposited on the highly doped silicon substrate to form the metal-insulator-semiconductor (MIS) structure. The film thickness was 25 nm. Top and bottom electrode was Au. Figure 1 shows the capacitance-voltage (C-V) curve of MOS structures with undoped and Nb-doped ZrO_2 films, annealed at 800℃. Higher accumulation capacitance was observed for Nb-doped ZrO_2 film. The relative dielectric constant estimated form accumulation capacitance, which includes the effect of interfacial layer, was plotted as a function of doping concentration in figure 2. The Nb 8% doped ZrO_2 shows the highest dielectric constant. The investigations on surface morphology, XRD and other electrical properties of Nb-doped ZrO_2 films prepared by the sol-gel method will be presented.

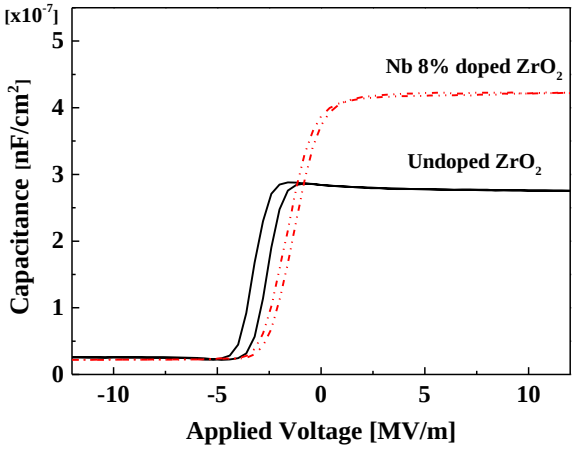

Figure 1. Capacitance-voltage characteristic of undoped and Nb-doped ZrO_2

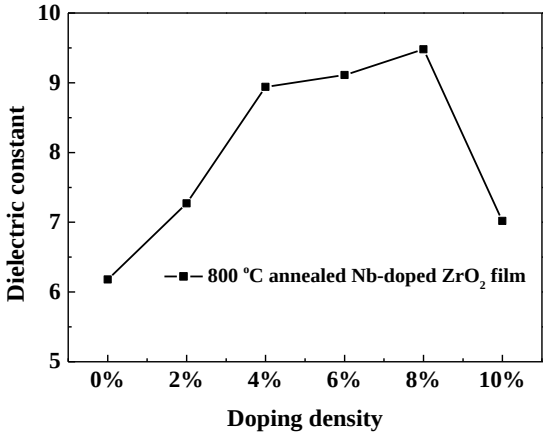

Figure2. Dielectric constant tendency with variation Nb-doping density.

[1] CZ Zhao et.al, “Dielectric relaxation of La-doped zirconia caused by annealing ambient”, nanoscale research letters,vol.6, pp.48. (2011)