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Domain Wall Motions in Ferromagnetic Thin Film Induced by Laser Heating Pulse

Hyun Soon Park*

Department of Materials Science and Engineering, Inha University, Incheon 22212, Korea

*Correspondence to:
Park HS,
https://orcid.org/0000-0002-1039-7334
Tel: +82-32-860-7533
Fax: +82-32-862-5546
E-mail: hsparkinha@inha.ac.kr

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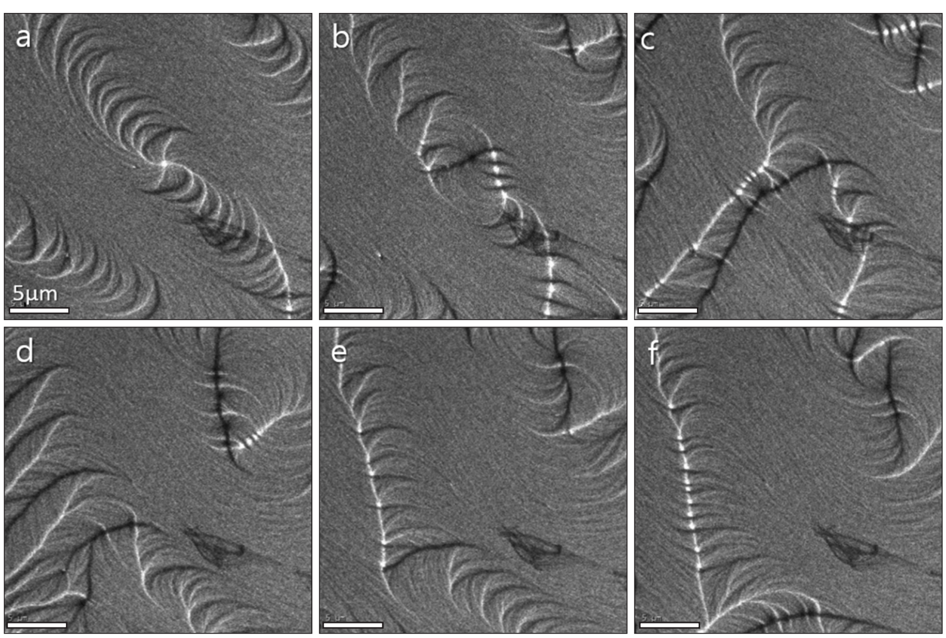
Soft ferromagnetic materials are utilized for various electromagnetic devices such as magnetic recording heads and magnetic shielding. In situ observation of magnetic microstructures and domain wall motions are prerequisite for understanding and improving their magnetic properties. In this work, by the Fresnel (out-of-focus) method of Lorentz microscopy, we observe the domain wall motions of polycrystalline Ni/Ti thin film layers triggered by single-shot laser pulse. Random motions of domain walls were visualized at every single pulse.

Key Words: Lorentz microscopy, Ferromagnetic thin film, Domain wall, Laser heating pulse, TEM



Domain wall motions (Chikazumi, 1997) were *in situ* observed by Lorentz microscopy (Caltech's second-generation ultrafast electron microscope: Zewail et al., 2010). Polycrystalline thin film layers of Ni on Ti (30 nm/30 nm) were deposited sequentially by electron beam evaporation onto a Si_3N_4 membrane (15 nm thick, 0.25×0.25 mm^2 window). To trigger the domain wall motions,

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single-shot laser pulse of about 0.24 μJ (Q-switched Nd:YAG laser at 532 nm) was applied to the specimen. The laser pulse was estimated to be 50 μm full-width-at-half-maximum Gaussian spot size. Lorentz microscopy images were taken under the over-focused condition (+4 μm) in low magnification mode with the main objective lens turned off. In the over-focused condition, domain walls (DWs) appear as white and black lines depending on the sense of rotation of the magnetization. Applying every single heating-pulse (a~f), the domain walls (cross-tie walls, vortex, magnetic ripples) were changed severely because of soft magnetic properties, meaning that the domain wall motions are irreversible. To make the domain wall motions reversible, we need to control the sample dimension, laser fluences, magnetic properties (Graef et al., 2001; Lee et al., 2017; Park et al., 2010).

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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