Physical Properties of Spin Coated Arsenic Sulfide Films

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Chalcogenide materials are usually classified as those in which sulfur, selenium, or tellurium form one of the main constituents, usually in the form of crystal, ceramic, or glass [1]. They have become a great interest to scientists today due to their characteristic properties as they can be used in a variety of applications such as data recording media, sensors, optical communications and integrated optics [2]. However, their behavior has not been fully understood. In this paper, we analyze the physical properties of a particular chalcogenide, arsenic sulfide (As_2S_3).

There are several deposition methods to make amorphous As_2S_3 films such as thermal vapor deposition and spin coating deposition. In our lab, we use the spin coating method as it is the cheapest, as well as effective in producing a thin layer of transparent film. We are trying to see the effects of annealing temperature on the density of these films and relating this density change to the refractive index of the films. This can be done by depositing As_2S_3 dissolved in propylamine on a substrate (glass or silicon) such that it is spun for 20 seconds at 1000 rpm to produce a thin layer of film. After depositing, it is baked at different temperatures in a vacuum oven. After baking, we calculate the density of the films. The average densities of the films baked first at 65^0C for one hour and then baked at different temperatures are summarized in the table below.

Temperature (^{0}C for 1 hour)	Range of Density (g/cm^3)
65	~2.9 – 3.2
90	~ 3.3 – 3.6
150	~ 3.5 – 4.2

Table 1. Density of As_2S_3 thin films annealed at different temperatures.

It can be noted from the data above that the density of the films increases with increasing temperature. When Thermogravimetric Analysis (TGA) is conducted on them, it is noted that there is greater loss in mass of the films that are baked at higher temperatures as compared to those which are baked at lower temperatured. Since density depends only on the mass of a substance and its volume (d=mass/vol), the only factor that can cause an increase in density observed above is a decrease in volume. This may suggest that by heating the film, the molecules overcome the activation energy which allows them to become more stable and form closer bonds in the glass.

After all the data is collected, we will be able to develop a strong correlation between the density and the refractive index, which will help us understand the relation of thermal, structural, and optical properties of this important infrared material.

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