On plasma formation from tungsten nanofragments via electrical explosion

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Plasma-surface interaction in fusion devices result in intence surface modification e.g. in growth of layers of helium-filled nanowires of tungsten - fuzz. Spontaneous ignition of arcing at such a surface occurs much easily. Explosive-electron emission pulse-periodic functioning results in plasma formation via electrical explosion of micron-scale areas of W-fuzz layer.

We have calculated the estimation of tungsten fuzz nanostructure electrical resistivity due to electron scattering by helium nanobubbles distribution to be 0.265 mOhm cm for single nanowire and 1.92 mOhm cm for the fuzz layer (of 1/20 density) [Tsventoukh and Kulagin 2025 Phys. Plasmas 31, 092509]. It allow us to build "avalanche" model for the helium-filled nanowires electrical explosion with energy transfer from primary exploding nanowire to the secorndary via explosion products [Tsventoukh 2025 Phys. Plasmas 32, 052502].

One need to determine the explosive plasma composition id est average charge of the ions (electron and ion densities) fraction of neutral metal nanoclusters in net plasma produced

Two-temperature model [Tsventoukh 2021 Phys. Plasmas 28, 024501] has been upgraded to include calculated resistivity of W-fuzz in the following form $\rho_{1nw} = m_e/ne^2 \times v_2 \times (1 + T/15kK)$, where v_2 is the frequency of electron scattering by helium nanobubbles in the nanowire, giving at 300 K the value of resistivity about 0.265 mOhm cm. Approximation of the average ion charge $Z = T_e \times [1 - (lgn - 20)/5]/eV$ gives average charge of tungsten ions reaching values of about +3 for typical explosion conditions. Work supported by RSF grant 22-12-00274-P.