Growth and Investigation of Hexagallate Substrate Crystals for Strain-Engineered Functional Oxide Layers

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Barium hexaferrite ($BaFe_{12}O_{19}$) is a commercially important magnetic material with ferrimagnetic order below approximately 720 K. It is also known to be a quantum paraelectric, and hence we are exploring strain engineering as a possible pathway to make $BaFe_{12}O_{19}$ into a room-temperature multiferroic [1]. For the growth of strain engineered $BaFe_{12}O_{19}$-thin films, lattice-matched substrate crystals are required. The material of choice for this purpose is doped strontium hexagallate ($SrGa_{12}O_{19}$).

Both mentioned compounds crystallize in the hexagonal magnetoplumbite-structure ($P6_3/mmc$), yet with a certain lattice mismatch. Until recently, the absence of isostructural commercial substrates was a fundamental limitation for the growth of high-quality epitaxial films of hexaferrites. Therefore, we started to re-develop hexagallate substrate materials for epitaxial applications in the framework of the Joint Lab between Cornell University and the Leibniz-Institut für Kristallzüchtung.

The growth of the crystals is mostly conducted by top-seeded solution growth (TSSG), similar to the pioneering work by *Mateika and Laurien* [2]. The grown crystals were doped with Mg and Zr to obtain $Sr_{1.03}Ga_{10.81}Mg_{0.58}Zr_{0.58}O_{19}$ (SGMZ). This not only further influences the lattice parameter but, most beneficially, increases the width of the growth window by about 100 K. Recently, we investigated this further and provided an updated phase diagram [3].

In this contribution we will present the latest experimental results and future plans for the project described. We will discuss results of differential scanning calorimetry (DSC), laser-flash annealing (LFA), and X-ray diffraction (XRD) measurements and the obtained values for heat conductivity, elastic constants and obtained lattice parameters. Also, first insights and results on attempts to incorporate or substitute different metal ions into the structure with the aim to adjust the lattice parameter for the desired substrate will be presented.

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