Spin-lattice coupling in yttrium iron garnet studied by neutron scattering under ultrasound injection

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In yttrium iron garnet YIG [1], spin current has been observed as a spin Seebeck effect under a temperature gradient [2] and ultrasound injection [3,4]. The neutron scattering on a YIG single crystal under ultrasound injection has been performed using near backscattering TOF spectrometer DNA (BL02) with high energy resolution to observe the spin pumping effects. The magnetic Bragg peak at (220) was enhanced with decreasing temperature. Because the lattice vibration enhances the magnetic Bragg peak, the enhancement is expected to closely relate to the spin-lattice coupling. An observed sharp drop above 100 K in the longitudinal mode suggests the degradation of the spin-lattice coupling. It is consistent with the suppression of the spin Seebeck effect (spin current generation by thermal gradient) with increasing temperature above 100 K [5], proving the degradation mechanism by the spin-lattice coupling. The temperature dependence may be the origins of the other anomalies observed in YIG [6, 7]. In addition, the energy-width of the magnetic Bragg peak increases proportionally to the square root of the sample temperature increase induced by the ultrasound injection. The estimated effective mass based on a liquid model becomes light when magnetic domain walls are removed under a magnetic field [8].

References

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