Study of Functional Metal Oxides Thin Films using Infrared Synchrotron Radiation

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New device applications in materials sciences call for the merging of known physical properties with the nanoscale world. Examples include new ferroelectric materials obtained in thin films of just a few nanometers. These materials are often functional metal oxides, that are present in different technologies such as memory storage, energy harvesting and sensors[1].

However, the spectroscopic study of such functional thin films comes with new challenges. It is important to understand the influence of the film thickness, the substrate, and the interfaces present. All these parameters have a role in the new physical phenomena probed. To control the desired properties, it is necessary to understand the electric and structural signatures responsible for such properties. Exploiting the high brilliance and the stability of the synchrotron radiation in a wide infrared spectral range available at the AILES beamline of SOLEIL, we were able to perform infrared and Terahertz spectroscopic measurements on several thin film materials promising for applications.

One of these materials is the recently discovered HfZrO2 ferroelectric thin (below 20 nm) film[2]. This unexpected ferroelectricity in such nanometric films has stimulated new research into understanding its origin and opened a path to ferroelectrics memristors[3]. Beyond these promising applications, many fundamental aspects related to the ferroelectricity order in HfO2-based systems remain to be unveiled[4] e.g. ferroelectric transition temperature, role of non-polar coexisting phases, imposed electrode boundary conditions, electrical cycling effects. We report the results obtained from temperature and electric field dependence of transmission infrared and THz spectroscopy measurements.

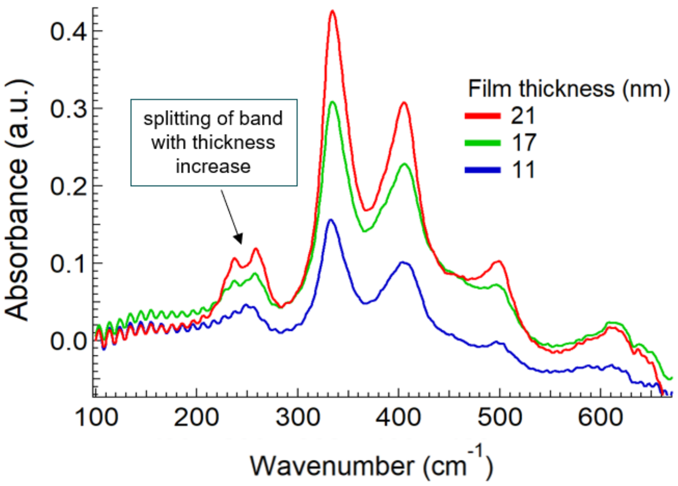

Fig. 1: Far-infrared absorption spectra of three different HfZrO2 film thickness: 11, 17 and 21 nm. The spectra are in accordance with theoretical calculations of the polar-orthorhombic ferroelectric phase.

References:

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