

Investigation of material science with high intensity ultrafast laser

ICR Kyoto Univ.¹, Masaki Hashida¹, and Shunsuke Inoue¹

E-mail: hashida @laser.kuicr.kyoto-u.ac.jp

The plasma produced by high intensity ultrafast lasers can generate radiations such as photons (THz waves, x-rays, lights), electrons, and ions, which are high potential as the quantum beam sources to explore structures and compositions of materials in the field of material science. As a pump for material processing, an intense THz wave is used for in-situ measurement for periodic surface structures induced by terahertz waves on solid materials with high-spatiotemporal resolution. The periodic surface structures can be generated on metal surfaces irradiated with intense terahertz waves at fluences slightly higher than the ablation threshold. The periodicity of the periodic structures can be as small as $\lambda/25$ for the wavelength of terahertz wave[1]. We have studied intense THz waves generated from argon cluster plasmas interacted with high intensity ultrafast laser and reported the mechanisms of THz wave generation[2]. By employing the irradiation of noncollinear double-pulse beams to argon clusters, a significant improvement of the characteristics (directionality, angle-controllable linear polarization, and energy enhancement) of THz waves have been offered[3].

As a probe for material science, electrons have relatively larger cross section of elastic scattering for atoms than that for x-rays. We have developed a short pulsed electron beam with laser accelerated electron pulses to demonstrate an ultrafast electron diffraction (UED). For the developed UED, laser accelerated electron pulses have been compressed by a phase rotator composed of two dipole and quadrupole magnets, and single shot imaging of diffraction has been demonstrated [4][5]. The electron pulse duration of 89fs has been estimated by scattered electrons with intense laser pulses. The short pulsed electron beam might be applied not only for UED but also for detecting the surface waves induced in the laser plasma. We have planned to detect the surface waves induced by THz waves with using ultrafast electron beam. The surface wave might be related to formation of periodic surface structures.

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