Micro and Nanostructured High-Temperature Superconductors for Transient Spectroscopic Methods

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Abstract

Even before its role in electroweak symmetry breaking, the Anderson-Higgs mechanism was introduced to explain the Meissner effect in superconductors.[1] Spontaneous symmetry-breaking yields massless phase modes representing the low-energy excitations of the Mexican-Hat potential. Only in superconductors does the gauge field move the phase mode towards higher energies, as a consequence of the charged condensate. This results in a low-energy excitation spectrum governed by the amplitude mode - the Higgs mode.[2] In time-resolved spectroscopy methods, activation of the Higgs excitation can be achieved via an additional vector potential added by applying a current through the superconducting sample. For this, tailored microbridges are crucial. Micro-structuring enables local, voltage/current dependent measurements where the current is applied through a 1D structure whose lateral dimension corresponds to the measurement area.[3] A variety of patterning techniques including chemical etching, electron beam lithography, focused ion beam, and laser writing can be used on HTC thin films as well as crystals. The laser writing technique, which allows local control over oxygen stoichiometry, is advantageous due to minimal structural damage to the surface and substrate.[4] This is particularly important for optical methods.[5] Micro- and nano-structuring of HTC samples further enables the direct manipulation of superconducting properties such as J_C caused by defect pinning centers, by e.g. the application of nanoparticles or the generation of holes.[6] Controlling the disorder level in 2D superconductors paves the way to study and differentiate the Higgs mode.[7] All in all, this provides a unique pathway to control and explore Higgs physics.

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References

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