

レーザー照射による窒素含有 $\text{Cr}_2\text{Ge}_2\text{Te}_6$ 薄膜の相変化挙動

Pulsed Laser Induced Phase Transition in N-incorporated $\text{Cr}_2\text{Ge}_2\text{Te}_6$ Film

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Phase change materials (PCMs) have been widely applied in many fields such as non-volatile memory, neuromorphic devices and optical memory, etc. Among them, Ge-Sb-Te compound (GST) is the most mature one and has been used in several commercialized products such as DVD, and the Optane memory due to its excellent performance. However, there are still some problems remained in GST to be solved like high reset current for melting process and poor thermal stability due to the low crystallization temperature. Recently, our group developed a new PCM: $\text{Cr}_2\text{Ge}_2\text{Te}_6$ (CrGT), which can show a higher thermal stability and a faster switching speed than GST. [1] The resistance change in the CrGT upon phase transition is anomalous with the GST, where a higher resistance in the crystalline phase can be observed than the amorphous phase. The high resistive crystalline phase has been demonstrated to be able to reduce the Joule heating energy for amorphization process. Our group has reported that the phase change behavior of the CrGT can be controlled by N incorporation. With increasing N content, the inverse resistance change from low resistance amorphous to high resistance crystalline phase in the CrGT has changed to a conventional one from high resistance amorphous to low resistance crystalline phase. In the N incorporated CrGT film with N content of 6.5 at. %, the resistivity keeps nearly constant even after crystallization, while a three-order of magnitude of resistance change can be obtained in a NCrGT based memory device by Joule heating. The large resistance contrast of the NCrGT device is due to the contact resistance difference in the NCrGT/metal electrode interface upon phase transition.[2] Although the NCrGT is a promising candidate for the phase change electrical memory, there have been no systematic studies of N doping effect of the CrGT on the optical property. In this work, the effects of N incorporation on the optical properties and phase transition behaviors of the CrGT were investigated with spectrophotometer and static pulsed laser. A negative reflectance change upon crystallization can be found in N incorporated CrGT films in visible light range. This is different from the case in the pure CrGT showing a positive reflectance change. It was confirmed by pulsed laser measurements that the crystallization speed was faster in the N incorporated CrGT film than in the pure CrGT. The results obtained indicate the NCrGT has a high potential for the field of optical memory.

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[1] Hatayama et al., ACS Appl. Mater. Interfaces, 10 (2018) 2725.

[2] Shuang et al., Appl. Phys. Lett. 112(2018), 183504.