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Superheating field in superconductors with nanostructured surface

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We report calculations of a dc superheating field H_s in superconductors with nanostructured surfaces. Numerical simulations of the Ginzburg-Landau (GL) equations were performed for a superconductor with an inhomogeneous impurity concentration, a thin superconducting layer on top of another superconductor, and superconductor-insulator-superconductor (S-I-S) multilayers. The superheating field was calculated taking into account the instability of the Meissner state with a nonzero wavelength along the surface, which is essential for realistic values of the GL parameter κ, particularly $\kappa \simeq 1$ for Nb. Simulations were done for the materials parameters of Nb and Nb_3Sn at different values of κ and the mean free paths. We show that the impurity concentration profile at the surface and thicknesses of S-I-S multilayers can be optimized to enhance H_s above the bulk superheating fields of both Nb and Nb_3Sn. For example, a S-I-S structure with 90 nm thick Nb_3Sn layer deposited on Nb can boost the superheating field up to $\approx$ 500 mT, while protecting the SRF cavity from dendritic thermomagnetic avalanches caused by local penetration of vortices.

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