

Advanced Research Center for Beam Science - Laser Matter Interaction Science -

<http://laser.kuicr.kyoto-u.ac.jp/e-index.html>



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Dr TILLACK, Mark University of California, USA, 11 October 2007

Scope of Research

By making the physics of interaction between femtosecond laser and matters clear, possibility for new applications is being developed in such as laser processing and laser nuclear science. The interaction of femtosecond laser and matter differs from that of nanosecond laser in physics such as ionization and ablation process. Soft-ionization and ablation by the femtosecond laser can be applied to mass spectrometry and nano-scale structural formation and matter reforming, respectively. In addition, with the progress of short pulse lasers, even a small-sized equipment can create ultra-high optical field. In this strong electromagnetic field the motion of an electron becomes relativistic, and the electron is accelerated easily above MeV, emitting high energy pulse x-ray and ions. Laser produced radiation has the feature such as impulse, a point source and high intensity, and its potential to the new radiation source is expected. In our laboratory physics of intense laser matter interactions and its application are researched.

Research Activities (Year 2007)

Publications

Hashida M, Shimizu S, Sakabe S: Carbon Nanotubes Cathode Modified by Femtosecond Laser Ablation, *Journal of Physics: Conference Series*, **58**, 487-491 (2007).

Tokita S, Kawanaka J, Izawa Y, Fujita M, Kawashima T: 23.7-W Picosecond Cryogenic-Yb:YAG Multipass Amplifier, *Optics Express*, **15**, 3955-3961 (2007).

Presentations

Femtosecond Laser Ablation of Polytetrafluoroethylene, Hashida M, Mishima H, Shimizu S, Sakabe S, 27th Annual Meeting of The Laser Society of Japan, Miyazaki, 17-18 January 2007.

The Amount of Electrons Emitted from Solid Metal Plasmas Generated by Pulsed Laser, Masuno S, Hashida M, Sakabe S, 27th Annual Meeting of The Laser Society of Japan, Miyazaki, 17-18 January 2007.

Nano-ablation of Material with Femtosecond Laser Pulses, Hashida M, Shimizu S, Sakabe S, Research Meet-

ing of the Japan Society of Plasma Science and Nuclear Research, Kyoto, 9 March 2007.

Prospect of Femtosecond Laser Processing, Hashida M, Laser Expo 2007, Yokohama, 25-27 April 2007.

Progress of Intense Short Pulse Lasers and Their Applications, Sakabe S, Optical Society of Japan, Lecture Meeting, 22 June 2007, Kyoto Japan. (Invited)

Mechanism of Femtosecond Laser Ablation of Polytetrafluoroethylene, Hashida M, Mishima H, Shimizu S, Tokita S, Sakabe S, The 3rd Meeting of Japan Intense Light Field Science Society, Osaka, 18 July 2007.

Femtosecond Laser Ablation of Polytetrafluoroethylene, Hashida M, Mishima H, Shimizu S, Tokita S, Sakabe S, The 68th Annual Meeting of the Japan Society of Applied Physics, Hokkaido, 4-8 September 2007.

Highly-efficient Low-repetition-rate Mode-locked Cryogenic Yb:YAG Laser, Tokita S, Kawanaka J, Fujita M, Kawashima T, Hashida M, Sakabe S, Izawa Y, The 68th Annual Meeting of the Japan Society of Applied

Femtosecond Laser Nano-ablation of Polytetrafluoroethylene

Laser ablation experiments were performed on polytetrafluoroethylene (PTFE, C_2F_4) with short pulse generated from T^6 laser system. Ablation threshold of PTFE was investigated from the crater surface diameter dependence on the laser fluence. It was found that the ablation threshold was approximately proportional to pulse duration to the power 0.39 in the range of 130fs-400ps. The released ions upon ablation were detected by time of flight mass spectrometer (TOF-MS) with 130fs and 400ps. The difference was shown in detected ions energy spectrum and maximum energy of C^{3+} between two pulses. It was suggested that the ablation of organic polymer such as PTFE might be due to coulomb explosion.

