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Materials Characterization of Dissolved Chalcogenide Spin Coated Thin Films

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Abstract

Additive manufacturing technology introduced revolutionary new development in the field of aerospace manufacturing, medical equipment, and other industrial products. Our focus is to fabricate a space grade radiation-sensing device for space exploration application using additive manufacturing technology. Fabrication of ink is the first step of this process. We have developed both nano-particle and dissolution based chalcogenide glass ink. In this paper we report the formation of Se containing dissolution based ink dissolved in amines. Before starting printing, we studied initially spin-coated films. These films have been analyzed applying XRD, SEM, and EDS.

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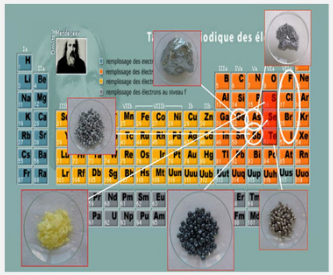
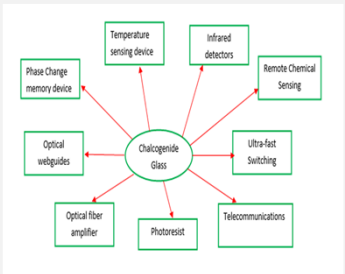
Introduction

Additive manufacturing technology or 3D printing is a process that creates a physical object from a digital design. Our main goal is to fabricate a space grade radiation sensing device using additive manufacturing technology. Ink development is the first phase of this process. We have developed both nano-particle and dissolved ink [1]. In this presentation we demonstrate the dissolved ink making process of Se based chalcogenide glass and report material characterization of dissolved Chalcogenide Spin Coated Thin Films using tensiometer, XRD, SEM, EDS.

Chalcogenide Glass & Its Applications

Chalcogenide glasses have a wide range of applications because of its significant unique physical and chemical properties including absorption coefficient, nonlinear optical susceptibility, resistance, crystal structure and morphology, wide IR transmission window or high values of refractive index [2].



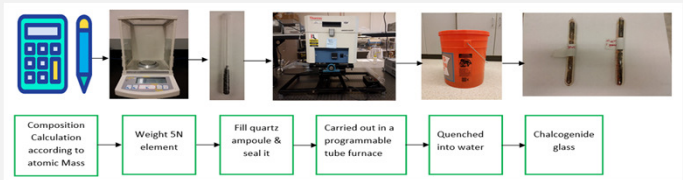


Objective

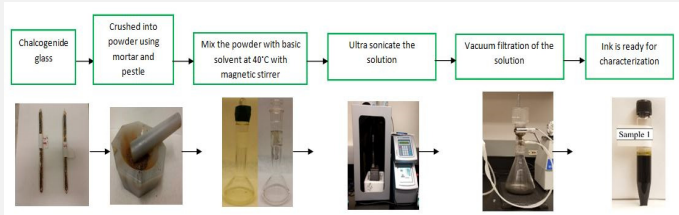
- To develop dissolution based Ge-Se chalcogenide glasses ink for fabricating radiation sensor using additive manufacturing technology.
- To apply Ag diffusion technique under radiation source to monitor radiation dose.
- Using Additive manufacturing technology to avoid complexity of conventional deposition techniques and high cost.

Experimental Method

- **Glass synthesis**



- **Dissolution based chalcogenide glass (Ge_xSe_{100-x}) ink formulation**



- **Contact angle of dissolution based chalcogenide glass ink**

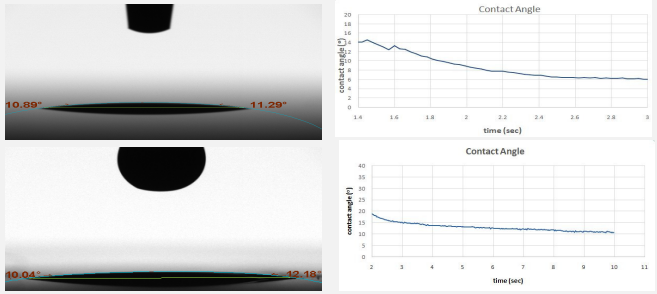
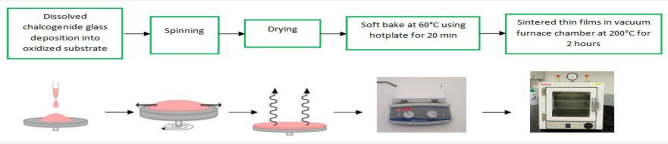


Fig. 1 Contact angle of Dissolution based chalcogenide glass ink (top) $Ge_{40}Se_{60}$, (bottom) $Ge_{30}Se_{70}$ in oxidized films.

- **Thin film preparation & sintering process**



Characterization

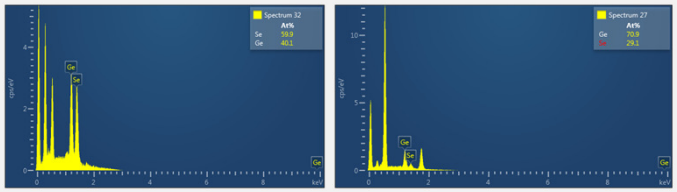


Fig. 2 (Left) EDS spectra of $Ge_{40}Se_{60}$ (right) EDS spectra of $Ge_{30}Se_{70}$ spin coated thin film shows that the compositional variance is within ±1% of the bulk . (Right)

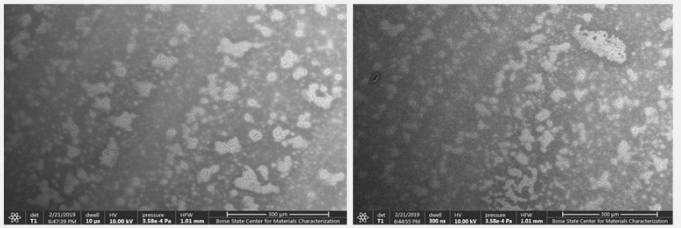


Fig. 3 SEM micrograph of spin coated $Ge_{40}Se_{60}$ (left) and $Ge_{30}Se_{70}$ (right).

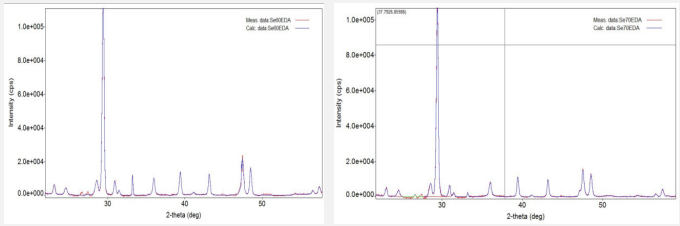


Fig. 4 (Left) XRD of spin coated thin Ge-Se film (left $Ge_{40}Se_{60}$) and (right $Ge_{30}Se_{70}$), DB no: 00-032-0410,01-083-1832, shows that the films are amorphous in nature.

Conclusion

Chalcogenide glasses are soluble in basic solutions and this property has been used for ink formation through dissolution. Before starting printing we did material and ink characterization. We measured 10º to 14º of contact angle which indicated that it has good adhesion with substrate. We also checked atomic composition of spin coated films using EDS and confirmed amorphous nature of spin coated films using XRD. In future, we will use this dissolution based ink for fabricating space grade radiation sensor using additive manufacturing technology on flexible substrate.

Acknowledgement
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Reference
1. **A Ahmed Simon et al., M & M (2019) in press.**
2. **S. M. R. Ullah et al., M & M (2019) in press.**
*Courtesy of Advanced Nano-materials and Manufacturing Laboratory, Boise State University**