Transition in proton energy scaling with linearly polarized laser pulses

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Particle acceleration using ultraintense, ultrashort laser pulses is one of intensively investigated topics in relativistic laser-plasma research. We investigated proton/ion acceleration in the intensity range of 5×10^{19}W/cm^2 to 3.3×10^{20} W/cm^2 by irradiating linearly polarized, 30-fs, 1-PW laser pulses onto 10- to 100-nm-thick polymer targets. The proton energy scaling with respect to laser intensity and target thickness was examined. The experimental results clearly showed, for the first time with a linearly polarized light, the transition of proton energy scaling from square ($\sim I^{1/2}$) to linear ($\sim I^1$), which is a consequence of hybrid acceleration consisting of TNSA and RPA [1]. In addition coulomb explosion assisted the free expansion in the post acceleration stage. A maximum proton energy of 45 MeV was obtained when a 10-nm-thick target was irradiated at the laser intensity of 3.3×10^{20} W/cm^2. The experimental results were supported by two- and three-dimensional particle-in-cell simulations.

[1] I J. Kim, K.H. Pae, C.M. Kim, H.T. Kim, J.H. Sung, S.K. Lee, T.J. Yu, I.W. Choi, C.-L. Lee, K.H. Nam, P.V. Nickles, T.M. Jeong, and J. Lee, arXiv: 1304.0333 [physics.plas-ph].