

Diagnostics of PF-1000 facility operation and plasma concentration on the basis of spectral measurements

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The paper concerns the monitoring of the operation of high-current pulse discharges and the determination of the plasma concentration within the dense magnetized plasma column by means of optical spectroscopy methods. In experiments performed within the large PF-1000 facility, which is operated at IPPLM in Warsaw, particular attention was paid to possibility of the determination of correctness of the operational mode.

In order to measure the visible radiation (VR), as emitted from the collapsing current sheath and the dense pinch region, the use was made of the MECHELLE[®] 900-optical-spectrometer, which was equipped with a CCD measuring head. The spectral measurements were performed at an angle of about 65° to the symmetry axis of the PF electrode system, through an optical window and a special collimator coupled with the quartz optical-cable. The observed VR emission originated from a part of the inner- and outer-electrode surfaces, the collapsing current-sheath layer and a portion of the dense plasma pinch-region (located a distance of 40-50 mm from the electrode ends).

Considerable differences were found in the optical spectra recorded for so-called “good shots” and for cases of some failures. In the case of a breakdown (damage) of the main insulator there were observed different Al-lines, which originated from the eroded insulator material. At so-called “bad vacuum” conditions there were recorded various C-lines, and at an uncontrolled air-leakage into the experimental chamber there appeared numerous N-lines. The appearance of these characteristic spectral lines made possible to determine whether the operation of the PF-1000 facility was correct or incorrect. The paper reports also on estimates of plasma concentration values, which have been performed on the basis of a quantitative analysis of the Stark broadening of the selected spectral lines.