# Spin dissipation in strained NiO (110) film

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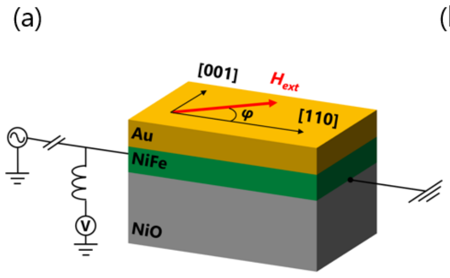
Making uniform magnetic domain in antiferromagnets is one of the issues in antiferromagnetic spintronics because the directions of the magnetocrystalline anisotropy are generally degenerate due to the crystalline symmetry [1-3]. For instance, in NiO having the NaCl type crystalline structure, the four (111) planes can form four different possible magnetic domains (T-domains) [4]. Recent studies on NiO (111) epitaxial films imply that the degeneracy of T-domains is broken possibly due to epitaxial strain [5,6]. In this study, we investigated the magnetic domain controlled by the breaking crystalline symmetry due to epitaxial strain. Quenched magnetic domains were characterized by spin dissipation measurement using the spin pumping effect [7].

Multilayers of NiO($t_{\mathrm{NiO}}$ = 0, 50 nm)/$Ni_{80}Fe_{20}$(5 nm)/Au(5 nm) were formed on a MgO (110) substrate using magnetron sputtering. Epitaxial growth of NiO (110) was confirmed by reflection high-energy electron diffraction (RHEED) and X-ray diffraction (XRD). Out-of-plane lattice parameter of NiO (220) was found to be compressed comparing to the bulk value [8]. Fig. 1(a) shows experimental setup for the spin dissipation measurement using the spin pumping effect. Fig. 1(b) shows the Gilbert damping constant $\alpha$ benchmarking the spin dissipation as a function of in-plane magnetic field angle $\varphi$. $\alpha$ is found to have maxima near $\varphi$ = 90 and 270° in the sample with $t_{\mathrm{NiO}}$ = 50 nm, while there is no appreciable variation in the control sample with $t_{\mathrm{NiO}}$ = 0 nm. This suggests that two of the four T-domains in which the Néel vectors are oriented at $\varphi$ = 0 and 180° are selectively emerged because the spin dissipation should be smallest when the Néel vector and the spin polarization of the pumped spin are collinear to each other. In the talk, we discuss the detail relationship among the strain, the crystalline symmetry, and the quenched magnetic domains.



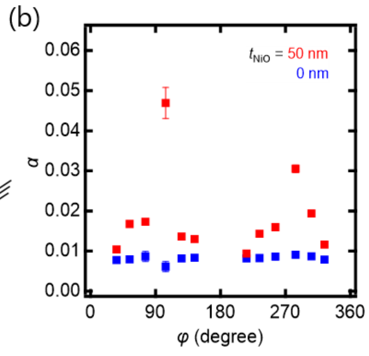




**Fig. 1**(a) Schematic illustration of the spin dissipation measurement . (b) The Gilbert damping constant $\alpha$ as a function of in-plane magnetic field angle $\varphi$ for NiO ($t_{\mathrm{NiO}}$ = 0, 50 nm)/$Ni_{80}Fe_{20}$ (5 nm)/Au (5 nm).

[1] H. Yan et al., Nat. Nanotech. **14** 131 (2019). [2] K. Kjærnes et al., Phys. Rev. B **103**, 224435 (2021).
[3] T. Higo et al., Nature **607**, 474 (2022). [4] D. Spanke et al., Phys. Rev. B **58**, 5201 (1998).
[5] T. Moriyama et al., Sci. Rep. **8**,14167 (2018). [6] T. Ikebuchi et al., Appl. Phys. Express **14**, 123001 (2021).
[7] T. Moriyama et al., Phys. Rev. Lett. **119**, 267204 (2017). [8] Z. Feng et al., J. Appl. Phys. **70**, 6161 (1991).