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Characterization of Cu electrodes after vacuum breakdown with AFM and SEM

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Cu electrodes are widely used in accelerators, for example in CLIC [1]. One of the problems arising in the accelerator 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.

In this study a Cu cathode with its surface covered with vacuum breakdown craters, was characterized with an Atomic force microscope (AFM) and a scanning electron microscope (SEM). The AFM was equipped with a Kelvin probe allowing for mapping of surface potential along with surface topography. Different areas of the electrode surface were characterized including both breakdown craters and plain Cu surface. The mapping was performed in ambient conditions with the probe revealing no major differences between the craters and undamaged Cu surface. The SEM imaging of the surface revealed various surface features including protrusion-like and sphere-like structures that are probably caused by rapid melting and solidification of the Cu electrode surface during the breakdown. These structures are an interesting subject for studying as they can potentially contribute to subsequent breakdowns.

[1] Compact Linear Collider (CLIC), last accessed 31 Jan 2021, 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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