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Preliminary experimental evidence for the protrusion hypothesis on CuO forest

Cu electrodes are widely used in accelerators, for example in CLIC [1]. One of the problems arising in such accelerators is the breakdown phenomenon [2] causing damage to the accelerating structures and disturbances in the accelerated beam. The cause of the vacuum breakdowns is still under investigation and the electrodes regularly investigated for clues. One possible explanation for the cause of breakdowns is the hypothesis stating the formation of nanoprotusions in the electrodes. These protrusions can enhance the local electric field being a possible cause for breakdowns but up to this point no one has seen the protrusions in Cu surfaces. In this study a forest of CuO nanowires (NW) was grown on a Cu substrate by heating the Cu in air. Field emission of the NWs was measured in a specialized system inside a scanning electron microscope. It consisted of a sample holder and a tip capable of approaching and going in contact to the sample. Voltage can be applied between tip and sample.

First field emission of the CuO forest was measured until breakdown occurred. After breakdown a new Cu surface was created and it was found that the field emission on a smooth and fresh surface is much smaller than on the CuO forest. After deforming the Cu surface mechanically, increased field emission current was measured until breakdown occurred.

[1] Compact Linear Collider (CLIC), last accessed 08 Sep 2023, URL: <http://clic.cern/>

[2] A. Palaia et al. "Effects of rf breakdown on the beam in the Compact Linear Collider prototype accelerator structure", *Physical Review Special Topics - Accelerators and Beams*, 16, 8 (2013) 081004. 10.1103/PhysRevSTAB.16.081004

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