Development of diagnostic system elements for DNPS

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Charge-exchange atoms diagnostics, those that give information on the energy distribution of plasma fast ions, is important for the formation of the ITER regime and plasma studies in the state of thermonuclear burning. This information is important for increasing the efficiency of ion heating and studying the retention of ions in stable plasma. It is promising to use sensitive elements based on synthetic diamond material in the diagnostics of neutral atom flows, due to its high sensitivity to atoms, radiation resistance and thermal resistivity. At present, the Diamond Neutral Particle Spectrometer (DNPS) ITER is being developed to determine the energy spectrum of the charge-exchange atoms for calibration of the Neutral Particle Analysis (NPA) and to re-test the measurements in the energy range 50 keV-8 MeV [1-3]. The DNPS is installed in the vacuum pipe of the NPA system, and is located at a distance of 10 meters from the first wall of the ITER. The structure of the DNPS design includes two diamond detectors with different sensitivity. The main goal of the DNPS is to measure the energy spectrum of charge-exchange atoms for NPA calibration in the energy range 50 keV-8 MeV.

The development of the case of a diamond detector for DNPS was carried out in [1]. As shown by testing [1], a certain refinement of the design of the diamond detector is required. In this work, a diamond detector design has been designed to reduce its size and reduce leakage currents. The principal difference of the new model is the absence of fixing screws in the design of the diamond mandrel, due to the changed arrangement of the ceramic insulators. The developed design of the diamond detector allowed to reduce its overall dimensions and reduce the leakage currents. Dimensions of the developed diamond detector - 16 x 20 x 10.4 mm, in contrast to the dimensions of the detector, developed in [1] - 53 x 23 x 14.5 mm.

In work, also, tests of the detector on the neutron generator are carried out. Neutron tests were conducted to determine the sensitivity of the model of the diamond detector. In the ITER (DT) plasma, during the discharges with a power of 500 MW, the expected neutron flux density (1010 cm‑2 • s-1) will significantly exceed the atomic flux density (5 × 106 cm-2 • s-1) and with the sensitivity of the diamond detector to neutrons more than 10-3 cm2, DNPS will mainly detect neutrons. As a neutron spectrometer, DNPS will monitor the neutron flux and measure the plasma ion temperature.

References

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