Generation of Large Spin Accumulation in S/N/S Josephson Junctions

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Spintronics is a significant research field in terms of both fundamental physics and its applications. Spin accumulation is a key physical quantity since it is equivalent to a local magnetic field. It can thus be possible to modulate superconducting phases by generating a large spin accumulation in superconductors. However, the spin accmulation signals obtained in previous studies are not sufficient to achieve such modulation. Therefore the enhancement of the spin accumulation is indispensable.
In this work, we attempt to enhance the spin accumulation in $Ni_{81}Fe_{19}$/Cu lateral spin valve structures, to apply for inducing the superconducting phase transition. By inserting the MgO insulating layer in between $Ni_{81}Fe_{19}$ and Cu, the spin accumulation signal is found to be enhanced by a factor of ten compared to the Ohmic case and reaches 10 μV at 10 K. The spin diffusion length of Cu at 10 K becomes 1.3 μm, twice larger than the previous study of $Ni_{81}Fe_{19}$/Ag lateral spin valves[1]. With increasing the interface resistance furthermore, on the other hand, the spin signal exponentially decreases. This can be explained by the large reduction of the spin polarization of the insulating layer. We will also show some results of the spin current injection with such a large spin accumulation into S/N/S Josephson junctions and discuss effects of spin accumulation on supercurrents and a possibility to induce a $0-\pi$ transition.

[1]Y. Fukuma, L. Wang, H. Idzuchi and Y. Otani, Appl. Phys. Lett. **97**, 012507 (2010).