Variable energy positron annihilation lifetime spectroscopy studies of perovskite oxide electronic materials

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The potential of ABO₃ materials for electronic applications has been long recognized due the diverse range of electron properties exhibited by otherwise structural similar materials [1]. The discovery that a two dimensional electron gas can form at the interface between, for example SrTiO₃ and LaAlO₃ has accelerated this interest [2]. More recently, the realization that the transparent perovskite oxide BaSnO₃ can exhibit excellent conductivities has further extended the possible applications range for these materials [3]. Here we report positron annihilation lifetime measurements (PALS) and supporting density function theory (DFT) calculations on two perovskite materials lanthanum aluminate, LaAlO₃ and barium stannite BaSnO₃.

It has been difficult to grow LaAlO₃ thin films of sufficient thickness to enable characterization by VE-PAS methods, here we detail VE-PALS measurements 120 nm and 140 nm thick films grown by pulsed laser deposition, and on LaAlO₃ single crystal substrates. The results of DFT calculations, performed using Abinit, on positron lifetimes are also given.

Further, we report the results of VE-PALS measurements on BaSnO₃ films, both undoped and La-doped, grown by molecular beam epitaxy by two different groups. DFT calculated positron lifetime values for cation vacancy defects in barium stannite are reported. The relations between carrier concentration, dopant concentration and vacancy defect content inferred from PALS is discussed.

The PALS results and calculated positron lifetime values for LaAlO₃ and BaSnO₃ are compared to those obtained previously for the perovskite oxide titanates SrTiO₃ and PbTiO₃.

References

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