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Growth and characterization of $CaVO_3$ thin films

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Epitaxial strain and oxygen stoichiometry allow tuning the *d* bandwidth or the *d*-band filling in complex oxides thin films, affecting the electron-electron correlation and in turn the magnetic and electronic properties. Controlling these parameters through a proper choice of substrates and/or oxygen deposition pressures is extremely valuable in exploring new physical properties otherwise not attainable in bulk samples. In this framework, $CaVO_3$ (CVO) represents an intriguing case. Studied as a model for electron-electron correlations given its d^1 configuration, it is expected to be a Pauli paramagnetic metal in bulk form. However, small deviations in oxygen can cause a variety of different characteristics, from Curie-Weiss paramagnetism to antiferromagnetism and insulating behavior. In this context, the synthesis of CVO thin films will allow probing the sensitivity Pauli paramagnetic metallic state to epitaxial strain and stoichiometry.
Epitaxial CVO thin films have been grown on $SrTiO_3$ (STO), $LaAlO_3$ (LAO) and $(La_{0.27}Sr_{0.73})(Al_{0.65}Ta_{0.35})O_3$ (LSAT) substrates by Pulsed Laser Deposition in vacuum (4.9×10^{-6} Torr) between 550°C and 650°C. The film thickness ranged from 40 nm to 60 nm. X-Ray diffraction data indicates a $CaVO_3$ single phase and single orientation structure independent of the substrate. The CVO out-of-plane lattice parameter ranges from 3.752 Å for STO and LSAT to 3.773 Å for LAO compared to the bulk value of 3.77 Å, in agreement with the tensile strain induced by all the substrates in the CVO surface plane. Atomic Force Microscopy measurements have shown RMS roughness of 0.461 nm, 0.766 nm and 1 nm for STO, LAO and LSAT respectively. The temperature dependence of the magnetic susceptibility has been measured for zero field cooled (ZFC) CVO films in a 1 kOe magnetic field showing a typical Pauli paramagnetic behavior bulk-like. Transport measurements revealed metallic behavior independent of the substrate with a resistivity temperature dependence well described by a $\rho=\rho_0+AT^2$ formula as expected for a system dominated by strong electron-electron correlations. X-ray absorption (XA) measurements at the vanadium $L_{2,3}$ edges and oxygen *K* edge to evaluate the CVO electronic structure have shown no differences in the spectra as a function of the different substrates strains. The oxygen *K* edge has shown to be very sensitive to the V valence state, suggesting a 4+ valency for vanadium. Surface effects as well as time effects on the V valence state evaluated through XA have indicated a higher number of 3+ V ions at the surface of the films compared to the bulk and an increase of the 3+ valency over time.

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