Growth of thin films: how to control structure and microstructure?

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Synthesize materials in thin films form becomes of increasing importance for numerous applications in areas as varied as microelectronics and environment. Miniaturization and integration of devices are in fact possible with thin films while offering high performance. However, thin films properties are strongly correlated to their structural and microstructural characteristics. Through various examples of multifunctional oxides thin films, we will show how we can control these characteristics.

The strong influence of the substrate nature will be illustrated by pure and Nd-doped $SrTiO_3$ thin films deposited by Pulsed laser Deposition (PLD) on various substrates ($LaAlO_3$, MgO, $SrTiO_3$, sapphire, SiO_2). $SrTiO_3$ based thin films are intensively investigated as suitable dielectric material for very large scale integrated devices, such as dynamic random access memories (DRAMs). Another example will focus on TiO_2 thin films also prepared by PLD. Due to special properties such as large energy gap, high refractive index and dielectric constant, this material is used in various applications such as optical devices, self cleaning coatings, sensors and catalysts. We will show the effect of substrate orientation and synthesis temperature on the control of allotropic variety (anatase or rutile) TiO_2 thin films deposited in particular on M-, R and C-sapphire. Finally, the influence of the method used for film growth will be illustrated by the example of $Ca_{1-x}Sr_xSnO_3$ thin films. Alkaline earth stannates $MSnO_3$ (M = Ca, Sr, or Ba) are of great interest due to their unusual dielectric and semiconducting properties, leading to various applications such as thermally stable capacitors and moisture sensors. We will compare the structure and microstructure of such films synthesized by PLD and by Chemical Solution Deposition on (100) $SrTiO_3$.

Keywords: multifunctional oxides, thin films, pulsed laser deposition, chemical solution deposition, epitaxial growth, structure, microstructure

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