Water-Soluble Transition Metal Oxide Sacrificial Layers for the Transfer of Epitaxial Magnetic Thin Films

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The field of low-cost electronics is rapidly expanding, and the epitaxial growth of oxide thin films, including magnetic materials, on Si-substrates required advanced technical means. Consequently, significant attention is devoted to the process of detaching the oxide of interest from its deposition substrate, followed by its transfer onto a suitable substrate via the etching of an intermediate sacrificial layer (SL) [1]. The use of a SL offers several advantages, as the flexible polymer employed for the transfer can also be fully processed in the design of flexible heterostructures [2]. It lets envisioned a modification of the magnetic properties such as the anisotropy with applied bending strain for instance. In line with environmental considerations, increasing research is focusing on the development of SL that can be etched with soft solutions like water. The objective is to release the material without compromising its properties or inducing interdiffusion, which can lead to undesirable phase formation. For example, when $Sr_3Al_2O_6$ (SAO) interacts with $La_{0.7}Sr_{0.3}MnO_3$ (LSMO), such issues may arise.
In this study, we present a method to overcome this limitation by employing an oxygen-deficient LSMO protective layer, which enables the clean detachment of a freestanding LSMO film (see Figure 1) [4]. Beyond the conventional use of SAO, there is a pressing need to explore new SL with distinct lattice parameters and symmetries to facilitate the epitaxial growth of a broader array of materials. In this context, we identify alternative SL within the transition metal oxide family, such as $SrVO_3$ [5], which undergoes the expected chemical reaction with water: $MO_{(s)} + H_2O_{(l)} \longrightarrow M(OH)_{2(s)}$ (where M represents an alkaline earth metal). We also extended our investigation to molybdate (AMO_3, where A = Sr, Ca, Ba) and vanadates compounds, specifically solid solutions of $Sr_{1-x}Ca_xVO_3$ ($0 \leq x \leq 1$) [6]. In addition to introduce new materials to the scientific community, we successfully demonstrated the transfer of a $SrTiO_3$ thin film—an important perovskite material—onto a Si (001) wafer.

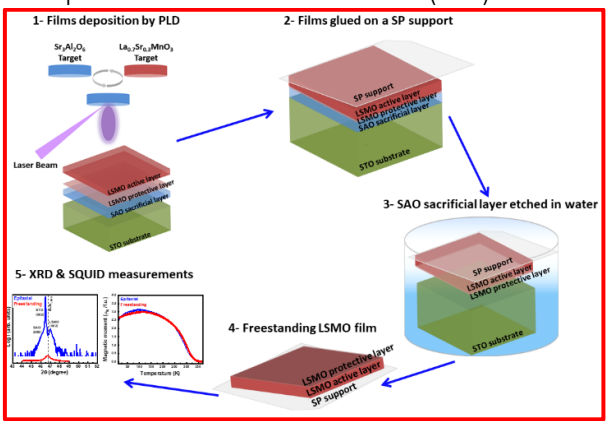

Figure 1. Illustration of the steps in the preparation of magnetic LSMO freestanding films.

References

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