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Bi_2WO_6 epitaxy-deterministic influence of oxygen vacancies

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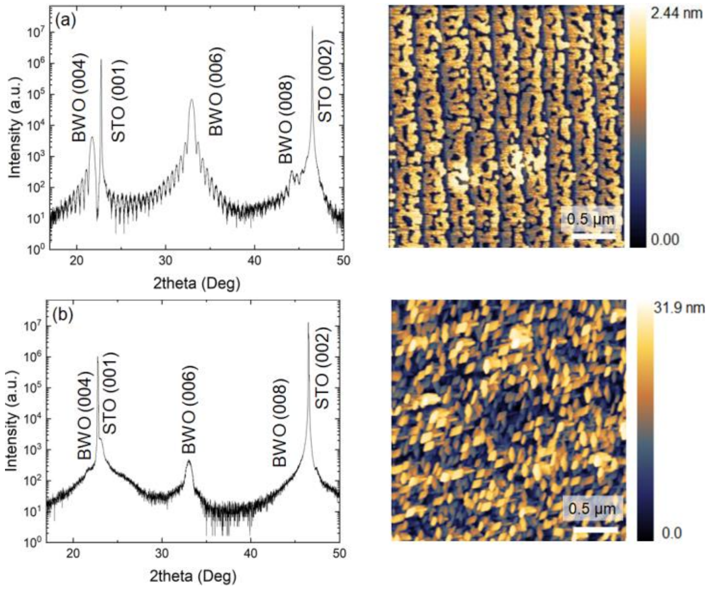
Layered Bismuth-oxide Aurivillius compounds are attractive for lead-free ferroelectric/piezoelectric applications and offer superior fatigue-free performance and low leaky characteristics. Within the Aurivillius family, Bi_2WO_6 is the primitive member but exhibits the highest ferroelectric polarization. Furthermore, Bi_2WO_6 is predicted to be a bulk Rashba ferroelectric, whereby the Rashba spin-splitting of electronic bands could be tunable ferroelectrically, thereby could open new possibilities for spintronics applications [1].

Motivated by this potential for spintronics, we explored the growth of Bi_2WO_6 thin film on $SrTiO_3$ (001) substrates using the pulsed laser deposition technique. Our study reveals a surprising aspect of Bi_2WO_6 epitaxy, which sensitively depends on the presence of oxygen vacancies on the substrate surface. Coherent, single-phase (001)-oriented Bi_2WO_6 films with an atomically smooth surface can be grown on the stoichiometric $SrTiO_3$ substrates. Residual oxygen vacancies on the substrate surface, however, lead to the collapse of the epitaxy and rough thin film growth. Extended in-situ oxygen annealing of the $SrTiO_3$ substrate or insertion of few monolayers of the $SrRuO_3$ buffer layer is shown to restore the epitaxial growth of Bi_2WO_6. Combining X-ray diffraction-based structural analysis and scanning transmission electron microscopy measurements, we shed light on this oxygen vacancy-dependent growth behavior of Bi_2WO_6.



(a) (left) XRD and (fight) AFM data of Bi_2WO_6 thin film grown on a stoichiometric $SrTiO_3$ substrate. (b) (left) XRD and (right) AFM data of Bi_2WO_6 thin film grown on an $SrTiO_3$ substrate containing residual oxygen vacancies.

[1] H. Djani *et al., npj Quantum Mater.* **4**, 51 (2019).