

Introduction

Superconductors are an important tool for use in transmitting huge amounts of power in situations where weight is critical, such as in aerospace.

Normally the power lost as heat in a conductor is proportional to the current squared, and proportional to the length, but in superconductors there is almost no power loss no matter the current or length.

However there exists a critical current I_c after which the superconductor will conduct normally. This arises when the induced magnetic field changes the properties of the material such that it can no longer superconduct.

It is important to understand what will happen in a network of multiple parallel lengths of superconductor if one or more lengths of a lower I_c ceases to superconduct.

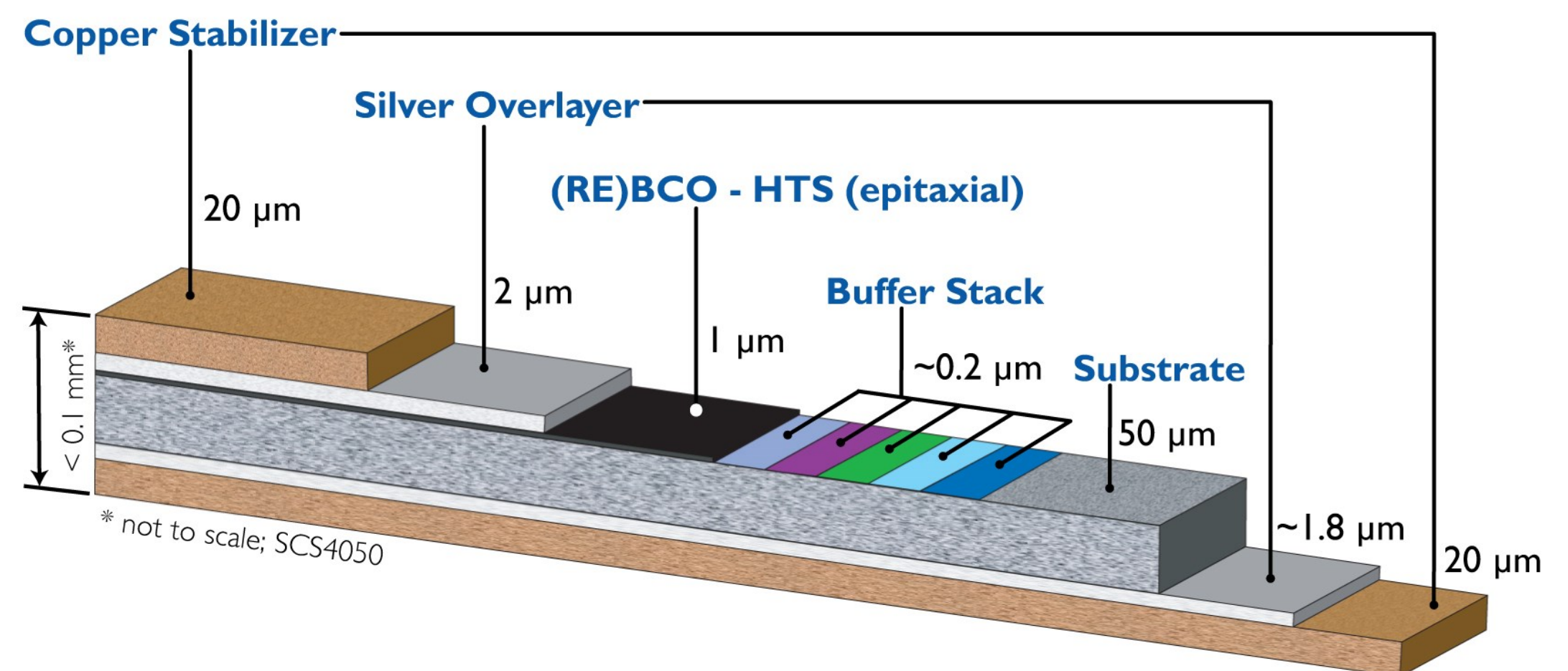


Fig 1: Layer stack up of the High Temperature Superconductor (HTS 2G) used in this experiment. (RE)BCO-HTS is the actual superconductor which is only a micrometre thick.

