XPS characterization of iron/fluorine co-doped BST thin films for tunable microwave applications

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Barium strontium titanate (BST) is a very promising material for tunable microwave applications like phase-shifters and tuneable filters. In recent years, therefore, the influence of e.g. annealing conditions and processes on thin film properties and their dielectric performance were largely investigated. However, only a few groups have tried to tune the properties of sputtered BST thin films using different dopants, like iron and fluorine, simultaneously. Such co-doped thin films can be achieved by RF magnetron sputtering, using a co-sputter target [1, 2] and a subsequent two-step annealing process. The first annealing process provides the crystallinity of the films. In the second annealing process the fluorine co-dopant is introduced into the BST thin films by a diffusion controlled process.
X-ray photoelectron spectroscopy (XPS) was applied as a powerful tool to characterize the oxidation state of the used iron dopant as well as the surface elemental composition of the deposited BST thin films. XPS sputter depth profiling provides the homogeneous distribution of the iron and fluorine dopant and validates the co-sputter deposition process and the subsequent fluorine co-doping by the diffusion controlled fluorination process as a suitable way to fabricate Fe/F co-doped thin BST films.

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1. F. Stemme, M. Bruns, H. Geßwein, M. Schroeder, M. Sazegar, M. D. Drahus, R.-A. Eichel, F. Paul, J. Haußelt, and J. R. Binder, *Effects of thermal processing and iron doping in co-sputtered barium strontium titanate thin films*, Journal of Materials Science, Journal of Materials Science, 47 (2012) 6929-6938
2. F. Stemme, H. Geßwein, M. D. Drahus, B. Holländer, C. Azucena, J. R. Binder, R.-A. Eichel, J. Haußelt, and M. Bruns, *Characterization of non-stoichiometric co-sputtered $Ba_{0.6}Sr_{0.4}(Ti_{1-x}Fe_x)_{1+x}O_{3-\delta}$ thin films for tunable passive microwave applications*, Analytical and Bioanalytical Chemistry, 403 (2012) 643-650.