PROPERTIES AND APPLICATION OF GERMANIUM SULPHIDE GLASS

C. C. Huang and D. W. Hewak
Optoelectronics Research Centre, University of Southampton

J. V. Badding
Dept of Chemistry, Penn State University, USA

Key words to describe this work: germanium sulphide glass, SEM, Raman, FT-IR, UV-VIS, DTA and XRD

Key Results: The germanium sulphide glass properties have been characterized by SEM, Raman, FT-IR, UV-VIS, DTA, and XRD

Introduction

Chalcogenide glasses, especially sulphide glasses, are becoming more and more important for the fabrication of optoelectronic devices in part because of the high nonlinearity, strong photosensitivity and other unique properties they have (1-3). Traditionally, the sulphide glasses are made in bulk form by traditional melt-quenching method in the quartz ampoule. The bulk glasses are then reprocessed to form fibre or planar waveguides. In this research work, the germanium sulphide glass has been characterized by a series of scientific methods including Raman, FT-IR, UV-VIS, DTA, SEM and XRD. From the analysis results, we can identify the properties of germanium sulphide glass which has shown the high potential for the fabrication of the germanium sulphide glass optical fibres and planar waveguides.

Apparatus and experimental methods

Crystalline germanium sulphide powders were sealed in an evacuated quartz ampoule (~$4x10^{-6}$ mbar). The ampoule was placed in an electric furnace and held at 900 °C for 6 hours. Then a glassy sample was obtained by quenching this ampoule in the air. After that, the germanium sulphide glassy sample was annealed at 350 °C for 8 hours.

Results and Discussion

The Raman spectrum of the germanium sulphide glass planar waveguide is shown in Fig. 1. From the Raman spectrum, we can identify that the film is in a glassy phase which also matches the XRD result (Fig.2). By SEM-EDX technique, the composition of the germanium sulphide glass is $GeS_{1.72\pm0.02}$.

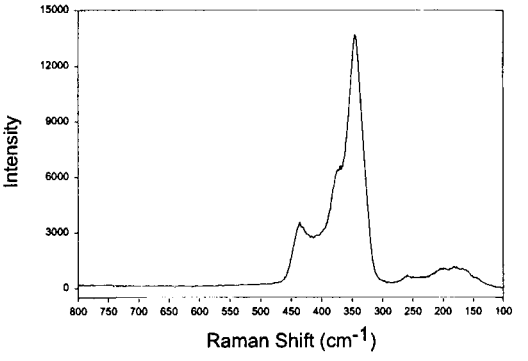

Fig.1 Typical Raman spectrum of germanium sulphide glass

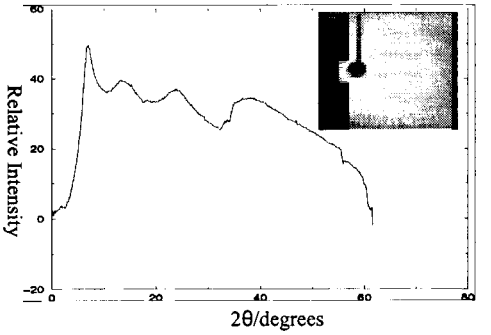

Fig.2 XRD pattern of germanium sulphide glass

We also use DTA to obtain some thermal properties of the germanium sulphide glass (Fig.3). From the results, the glass transition temperature (T_g) is 456°C, the crystallization temperature (T_x) is 620°C, and the melting temperature (T_m) is 715°C. These indicate a thermally stable glass which can be used at up to 450°C without risk of crystallization of the glass.

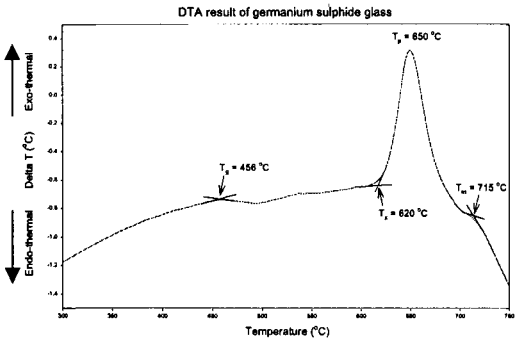

Fig.3 DTA results of germanium sulphide glass

The UV-VIS spectrum of germanium sulphide glass obtained by Varian Gary 500 Scan UV-VIS-NIR Spectrophotometer is shown in the Fig. 4. From the UV-VIS spectrum, we can estimate that the germanium sulphide glass has an absorption edge at ~425nm (2.9 eV).

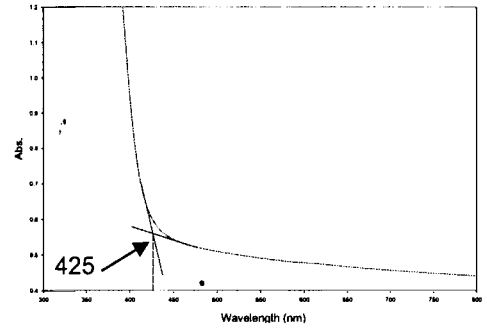

Fig.4 Typical UV-VIS spectrum of germanium sulphide glass

Conclusion

The optical third-order nonlinearity of germanium sulphide glass (n_2~7.5×10^{-5} cm^2/GW), which is 750 times that of silica) was measured [5] by D. Marchese *et al.*, making this glass one of the best candidates for ultra-fast nonlinear optical applications. This research work provides a series of characterization methods toward the germanium sulphide glass which has shown a very high potential in optical fibres and planar waveguides.

References

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