Adsorption-Controlled Growth of $SrTiO_3$ by Oxide MBE

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Historically, the growth of stoichiometric $SrTiO_3$ by conventional molecular-beam epitaxy (MBE), utilizing elemental sources, has been challenging due to the precise calibration required. It would be useful if there were a thermodynamic regime where the composition of $SrTiO_3$ was self-regulating. One demonstrated way to achieve such automatic control of stoichiometry in $SrTiO_3$ is by supplying an excess of the volatile organometallic precursor titanium isopropoxide to grow $SrTiO_3$ by metalorganic MBE (MOMBE). Another means, and the one investigated here, is to stick with elemental sources but increase the substrate temperature. When $SrTiO_3$ is heated to high temperature, it does not evaporate congruently; rather, it loses more strontium than titanium. This difference in the vapor pressures of the volatile species suggests that adsorption-controlled growth of $SrTiO_3$ may be possible by conventional MBE. We report a thermodynamic window in which $SrTiO_3$ can be grown via adsorption control by conventional MBE. A new high-temperature laser substrate heater installed in Cornell University's PARADIM Thin Film Facility allows substrate temperatures to reach up to 2000 ℃.

We show that the growth window for our highest quality adsorption-controlled $SrTiO_3$ is from approximately 1450-1475℃, with a Sr:Ti ratio of 5:1. All films were grown on $LaAlO_3$ (100) substrates. Figure 1 shows XRD data for samples grown at several temperatures including the adsorption-control window.

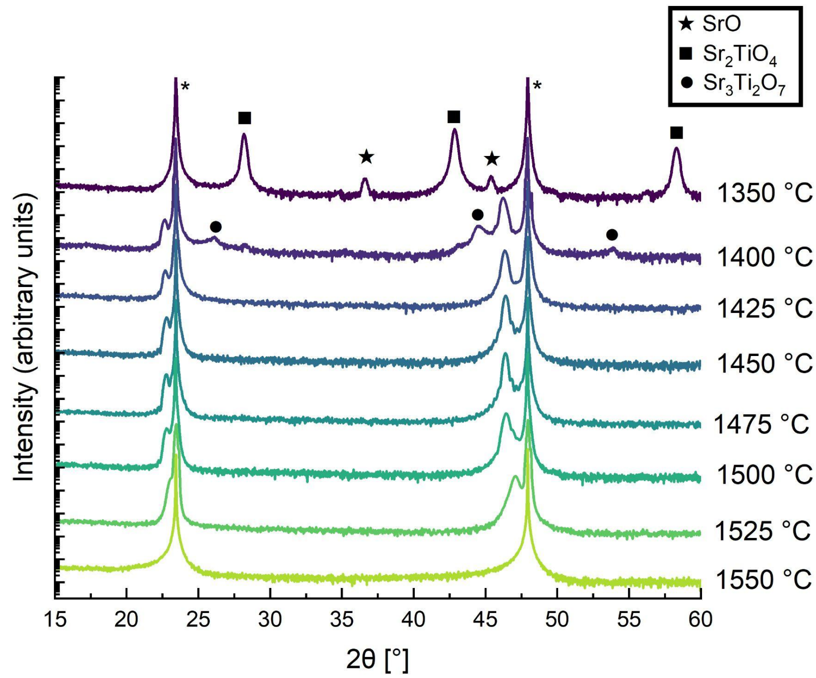

Figure 1: θ-2θ x-ray diffraction scan showing approximately 33 nm thick films of $SrTiO_3$ grown by MBE on $LaAlO_3$ (100) at a range of temperature from 1350-1550 ℃ at a background pressure of 10% ozone of 1×10^{-6} Torr.