Recristallized Graphite Utilization as the First Wall Material in Globus-M Spherical Tokamak


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Globus-M spherical tokamak, built at A.F.Ioffe Physico-Technical Institute in 1999 is the first Russian spherical tokamak and has the broad area of research in controlled fusion [1]. Besides small aspect ratio (A=1.5) the distinguishing feature of the tokamak is the powerful energy supply system and auxiliary heating, which give opportunity to reach high specific power deposition up to few W/cm^3. The utmost plasma current density and B/R ratio among spherical tokamaks allow operation in the range of high plasma densities ~ 10^{20} m^{-3}. This feature results in big power density loads to the first wall due to small plasma-wall spacing. The area of the first wall armour was gradually increased during few years since 2003, and nowadays reaches almost 90% of the inner vessel surface faced to plasma. Plasma facing protecting tiles are manufactured from recristallized graphite doped by different elements (Ti, Si, B). Additionally the plasma facing surface was protected by films deposited during boronization. The tendency of short time and long time scale plasma parameters variation are discussed including the plasma performance improvement with increase of protected area. Technology of tiles preparation before installation into the tokamak vessel is briefly described, as well as technology of plasma facing armor preparation before the plasma experiments. Few protecting tiles doped by different elements which were exposed to plasma fluxes of dissimilar power densities for a long time were extracted from the vacuum vessel. The analysis of tiles material (RGT-91) to hold (accumulate) deuterium was made. The distribution of absorbed deuterium concentration along poloidal coordinate was measured. The elementary composition of the films deposited on the tiles was studied by Rutherford back scattering technique and by nuclear resonance reaction method. Other modern methods of surface and structural analysis of material exposed to prolonged interaction with plasma were used. Among them are electron raster microscopy, Raman and IR spectroscopy, etc. The data obtained were compared with characteristics of tiles, which were not exposed to plasma interaction. [1] V.K Gusev, et al., "Globus-M spherical tokamak", Technical Physics, 44, no.9, p.1054, 1999.