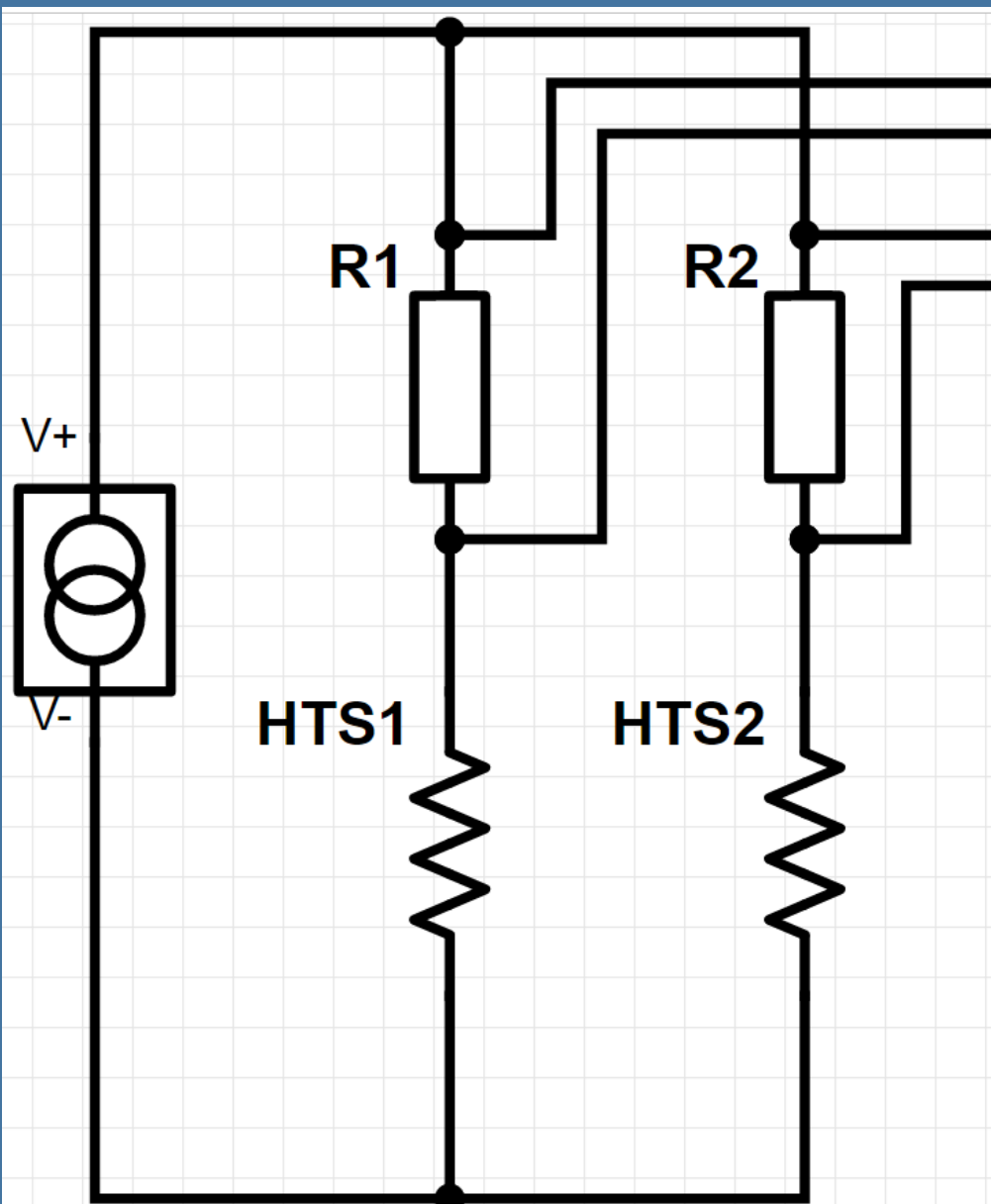


Fig 2: Circuit Diagram of the experiment where HTS1 and HTS2 are the lengths of superconductor and R1 and R2 are the current sense resistors.

Method

Lengths of high temperature superconductor (HTS) were placed in liquid nitrogen (LN2) in different configurations and with different currents. The current in each conductor was measured by connecting a low value resistor in series.

The resistor needed to first be calibrated by placing it in the LN2 and measuring its resistance with a four-wire current measurement.

Figure 2 shows a network of two lengths of HTS in parallel, with R1 and R2 used to measure the current through each superconductor. The current was increased until about 240 Amps, where the critical current was reached in both conductors. Finally the voltage drop across the connection between the HTS and the copper busbar was measured.

