All-oxides heterojunctions: growth and characterization by photoelectron spectroscopies

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Recent advances in the growth of epitaxial oxide thin films have fostered a steady increase of research on perovskite oxide heterojunctions, which are now produced with unprecedented quality. All-oxide perovskite interfaces can be regarded as a platform for synthetic quantum matter, offering a wide range of complex magnetic, transport and correlation-related physical properties. Applications of these ultra-thin interfaces in the field of electronics, photon harvesting, photovoltaics and photocatalysis strongly rely on the capability to master band gap engineering at the nanoscale.

X-ray photoemission spectroscopies (XPS) are playing a key role in the investigation of electronic and structural properties of all-oxide heterointerfaces [1]. Core level and valence band XPS can be combined to probe the band gap alignment [2]. The use of tunable light sources allow to change the in-depth sensitivity, with the possibility to profile the band-gap close to the interface and to compare the results with bulk electronic states [3]. Finally, the spectral weight enhancement obtained by tuning the photon energy [4], has disclosed unexpected possibilities in the study of band dispersion at buried interfaces.

Here, the combination of these techniques is focused on the study of oxide thin film grown on $SrTiO_3$ (001), as these systems can host a two dimensional electron gas (2DEG) at the interface and display magnetic ordering and superconductivity effects, disclosing possible applications in the next-generation nanoelectronic devices. We will show how RF sputtering technique can be used to effectively grow high quality, epitaxial ultrathin (< 2 nm) films, with both perovskite and non-perovskite crystal structure; in particular, we will discuss the use of X-ray photoelectron diffraction as a tool of film crystal order assesment [5]. Finally, the junction band diagrams obtained with XPS will be discussed in detail, through the comparison of review of several theoretical and experimental results [6].

References

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