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Numerical modeling of high power breakdown in metamaterials.

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— Metamaterials consist of subwavelength structural inclusions layered in a periodic fashion, which provide an effective response to electromagnetic (EM) radiation. The electric or magnetic responses of these materials are based on the resonant nature of their constitutive micro-structures. Under high power EM radiation, these resonances can result in the production of high amplitude currents and field amplification. Depending on the background gas and supporting pressure, breakdown can occur. The formation of plasma can strongly modify the EM response of the metamaterial and thus a detailed study on the breakdown threshold, plasma localization and EM response modification is necessary. Here, we present three-dimensional numerical simulations of high power – high frequency air breakdown in metamaterials. We use a self-consistent fluid description of the plasma formation and dynamics coupled with Maxwell's equations via the electron momentum equation. We study two typical (for metamaterials) micro-structures: The Split Ring Resonator and the Cut Wire pairs. Breakdown threshold is identified for both configurations. Calculations of transmittance and retrieval of the metamaterials' effective parameters help us quantify the effect of plasma formation on the EM response of these metamaterials.

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