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Resistivity Measurement of Metal Surfaces to Track Down Dislocations Caused by Surface Conditioning

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Conditioning of a metal surface in a high-voltage system is the progressive development of resistance to vacuum arcing over the operational life of the system.
This is relevant for accelerator cavities where high level of performance is only achievable after long conditioning period. Beyond the accelerator research field, this is an important topic for any technology where breakdowns can cause device failure, either by directly disrupting device operation or by causing cumulative hardware damage.

We are developing a direct method to measure the surface resistivity of a metal surface that is being conditioned by inducing a high frequency (GHz) radio-frequency current in the parallel-plate electrode system. If the system can function as a resonant cavity, the surface resistivity data would be encoded in its quality factor (Q-factor). The changes in the resistivity measured in cryogenic conditions would indicate a formation of dislocations under the surface, something that has been speculated as an important process behind the conditioning.

We will present the algorithms used to extract the Q-factor from experimental data and the results of experiments done using copper electrodes and test cavities. Small changes in resistivity (less than 0.6%), induced by temperature changes, were measured. We also show the preliminary results of the 3D EM simulations, where the electrode system in the cryogenic setup in FREIA laboratory is modified to act as a resonant cavity.

Topic

Experiments and Diagnostics

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