Cu_2Sb 型 MnGaGe 規則合金薄膜の磁気特性の下地層依存性

孫銘嶺 [1,2], 窪田崇秀 [1,3], 伊藤啓太 [1,3], 高橋茂樹 [4], 園部義明 [4], 高梨弘毅 [1,3]
（東北大学金属材料研究所 [1], 東北大学大学院工学研究科 [2],
東北大学スピントロニクス学術連携研究教育センター [3], サムスン日本研究所 [4]）

Buffer layers dependence of magnetic properties for Cu_2Sb-type MnGaGe films

Mingling Sun [1,2], Takahide Kubota [1,3], Keita Ito [1,3], Shigeki Takahashi [4], Yoshiaki Sonobe [4] and Koki Takanashi [1,3]
(Institute for Materials Research, Tohoku University [1], Graduate School of Engineering, Tohoku University [2],
Center for Spintronics Research Network, Tohoku University [3], Samsung R&D Institute Japan [4])

Introduction

Memory industry is an indispensable part of the information society. In order to meet the upcoming 5G era, next generation memories must possess higher speed to be used as cache memory and greater capacity to be used as main memory. Magnetoresisitive random access memory (MRAM), a candidate of next generation memories, has attracted significant attention for its non-volatile attribute and high working speed. Nowadays, the latest semiconductor technology node is approaching to 7 nm. From the viewpoint of thermal stability, the magnetic anisotropy energy (K_u) of the materials which are used to deposit the electrodes of magnetic tunnel junctions must be high enough to make appropriate use of the latest nano-fabrication process. Therefore, the research and development of magnetic materials with high K_u are very crucial. Our group has been working on Cu_2Sb-type MnGaGe films. In our previous study, the saturation magnetization of 260 emu/cm^3 and K_u of 8.1×10^6 erg/cm^3 were found in our MnGaGe films deposited on MgO (100) substrates [1]. However, the poor squareness of magnetization curves and the relatively large orientation dispersions of MnGaGe layers were observed, showing that the orientation dispersion of MnGaGe layers are relatively large. In this presentation, we will report the optimizing experiments of MnGaGe films by using several buffer layers.

Experimental

All metallic layers were deposited by using an ultrahigh-vacuum magnetron sputtering system with a base pressure less than 4×10^{-7} Pa, and a MgO layer was deposited by using an electron beam evaporation system. The stacking structure of this work was MgO (100) substrate/buffer layer(s)/ MnGaGe (*t*)/MgO (2 nm)/Ta (5 nm). The layer thickness, *t*, was varied from 5 nm to 100 nm. MnGaGe layers were deposited by co-sputtering technique using a MnGa target and a Ge target. Different types of buffer layers such as Cr (60 nm), Cr (60 nm)/Pt (5 nm), Cr (20 nm)/Ru (40 nm) and Cr (60 nm)/MgO (2 nm) were used. After the deposition process, the samples were annealed in a stand-alone vacuum furnace. X-ray diffraction (XRD) measurements were carried out using the Bruker D8 Discover system, and magnetization curves were measured by a vibrating sample magnetometer at room temperature.

Results and discussions

From the XRD measurement results, we know that undesired 110 and 220 peaks appeared for all the annealed samples using single metal buffer layers. In contrast, samples using Cr/MgO hybrid buffer layer exhibited (001) orientation clearly. Neither 110 nor 220 peak appeared in the Cr/MgO samples after the annealing process. In addition, the squareness of magnetization curves and FWHM of the 001 diffraction were improved for the Cr/MgO samples.

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Reference

[1] M.-l. Sun, *et al., The 2019 Joint MMM-Intermag Conference*, **DH-09** (2019).