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Investigation of electrical breakdown phenomena: multiscale-multiphysics simulations and experimental aspirations

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Many high electric field applications, for example, Compact Linear Collider in CERN are significantly limited by the presence of the phenomenon of electrical breakdowns. In case of sufficiently high applied electric field, even in ultra high vacuum conditions, electrical discharge appears, induces disturbances into the operating regime of the device, causes material damage and generally, limits significantly operation of the device. Phenomenon itself is known for long time, however, it's exact initiation mechanisms still remain elusive. Current hypotheses suggest, that electric field influence leads to a formation of field enhancing nanoscale tip. This tip will initiate significant field emission currents, evaporation of netural atoms, formation of plasma and finally –complete electrical breakdown. In current talk we explore these hypotheses of electric field assisted surface diffusion as the initiation mechanism of the field emitters by the studies conducted using multi-physics-multi scale simulation framework FEMOCS and DFT calclulations with nanoscale materials exposed to high field. We consider investigations of the machine learning algorithms to enable computationally practical incorporation of electric field influence to electron structure. The theoretical investigations are complemented by in situ electron microscopy experimental outlooks for confirmation and validation of computational studies.

Topic

Modeling and Simulations

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