Spin-coated As30Se70 chalcogenide glass thin films – novel approach for solvent formulation

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Abstract

Chalcogenide glasses (ChGs) are semiconducting materials with high refractive index and wide IR transmission window. Due to their unique properties, they have found many applications in optics, optoelectronics and photonics. ChGs can be used in a form of bulk material, fibers or as a thin film deposited on appropriate substrate. The thin films are frequently deposited by physical vapor deposition techniques (e.g. thermal evaporation, laser ablation, etc.) but solution based techniques (e.g. spin-coating, dip-coating, spiral bar-coating, etc. [1]) which exploit solubility of ChGs in volatile alkaline amines are also gaining attention. The main advantage of solution based deposition techniques lies in low cost instrumentation, simplicity of thin films deposition and ability to use flexible substrates. However, poor solubility of selenide ChGs in volatile amine solvents limits the variety of glass compositions suitable for solution processing.
Previously, the arsenic-selenide thin films were deposited from ethylenediamine [2] or ethanolamine [3] solutions but their optical quality, roughness or targeted composition were highly affected. Also, the high boiling points and low volatility of used solvents dampened the possibility of successful organic residuals removal from deposited thin films.

In this work, we present the study of volatile amine-based solvent formulation and its influence on As30Se70 ChG solubility and dissolution mechanism. The stable solutions of quantitatively dissolved selenide ChG were used for spin-coating of thin films in specular optical quality. The post-deposition thermal treatment proved to have high impact on thickness, optical properties and structure of studied thin films. The content of organic residuals was also significantly reduced. The proper solvent formulation and thermal stabilization process yielded the thin film with high refractive index, very low surface roughness and composition close to the source bulk glass.

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Acknowledgements

Authors appreciate financial support from projects and grants No. 16-13876S (GACR), LM2015082 and ED4.100/11.0251 (MEYS Czech Republic) and CZ.02.1.01/0.0/0.0/16_013/0001829 (European Regional Development Fund-Project).

Keywords: Chalcogenide Glasses, Thin films, Spin coating, Solution Processing