サブミクロン厚み単結晶磁気光学ガーネット絶縁体上薄膜基板の作製

Fabrication of a Sub-micron-thick Monocrystalline Magneto-optical Garnet Thin Film on Insulator Substrate

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Thin films of high quality materials on low-refractive-index clad layers and proper handling substrates are essential for exploring nanophotonics using conventional lithography processes, as represented by silicon-on-insulator (SOI) substrates for silicon photonics. The lack of magneto-optical (MO) counterparts of SOI substrates (namely MOOI substrates) seems to hamper the rapid progress of magneto-nanophotonics, despites its importance for non-reciprocal and topological photonic devices leveraging broken time reversal symmetry in MO materials [1,2]. Previously, we reported a preliminary result on the fabrication of a MOI substrate loading a high-quality monocrystalline yttrium iron garnet (YIG) layer using wafer bonding and grinding [3]. In this report, we discuss the fabrication of a MOI substrate with a sub-micron-thick MO layer by additionally employing a dry etching process, which allows for precise thickness control.

In the experiment, we firstly bonded a Bi-substituted YIG wafer (3×4 mm^2) with a thickness of 240 μm on a Si substrate using adhesive wafer bonding (Fig. 1a) with an intermediate spin-on-glass layer. The sample was then annealed in a vacuum chamber at a temperature of 150°C for 14 hours. Subsequently, physical grinding (Fig. 1b) was performed to thin down the bonded YIG layer to ~1.5 μm. Finally, we conducted dry etching (Fig. 1c) based mainly on Ar plasma for adjusting the thickness to around 770 nm. The thickness control was rather precise thanks to a slow and reproducible etching rate of 19 nm/min. Figure 2 shows a picture of the completed MOOI substrate. A variation of thickness and some scratches on the YIG surface can be found. Both are formed during grinding and thus can be largely mitigated by refining the corresponding process.

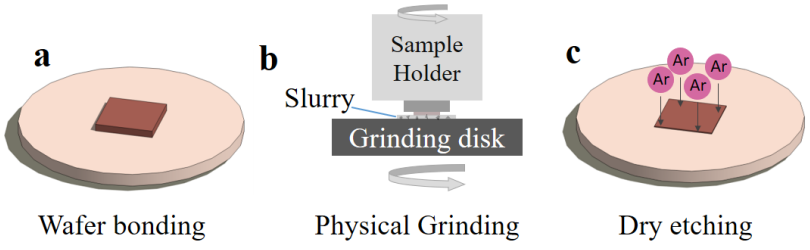

Fig.1. Fabrication process flow. a) Wafer bonding; b) Physical grinding; c) Dry etching

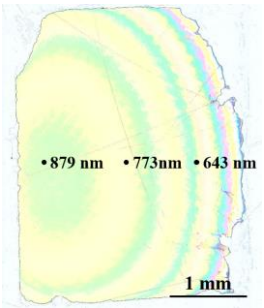

Fig. 2. Completed MOI substrate

Acknowledgements: The authors thank N. Nishiyama, W. Fang, J. Kwoen, N. Morais, M. Arita, S. Ishida and H. Yoshikawa for fruitful discussions. This work was supported by JSPS KAKENHI Grant-in-Aid for Specially Promoted Research (15H05700), KAKENHI (17H06138, 19K05300), NEDO, JST CREST(JPMJCR19T1), JST PRESTO (JPMJPR1863), Nippon Sheet Glass Foundation.

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