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Material Irradiation Tests in the ITER Divertor Relevant Settings

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Various types of multilayer laser mirrors and piezoelements underwent radiation tests to assess the influence of neutron and gamma-ray fluxes similar to those expected in diagnostic ports of ITER divertor. The optical and thermal performance of laser mirrors and the piezoelectric coefficient of the piezo-elements were under investigation. The test was performed in the RIAR irradiation facility RBT-6 using ITER relevant neutron and gamma fields with a neutron flux of ~10^12 n/cm^2/s and a fluence of ~10^19 n/cm^2 (E > 0.1 MeV); heating did not exceed 200 C. Special racks for arranging the test samples of mirrors and piezo-elements in the reactor were designed with neutron shields for adjusting neutron and gamma-ray spectra; also, helium atmosphere for the in-situ cooling was used. The neutron spectra, estimated using MCNP and tested experimentally, are provided and compared with those expected in ITER under baseline inductive burning plasma conditions (Q = 10). The tested laser mirrors (40 samples of 4 types) have a metallic sublayer (Al or Ag) and a multilayer dielectric coating (ZrO2 / SiO2 or Sc2O3 / SiO2). The mirrors are designed for broadband reflection and high laser power breakdown threshold at the wavelengths 956nm, 1047nm and 1064nm (high-power lasers of divertor Thomson scattering), as required for the combined diagnostics 55.EA (laser-induced fluorescence) and 55.C4 (Thomson scattering). The mirror breakdown threshold and heating resistance up to 200-250 C were tested before irradiation; further tests are planned. The piezoelectric coefficient of the two piezo-ceramic types chosen for stick-slip and resonance piezo actuator types was measured before and after irradiation. Experimental approaches and facilities used for irradiation, and pre- and post-irradiation measurements are described in detail. The first results and outlook of further experiments are also presented.

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