Plasma parameters of explosive emission splashes of tungsten fuzz nanostructure

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Plasma–surface interaction leads to modification of both the surface and the plasma. At certain conditions, at low He-plasma ions energy (tens of eV), a hot tungsten nanostructure being formed. At a larger ions energy (hundreds of eV), a spontaneous breakdowns occur at a such surface, arising as explosive electron emission splashes of electric current and leaving a burned-out areas. Pure field-emission approach is unable to explain such ignitions due to enormous spread in the emission current density of many orders of magnitude. Thus, the purpose of this work is twofold: to apply the liquid metal nanojet explosion model to nanowires with helium bubbles and to describe the positive feedback between explosions of adjacent nanofragments. An equivalent sputtering coefficient estimation has been obtained as the ratio of tungsten-to-plasma densities, which reaches 10 for the mass per charge loss rate due to arcing of about 2 mg/C. Corresponding tungsten ions flux reaches 10^{20}–10^{21} cm^{-2} s^{-1}. Large mass per charge loss rate (few mg/C) could arise from mechanical destruction of the nanowires fragments under the explosive plasma impact, and from reduction of the average tungsten ions charge due to reduction of the effective critical temperature (cohesive energy) of nanofragments. The latter mechanism has been applied to arcing experiments with Nb–Al cathodes, and it was demonstrated that the model allows to derive the same estimation of the reduced critical temperature (cohesive energy) from measured average plasma ions charge, their kinetic energy and cathode-potential fall [1].

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