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Field emission-driven microdischarges

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ABSTRACT

For over half a century, it has been known that the onset of field emission can lead to anomalous breakdown for electrode gaps spaced <10 μm apart. In adddition, field emission can serve as a substantial source of primary electrons in a microdischarge operating well below the breakdown threshold at atmospheric pressure. To better understand the role of field emission in a microdischarge, we have developed kinetic simulations and fluid models. Theoretical results from both our simulations and models have shown that the anomalous breakdown at the microscale is due to ion-enhanced field emission. In addition, they predict an entirely new prebreakdown regime – the field emission-driven microdischarge – in which field-emitted electrons interact with the surrounding gas to produce ions and excited metastables. Experiments conducted in our lab agree well with the predictions of our simulations and fluid model for parallel plate electrode spacings ranging from 4.8 to 14 μm.