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Flux ratcheting: enhanced magnetic flux expulsion in SIS multilayer structures

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A program of quantitative measurements of magnetic flux expulsion on flat macroscopic samples has been used to assess and categorise magnetic expulsion efficiency. The measurement setup is a magnetic flux lens based on closed-topological heating/cooling through the material's superconducting transition. This offers systematic and repeatable expulsion measurements for bulk, thin film and multilayer samples. Of particular interest is the magnetic response of superconductor-insulator-superconductor (SIS) multilayer structures, which can exhibit a response that is characteristically different to that of bulk Niobium, if thermally manipulated in a specific way - this process we term "flux ratcheting".

Flux ratcheting is the incremental expulsion of trapped magnetic flux with repeated, controlled thermal cycles on a SIS sample, such that the trapped flux is incrementally moved ("ratcheted") out, with limited magnetic relaxation. Measurements indicate flux ratcheting is particular to the SIS structure, and requires the Tc of the surface thin film to be greater than that of the substrate.

To assess the impact of flux ratcheting on cavity performance, the application of an SIS structure to a 1.3 GHz bulk Nb cavity has been prepared, and referenced to the baseline performance of the bare Nb cavity. The RF performance with and without flux ratcheting is compared, and first implications of magnetic flux ratcheting to RF cavity performance are discussed.

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Footnotes

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