Contribution ID: **34** Type: **oral**

Influence of nanoscale surface modifications to the estimated field enhancement and emission currents

Thursday, 23 March 2017 15:20 (30 minutes)

High field enhancement factor, in range 50-100 is commonly measured quantity in CLIC accelerator design. Such field enhancement values are usually associated with high aspect ratio surface irregularities appearing under applied electric fields. However, if dynamic surface change is present during ramping of the electric field or due to the lower than estimated work function value, change in field enhancement can be expected. In current study, we explore the influence of pre-existing low aspect ratio protrusions to the work function using DFT calculations with and without the applied electric field. As a result, we indeed observe the change of work function due to the surface defects. Also, the influence of the electric field is registered. Furthermore, possible mechanisms of formation of such surface inhomogeneities under the electric field are investigated by MD calculations of polycrystalline Cu. In these calculations we apply uniform electric field over the nanocrystallyne Cu (simulating the material near or at a breakdown site). As a result, grain boundaries act as the weakest part of the material and demonstrate the ability to induce the growth of small scale protrusions. Combination of such effects with the dynamic surface changes may be responsible of observed high field enhancement effects.

Type of contribution

Oral

session

Modelling and Simulations

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Session Classification: Modeling and simulations

Track Classification: Modeling and simulations