Growth and characterization of $Dy_{1-x}Y_xMnO_3$ single crystals by optical floating zone technique: A combined X-ray diffraction and DC magnetization study

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Rare earth manganites $RMnO_3$ (R = La^{3+} - Lu^{3+}, Y^{3+}) represent a fascinating family of multiferroic compounds due to an interplay between their charge, lattice and spin. Pure and Y^{3+} substituted $DyMnO_3$ samples were synthesized by solid state reaction method and grown as single crystals by optical floating zone method. $Dy_{(1-x)}Y_{(x)}MnO_3$ single crystals grown in Argon atmosphere, crystallize in hexagonal structure belonging to the *$P6_3cm$* space group. The structural analysis has been carried out by Rietveld refinement using synchrotron X-ray powder diffraction (SXRPD) data. The results obtained after the Rietveld refinement clearly demonstrate that the unit cell volume and lattice parameters decrease with increasing Y^{3+} substitution at Dy^{3+} site in $DyMnO_3$. Further, magnetic susceptibility (χ_{dc}) measurements on single crystals of h-$Dy_{(1-x)}Y_{(x)}MnO_3$ reveal that the Y^{3+} substitution enhances the antiferromagnetic ordering temperature (T_N) from 67 K for h-$DyMnO_3$ to 72 K for h-$YMnO_3$. Unlike the T_N ordering, the first spin reorientation (SR) transition temperature of Mn^{3+} decreases with increasing Y^{3+} substitutions. The remaining two magnetic transitions at still lower temperatures, i.e. Dy^{3+} ordering temperature ($T_{Dy^{3+}}$) and second SR temperature (T_{SR2}), remain unaffected by Y^{3+} substitution up to x = 0.75. We also present a magnetic phase diagram *of h-$Dy_{(1-x)}Y_{(x)}MnO_3$* showing stability field regions of different transitions. We believe that our study helps in understanding the magnetic transitions of the other h-$REMnO_3$.