4 - 18 Target Polarization Effect on Energy Loss of Ions near the Bohr Velocity*

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Energy loss of ions near the Bohr velocity in matter is one of the important topics in intense heavy ions beam driven high energy density physics and inertial confinement fusion. With the increase of ionization degree, plasma electrons will lead to changes in the process of ion energy deposition. Based on the ions-plasmas interaction device at 320 keV experimental platform, we present the experimental energy loss results of 1.07 MeV O^{5+} ions penetrating through a neutral hydrogen target and a low-density partially ionized hydrogen plasma target (radio frequency plasma). As show in Fig. 1(a), a decrease of energy loss with free electron density increase is found, which is very different from previous understandings. The experimental results are discussed by considering the target polarization effect - Barkas correction term. Near the Bohr velocity regime, the polarization correction term can play a key role in the ion-atom collisions. Modeling the polarization correction term on the classical energy loss formula, the experimental data of ions in the neutral target can be well fitted by the calculated value, this result is shown in Fig. 1(b) - the additional energy loss due to polarization effects is more than 25%. In the partially ionized plasma, the frequent thermal electrons collisions can induce the atomic excitation, correspondingly the polarization correction term changes, where it decreases with the fraction of excited atoms increasing. As shown in Fig. 1(c), the decrease of energy loss happens in our experiment. The polarization effect of atoms affects the energy loss in neutral materials, and the change of the polarization effect of excited atoms is an important factor affecting the energy deposition process at low ionization degree.

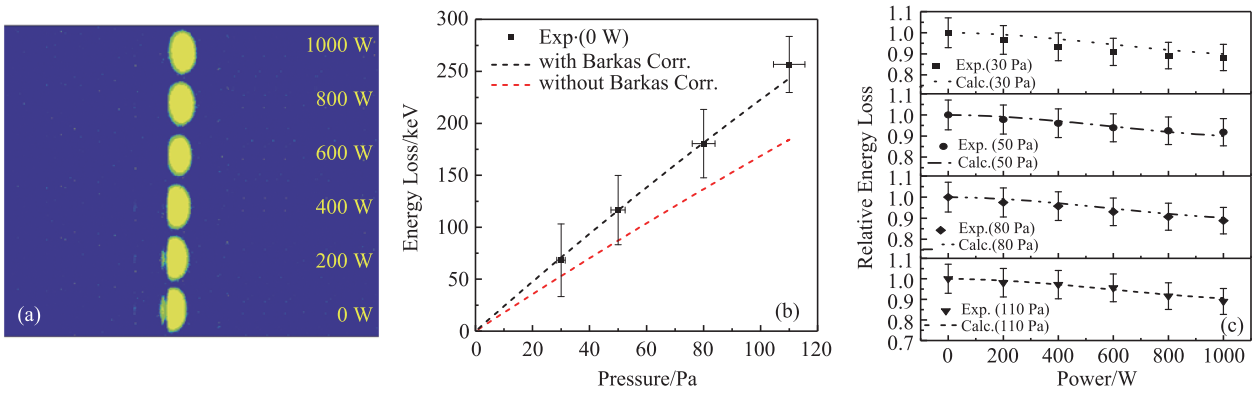

Fig. 1 (color online) (a) The energy spectrum of outgoing ion versus the increase of the input power, (b) In the neutral gas target, the caculated results of ion energy loss without Barkas correction (red dashed line) and with Barkas correction (black dashed line) are compared with the experimental results, (c) Comparison of experimental and calculated values of relative energy loss.

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