作成者：Nguyen Thi Van Anh（東北大CSIS）

研究プロジェクト名：　Investigation of efficient charge-spin conversion in the non-magnetic/ferromagnetic stack films

概要： This study focuses on the investigation of efficient charge-spin conversion in the non-magnetic/ferromagnetic (NM/FM) stack films with various NM materials such as the oxides. In particular, the relationship between the efficiency for conversion and the static and dynamic magnetic properties such as the magnetic anisotropy and the damping constant will be investigated under the control of the interfacial conditions. The achievements here would contribute to the realization of new concepts of spintronic devices.

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期待される研究成果：

The investigation of efficiency for charge-spin conversion in NM/FM stack films and its relationship with the static and dynamic magnetic properties would be beneficial for both device applications, and the designing of guidelines for researches on next-generation energy-saving spintronic devices.

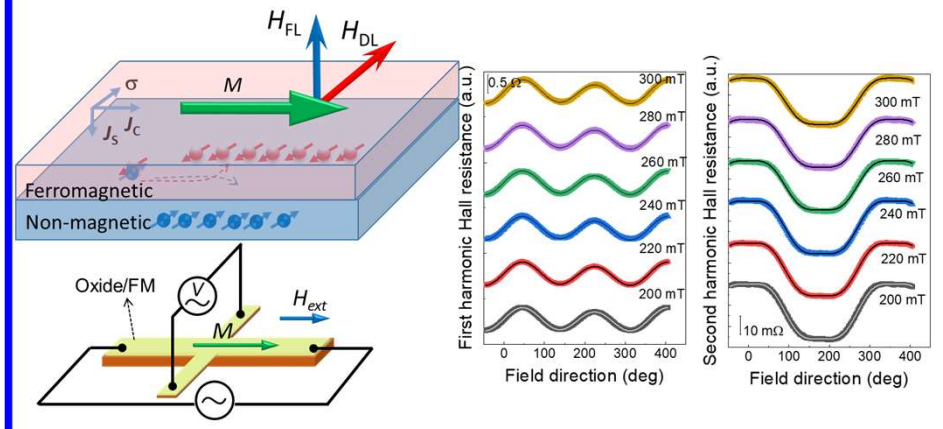

Fig. 1: Harmonic Hall measurement for a NM/FM heterostructure to evaluate the efficiency of the charge-spin conversion.

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概要：　Spin-orbit torque induced magnetization switching in oxide/ferromagnetic stacks has attracted immense interest owing to its potential for the development of high-performance spintronic devices, realized by tuning the surface oxidization. Since both of the Slonczewski-like (H_{SL}) and the field-like (H_{FL}) effective fields would contribute to the magnetization reversal, a detailed understanding and manipulation of H_{SL} and H_{FL} in these structures are necessitated. This request has been shown in this study for a typical Ta-O/Co-Fe-B stacks, which would be beneficial for spintronic device applications.

研究成果（実施状況）：　Using the Harmonic Hall measurement, H_{SL} and H_{FL} for Ta-O/Co-Fe-B stacks with different Ta-O thickness ($t_{Ta\text{-}O}$) were evaluated. Fig. 1 shows that both of $|H_{SL}/I|$ and $|H_{FL}/I|$ increase and converge to a certain value as $t_{Ta\text{-}O}$ increases. Moreover, $|H_{FL}/I|$ is higher than $|H_{SL}/I|$. These results suggest the contributions of both of the bulk and interfacial effects to the magnetization reversal process of this system. This research would be important for designing spintronic devices, and opening the guidelines for next researches on oxide-based spintronics.

