ABSTRACT

Scientists/researchers worldwide are trying to find a new ferroelectric material, which is suitable for different applications. Over the 90 years of ferroelectrics research, almost all possibilities of ferroelectric materials have been tried. However multiferroic (materials exhibiting ferroelectric as well as ferromagnetic properties) is still in its infant stage of research, and the scientific community has to go a long way to develop the multifunctional devices for our day-to-day applications. The hurdle is mainly because of the mutual exclusion of the ferroelectric and the ferromagnetic properties in a single material. While a group of researchers playing with the elements, which possess the boundary condition of both ferroelectric and ferromagnetic properties, the others are trying to prepare solid solutions/multi layers of very good ferroelectric material with well-known ferromagnetic material. Yet another group trying to prepare the composites of ferroelectric and ferromagnetic material in a common host. In the line of these, a new method is proposed to explore the ferroelectric properties from a well-known ferromagnetic material by suitable modification in the material. Yttrium iron garnet (YIG) is known for its ferrimagnetic properties. The magnetic properties of this material could be studied without domain effects, since this material has a single magnetic domain. The Garnet structure is generally cubic and oxygen atoms constitute a tetrahedron and octahedron bonded with two divalent dodecahedral sites. In this fashion there are 96 atoms per cubic unit cell having $a \cong 12$Å. The spontaneous magnetization observed in YIG with the chemical formula $Y_3Fe_2(FeO_4)_3$, is attributed to its perovskite-like phase, which actually originates from the garnet phase. Detailed structural studies of some other compounds of garnet family such as $Ca_3Fe_2Sn_3O_{12}$ showed $CaSnO_3$ perovskite like structure with a small amount of pyrochlore/secondary phase due to impurity of α-Fe_2O_3 phase. The existence of spontaneous magnetization in the perovskite like phase (layered perovskite/post perovskite) in garnet structure has encouraged us to explore the possibility of ferroelectricity in a ferromagnetic material because most of the archetypical ferroelectric materials such as $BaTiO_3$, $PbTiO_3$, etc belong to perovskite structural family.

Key Words: Ferroelectric, Ferromagnetic, Multiferroic, Perovskite, Garnet.