Modification of Magnetic Properties in Garnets caused by Swift Ion Beam Irradiation

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Magnetic properties of garnet ferrites can be modified by swift ion beam irradiation due to the formation of amorphous beam tracks [1, 2, 3]. The diameter of the amorphous ion tracks, about 20 nm, is small enough for the wavelength of light and magnetostatic waves, therefore the modifications of magnetic properties caused by ion-beam irradiation can be used to fabricate functional magneto-optical devices.

We investigated the radiation effects of garnets and their potential for microfabrication. The swift ion beam was irradiated by the tandem accelerator at the Japan Atomic Energy Agency in Tokai. Magnetization hysteresis measurements and micromagnetic simulations were performed to reveal radiation effects on magnetization. By the ion beam irradiation, saturation magnetization monotonically decreases with increasing beam fluence, which is well explained by the ion-beam coverage model [1]. The simulations implied that the magnetization decrease could be classified into two categories depending on the beam fluence. One is the high fluence region, where the amorphous tracks are interconnected and the ferromagnetic region is fragmented. In this case, the magnetization curve of the irradiated garnet is strongly influenced by its crystal anisotropy [2, 3]. Another case is in the low fluence region; because the amorphous tracks are isolated, ion beam irradiation can be applied to micro-scale magnetization control without significantly degrading magnetic excitation.

Micro-scale magnetization patterning has also been demonstrated. Anti-dot structures with locally controlled magnetization were fabricated by masking the swift ion beam with a photoresist thicker than 15 μm (fig. 1). We will report the results of the excitation of magnetostatic waves in the samples.

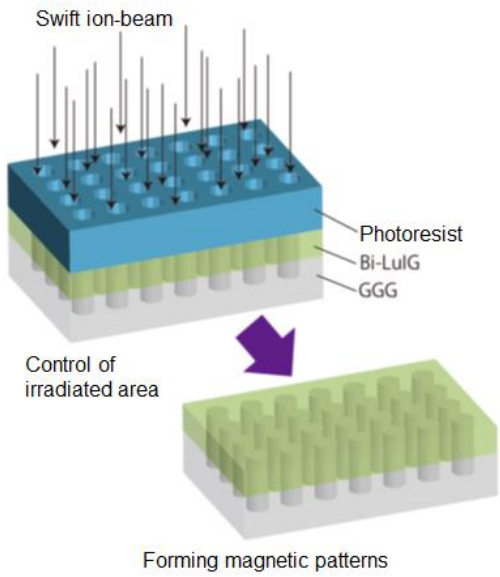

Figure 1. Schematic illustration of magnetization patterning by ion-beam irradation.

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