Analysing laser machined YBCO micro bridges using Raman spectroscopy and transport measurements aiming to investigate process induced degradation

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Machining high temperature superconducting (HTS) thin films is very challenging due to the material's delicacy. HTS degrade easily when being exposed to humidity, chemicals, electrons/ions, and heat [1-4]. While it is difficult to machine HTS, their critical current density (J_c) can be enhanced by edge-barrier pinning [5]. In this project, we machine 200 nm thin YBCO micro bridges with a femtosecond laser (300 fs, 1030 nm) as a chemical free and flexible method with minimal edge damage. To analyse the bridges before and after the laser processing both transport measurements and Raman spectroscopy are used. While transport measurements are commonly used to measure changes in J_c, we are proposing to use Raman spectroscopy as a new method for quick measurements during the laser processing of YBCO micron bridges to identify heat damages. The link between changes in the Raman spectrum and transport measurements is investigated by identifying spectral changes caused by repeated heat treatments at 300 °C in air while while sequentially measuring J_c and Raman spectra. The goal is to use the obtained data to predict J_c losses from changes in Raman peak intensities and shifts. The limitations of this technique are further investigated when applying it to laser machined YBCO bridges which were exposed to highly localised heating. They also have geometries small enough (< 10 µm) to be a potential problem in relation to the relatively large Raman probe spot size (4 µm). Results show that above certain widths a femtosecond laser can be used to successfully machine bridges with no loss in J_c and that there is some correlation in the Raman spectra.

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