QUASI-CONTINUOUS XENON PLASMA SUSTAINED BY PERIODIC-PULSED LASER RADIATION

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The possibility of sustaining stable periodic-pulsed optical discharge (POD) in high pressure xenon with focused (NA = 0.1 – 0.15) periodic-pulsed YLR-QCW laser radiation (λ = 1.07 um) [1] initiated from arc discharge plasma in every pulse has been discovered experimentally. Meanwhile, laser pulses with 200 us to 500 us duration and 300 W to 500 W power did not break the stability of the arc discharge with current being considerably lower than the nominal one.

In addition, for pulse frequencies above 2.2 kHz it was discovered that the stable quasi-continuous plasma could be sustained with laser radiation power being 250 W to 600 W and pulse duration being 200 us. Meanwhile, time between the pulses, in which the plasma cools down, could be above 200 us with radiation emitted from the plasma region stopping in 10 us to 20 us. A filming with 2×104 FPS showed the discharge plasma initiation and propagation phases, as well as the “dark” phase with duration above 180 us. By the end of each laser pulse the plasma had become steady-state, approximately corresponding to the continuous optical discharge (COD) state with the same sustaining laser power level [2].

Though considerable energy percentage in the POD is spent on heating the gas cooled during the “dark” phase, the POD plasma brightness considerably exceeds the COD plasma brightness with the same laser power for a large amount of time, especially in UV spectral range, which means this plasma has a higher temperature. The amount of temperature increase can also be judged by ionic lines in POD plasma increasing dramatically as compared with COD plasma.

The problem of the laser power absorption mechanism during the optical discharge propagation starting phase is yet to be discussed. Estimations show that by the time of the next pulse electron concentration left is not enough for the starting plasma propagation due to free-free laser radiation absorption processes. The initial absorption process seems to be provided with Xe atoms probably in 6s excited states, which are close to the laser generation line in wavelength range from 1.05 um to 1.09 um.

Due to the POD spectral brightness being considerably higher than that of the COD, as well as to the POD high stability and repeatability from pulse to pulse, the POD phenomenon can be applied in plasma radiation sources where high stability and high brightness in a wide spectral range are required.

The authors appreciate NTO “IRE-Polyus” (IPG Photonics branch) for their help.

References

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