Effect of the deposition process and the substrate nature on the properties of sputtered lanthanum cuprate films

Nolwenn Tranvouez\(^1\), Jean-Francois Pierson\(^2\), Fabien Capon\(^3\), Jean-Philippe Bauer\(^2\)

\(^1\)INPL/IJL, nancy, France  \(^2\)IJL, nancy, France  \(^3\)IJL, nancy, Germany

nolwenn.tranvouez@mines.inpl-nancy.fr

Lanthanum cuprate (La\(_2\)CuO\(_4+d\)) exhibits superconducting properties. Although sputtering processes are widely used for the deposition of high quality oxide films, only few publications are focused on the synthesis of lanthanum cuprate sputtered films. Moreover, the literature does not report information about the effect of the deposition process on the structure and the properties of La\(_2\)CuO\(_4+d\) films. In this presentation, we aim to show the effect of different depositions processes on the film composition, structure and properties.

As a first process, lanthanum cuprate films were deposited by co-sputtering of metallic copper and lanthanum targets in various Ar-O\(_2\) reactive mixtures. The oxygen flow rate introduced into the deposition chamber was optimised to fully oxidise the sputtered atoms. The atomic ratio La/Cu in the film was adjusted by the variation of the pulsed DC current applied to the copper target. Within this process, the experimental window range for successful La\(_2\)CuO\(_4+d\) deposition was found to be very narrow. The second process, namely, reactive sputtering of a mixed La-Cu target, showed easier control on the film composition. The La/Cu atomic ratio in the film is strongly dependent on the target composition and a copper enrichment on the target surface was noticed, inducing a evolution of the film composition. The third process used a composite target: La target and a Cu ring. The La/Cu atomic ratio was controlled by the dimensions of the ring and of the erosion area. Several rings were used in order to optimize the deposition of La\(_2\)CuO\(_4+d\).

Whatever the deposition process, as-deposited films were amorphous. An annealing step in air at 600 °C was necessary to obtain the crystalline La\(_2\)CuO\(_4\) phase. Such an annealing process induced the formation of thermal stress. The film adhesion was studied as a function of the substrate nature (silicon, SrTiO\(_3\), fused silica, stainless steel)

\textbf{Keywords}
\begin{itemize}
  \item sputtering
  \item La\(_2\)CuO\(_4+\delta\)
  \item superconduction
  \item coating
  \item X ray diffraction
\end{itemize}