Growth of Rare Earth Iron Garnet Single Crystals

D. Prabhakaran
d.prabhakaran@physics.ox.ac.uk
Clarendon Laboratory, Department of Physics, University of Oxford, Oxford OX1 3PU
United Kingdom

The family of YIG garnets $Y_3Fe_5O_{12}$, has been well known for a long time, but the magnetic structure is more complex and very challenging to solve, because of many magnetic exchange pathways. Rare earth iron garnet with the common formula $RE_3Fe_5O_{12}$, has attracted considerable attention due to its strong spin-orbit coupling, complex nature and the intermediate ionic nature of transition metal and oxygen bonds i.e., Fe–O, which account for the strongly correlated electron system. It is also the compound which exhibits low field magnetodielectric response at room temperature which is appealing for practical applications. $RE_3Fe_5O_{12}$ has cubic symmetry with the space group Ia–3d. The unit cell of $RE_3Fe_5O_{12}$ is composed of RE-O and Fe-O clusters forming three dodecahedral (REO_8), three tetrahedral (FeO_4) and two octahedral (FeO_6) sites. Due to this complicated structure of rare earth iron garnets, magnetic moments are distributed over several sites and to solve the complex exchange interactions, good quality single crystals are essential [1,2].

Here we report the growth of $(Ho,Y)_3Fe_5O_{12}$ single crystals using the travelling solvent optical floating zone technique. Optimizing the growth speed and the atmosphere is essential to achieve a high-quality crystal. This will be important for gaining insight into the fundamental physics of these rare-earth garnet compounds and may consequently open a new direction for the technological application of the garnet compound.

References

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