Structural, magnetic and optical properties study of tellurium–based: $Sr_{3-x}Pb_xFe_2TeO_9$ ($0 \leq x \leq 2.25$) double perovskites

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Materials family of $A_3B'_2B''O_9$ (A = alkaline–earth metal ions with valence +2, B' and B''= transition metal ions with valences +3 and +6 respectively) were subjected to extensive studies, and have attracted significant interest owing to their physical properties and technological applications. The discovery of colossal magnetoresistance (CMR) in the ordered $A_2B'B''O_6$ double perovskite oxides has given rise to many recent research [1–3].

Polycrystalline samples of the series of triple perovskites $Sr_{3-x}Pb_xFe_2TeO_9$ ($0 \leq x \leq 2.25$) were synthesized using solid state reaction [4]. These materials have been studied by a combination of XRPD, Mössbauer spectrometry, Raman and UV–Vis spectroscopies. The crystal structures were resolved by the Rietveld refinement method, and revealed that this $Sr_{3-x}Pb_xFe_2TeO_9$ ($0 \leq x \leq 2.25$) system shows one space group change from tetragonal *I*4/*m* ($0 \leq x \leq 1$) to another tetragonal form *I*4/*mmm* ($1.25 \leq x \leq 1.88$) and a second transition to hexagonal *R*-3*m* ($2.08 \leq x \leq 2.25$). The valence state of iron in the Fe site was determined to be Fe(III) by Mössbauer spectrometry, which also revealed two sites in a concordance with the XRPD measurements. ^{57}Fe Mössbauer spectra measurements show paramagnetic and magnetic ordering behaviors. The observed Raman spectra as a function of composition show obvious changes on the positions (wavenumbers), the FWHM and the intensities of the modes confirming the phase transformations observed by the XRPD results. These structural transitions led to a distinct change in the optical band gap energy, varying from 2.14 to 1.85 eV.

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