Crystal orientation dependence of the spin current transmission in single crystalline NiO thin films

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Spin current transmission in antiferromagnetic materials is one of the intriguing phenomena in the emerging antiferromagnetic spintronics [1]. We previously investigated the spin current transmission in a polycrystalline NiO by means of the spin pumping effect and estimated the spin propagation length λ_{NiO} to be 22±3 nm [2]. In this work, we prepared single crystalline NiO thin films with various crystal orientations and investigated the crystal orientation dependence of the spin current transmission.

NiO (t_{NiO}) / $Fe_{20}Ni_{80}$ (5) / SiO_2 (5) (unit: nm) multilayers were deposited on an Al_2O_3 (0001) and a MgO (001) substrate by magnetron sputtering. From the XRD and RHEED images, the NiO films were found to be epitaxially grown with (111) and (001) orientation on the Al_2O_3 (0001) and the MgO (001) substrates, respectively. Ferromagnetic resonance (FMR) measurements were performed by the homodyne detection technique [3]. FMR spectra were taken at room temperature by sweeping an external field with a fixed frequency. The Glibert damping constant α is estimated from the FMR spectra. We focus on the enhancement of α due to the spin pumping effect with respect to the NiO thickness, which reflects the spin transmission in NiO [2]. α is plotted as a function of NiO thickness (Fig. 1) for (111) and (001) epitaxially grown NiO films. The asymptotic fitting based on the spin pumping model [4] results in λ_{NiO}=68±10 nm for the NiO (111). On the other hand, for NiO (001), α does not change much in the measured thickness range, which may suggest λ_{NiO} could be gigantic. Furthermore, in order to assure that spin current passed through the NiO layer, the enhancement of α in Pt/NiO/Py trilayer thin films was also investigated. The details will be discussed in the talk.

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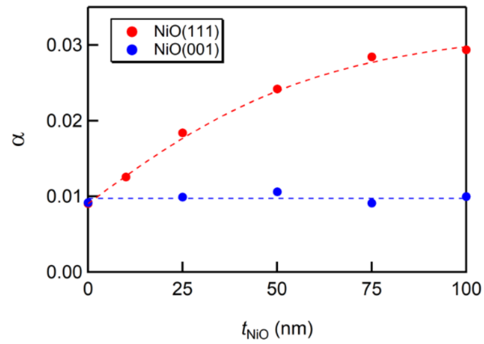

Fig. 1. α as a function of t_{NiO} in single crystalline NiO