Targets Modification During NBT Thin Films Deposition

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Deposition of $Na_{0.5}Bi_{0.5}TiO_3$ (NBT) thin films attracts attention of many research groups because of lead free NBT composition and high electro-mechanical parameters. In the abstract we discuss modification of the ceramic targets that occurs during NBT thin films deposition. NBT thin films are usually prepared by various methods, including pulse laser deposition, radio field (RF) magnetron sputtering, high-frequency sputtering and their combinations. These methods allow to obtain thin films with quite good electro-physical parameters. At the same time some additional phases appear in the thin films and the reasons for that are not clear up to now. Among the possible reasons one should mention targets modification during bombardment process. Change of the target surface significantly influences structure of the films deposited.

Ceramic NBT targets, used for thin films deposition, were sintered by usual technology [1,2]. It was observed that color of the targets surface was changed from light yellow-green to dark brown during the deposition process when pure Ar working gas was used at low RF power. The surface was getting completely black when RF power was increased. At the same time XRD patterns showed complete correspondence of the target surface layer to NBT structure of the original ceramics. Further usage of the target for films deposition in the mixed atmosphere of Ar and O_2 (1:1) restored original color of the target. Alternatively the original color could be restored by annealing of the target in air at temperature 600^0C during 2 hours. It is taken into account that during deposition the targets were subjected to local thermal excitation in contact with the plasma and were exposed to radiation from working gas discharge. It is assumed that the targets color was changed due to F-centers which emerged on the target's surface bombarded by Ar ions. Similar color changes were observed earlier in [3] for NBT single crystal heat treated in various atmospheres.

Using high RF power increased heating the target surface. Examination of target XRD patterns after series of depositions on different levels of RF power shows absence of significant differences in the patterns, when the temperature of the target is below 300^0C. For higher temperatures XRD patterns showed appearance of additional peaks at $2\Theta=30^0$ and $2\Theta=50^0$ that indicated changes in stoichiometry of the target surface layer. It should be noted that XRD patterns of NBT films deposited at high temperatures also showed the same peaks. It is argued that additional peaks correspond to $Bi_2Ti_2O_7$ phase. The experiments show that during the deposition process some part of the target substance reprecipitated on the target surface in amorphous state. Additional $Bi_2Ti_2O_7$ phase was synthesized when the target temperature exceeded 400^0C.

1. A. Daryapurkar, J. Kolte, P. Gopolan, Thin Solid Films, 579, 44-49, (2015).
2. S. Quignon, C. Soyer, and D. Remien, Am. Ceram. Soc., 95, 3180-3184, (2012).
3. T.V. Kruzina, T. V. Panchenko, V. M. Sidak, S. A. Popov, V. S. Shchetinkin. Vìsnik Dnìpropetrovs'kogo unìversitetu. Serìâ Fìzika, radìoelektronika. Issue 23. V. 24, 106-109, (2016).