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

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The potential of ABO_3 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 $SrTiO_3$ and $LaAlO_3$ has accelerated this interest [2]. More recently, the realization that the transparent perovskite oxide $BaSnO_3$ 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, $LaAlO_3$ and barium stannite $BaSnO_3$.

It has been difficult to grow $LaAlO_3$ thin films of sufficient thickness to enable characterization be VE-PAS methods, here we detail VE-PALS measurements 120 nm and 140 nm thick films grown by pulsed laser deposition, and on $LaAlO_3$ 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 $BaSnO_3$ 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 $LaAlO_3$ and $BaSnO_3$ are compared to those obtained previously for the perovskite oxide titanates $SrTiO_3$ and $PbTiO_3$.

References

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