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Point defect identification in perovskite oxide thin films and surfaces using a variable energy high intensity positrons

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Variable energy positron annihilation lifetime spectroscopy measurements using the high intensity positron beam have been performed on high quality SrTiO_3 , and $\text{SrTiO}_3/\text{LaAlO}_3$, thin films grown by pulsed laser deposition (PLD) and on near surface region of SrTiO_3 substrates subjected to PLD growth conditions. The measurements were performed using the NEPOMUC beamline at Heinz Maier-Leibnitz Zentrum (MLZ), Garching. The presence of vacancy-related point defects is detected, at concentrations below approximately 100 ppm. The positron lifetime spectra are deconvolved and the lifetime component characteristic of the two types of perovskite oxide, ABO_3 , cation monovacancy, the B-site and A-site vacancies, are identified and are consistent with density functional theory calculated positron lifetime values. Measurements on the process modified near surface region of the SrTiO_3 substrate provide evidence for the presence of Ti-vacancy O-vacancy divacancy complexes. Changes in positron trapping with UV illumination are observed. The measurements also observe changes in the vacancy defect content on annealing $\text{SrTiO}_3/\text{LaAlO}_3$ structures, the conductivity of the interface is also changed.

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