3P-18

Efficient ion acceleration using two-layer thin film target for picosecond petawatt laser driven neutron generation

ピコ秒ペタワットレーザー駆動中性子発生のための２層薄膜ターゲットによるイオン加速の効率化

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Neutrons are expected to be used in various applications such as radiography technology, and numerous neutron generation experiments using lasers have been done. In order to improve the number of neutron generation, efficient acceleration of protons and deuterons is necessary. Acceleration experiments of protons and deuterons by LFEX laser have been conducted with CD (deuterated polystyrene) as a target. In this research, to further improve the accelerated ion energy, we conducted the experiments with the Au coated CD foil target. We measured the maximum energy of protons was enhanced for with coated CD foil.

1. Introduction

Laser-driven fast neutrons are expected to be applied for radiography technology because of the possibility of higher resolution than ones from accelerator and reactor. Such the fast neutrons are generated by pitcher-catcher system that transports laser energy to neutrons. Pitcher means the foil target that generate Multi-MeV ion beams by the irradiation of ultra-intense (>10^{18} [W/cm^2]) laser and Catcher means the converter that generate neutrons by nuclear-reaction between the incident ion beams such as deuterons and protons. It is well known that deuterons and protons are accelerated with the CD (deuterated polystyrene) foil toward the target normal direction. However, according to 1D-PIC (Particle-in-Cell, PICLS[1] code) simulation, we found ions are accelerated to higher energy with Au (Z=79) coated CD foil.

2. Experiments

The experiment was conducted to compare the two targets using LFEX laser in Osaka University [2][3]. One of the targets was the 1.5 μm-thick CD foil and the other was the 1.5 μm-thick CD foil with 50 nm-thick Au on front side (laser irradiated side). We measured the energy of protons and deuterons with Thomson Parabola Ion Spectrometer on rear side of the target on laser-axis.

3. Results

Fig.1 shows the spectrum of deuterons and protons measured for 3 shots. About 401 J laser energy was delivered on the CD foil target and about 383, 446 J was delivered on the Au coated CD foil. We found the higher maximum energy of proton was measured with Au coated CD foil than with CD foil despite of lower laser energy as shown in Fig. 1. This result seems to be due to the stronger sheath electric field due to gold coating.

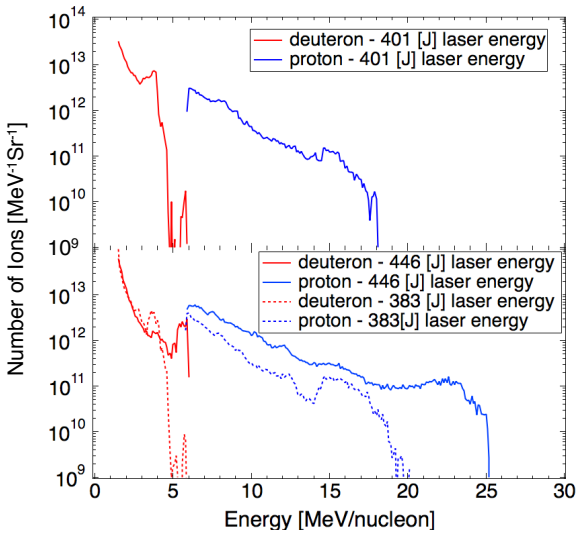

Fig.1 Energy spectra for 3 shot (upper is for the CD foil shot and lower is for the Au coated CD foil shots)

Acknowledgements

This work was funded by Grants-in-Aid for Scientific Research from A-STEP/JST(AS2721002c) and PREST/JST (JPM-JPR15PD).

References

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