Magnetic properties of Ta/CoFeB/Ta junction fabricated by sputtering

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Magnetic Skyrmion is one of the candidates for novel information carrier in spintronics applications such as magnetic racetrack memories and logics [1,2]. Unlike conventional electric devices, utilize of Brownian-motion of Skyrmions for computation is also proposed and confirmed in Ta/CoFeB/Ta junction at room-temperature [3]. For the control of Skyrmions motion, voltage controlled magnetic anisotropy (VCMA) can be utilized [4]. In order to induce VCMA, diffusion of heavy metals(HMs) to magnetic layer by annealing is needed [5]. However, method to fabricate films possess both of Skyrmions and VCMA has not been clarified in Ta/CoFeB/Ta junctions. In this work, we investigated deposition and annealing condition dependence of magnetization and behavior of Skyrmions in Ta/CoFeB/Ta junctions. The combination of Brownian-motion and VCMA has possibility to realize ultra-low-power computing.

Ta/CoFeB/Ta/MgO/SiO_2 junctions were deposited on silicon substrates with oxide film using magnetron-sputtering technique. We varied sputtering power for the deposition of Ta insertion layer between CoFeB and MgO (Describe as LOW [75W] and HIGH-power [100W] Ta layer). In order to diffuse HMs to crystalized CoFeB layers, we performed post-deposition annealing in vacuum. The magnetization of films were measured using VSM. Skyrmions were observed by MOKE-microscope.

Figure 1 is MOKE-microscope images for the film with LOW-power Ta layer. We observed Skyrmions and Brownian-motion only in the film with LOW-power Ta layer. Figure 2 shows *M-H* curves of the films with Low and High power Ta layer. We found suppression of perpendicular magnetic anisotropy (PMA) in annealed films. Magnetic susceptibilities in annealed films around zero-field are 45.6 and 30.4 emu/cc/Oe in films with LOW and HIGH-power Ta layer respectively. This is the reason of no Skyrmions were observed in film with HIGH-power Ta layer. One possible explanation of this different PMA is difference of distribution of Ta in the junctions before annealing, which decides formation of magnetic dead layer while annealing. This research and development work was supported by the Ministry of Internal Affairs and Communications

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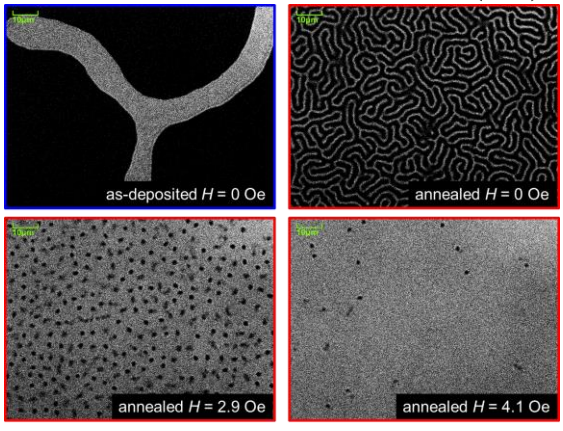

Figure 1 MOKE-microscope images of film with LOW-power Ta layer.

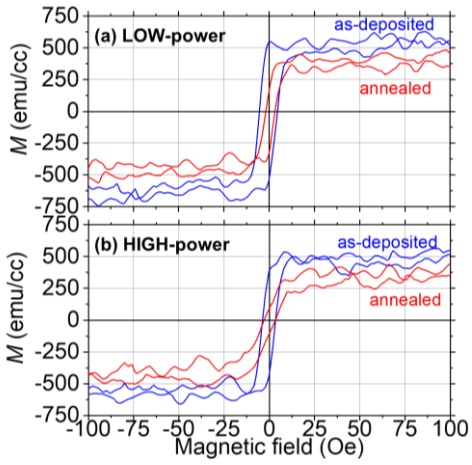

Figure 2 Magnetization curves of as-deposited and annealed films measured with out of plane external field at 300K.