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Material Science Activities for Fusion Reactors in Kazakhstan

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Paper contains results of fusion material testing national program and results of activities on creation of material testing spherical tokamak.
Hydrogen isotope behavior (diffusion, permeation, and accumulation) in the components of the first wall and divertor was studied taking into account temperature, pressure, and reactor irradiation. There were carried out out-of-pile and in-pile (reactors IVG-1M, WWRK, RA) studies of beryllium of various grades (TV-56, TShG-56, DV-56, TGP-56, TIP-56), graphites (RG-T, MPG-8, FP 479, R 4340), molybdenum, tungsten, steels (Cr18Ni10Ti, Cr16Ni15, MANET, F82H), alloys V-(4-6)Cr-(4-5)Ti, Cu+1%Cr+0.1%Zr, and double Be/Cu and triple Be/Cu/steel structures.
Tritium permeability from eutectic Pb+17%Li through steels Cr18Ni10Ti, Cr16Ni15, MANET, and F82H were studied taking into account protective coating effects. The tritium production rate was experimentally assessed during in-pile and postreactor experiments. There were carried out radiation tests of ceramic Li$_2$TiO$_3$ (96\% enrichment by Li-6) with insitu registration of released tritium and following post-irradiation material tests of irradiated samples.
Verification of computer codes for simulation of accidents related to LOCA in ITER reactor was carried out. Codes’ verification was carried out for a mockup of first wall in a form of three-layer cylinder of beryllium, bronze (Cu-Cr-Zr) and stainless steel.
At present Kazakhstani Tokamak for Material testing (tokamak KTM) is created in National Nuclear Center of Republic of Kazakhstan in cooperation with Russian Federation organizations (start-up is scheduled on 2008). Tokamak KTM allows for expansion and specification of the studies and tests of materials, protection options of first wall, receiving divertor tiles and divertor components, methods for load reduction at divertor, and various options of heat/power removal, fast evacuation of divertor volume and development of the techniques for prevention of failures of intrachamber components. High parameters of power loads (up to 20 MW/t/m$^2$), wide range of used techniques and diagnostics allow for carrying out the studies and tests in divertor volume and at first wall, including mockups of DEMO vanadium module and lithium divertor module on the basis of capillary-porous system. The paper contains description of tokamak KTM features and material science program in support of creation of experimental modules for DEMO, ITER and fusion power reactors.