非局所配置におけるマグノン拡散長の温度依存性

Temperature dependence of magnon spin diffusion length determined by non-local magnon transport measurement

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Spintronics is new technology in which electron spins and charges are used simultaneously. In the field, magnons play a central role because they can convey spin information through magnetic insulators over a μm distance [1, 2]. Therefore, the characteristic length scale of the magnon transmission is an important quantity for spintronic devises. In this study, we systematically measured temperature dependence of the magnon spin diffusion length in a magnetic insulator and found a rapid increase of the magnon spin diffusion length below 100 K.

The magnon spin diffusion length is determined by using a non-local magnon transport measurement [2]. The setup for non-local magnon transport measurement is shown in Fig.1. Two electrically isolated Pt stripes were made on a magnetic insulator yttrium iron garnet (YIG) substrate using a conventional EB-lithography process. When a charge current is applied to one of the Pt stripes, magnons are created in YIG by the spin Hall effect in the Pt. These magnons carry spins in YIG and give rise to a non-local voltage at the other Pt stripe owing to the inverse spin Hall effect. This magnon transmission can be described by the magnon diffusion equation derived in the reference [2]. We estimate the magnon spin diffusion length from the non-local signals at various temperatures. We found that the magnon spin diffusion length increases up to 23.6 μm at 50 K (Fig. 2).

[1] Y. Kajiwara, K. Harii, S. Takahashi, J. Ohe, K. Uchida, M. Mizuguchi, H. Umezawa, H. Kawai, K. Ando, K. Takanashi, S. Maekawa, and E. Saitoh, Nature 464, 262–266 (2010).

[2] L. J. Cornelissen, J. Liu, R. A. Duine, J. Ben Youssef, and B. J. van Wees, Nature Physics 11, 1022 (2015).

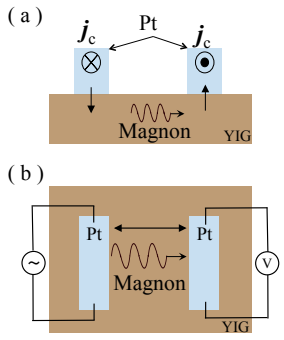

Fig. 1. Schematic illustration of the experimental setup. (a) Side view. (b) Top view.

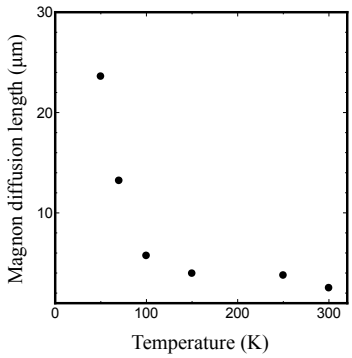

Fig. 2. Temperature dependence of the magnon spin diffusion length.