IAEA FEC 2014

Contribution ID: **644** Type: **Poster**

Physical Processes Taking Place in the Dense Plasma Focus Devices at the Interaction of Hot Plasma and Fast Ion Streams with Materials under Tests and some Results of the Irradiation

Friday 17 October 2014 08:30 (4 hours)

Dense Plasma Focus device represents a source of powerful streams of penetrating radiations (hot plasma, fast electron and ion beams, X-rays and neutrons) of nanosecond-scale pulse durations. Power flux densities of the radiation types may reach in certain cases the values up to 1013 W/cm2. They are widely used at present time in more than 30 labs in the world in the field of radiation material science. Areas of their implementations are testing of the materials perspective for use in modern fusion reactors (FR) of both types, modification of surface layers with an aim of improvements of their properties, production of some nanometer structures on their surface, and so on. To use the above-mentioned device correctly in these applications it is important to understand mechanisms of generation of the above-mentioned radiations, their dynamics inside and outside of the pinch and processes of interaction of these streams with targets. In this report the most important issues on the above matter will be discussed in relation to the cumulative hot plasma stream and the beam of fast ions with illustration of experimental results obtained at four DPF devices ranged in the limits of bank energies from 1 kJ to 1 MJ. Among them mechanisms of a jet formation, a current abruption phenomenon, a super-Alfven ion beam propagation inside and outside of DPF plasma, generation of secondary plasma and formation of shock waves in plasma and inside a solid state target, etc. Nanosecond time-resolved techniques (electric probes, laser interferometry, frame self-luminescent imaging, X-ray/neutron probes, etc.) give an opportunity to investigate the above-mentioned events and to observe the process of interaction of the radiation types with targets. After irradiation the specimens are analyzed by contemporary instrumentation: optical and scanning electron microscopy, local X-ray spectral and structure analysis, atomic force microscopy, the portable X-ray diffractometer that combines X-ray single photon detection with high spectroscopic and angular resolutions, an X-ray microCT system with Cobra 7.4 and DIGIX CT software, micro-hardness measurements, etc. A number of results in this area are presented.

Country or International Organisation

Poland

Paper Number

MPT/P7-43

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Session Classification: Poster 7