

The study on spin-orbit torque using metallic disordered atomic structure of metallic glass

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Large spin-charge conversion in metastable disordered atomic structure of metallic glass was reported recently ^[1]. The anomalous temperature dependence of inverse spin-Hall effect can be explained by the phonon skew scattering contribution due to the nature of metastable atomic structure. However, charge-spin conversion as well as spin-orbit torque using metallic glass has never been studied so far. In this study, we focused on spin-orbit torque using Pd-Si binary alloy metallic glass which is known to show large glass forming ability.

Figure 1 shows schematic illustration of this study. Spin current generated by charge-spin conversion in nonmagnetic metallic glass layer injects into ferromagnetic layer and exerts spin-orbit torque. Spin-orbit torque ferromagnetic resonance measurement was performed to evaluate charge-spin conversion efficiency quantitatively. Figure 2 shows typical ferromagnetic resonance spectrum observed for Si / SiO₂ sub. / Pd-Si (5) / Ni-Fe (4) / Al₂O₃ (3) sample (thickness is in nm). The signal is fitted by summation of symmetric and anti-symmetric Lorentzian function as shown in solid curves in the figure. Effective spin-Hall angle was evaluated to be 0.20 ± 0.03 , which is obtained by modulation of ferromagnetic resonance linewidth induced by direct current. Charge-spin conversion efficiency is found to be enhanced by a factor of ~ 10 compared with Pd, whereas electrical resistivity is increased by a factor of only ~ 3 . Detailed experimental results will be discussed in the presentation.

- [1] W. Jiao, D. Z. Hou, C. Chen, H. Wang, Y. Z. Zhang, Y. Tian, Z. Y. Qiu, S. Okamoto, K. Watanabe, A. Hirata, T. Egami, E. Saitoh, and M. W. Chen, arXiv:1808.10371.
[2] S. Iihama, Y. Koike, Z. Lu, K. Watanabe, M. W. Chen, and S. Mizukami, submitted

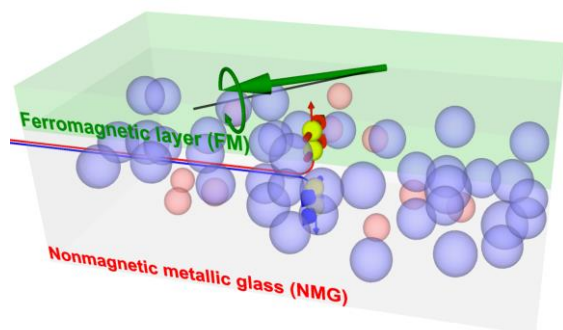


Fig. 1. Schematic illustration of spin-orbit torque in ferromagnet / nonmagnetic metallic glass bilayer.

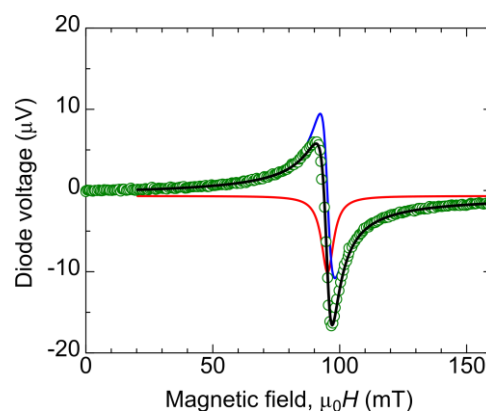


Fig. 2. Typical spin-orbit torque ferromagnetic resonance spectrum observed for Pd-Si nonmagnetic metallic glass / Ni-Fe bilayer.