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M2Or4C-05: Microwave Microscopy of Materials Limitations of Superconducting RF Cavities

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There are considerable efforts world-wide to use Superconducting Radio Frequency (SRF) cavities to accelerate charged particles to high energies. These cavities are limited by surface defects which lead to cavity breakdown at high accelerating gradients. A novel near-field magnetic microwave microscope that can study these defects was successfully built using a magnetic writer from a conventional magnetic recording hard-disk drive. We study the 3rd harmonic response-V_{3f}(T, H_{rf}) because it is far more sensitive to rf field amplitude H_{rf} and temperature (T) than linear response measurements. In our experiments on Nb surfaces we observed 2 different classes of nonlinearity, which we call Low-field and Periodic. In the low-field case we observe that V_{3f} increases uniformly as a function of applied rf field amplitude, reaches a peak value and decreases to lower values. In the periodic case there exists a relatively strong onset nonlinear response signal with periodic dips at H_{rf} = H_1(T), H_2(T), H_3(T)⋯Both types of nonlinearity are observed in both bulk Nb and thin film Nb samples. The periodic case nonlinear response can be linked to the Josephson effect at or near the surface and is in good agreement with the nonlinear response expected from rf-current-biased Resistively and Capacitively Shunted Junction (RCSJ) model. Depending on the location of the probe on the surface of the material we can see response of either low-field or periodic character, or a combination of both. Efforts to image third harmonic response across Nb surfaces will be presented.

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