Formation of self-organized periodic nano-structures by an intense pulse of femtosecond EUV laser

Thanh-Hung Dinh, Masahiko Ishino, Yoshiteru Yonetani, Toshiyuki Kitamura, Noboru Hasegawa, and Masaharu Nishikino

National Institutes for Quantum and Radiological Science and Technology, Kizugawa, Kyoto, Japan
dinh.thanhhung@qst.go.jp

The interaction of a solid material with focused, intense pulses of x-ray radiations creates a strong electronic excitation state within an ultra-short time and on ultra-small spatial scales. Although the dynamic response of solid to such a nano-excitation has a great application potential for material processing, it is far from being fully understood due to lack of experimental tools (e.g. light sources, detection techniques) precise enough to operate at the relevant temporal and spatial scales [1]. In this study, we benchmark a macroscopic experimental result against microscopic theoretical approaches, revealing features of the nano-excitation in silicon-based material. We found the periodic nano-features can be created at the interaction region by focusing one pulse of extreme ultraviolet (EUV) irradiation from the SACLA free electron laser. Numerical calculation suggests that formation of these nano-features is attributed to a collective motion obeying the Gross-Pitaevskii equation. Our result contribute to modeling the physics process of ultra-short pulse x-ray – matter interaction.

[1] T. –H. Dinh et al., *Commun*. *Phys*. **2019**, *2*, 150.