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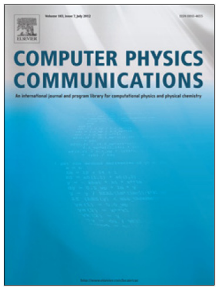

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A finite element procedure for radio-frequency sheath-plasma interactions based on a sheath impedance model

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Abstract

A finite element code that solves self-consistent radio-frequency (RF) sheath-plasma interaction problems is improved by incorporating a generalized sheath boundary condition in the macroscopic solution scheme. This sheath boundary condition makes use of a complex sheath impedance including both the sheath capacitance and resistance, which enables evaluation of not only the RF voltage across the sheath but also the power dissipation in the sheath. The newly developed finite element procedure is applied to cases where the background magnetic field is perpendicular to the sheath surface in one- and two-dimensional domains filled by uniform low- and high-density plasmas. The numerical results are compared with those obtained by employing the previous capacitive sheath model at a typical frequency for ion cyclotron heating used in fusion experiments. It is shown that for sheaths on the order of 100 V in a high-density plasma, localized RF power deposition can reach a level which causes material damage. It is also shown that the sheath-plasma wave resonances predicted by the capacitive sheath model do not occur when parameters are such that the generalized sheath impedance model substantially modifies the capacitive character of the sheath. Possible explanations for the difference in the maximum RF sheath voltage depending on the plasma density are also discussed.

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