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INVESTIGATION OF CRYSTAL GROWTH AND PROPERTIES OF RARE-EARTH SCANDATES

Uecker R.*, Albrecht M.*, Velickov B.*, Wilke H.*, Schlom D. G., Fornari R.***

*Institute for Crystal Growth, Berlin/Germany, cryst@ikz-berlin.de

**Pennsylvania State University, University Park, PA/USA

Rare earth scandate crystals ($Re ScO_3$) represent a group of promising materials for several advanced applications. Among them that RE-scandates with the larger RE ions (La - Ho) are orthorhombic perovskites. They belong to the space group *Pbnm* (no. 62). The span of their pseudo-cubic unit cell parameters covering the range between 3.94 Å ($HoScO_3$) and 4.06 Å ($LaScO_3$), their thermal expansion coefficients, and their good thermal and structural stability favor these crystals for substrates for the growth of uniformly strained $SrTiO_3$ and $BaTiO_3$ films below the critical thickness for relaxation. Under such strains, the ferroelectric properties of $SrTiO_3$ and $BaTiO_3$ have been extremely enhanced. The transition temperature (T_C) of these materials is increased by several hundreds of degrees. This is the largest strain-induced shift in T_C ever achieved.

The $Re ScO_3$ crystals dealt with melt congruently at about 2000–2200°C. These crystals were grown by the conventional Czochralski technique with RF-heating and automatic diameter control. Because of their high melting temperature the heat transport during the growth is dominated by radiation. However, for some of these crystals this radiant heat transport is hindered by absorption within the growing crystal. This leads to a flattening of the radial temperature gradient in the melt resulting in a weakening of the thermally driven flow. In this way a potential is created for the formation of thermal instabilities near the crystal-melt interface. This situation is the trigger for an extremely tendency of some of these crystals to spiral growth. The increase of the thermal flow via a stronger Marangoni flow by the introduction of a conical baffle led to the inhibition of spiral formation.

The composition of the grown $Re ScO_3$ crystals is non-stoichiometric. As a rule the perfection of the grown crystals is quite good. The full width at half maximum of the rocking curves are in an excellent range (8-25 arc sec), and the etch pit density was found to be about $10^4/cm^2$. Frequently, however, fine inclusions occur especially in the $GdScO_3$ crystals. These inclusions were identified by TEM. Variations in color sometimes appear in dependence on the growth atmosphere.