Self-limiting Growth of Barium Titanate via Molecular Beam Epitaxy

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Even though barium titanate is one of the most investigated ferroelectrics, it is still a challenging thin film material to grow using molecular beam epitaxy (MBE). This is largely because there does not exist a well controlled growth approach or corresponding understanding, to lock-in stoichiometric growth. To improve on the control of stoichiometric growth, we have investigated off-stoichiometric growth of BaTiO3 thin films on STO:Nb (0.5%) using both a shuttered-RHEED and a co-deposition technique, varying the dwell time in between layers. The stoichiometry of the corresponding films has been determined using X-ray photoelectron spectroscopy (XPS) and the lattice parameter by X-ray diffraction (XRD). Piezoforce microscopy (PFM) was used to compare the ferroelectric properties as a function of growth approaches and parameters. The XPS results indicate, rather surprisingly, that excess barium does not incorporate into $BaTiO_3$ lattice and instead the excess barium accumulates as a BaO layer on the surface. We will discuss a self-limiting growth approach to achieve stoichiometric growth of $BaTiO_3$ thin films.