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Thermal Tests of Large Dielectric Mirrors

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The reflectance of multilayered dielectric mirrors can reach 100% in a preset range of wavelengths. This makes them very attractive to be used for optical diagnostics in ITER as secondary mirrors. Since diagnostics mirrors in ITER will operate under influence of neutron fluxes up to 10^12 n/cm2s and temperatures of 150 to 200C, dielectric mirrors should be tested in similar conditions.
Previous investigations have shown that the dielectric mirrors of relatively small size (d25x2 mm) can sustain neutron fluences of 10^19 n/cm2 and temperatures up to 280C if sufficient adhesion of dielectric coating to a substrate is provided. It is assumed that heating, including radiation induced, plays the main role in damaging mirror coating at least in test conditions. The tendency of reflectance spectrum of dielectric mirrors to shift its peaks under heating has been also revealed. Taking into account that the actual diameter of diagnostic mirrors will be about of d100 mm and even more, the thermal tests of dielectric mirrors of similar size had to be performed.
Several mirrors of d100x10 mm were manufactured by NPO 'Luch' using standard technology of laser mirrors production. The multilayered coating of TiO2/SiO2 had been evaporated to substrates of silica glass K-8 and fused silica KU-1. The reflectance of the samples exceeded 95% in the range of 400-700 nm except few wavelengths at which it was about 90% (negative peaks in the reflectance spectrum). The samples were heated up to 250C in vacuum oven under air pressure of 10^-3 Pa. The heating was performed in two regimes. In the first regime, the temperature was constantly about of 250C for 7.5 hours. In the second one, the temperature were subsequently raised up to 250C and fallen down to 100C two times during 7 hours.
In both regimes the samples retained their coatings undamaged. The working range was found to be shifted towards long wavelengths. The reflectance in almost all working range remained the same, except the negative peaks with originally low reflectance. At these peaks the reflectance reduced down to 80%.
The results show that multilayered dielectric mirrors of large size sustain thermal loads which are supposed to be similar to ITER conditions. Considering the critical role of heating effects, the dielectric mirrors can be recommended as prototypes for secondary diagnostic mirrors in ITER.