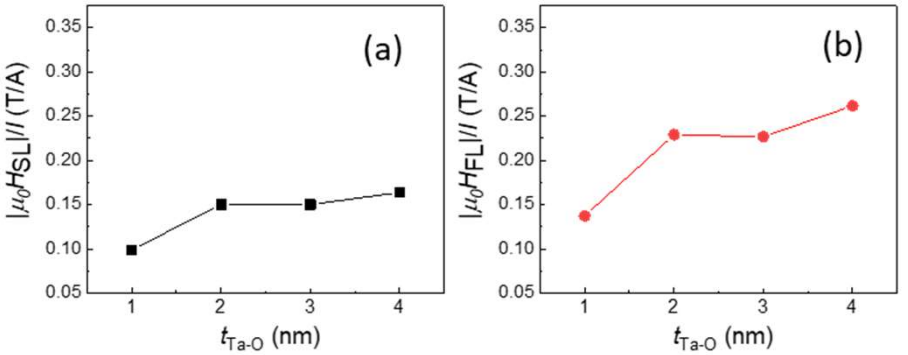

Fig. 1: $t_{Ta\text{-}O}$ dependence of $|\mu_0 H_{SL}|/I$ (a); and $|\mu_0 H_{FL}|/I$ (b).

主要発表論文等： [1] T. V. A. Nguyen et al., Abstract for 81th JSAP Autumn Meeting, 2020; [2] Abstract for 68th JSAP Spring Meeting (2021) .他

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概要： To understand the charge-spin conversion in Ta(O)/Co-Fe-B bilayer films with the different levels of the oxygen incorporation into the Ta(O) layer, we studied the corresponding changes in the dynamic magnetic properties under both in-plane and out-of-plane magnetic fields using ferromagnetic resonance measurement technique. The spin-orbit torque (SOT) induced magnetization switching in Ta(O)/Co-Fe-B bilayer films was investigated by using extended harmonic Hall measurement.

研究成果（実施状況）： Dynamic magnetic properties of Ta(O)/Co-Fe-B bilayer films are strongly influenced by the oxidation condition of the Ta(O) layer. In Fig. 1 (a), a slight change of the oxygen incorporation into the Ta-O layer would decreases the in-plane and out-of-plane damping constants (α_{IP} and α_{OP}). Fig. 1 (b) shows the current density dependence of the SOT effective fields (H_{SL}, H_{FL}) in different bilayers with different oxidation condition and various thicknesses of the Ta(O) layer. These results suggest that it is possible to control the SOT effective fields by tuning the oxygen incorporation into the Ta(O) layer.

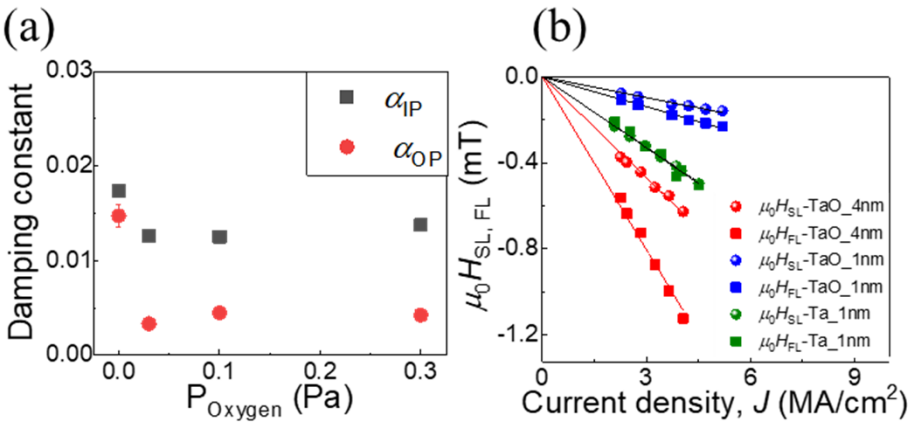

Fig. 1: (a) Oxygen pressure dependence of α_{IP} compared with α_{OP}. (b) Current density dependence of the SOT effective fields (H_{SL}, H_{FL}).

主要発表論文等： [1] T.V.A. Nguyen et al., AIP Advances, 12, 035133 (2022).
[2] T.V.A. Nguyen et al., IEEE International Magnetics Conference, 2021.