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FTP/4-5Rb: Low Activation Vanadium Alloys for Fusion Power Reactors - the RF Results

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The Results of development and researches of functional properties of low activation vanadium alloys (V-Ti-Cr and V-Cr-W-Zr-C systems) being developed for the cores of nuclear fusion and fission (Gen-IV, space) power reactors are presented.
Scientific and technological problems of the investigations are related with enhancement of functional properties based on (1) special optimized thermal (TT), thermomechanical (TMT) and thermochemical (TCT) treatments of V-4Ti-4Cr alloys, and (2) development of new (V-Cr-W-Zr-C system) vanadium alloys.
The TMT and TCT regimes ensuring the capability of significant (up to 2 times) enhancement of yield strength in the temperature range up to 800 C keeping relatively high plasticity reserve have been found for alloys.
The results of the theoretical, modeling and simulating studies of characteristics of self-point defects and dislocations, their interactions and mobility are presented. Nuclear physics characteristics (primary radiation damage, activation, transmutation, postreactor cooling) of alloys irradiated for a long time in neutron spectra of the fusion reactor DEMO-RF (15,3 dpa/year) and fast power reactor BN-600 (80 dpa/year) are calculated.
The interaction characteristics of V-4Ti-4Cr alloy with hydrogen and the influence of hydrogen on mechanical properties of the alloy (impact toughness, internal friction) have been studied.
Obtained results allows one to recommend the vanadium alloys for applications in nuclear reactors at operating temperature window 300 C –800(850) C. The planes of high-dose and high-temperature reactor tests of vanadium alloys are scheduled at material science assemblies of reactor BN-600 (2013 –2015, doses 50 –200 dpa, irradiation temperatures 400 C–800 C).

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