Diamond detectors environmental compatibility in VNC ITER conditions at elevated operation temperature

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The ITER vertical neutron camera (VNC [1]) is devoted for measurement of the neutron yield in a poloidal section of a tokamak plasma with a given time resolution and reconstruction of the neutron source profile. In the structure of VNC the fast neutron detection unit (FNDU) is used. FNDU includes two diamond detectors and two fission chambers. Diamond detectors and fission chambers are placed in a sealed gas-filled FNDU housing. In ITER operation mode at a power of 500 MW, significant neutron fluxes and a high operation temperature of up to 150 °C are expected at the location site of the FNDU. FNDU will be subjected to periodic technological heating to
250 °С.

There were performed 4 types of tests of the FNDU prototype developed and manufactured in JSC NIITFA: thermal cycling, operation at elevated temperature conditions and mechanical exposure, radiation tests after thermal and mechanical exposure, radiation tests of diamond detectors in the structure of the FNDU at elevated temperatures.

Testing of FNDU diamond detectors at elevated temperatures was carried out in the JSC "SRC RF TRINITI" under the neutron flux from the neutron generator. FNDU was placed inside the heating installation located at a distance of 15 cm from the ING-07T generator. The spectra of the detector response were measured before heating turning on, then 3 hours after heating up to 100 ºC and after 3 hours after heating up to 150 ºC. According to the measured spectral responses of the detector under 14 MeV neutron flux from ING-07T generator at temperatures of 18 ºС, 100 ºС,
150 ºС the main spectrometric characteristics of the detectors were determined:

- the position of the peak corresponding to the (n, α) reaction on carbon;

- the width of the peak corresponding to the (n, α) reaction on carbon;

- count rate on the peak;

- sensitivity of diamond detectors to 14 MeV neutrons.

The tested 2 diamond detectors and 2 fission chambers in the FNDU composition after thermal and mechanical effects comply with the technical requirements. It was experimentally shown that the sensitivity of diamond detectors at temperatures of 18 °C, 100 °C, 150 °C differ less than 20%.

It is shown that the FNDU prototype after thermal cycling, testing under conditions of elevated temperature and mechanical exposure retained its operation ability. Experimentally demonstrated stable operation of diamond detectors in the composition of the VNC at elevated temperatures under the neutron flux of neutron generator.

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References

1. V.N. Amosov, S.A. Meshchaninov, N.B. Rodionov. Applied Physics (Rus), No. 4, 2011,
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