Repetitive tabletop plasma focus to produce a tunable damage factor on materials for fusion reactors

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Future thermonuclear reactors need materials capable of withstanding the extreme radiation and heat loads expected from high rate plasma. In particular, in the projected tokamak ITER, energy loads in the divertor associated with the Type I ELMs in the order of ~ 100 to 300 J/cm² are expected to have a duration of \( \tau \sim 0.1 – 0.5 \text{ ms} \), with a number of pulses of ~ \( 10^3 \) per shot, and a frequency in the order of 0.5 to 2 Hz [1]. Thus a damage factor \( F \sim q \cdot \tau^{1/2} \sim 10^4 \text{ (W/cm²)s}^{1/2} \) per pulse is expected. Recently the axial plasma dynamics after the pinch in a tabletop plasma focus of hundred joules, PF-400J, was characterized by means of pulsed optical refractive diagnostics [2]. From those measurements, the energy, interaction time and power flux of the plasma burst interacting with targets was obtained. It was found that the effects on material samples highly depend on the distance from the anode top where the sample is located. In particular, damage factor on target of the order of \( 10^4 \text{ (W/cm²)s}^{1/2} \) can be obtained. This is an equivalent damage factor than the expected from type I ELMs on the ITER divertor. The PF-400J operating at 0.077 Hz is being used to study of the effects of fusion-relevant pulses on material targets [3]. A new hundred joules device to be operated up to 1Hz including tunable damage factor has been designed and is currently being constructed, thus thousand cumulative shots on materials could be obtained in few minutes. Therefore, important progresses in materials testing for fusion reactors using tabletop plasma focus devices as plasma sources could be achieved. The design parameter, practical details and the status of the device will be presented. The scaling of the damage factor for plasma foci operating at different energies is also discussed.

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