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Coupled Mode Theory: A Path to Stable Microplasma Arrays[1]

JEFFREY HOPWOOD, ZHIBO ZHANG, Tufts University — Atmospheric plasmas are challenging to generate across large dimensions due to a plethora of instabilities. Recently, however, microplasmas have been generated with electron densities approaching that of a plasma torch, but with gas temperatures near room temperature. The possibility of treating large areas of low-temperature material with dense, atmospheric pressure plasma is attractive, but requires that microplasma concepts be dimensionally scaled. In this work we demonstrate that strong coupling among arrays of microwave resonators allows for the production of 1-dimensional arrays of microplasmas. Each microplasma is sustained at the tip of a quarter-wave microstrip resonator which is driven at 400 MHz. This individual resonator stabilizes the 200 micron plasma against the glow-to-arc transition. Linear arrays of identical quarter-wave resonators naturally redistribute energy among each other according to coupled mode theory. This redistribution of energy allows us to sustain multiple microplasmas by simply supplying power to just one resonator in an array. In the paper, we show that coupled mode theory, 3-D electromagnetic simulations, and experimental optical emission from microplasma arrays of 5 and 16 resonators are in close agreement.

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