Chalcogenide Advanced Manufacturing
Partnership Open Day March 9, 2015

Manufacturing Gallium Lanthanum Sulphide Glass

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Abstract

A glass series of gallium-lanthanum-sulphide (GLS) has been studied in order to understand its thermal and optical properties and how this varies through compositional change. GLS is a fascinating glass material which transmits mid-infrared light and has many active and passive applications in this wavelength regime - and in other optical and electronic devices. For practical applications, it is important to understand how this glass changes, in terms of performance, through variation of its stoichiometry.
Glass melts have been produced in-house and subsequently cut and polished into various thicknesses by specialist glass polishers Crystran Ltd. Glass samples are of various composition, ranging from 45/55 to 75/25 (wt% Ga_2S_3 / wt% La_2S_3). Thermal and optical properties of the glass series have been determined through the use of several characterisation techniques.

What is GLS used for?

- Mid-infrared transmitting lenses, prisms, windows
- Optical fibre (transmission, fibre lasers, amplifiers)
- Microspheres (micro-resonators), nanowires, metamaterials
- Thin films (integrated optics, solar cells and phase-change memory)

How is it made?

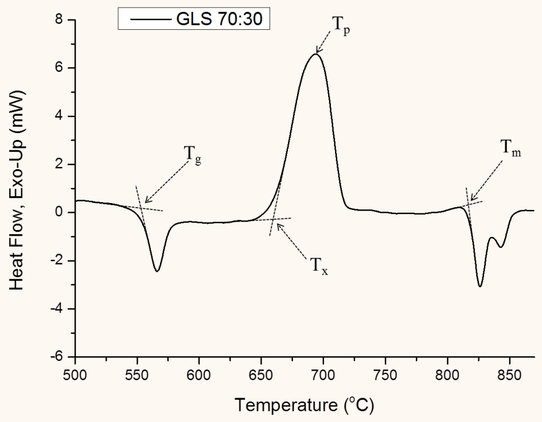
- Inert atmosphere melting
- Preform and crucible drawing
- High temperature synthesis by surface tension
- Sputtering, pulsed laser deposition or spin coating

Thermal Analysis

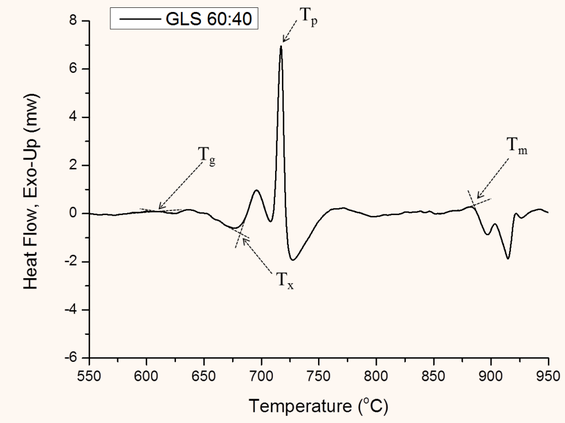
Thermal analysis determined the characteristic temperatures - glass transition ,T_g, onset of crystallization, T_x and onset of melting, T_m though the use of differential thermal analysis (DTA)

Wide (T_x - T_g) gap = Good thermal stability for fibre drawing
Wide (T_p - T_x) peak = Slower crystallisation event
Narrow (T_m - T_p) gap = Crystallisation will occur far from glass working temperature

Good

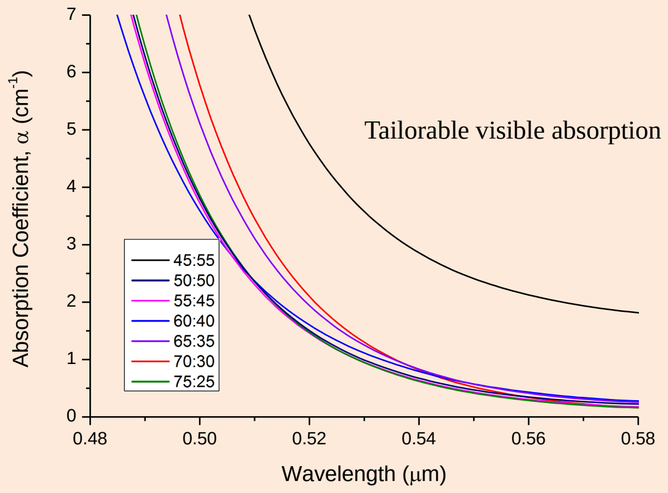


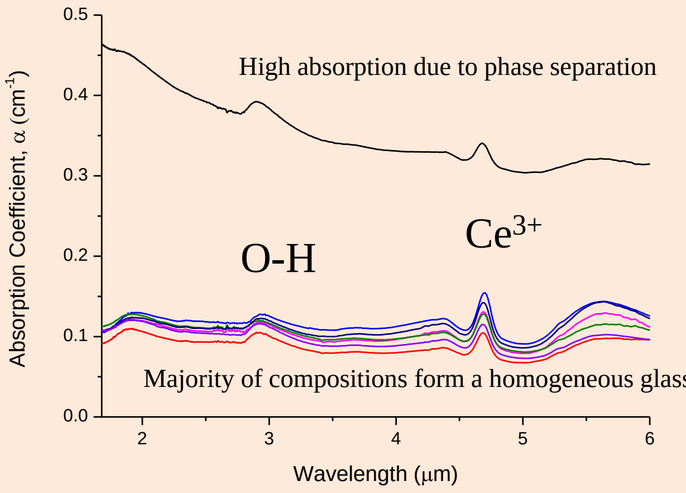
Not so Good

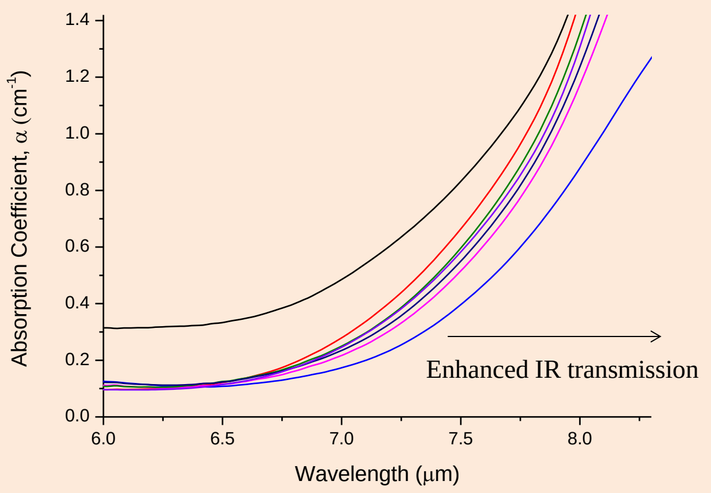


Spectroscopy

UV-Vis-NIR and FTIR spectroscopy have been used to determine the electronic and multiphonon edges of the glasses
As well as distinguishing the transparency window of the glass samples, absorption peaks are found and linked to impurity sources







Conclusions

The thermal and optical properties of bulk GLS can be tailored to the user's desire and used in many device applications. Considerable differences throughout the series of glass compositions has been summarised in the form of tables and graphs which can be used as reference when determining which GLS ratio is most suitable for the user's desired application. Further results are available on request which include full thermal analysis results, refractive indices by ellipsometry, present bonds by Raman spectroscopy and molecular structure details by X-ray diffraction.

Grant Reference: EP/H02607X/1 - EPSRC Centre for Innovative Manufacturing in Photonics

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Research Sponsored by EPSRC, the Engineering & Physical Sciences Research Council

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