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Spatiotemporal Imaging of Gigahertz Frequency Magnetization Dynamics Using the Time Resolved Anomalous Nernst Effect[1] JASON BARTELL, DARRYL NGAI, ZHAOQI LENG, G.D. FUCHS, Cornell University —
We report on the first demonstration of spatiotemporal magnetic microscopy based on the Time Resolved Anomalous Nernst Effect (TRANE). In TRANE microscopy, pulsed laser light is used to create a transient thermal gradient perpendicular to the film plane. The anomalous Nernst effect generates a corresponding transient electric field that is proportional to the cross product of both the thermal gradient and the in-plane projection of the magnetic moment. We demonstrate TRANE microscopy and use it to study the magnetic configuration and excited magnetization dynamics of patterned ferromagnetic structures. We show that the time resolution exceeds 30 ps, allowing measurement of dynamics above 16 GHz. We observe that the spatial resolution using a thermal gradient generated from focused light matches the optical diffraction limit, indicating that lateral thermal diffusion does not limit resolution. Numerical simulations of the time-dependent thermal gradient indicate that the thermal spot can be confined to nanoscale dimensions using, for instance, a plasmon antenna. This could allow TRANE microscopy to achieve bench-top imaging of magnetization with spatial resolution comparable to the domain wall width and temporal resolution in the GHz range.

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