High energy Oxygen ion irradiation effects on $Sr[(Mg_{0.316}Co_{0.016})Nb_{0.666}]O_3$ thin films

Bhagwati Bishnoi[1*], P.K.Mehta[1] and Ravi Kumar[2]

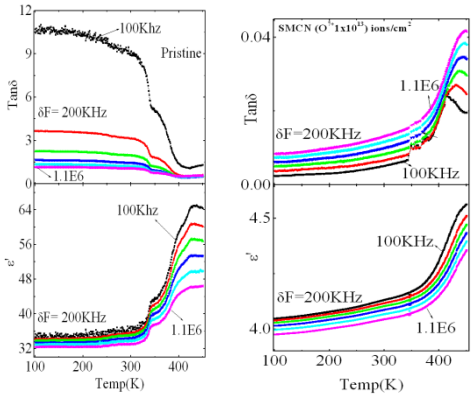
(1) Department of Physics, M.S. University of Baroda, Vadodara- 390 002, India
(2) Material Science Division, Inter University Accelerator Centre, New Delhi-110 067, India
*Corresponding Author.

Abstract: $Sr[(Mg_{0.316}Co_{0.016})Nb_{0.666}]O_3$ [SMCN] thin films have been fabricated on ITO coated glass substrate using Pulse laser deposition technique and then irradiated with 100MeV O^{7+} beam for the first time. The XRD shows that films grown on ITO coated glass substrate are well textured polycrystalline films. Irradiation of these films by oxygen ion beam leads to partial amorphization and degrades Dielectric properties. Degradation of dielectric properties of irradiated are also due to strain induced pinning of ferroelectric domains (Fig.a,b).

The study of ferroelectric thin films have generated a lot of interest in recent times due to their unique advantages over bulk as well as have varied applications in memory devices, micro-electromechanical systems, NEFERAm's, tunable microwave devices etc. The materials studied so far include PZT, PLZT, PMN-PT, PFN and SBT probed for its memory applications. Though Lead based systems shows good ferroelectric properties but they suffer from severe fatigue problems. This can be overcome by the strontium and bismuth based layered systems [1]. Further, as its dielectric properties are influenced by point defects Swift heavy beam ion induced modifications can provide an ideal way to investigate microstructure related dielectric response. Here we present perhaps for the first time results on pristine and irradiated thin films of $Sr[(Mg_{0.316}Co_{0.016})Nb_{0.666}]O_3$ [SMCN]. Thin films of SMCN were prepared by PLD technique using KrF excimer laser beam λ= 248nm, energy density of 220mJ/cm^2. The well characterized film were irradiated at room temperature with 100MeV O^{7+} ions at fluence of $1x10^{12}$ and $1x10^{13}$ ions/cm^2 using a 15UD tandem accelerator at the Nuclear Science Centre, New Delhi, India.

The thickness of all the films is measured by stylus Profilometer. X-ray diffraction data was used to confirm the formation of a single phase compound. The dielectric properties of the Pristine and irradiated films were characterized by 4285A LCR Bridge in frequency range on 100 KHz-30MHz and in temperature 100K to 450K.

The X-ray diffraction of the film show well textured single polycrystalline phase. Irradiation of these films with O_2(100MeV) results into peak broadening and decrease in peak intensity. Overall crystallinity decreases after irradiation. This may be due to the fact that after irradiation there is amorphization in the films. The grain size calculated using Debye-Scherrer formula shows reduction with increase in fluence. The permittivity measurements on pristine films show the abrupt rise in dielectric constant and loss tangent (tanδ) as compared to that of bulk [2]. This is likely to be the effect of strain produced in the films due to lattice mismatch, oxygen deficiency and various other parameters during film deposition. Irradiations of these films have lead to degradation of the dielectric properties but its Q-values (low dielectric loss) are improved to a large extent when compared to bulk. The dielectric/ferroelectric properties can be regained by annealing the films.



Composition $Sr[([(Mg_{0.316}Co_{0.016})Nb_{0.666}]O_3$	Particle size (nm)	Lattice Strain
Pristine	14.3103	0.013663
$O_2(1x10^{12})$ions/cm^2	12.6332	0.0155
$O_2(1x10^{13})$ions/cm^2	11.236	0.0165

Fig (a,b).Temperature vs. (ε') and tanδ curves

of Pristine (a) and Irradiated ($1x10^{13}$ions/cm^2) (b) films.

[1]Basavaraj Angadi, P. Victor, V.M. Jali, M.T.lagare, Ravi Kumar, S.B.Krupanidhi, Mat Science Engg. B100 (2003) 93.

[2] P.K.Mehta, Bhagwati Bishnoi, Ravi Kumar, R.J.Choudhary, D. M. Phase Solid State Phenomena 155 (2009) 145-149.