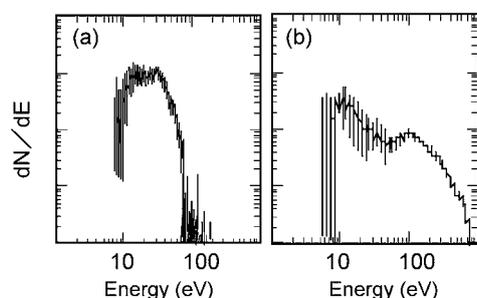


Figure 1. Energy spectra of detected ions. (a) 130fs, $0.78J/cm^2$, (b) 400ps, $40J/cm^2$.

Upgrade of the T^6 Laser System

The T^6 -laser has been operated for the study of laser-matter interaction physics and its applications since 1987 (since 2004 at ICR), and lots of fruits were obtained by not only our laboratory members but also the collaboration with another universities and industrial enterprises. For future more advanced research complete renovation and upgrade of the laser system was done through June–September, 2007. The upgraded points are (1) higher stability of output energy, (2) stable protection of front-end stage from backward-reflected light from laser-matter interaction, (3) more safety for the laser users, and (4) more convenience of pulse monitors for users. Especially for the point (1) the highest stability has been achieved in our knowledge. (The detail will be published and patented in 2008). Here the system configuration is briefly described. Figure 2 shows a schematic of the T^6 laser system which consisted of four-pass pre-amplifier, four- and five-pass power amplifiers.

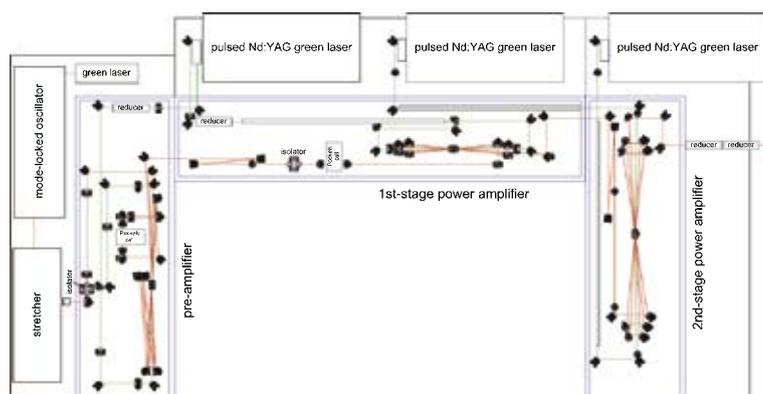


Figure 2. Schematic of the upgraded T^6 laser system.

Physics, Hokkaido, 4–8 September 2007.

Nano-ablation Processing with Femtosecond Laser Pulses, Hashida M, Mishima H, Shimizu S, Tokita S, Sakabe S, Optics & Photonics Japan 2007, Osaka, 26–28 November 2007.

Grants

Sakabe S, et al., Time Resolved Electron Microscope with Intense Femtosecond Laser Produced Electrons, Grant-in-Aid for Scientific Research (A), 1 April 2006–31 March 2009.

Hashida M, Advanced Material Processing with Femtosecond Lasers, Iketani Science and Technology Founda-

tion, 20 July 2007–31 March 2008.

Hashida M, Improvement of Ablation Rate for Femtosecond Laser Processing, Amada Foundation for Metal Work Technology, 20 December 2007–31 March 2009.

Awards

Hashida M, Sakabe S, LSJ Award for Distinguished Achievements in Research, Carbon-nanotube Cathode Modified by Femtosecond Laser Ablation, The Laser Society of Japan, 31 May 2007.

Tokita S, Encouragement Prize, Sapphire-conductive End-cooling of High Power Cryogenic Yb:YAG Lasers, The Laser Society of Japan, 31 May 2007.