University Pardubice

Faculty of Chemical Technology

Department of General and Inorganic Chemistry

Photoinduced Effects in Chalcogenide Glasses Based on Ge-Ga-S System

Supervisor: Prof. Wagner Tomas

Student: Jing Ren

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I hereby confirm that I have written this paper independently. All the reference literature and information used in the paper are quoted in the list of reference literature.

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Dated in Pardubice on 25 May 2009

Jing Ren

Acknowledgements

Life is certainly uncertainty.

I just realized that I had been lucky to finish my Ph.D. study in a small, quiet city named Pardubice in Czech Republic, three years have past by. When I reflected on things happened here, I could say that I liked my supervisor Prof. Tomas Wagner since the first time I met him. He is a real gentleman, considerable and understanding. I would like to first express my greatest gratitude to him for his guidance, scientific help and financial support throughout the whole period of my study. I also thank his wife, Mrs. Valerie, for her kindness to me. She is a model wife.

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No matter where I am, my heart is with my family.

No matter what I do, I want to make my mum be proud of it.

To my brothers and friends in China

To world peace

Abstract

The main objective of this thesis is to investigate the potentials of Ge-Ga-S glass system as a host material for some important technological applications after, of course, doping with different active ions. In this thesis, we present our research on the photo-(or laser) induced optical properties changes in Ge-Ga-S based chalcogenide glass system. Here by “the optical properties changes”, we mean **1) photoinduced change of refractive index, 2) photodarkening**, **3) photoluminescence**, **4) second harmonic generation** and **5) third-order nonlinearity**. And finally, part of the work has been devoting to the studying of **a.c. ionic conductivity**.

When AgI was introduced into Ge-Ga-S matrix, we observed enhanced photosensitivities in terms of larger increase in the refractive index and absorption coefficient after exposure as compared with samples without AgI. These phenomena were characterized by means of **ellipsometry spectroscopy** and the time evolution of **transmission spectra** at every 10 milliseconds. Meanwhile, we also found that AgI-doped glass samples showed high ionic conductivities which were demonstrated by **impedance spectroscopy**. AgI-doped glasses are expected to find applications in **photolithography, optical storage** and **solid state electrolyte**.

AgI doped glasses showed larger value of third-order nonlinear optical susceptibilities $\chi^{(3)}$ as compared with glasses without AgI. This was confirmed by means of **Z-scan measurement**. Larger values of second-order nonlinear optical susceptibilities $\chi^{(2)}$ were obtained in AgI-doped glasses as well after simultaneous polarized optical treatment together with an electrostatic dc-electric field. The values of $\chi^{(2)}$ were calculated by **Maker fringe method**. Glasses exhibiting high nonlinear optical response are promising candidates for photonic applications like **optical limiting devices**, **optical computing** etc.

Keywords: photo-induced effects, chalcogenide glass, nonlinear optics