# Phase Transitions and Octahedral Rotations in Epitaxial $Ag(Ta_xNb_{1-x})O_3$ Thin Films under Tensile Strain

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Epitaxial $Ag(Ta_{0.5}Nb_{0.5})O_3$ (ATN) films under tensile strain were deposited on $(Ba_{0.4}Sr_{0.6})TiO_3/LaAlO_3$ $(001)_p$ and $KTaO_3$ (001) substrates. These films exhibited a domain structure with the *c*-axis aligned primarily along the in-plane direction in contrast with the poly-domain nature of bulk ATN ceramics or relaxed films. While the generic phase transition sequence of the tensile films was qualitatively similar to bulk, the tetragonal and orthorhombic phase field regions expanded by ~270 °C in $ATN/(Ba_{0.4}Sr_{0.6})TiO_3/LaAlO_3$. Furthermore, the films were found to be in the $M_3$ (complex octahedral tilting with disordered Nb/Ta displacements) phase at room temperature with either significantly reduced tilt angles or a suppression of the long range order of the complex tilt as compared to bulk materials. It was observed that the octahedral tilt domains were oriented with the complex tilt axes lying in the plane of the film due to the tensile strain. This work demonstrates that tensile strain can be used to strain-engineer materials with complex tilt systems and thereby modify functional properties.