23Ap03

非相対論から相対論的強度のレーザーによるナノメートル厚ターゲット large-area suspended graphene を用いたイオン加速

Laser ion acceleration with a large-area suspended graphene target from non-relativistic to relativistic laser intensities

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Laser ion acceleration has been intensively investigated after the development of chirped pulse amplification (CPA) technique[1]. The accelerated ions are applicable for cancer therapy, radioisotope production, and fast ignition for inertial confinement fusion. To achieve higher ion energies, target thickness should be reduced[2]. However, thinner targets can be easily broken by the pedestal or prepulse before the main pulse arrival. We have developed a large-area suspend graphene (LSG) target, which is a single to multiple layered freestanding graphene sheet[3]. Graphene is the thinnest and the strongest material, hence LSG has the potential to be the best targets of laser ion acceleration.

We have conducted several experiments with LFEX laser in Osaka University and J-KAREN-P laser in Kansai Photon Science Institute, National Institutes of Quantum Science and Technology. The LFEX laser irradiates on LSG targets with target normal angle. The maximum intensity is $\sim 4 \times 10^{18}$ W/cm^2[4, 5]. The J-KAREN-P laser is focused on LSG targets with 45 degree of incident angle at the intensity of $\sim 5 \times 10^{21}$ W/cm^2[6, 7]. We have tested the irradiation of non-relativistic laser intensity, $< 10^{18}$ W/cm^2, by putting the targets at defocusing positions of J-KAREN-P. Thomson parabola spectrometer and CR-39 stack are used to diagnose the accelerated ions. In the all experiments, no plasma mirrors are used.

We have observed energetic ions with relativistic laser intensities, $a_0 \sim 48$ of J-KAREN-P best focus shots and $a_0 \sim 1.8$ of LFEX. Furthermore, MeV energy ions are also observed with non-relativistic laser intensity, $a_0 < 1$, in defocused experiments of J-KAREN-P. These results imply that LSG has special features no other materials have. We discuss these specialities using particle-in-cell simulations.

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