Mercury thiogermanate HgS-GeS2 glasses: macroscopic, electric, and structural properties

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Abstract

Mercury thiogermanate HgS-GeS2 glasses were synthesized and characterised. Macroscopic property measurement including density, X-ray diffraction (XRD), and differential scanning calorimetry (DSC) were performed. The glass-forming range for xHgS×(1-x)GeS2 compositions was found to be limited to x £ 0.6. As x increases, the glass transition temperature, Tg, decreases from 483 ∘C to 273 ∘C. The total electrical conductivity, studied using a high resistance meter, shows that the mercury thiogermanate glasses are electronic insulators, 4.5'10-15 S cm-1 ≤ s298(x) ≤ 4.0'10-13 S cm-1, with a non-monotonic electronic behaviour. Raman spectra of the (HgS)x(GeS2)1-x was also measured over the entire range $0.0 \leq x \leq 0.6$. The addition of HgS to the host GeS2 glass leads to a well-defined feature at _˜320 cm-1 which eventually trespasses in its intensity that of the vibrational modes corresponding to GeS4 tetrahedra at around 340 cm-1. Finally, high-energy X-ray diffraction experiments were carried out. The results show that (i) two mercury bonding patterns (HgS2/2 and HgS4/4) are present simultaneously in mercury thiogermanate glasses HgS–GeS2 and (ii) the population and interconnectivity of chain-like (HgS2/2)n and tetrahedral (HgS4/4)n dimorphous forms determine both the structural features and fundamental glass properties (thermal, electronic, etc.).

Keywords: Chalcogenide glasses, Electric conductivity, thermal properties, Raman, High energy X ray diffraction

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