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A Computational Tool for Static Simulations of Semiconducting Field Emitters

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Cold electron emission and vacuum breakdown are gaining popularity due to their significance in applications such as electron sources for mobile 3D medical imaging [1] and high-gradient particle accelerators [2]. The robust development of such devices is hindered by the lack of both effective computational models to engineer and optimise them through simulation and tools for the processing and analysis of experimental field emission results.

An initial model, GETELEC, has been reported for the computation and analysis of field emission and Nottingham heat [3] from metals. We expanded and generalized GETELEC to calculate the Nottingham heat and the field emission currents from semiconducting and insulating materials. Thus, providing the boundary conditions to calculate electron injection into vacuum from semiconductors, and the current and heat distributions in the emitting crystal.

Here we present our attempts to combine GETELEC with a commercial finite element method software (COMSOL) to resolve the band structure inside the semiconductor when a high field is applied and electron emission occurs. Our model aims to find solutions to the nested-self-consistent problem of solving the Poisson and current continuity equations for 3D semiconducting geometries. Resulting in an accurate and user-friendly computational tool to design semiconducting field emitters

[1] A. Mavalankar, et. al., in 2018 31st International Vacuum Nanoelectronics Conference (IVNC) (IEEE, Kyoto, 2018), pp. 1–2.

[2] N. Burrows et. al., CERN Yellow Reports, CERN-2016-004, (2016)

[3] A. Kyritsakis and F. Djurabekova, Computational Materials Science 128, 15 (2017).

Topic

Field Emission

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