Electron absorption and backscattering by plasma-facing solids

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We present a novel method [1] for calculating from a microscopic model the sticking and backscattering probabilities for an electron hitting the wall of a low-temperature plasma. The method, based on an invariant embedding principle, utilizes the large electron penetration depth at energies typical for plasma applications to factorize the sticking and backscattering probabilitities into probabilities for quantum-mechanical transmission through the surface potential of the wall and internal backscattering. Besides emission of optical phonons and/or interband Coulomb collisions elastic scattering due to imperfections at the plasma-wall interface can be taken into account. The method is flexible and numerically very efficient. It could thus be the basis for developing a realistic description of electron-surface interaction as it occurs in many bounded plasmas. Applying the approach to silicon dioxide, sapphire, and magnesium oxide we obtain angle- and energy-dependent sticking probabilities significantly less than unity, in accordance with available electron beam scattering data, but in disagreement with the perfect absorber model widely used in plasma modeling for electrons at low energies.

[1] F. X. Bronold and H. Fehske, Phys. Rev. Lett. 115, 225001 (2015)

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