

Keynote Lecture

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The World of Perovskites: Phase Transitions and Exotic Properties

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Oxide perovskites with a general chemical formula ABO_3 constitute an important class of technologically significant materials widely used in commercial capacitors, sensors, actuators and optical devices. The upper part of the earth's lower mantle extending from 670 to 2990 km deep is also predominantly composed of perovskite type $(Mg,Fe)SiO_3$. The perovskite compounds and their solid solutions exhibit many exotic phenomena such as ferroicity, antiferroicity, multiferroicity, piezoelectricity, electrostriction, superconductivity, colossal magnetoresistance, many types of magnetic and cationic orderings and quantum critical point. They owe these phenomena to a rich variety of phase transitions that can be induced by a wide range of variables, such as composition, temperature, pressure, magnetic field, electric field, external stresses and particle size. The main focus of this lecture would be on recent developments on phase transition studies in materials like $CaTiO_3$, $SrTiO_3$, $PbTiO_3$, $PbZrO_3$, $NaNbO_3$, $BaTiO_3$, $Pb(Fe_{1/2}Nb_{1/2})O_3$, $Pb(Mg_{1/2}Nb_{1/2})O_3$, $BiFeO_3$ and their solid solutions. The examples to be covered in this presentation would include (i) antiferrodistortive tilt transitions (ii) ferroelectric, antiferroelectric, ferrielectric, quantum paraelectric, quantum ferroelectric and relaxor ferroelectric transitions, (iii) morphotropic phase transitions, (iv) isostructural phase transitions, (v) antiferromagnetic and spin reorientation transitions, (vi) tricritical transitions, (vii) stress-induced structural transitions and (viii) size induced transitions. The need for complimentary diffraction techniques (X-ray, neutron and electron diffraction) in conjunction with physical property measurements in capturing the signatures of these phase transitions will be highlighted. The results of group and Landau theory considerations will also be presented. The origin of exotic functional properties of the perovskite compounds and their solid solutions will be discussed.

Keywords: Perovskites, Ferroics, Multiferroics