Crystal growth and characterization of hexagallate bulk single crystals

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Modern information and communication technologies will require frequency bandwidths from ~600 MHz up to several terahertz for ultra-fast, low-cost and environmentally friendly data processing. For these challenges, magnetic materials such as single-crystalline barium hexaferrite ($BaFe_{12}O_{19}$) films are attractive for the generation of spin waves used as data carriers in novel computing devices. To achieve epitaxial films with excellent structural and magnetic perfection, a suitable substrate material with small lattice mismatch is required. For the growth of barium hexaferrite by liquid phase epitaxy, alkaline-earth hexagallates are the substrates of choice, because it has already been demonstrated that they can support the growth of epitaxial films with high crystal quality [1]. If high-quality films could be also grown by molecular-beam epitaxy, it would bring an opportunity to engineer the properties of hexaferrites using strain engineering. Mateika and Laurien gave the first report on bulk growth of the hexagallate $SrGa_{12}O_{19}$ single crystal [2]. It melts peritectically and must be grown from melt solutions with SrO excess. Unfortunately, the growth window from which this phase crystallizes is very narrow; but the authors were able to increase the yield significantly by an equimolar partial substitution of Ga^{3+} with Mg^{2+} and Zr^{4+}. We showed that Mg^{2+}/Zr^{4+} co-doping is effective, because it widens the crystallization window [3]. Meanwhile, high-quality bulk crystals of (Mg,Zr):$SrGa_{12}O_{19}$ (SGMZ) with diameters close to one inch were grown at IKZ in the framework of the activities of the IKZ-Cornell joint lab [4]. A novel X-ray diffraction rocking curve imaging procedure specifically developed for SGMZ substrates reveals that the rocking curve widths are typically below 23 arcsec. It is intended to introduce other, and possibly more metal ions into the structure – with the aim to perfectly adjust the lattice parameters for the desired films and to evaluate the potential for optical applications. First results will be presented.

References
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