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Investigation of self-excited plasma series resonance oscillations in multi-frequency capacitive discharges EDMUND SCHUENGEL, JULIAN SCHULZE, Department of Physics, West Virginia University, Morgantown, WV 26506, IHOR KOROLOV, ARANKA DERZSI, ZOLTÁN DONKÓ, Institute for Solid State Physics and Optics, Wigner Research Centre for Physics, Hungarian Academy of Sciences, Budapest, Hungary — The self-excitation of plasma series resonance (PSR) oscillations is a dominant feature in the current of asymmetric capacitively coupled radio-frequency discharges. The asymmetry can be caused by an asymmetry of the chamber geometry and/or that of the applied voltage waveform. We study the self-excitation of the PSR in a geometrically symmetric, electrically asymmetric capacitive argon discharge using PIC/MCC simulations as well as an analytical model. The results show that increasing the number of subsequent harmonics in the driving voltage waveform enhances the asymmetry and, therefore, leads to a significant increase of the current amplitude of higher harmonics, which are generated due to the nonlinearities of the sheaths. These high-frequency resonance oscillations between the capacitive sheaths and the inductive plasma bulk can only be reproduced correctly by the analytical model, if the cubic sheaths charge-voltage relation and the temporal modulation of the bulk length and electron density within the RF period are taken into account. Furthermore, we demonstrate that the nonlinear electron resonance heating (NERH) associated with the presence of PSR oscillations significantly contributes to the total electron heating and causes a spatial asymmetry of the ionization.

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