Pulsed Laser Deposition of Epitaxial $Sr_3Al_2O_6$ as a Water-Soluble Sacrificial Layer for GaAs Deposition

Imran S. Khan[1+], **Bill McMahon**[1], **Andrew Norman**[1], **Andriy Zakutayev**[1]

[1] *National Renewable Energy Laboratory, Golden, CO, USA*

Despite the record high efficiency for GaAs solar cells, its terrestrial application is limited due to both the particularly high costs related to the required single crystal substrates and the epitaxial growth. Significant substrate reuse is one strategy that has been heavily explored by the PV community, however, the usefulness of all the existing techniques is limited due to the need for toxic etchants, substrate re-polishing and/or expensive intermediate process steps. A water-soluble lift off layer could reduce costs by avoiding these potential downsides.

$Sr_3Al_2O_6$ (SAO) is a water soluble, cubic oxide (space group *Pa-3*), with lattice constant 15.84Å. This is close to $(2\sqrt{2})a_{GaAs}$ = 15.99Å, giving a close lattice match between SAO <100> and GaAs <100> after 45° lattice rotation. We investigated the epitaxial growth of high structural quality SAO on single crystal $SrTiO_3$ (STO) substrates by Pulsed Laser Deposition (PLD), and the feasibility of subsequently growing GaAs epitaxially on top of it. We identified that pulsed laser deposited SAO on STO is polycrystalline for substrate temperatures lower than 650°C, however the films could be epitaxially crystallized partially by high temperature annealing. Careful optimization of the growth parameters for obtaining epitaxial SAO on STO was explored, and we identified that the SAO film quality is strongly dependent on the growth temperature and O_2 partial pressure. An STO capping layer was grown on the SAO to protect from moisture induced degradation, which was also epitaxial.

XRD spectra for the films with optimized deposition parameters showed SAO (400) and SAO (800) peaks that were epitaxially aligned to the STO (100) and STO (200) substrate peaks. TEM analysis revealed that the grown SAO films are epitaxially crystalline throughout the thickness. The epitaxial growth of the STO capping layer is a qualitative indication for the high quality of the SAO surface. Research activity is ongoing to experiment the practicability of growing GaAs on these sacrificial SAO films.

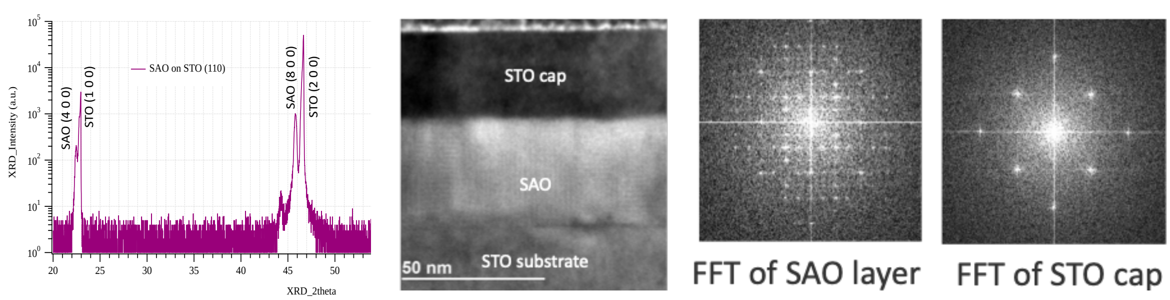

Figure: (left) XRD spectra, and (right) TEM image and FFT for the for SAO on STO (100) substrate.

+ Author for correspondence: Imran.Khan@nrel.gov

Supplementary Information

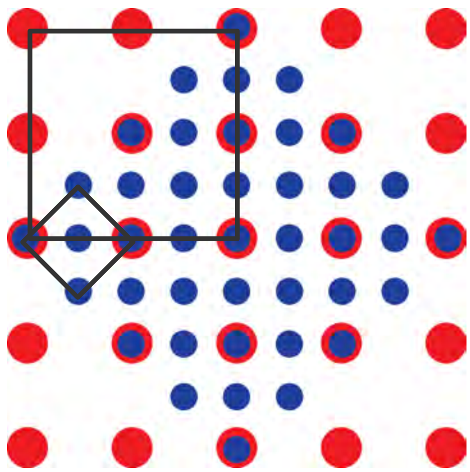

Figure 2. Projections of SAO (100) and GaAs (100) showing the similarity in the lattices of the two materials and the close match after a 45º lattice rotation.
Blue represents As atoms in GaAs and red represents Sr atoms in SAO. Black boxes outline unit cells of the two crystals.

After 45° lattice rotation
<100> SAO ∥ <100> GaAs