Temporal dynamics of OFI Ar plasma produced by high-intensity IR laser

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1. Introduction
Optical-field-induced ionization (OFI) plasmas produced by a high-intensity laser are suitable for excimer production. The temperature of the OFI plasma can be controlled low enough to enhance the excimer production processes, which are mainly the recombination processes in the plasma. Parameters other than the temperature of the OFI plasma can also be controlled by changing the plasma-initiating laser parameters, such as intensity and polarization. We have demonstrated the production of vacuum ultraviolet Ar excimers in the OFI plasmas produced by a high-intensity IR laser. The optical amplification of the Ar excimer at 126 nm has been reported [1]. However, the temporal and spatial evolutions of the OFI plasmas have not been evaluated. Here we observed temporal evolution of the OFI Ar plasma by using a time-resolved laser interferometer.

2. Experiment

Two-dimensional density distribution images were obtained by converting the phase shift of the interference fringes by using the inverse Abel transform. The shape of the Ar plasma was thus assumed to be line-symmetrical.

3. Results

Fig. 2 shows the Ar plasma density as a function of the delay time. The vertical axis is the plasma density and the horizontal axis is the time difference between the pump and probe lasers. The error bars on the horizontal axis were caused by a jitter of the two lasers described above. The plasma density was decreased by the two-body recombination process. Assuming the absolute values of the plasma density on the same order of the magnitude of the neutral gas density at 8 atm, the recombination rate would become on the order of $10^{13}$ cm$^{-3}$/s, which may be too large for the process. Details of the analysis will be discussed at the session.

4. Conclusion

We measured the temporal evolution of the OFI Ar plasma density. The result should be utilized for analysis of the optical amplification of the 126 nm Ar excimer.

Reference