EMPLOYING PRINCIPAL COMPONENT ANALYSIS FOR XRD SIGNAL EXTRACTION OF GERMANIUM ANTIMONY TELLURIDE THIN FILMS DURING CRYSTALLIZATION

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Germanium Antimony Telluride (GST) alloys may be employed as phase change alloys for recording applications. We have performed in-situ crystallization studies of $Ge_2Sb_2Te_5$ thin films deposited on silicon substrates. The addition (doping) of carbon into GST can affect crystallization temperature. Our in-situ XRD analysis monitored the conversion of amorphous GST thin films with various carbon contents as they converted to the cubic $Ge_2Sb_2Te_5$ phase. XRD analysis was performed using a Bruker D8 diffractometer equipped with a sealed-tube Cu Kα X-ray source, a 500 μm pinhole optic, and a Vantec 2000 area detector. A cryo-stage with a beryllium dome was employed to maintain vacuum conditions during film heating. The XRD signal proved very weak due to the thin deposition (~50nm) of the GST films and limited X-ray beam footprint. Such a weak signal was not sufficiently compensated by the large solid-angle of the area-detector to obtain good diffraction signal for quantifying phase transformation behavior. In addition, the XRD data were convoluted with artifact peaks from the Be dome cryo-stage. This created significant challenges for extracting the phase evolution behavior of the GST film. The use of Principal Component Analysis (PCA) served well to separate the relevant growth signal of the cubic $Ge_2Sb_2Te_5$ phase, while isolating and excluding the significant noise and artifact peaks from the dome/stage. Determination of crystallization behavior of various carbon-doped GST films is presented and discussed in terms of PCA data extraction methods. Additional discussion is given regarding the impact of carbon addition to the GST films.

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