Control of Magneto-Elasticity in Magnetic Thin Films

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Flexible spintronics has opened new avenue to promising devices and applications in the field of wearable electronics. Particularly, miniaturized strain sensors exploiting the spintronic function have attracted considerable attention, in which the magnetoelasticity linking magnetism and lattice distortion is a vital property for high-sensitive detection of strain.
In this talk, we will introduce our recent research activity for controlling the magneto-elastic properties of the magnetic thin film. First, we share the topics of the magnetostriction for Fe-Ga epitaxial thin films grown on the different substrates [1]. Fe-Ga is one of the representative materials exhibiting the large magnetostriction in the bulk form. We investigated the magnetostriction values for the Fe-Ga epitaxial thin films employing the optical cantilever method, and our results clearly indicated that large magnetostriction comparable to the bulk values can be achieved even in the thin film form. At the same time, it was confirmed that optical cantilever method we employed is reliable.
Then, we show the demonstration that the magnetoelastic properties of Fe_4N can be significantly varied by partially replacing Fe with Co or Mn. The high quality Fe_4N film exhibits large negative magnetostriction along the [100] direction (λ_{100}) of -121 ppm while $Fe_{3.2}Co_{0.8}N$ shows λ_{100} of +46 ppm. This wide-range tunability of λ_{100} from -121 to +46 across 0 allows us to thoroughly examine the correlation between the magnetoelasticity and other magnetic properties. We experimentally find the strong correlation between λ_{100} and magnetic damping (α). The enhanced extrinsic term of α is attributable to the large two magnon scattering coming from the large magnetostriction. In addition to the systematic experiment, we carried out the first-principles calculation, which indicates that the density of states at the Fermi level plays a primal role to determine both λ_{100} and the intrinsic term of α. Thanks to the giant tunability and the bipolarity of magnetoelasticity, magnetic nitrides are candidate materials for high-sensitive spintronic strain sensors [2].

The studies shown here were done in collaboration with Prof. Yasushi Endo, Mr. Hao Ding, Prof. Koki Takanashi, Dr. Ivan Kurniawan, Dr. Yoshio Miura, and Prof. Yusuke Shimada.

References

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