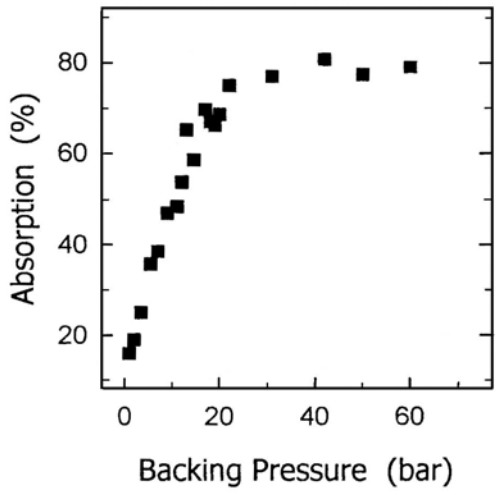
Efficient laser energy absorption in gas cluster plasmas irradiated by high intensity multi-picosecond laser pulses

Gas jet targets are commonly used in laser plasma interaction experiments with ultra-short pulse lasers. Such targets have the advantage of being a debris-free intense x-ray-XUV source, which can be operated at high repetition rate for applications in x-ray contact microscopy and XUV lithography. However, a major drawback of gas jet targets (in comparison to solid targets) is that the absorption of laser light in them is rather very small due to low gas density, which in turn, results in a poor x-ray conversion efficiency. This problem is overcome by converting gas jets into gas cluster jets, which with sub-picosecond lasers, lead to high absorption of laser light. For multi-picosecond laser pulses, the laser energy absorption in clusters is expected to be small as the cluster break-up time is of the order of picosecond. Experiments at Laser Plasma Laboratory, RRCAT, have shown for the first time that even for 25 picosecond laser pulses, clusters do lead to a high absorption of laser light.



Absorption of laser energy v/s backing pressure for argon gas

Laser energy absorption measurements in gas jets of argon and nitrogen for 25 ps laser pulses from the 100 GW Nd:glass laser chain, were carried out. Peak absorption of ≥ 75% was obtained at an intensity ~10^{15}W/cm^2, for a backing pressure of ≥ 25 atmospheres in both the cases. Under these conditions, both these gases form clusters. It was observed that in the case of helium gas, where clustering does not take

place, the laser light absorption was negligibly small. The results on high absorption are explained in terms of high density plasma formation due to initial cluster heating and break-up, followed by large absorption of the remaining laser pulse energy in this preformed plasma.

References:

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