Strain at the nanoscale in epitaxial $BaTiO_3$ films on silicon

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Ferroelectric oxides integrated on semiconductor substrates are of particular interest for various silicon-based electronic and photonic devices. Among them, the perovskite $BaTiO_3$ is an attractive candidate for integrated photonics and low power logic devices. The control of the crystalline orientation of the ferroelectric tetragonal cell (c- versus a-axis orientation) as a function of the processing parameters is a key issue.

In this study, a quantitative analysis of high-resolution transmission electron microscopy (HR(S)TEM) images using the geometric phase analysis (GPA) is proposed in order to support the growth strategy by molecular beam epitaxy (growth temperature, oxygen pressure and cooling conditions) of epitaxial $BaTiO_3$ films with the desired orientation. With GPA, maps of the strain in the $BaTiO_3$ films with respect to the Si substrate are determined with a high precision (0.1%) at the nanometric scale (1-2nm). From these maps, the local lattice parameters and thus the tetragonality (c/a ratio) of the $BaTiO_3$ films can be evidenced. HRTEM work is performed on an image corrected Hitachi HF3300S microscope (I2TEM-Toulouse) and HR(S)TEM on a FEI Titan Low-Base 60-300 (Zaragoza). It will be correlated to EELS analyses.