Preface

Spintronics, the research field at the intersection of magnetism and transport phenomena in solids, continues to churn out new physical phenomena and functionalities that often find industrial applications. The present Special Topics collection focusses on recent breakthroughs in the spintronics with ferrimagnetic materials, complex compounds that contain magnetic moments of different sizes or numbers that carry a finite magnetization although antiferromagnetically coupled. In 1948, Louis Néel discovered ferrimagnetism in ferrites (mainly Fe_2O_3) and coined the name. Most ferrimagnets are electrical insulators such as yttrium iron garnet (YIG), which is widely used in industry for microwave and magneto-optical applications. Ferrimagnetic rare earth-transition metal alloys are good metals, whereas the conductivity of magnetite (Fe_3O_4), another typical ferrite material, strongly depends on the temperature.

Ferrimagnetic materials combine the advantages of both the "controllability" of ferromagnets and the "fast dynamics" of antiferromagnets. External parameters such as the temperature can tune the relative magnetization of the antiparallel sublattices such that the total magnetization or angular momentum vanishes. This unique phenomenon of "compensation" and the associated fast magnetization dynamics have attracted much attention by the spintronics community.

For the present Special Topics collection, we solicited contributions to cover a wide range of methods, phenomena, and materials that represent spintronics research on ferrimagnetic materials. On the theory side, Barker et al. summarize an atomistic simulation method for the magnetic excitations of complex magnets at finite temperatures, whereas Nakata et al. present a theory of magnon transport including the topological Hall effect. Nambu et al. report a study of magnons in YIG by polarized inelastic neutron scattering. Chudo et al. focus on the angular momentum compensation temperature as measured by the Barnett effect and nuclear magnetic resonance. Sheng et al. address microwave and current-induced magnon transport phenomena induced in thin film devices based on iron garnets. Zhou et al. observe fast magnetization dynamics near the magnetic compensation point induced by electric currents in ferrimagnetic metals, whereas Avci focuses on the electrical control of magnetic excitations in the bilayers of ferrimagnetic insulators and heavy metals. Stupakiewicz et al. and Iihama et al. determine fast magnetization dynamics in the ultrafast magneto-optical response in ferrimagnetic insulators and in metals, respectively. Suemasu et al. report progress in the fabrication of rare earth-free ferrimagnetic Mn_4N films. Tanabe et al. determine that the electric voltages induced by magnetization dynamics are enhanced in nearly compensated ferrimagnetic GdFeCo alloys.

The Special Topics issue provides a snapshot of the research frontiers in a vibrant field. We hope that the collection provides a useful overview for the specialists and stimulate researchers in neighboring fields to contribute their expertise and help determining technological applications for fascinating new physical phenomena.

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