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Electron beam charging of tungsten microparticle X-ray targets

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Practical evidence suggests the important role of microparticles for the initiation of vacuum discharges. In the context of improving the performance of X-ray sources we simulated a stream of microparticles that intersect with an electron beam to convert electron energy in bremsstrahlung. Monte Carlo (MC) simulations of electron transport for single micrometer sized tungsten spheres in free space suggest that the comparatively high electron backscatter yield of high atomic number tungsten suppresses charging for impact energies beyond the tens of keV range. The backscattering yield as a function of the primary energy even slightly exceeds unity above a well-defined energy threshold. The simulation reveals that the exit energy of the backscattered electrons and the backscattering yield both decrease with increasing microparticle size, approaching the characteristics of thick targets. Dense streams of microparticles or a levitated layer in front of a plain substrate exhibit higher negative charging as electrons may interact with multiple particles or the substrate with decreasing electron energy at each interaction. Our findings support the understanding of the dynamics of microparticles in high voltage gaps and surface modifications upon their impact on solid electrodes that may cause vacuum discharges.

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Modeling and simulations

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