7th Asia-Pacific Conference on Plasma Physics, 12-17 Nov, 2023 at Port Messe Nagoya

Microplasma interacting with complex surfaces

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Microplasma sources have received growing attentions due their widespread applications in microsensors, biomedicine, energy conversion, etc [1]. Microplasma surface interaction, which can drastically modulate fundamental characteristics of the discharge, is of vital significance. In this report, we demonstrate the formation and transition behaviors of microplasmas around complex surface structures, such as microstructure arrays, via multi-dimensional numerical simulations, including particle-in-cell/Monte Carlo collision [2] fluid simulations [3-5]. The physical mechanisms of the interaction between microplasma and nonplanar structures are extensively investigated. It was found that the microdischarge occurs outside the cathode microcavities at the lowest pressure and starts penetrating the microcavities with a curved sheath edge as the pressure increases. At higher pressures, coupled periodic microhollow cathode discharges (MHCDs) are formed inside the microcavities. Further increasing the gas pressure results in the disappearance of the MHCDs, and the dominant discharge shifts outside of the microcavity and located above the protrusion tips. The effect of the space charge shielding on the discharge and the different electron emission conditions for microplasma formation are discussed. The breakdown characteristics in microgap with floating microparticles are also investigated. The results are beneficial for deeply understanding the microplasma formation with complex surfaces, which inform the scaling, design, and optimization of microplasma devices across a wide range of parameter regimes in practical applications.

References

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