Using THz Spectroscopy to study Nb_3Sn using the 25 T Split Florida-Helix

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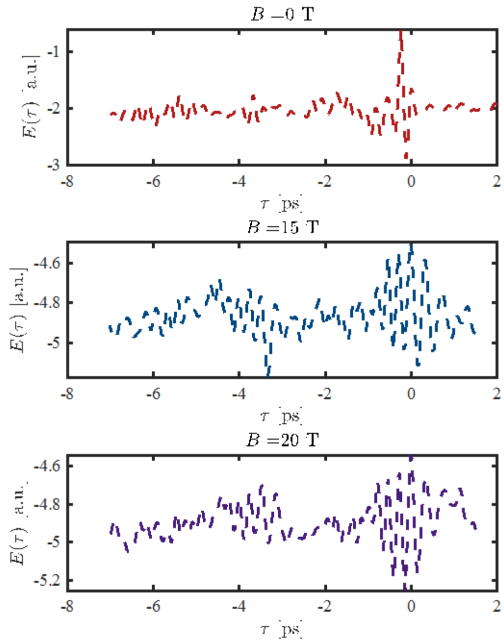
Introduction

THz spectroscopy has been extensively used to study the underlying non-equilibrium dynamics in correlated superconducting material systems on pico- and femtosecond time scales [1,2]. Working with such short time scales can reveal mixed state dynamics in type-II superconductors that often take on the form of quantized vortex lines or spin stripes [3,4].

Using a custom-designed optical pump – THz probe (OP spectroscopic system, we were able to study niobium tin (Nb_3Sn) and it electric response under high magnetic fields using the 25 T Split Florida-Helix. Niobium compounds have been extensively studied for their unique resistivity characteristics [5], critical temperature [6], and electron-phonon interactions. Nb_3Sn specifically is known to have a critical temperature as high as T_c = 18.3 K, which can be up to double th f other niobium compounds [7].



Experimental

The experimental setup is a portable OPTP time domain spectrometer constructed around the 25 T Split Florida-Helix magnet[8]. This system utilizes the Coherent Legend Elite titanium:sapphire laser to emit 25 fs pulses at the fundamental frequency (λ = 800 nm). The mair beam from the source is split into three branches that are used for optic exciting the sample at the fundamental frequency, generating broadbanc e system, and applying a gate pulse for detection in the air-biased coherent detection (ABCD) system. The THz arm transmits through a prototype A15 superconductor (Nb_3Sn) that is mounted within the 25 T magnet where it maintains a base temperature of 13 K.

Results and Discussion

The included figure shows several transmitted terahertz waveforms transmitted through the sample at 13 K as a function of magnetic field (15 T and 20 T are shown here). The calculated bandwidth (not shown) shows substantial narrowing as the field is increased and an overall decrease in the transmitted electric field. These data cannot be explained using a two-component model (superconducting and normal phase) and will require further experiments to elucidate.

Conclusions

We have demonstrated broadband terahertz time-domain spectroscopy through a prototype A15 superconductor as a function of temperature and magnetic field. The narrowing of the terahertz transmitted bandwidth as a function of external magnetic field cannot be explained using

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