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Switching Studies on Ge15In5Te56Ag24 Thin Films

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Abstract : Germanium Telluride based quaternary thin film switching devices with composition Ge₁₅In₅Te₅₆Ag_{24,} have been deposited in sandwich geometry on glass substrate with aluminum as top and bottom electrodes. The bulk glassy form of the said composition is prepared by melt quenching technique. In this technique, appropriate quantity of elements with high purity are taken in a quartz ampoule and sealed under a vacuum of 10⁻⁵mbar. Then, it is allowed to rotate in a horizontal rotary furnace for 36 hours to ensure homogeneity of the melt. After that, the ampoule is quenched into a mixture of ice - water and NaOH to get the bulk ingot of the sample. The sample is then coated on a glass substrate using flash evaporation technique at a vacuum level of 10⁻⁶mbar. The XRD report reveals the amorphous nature of the thin film sample and Energy - Dispersive X-ray Analysis (EDAX) confirms that the film retains the same chemical composition as that of the base sample. Electrical switching behavior of the device is studied with the help of Keithley (2410^c) source-measure unit interfaced with Lab VIEW 7 (National Instruments). Switching studies, mainly SET (changing the state of the material from amorphous to crystalline) operation is conducted on the thin film form of the sample. This device is found to manifest memory switching as the device remains 'ON' even after the removal of the electric field. Also it is found that amorphous Ge₁₅In₅Te₅₆Ag₂₄thin film unveils clean memory type of electrical switching behavior which can be justified by the absence of fluctuation in the I-V characteristics. The I-V characteristic also reveals that the switching is faster in this sample as no data points could be seen in the negative resistance region during the transition to on state and this leads to the conclusion of fast phase change during SET process. Scanning Electron Microscopy (SEM) studies are performed on the chosen sample to study the structural changes at the time of switching. SEM studies on the switched Ge₁₅In₅Te₅₆Ag₂₄ sample has shown some morphological changes at the place of switching wherein it can be explained that a conducting crystalline channel is formed in the device when the device switches from high resistance to low resistance state. From these studies it can be concluded that the material may find its application in fast switching Non-Volatile Phase Change Memory (PCM) Devices.

Keywords : Chalcogenides, Vapor deposition, Electrical switching, PCM.
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