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Structural phase transition of $Ge_2Sb_2Te_5$ cells with TiN electrodes using homemade W heater tip

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In these days, wireless communication systems such as mobile telephony have been grown remarkably. The systems require new memory devices having features of low power consumption, fast read/write speed, nonvolatile, and high density. These requirements are a driving force to develop new nonvolatile memories. Phase change random access memory (PRAM) has been regarded as one of the most promising candidates for the wireless communication systems. Phase change random access memory (PRAM), based on the reversible phase change of the chalcogenide alloy, $Ge_2Sb_2Te_5$ (GST), is widely regarded as a favourite candidate for the next generation memory. The PRAM operation relies on the fact that chalcogenide-based materials can be reversible switched from an amorphous phase to a crystalline state by an external electrical current. So, it is important to study the electrical property according to set/reset cycles, since film thickness shrinkage occurs with the phase transition. In this study, the phase transitions of a GST cell with a volume of 20 x 20 x 0.1 μm^3 were carried out by applying a reset pulse (10V and 50ns) and a subsequent set pulse (5V and 300ns) in the SPM equipment using a homemade W heater tip First, commercial AFM tip was used for Joule heating for the phase transition of the GST cell. After several heating processes, the coated conductive layer separated from the Si tip, because of the thermal expansion coefficient mismatch between the adhesion layer and Si tip. This failure made it difficult to evaluate the *I-V* behaviors. So we fabricated the homemade W heater tip using the focused ion beam (FIB) lithography on the commercial AFM cantilever. The GST phase transformations according to the number of cycles were confirmed by measuring the *I-V* curves, the cross sectional transmission electron microscope (TEM) observations both before and after applying the programming pulse. The two order difference in the resistance value between the reset and set states was maintained for 10^5 reset/set pulse cycles. The electron diffraction pattern obtained from the transformed area clearly showed the amorphous state. It is expected that this experimental set-up can be used to evaluate the fatigue behavior of GST cells with reset/set pulse cycles.

Keywords: Phase Change Random Access Memory, Ge2Sb2Te5, chalcogenide, scanning probe microscope, phase transition behavior, homemade W heater tip

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Synthesis of Supersaturated Solid Solution in Immiscible Cu-Nb System by Mechanical Alloying

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Mechanical alloying(MA) by high energy ball mill of pure Cu and Nb powders was carried out under the Ar gas atmosphere. We have revealed that the supersaturated solid solution can be produced in the range up to CuxNb100-x (x=5-30) by MA for 120 hrs, as demonstrated by X-ray diffraction, DSC analysis and by the electronic studies through a change in the superconducting transition in the low-temperature specific heat. The Cu30Nb70 samples ball-milled for 120 hrs exhibit only a broad exothermic heat release. The total energy, ΔHt accumulated during MA for the mixture of Cu30Nb70 powders increased with milling time and approached the saturation value of 7.5 kJ/mol after 120 h of milling. It can be seen that the free energy difference between supersaturated solid solution and Cu30Nb70 powders is estimated to be 7 kJ/mol by Miedema et al. Hence it is thermodynamically possible to assume the formation of a supersaturated solid solution phase in this system.

Keywords: mechanical alloying, immiscible Cu-Nb system, supersaturated solid solution, total enthalpy, superconducting transition