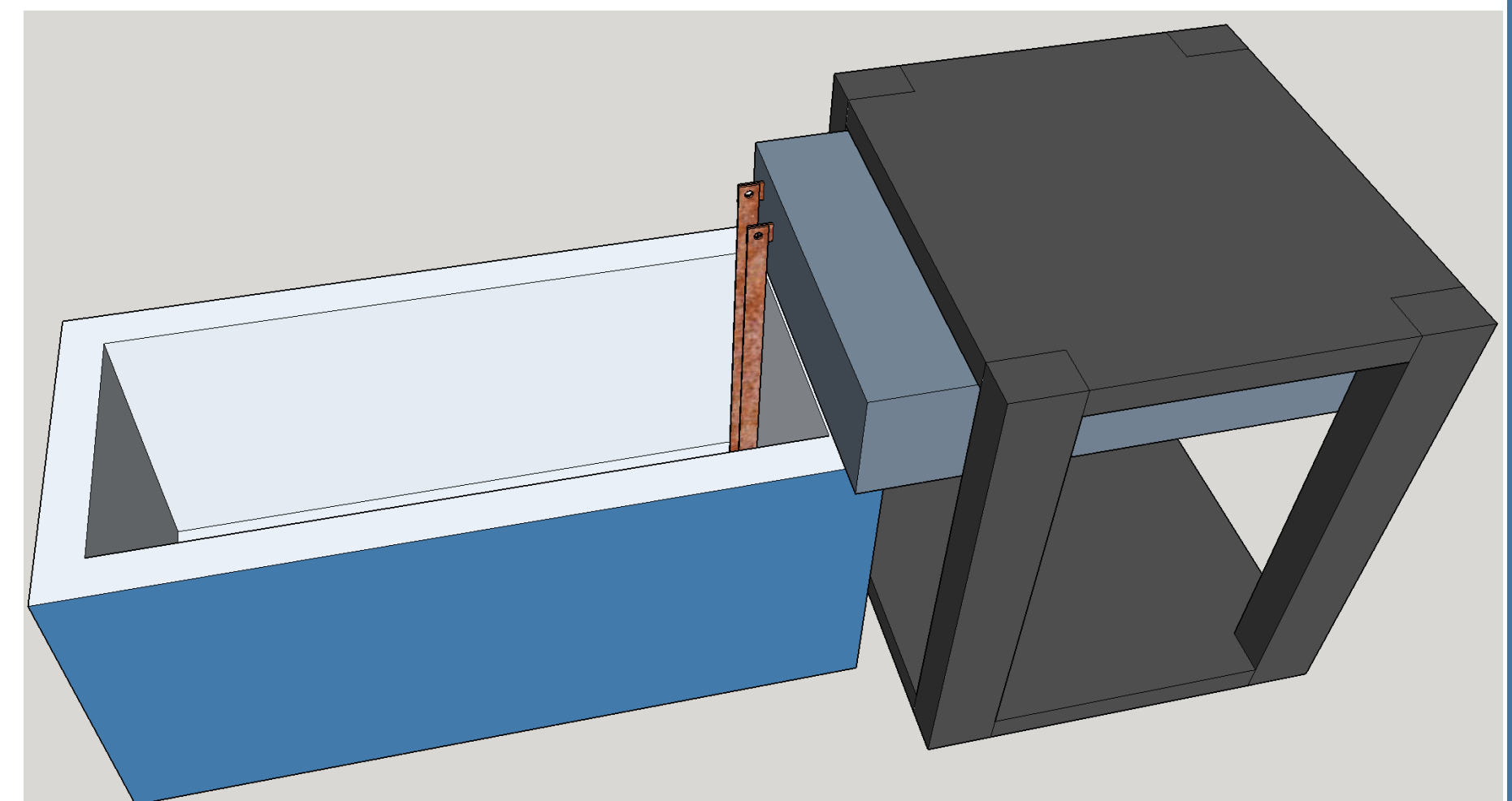


Fig 3: CAD Drawing of the experimental setup showing the cryostat on the left, copper busbars in the middle and the power supply on the right.

Results

The critical current for HTS1 was around 118 Amps, slightly lower than that of HTS2 at around 120 Amps. As the current ramped up HTS1 ceased to superconduct first, causing the remaining current to pass through HTS2, which quickly stopped superconducting. The voltage across the current supply increased above the over-voltage protection of the power supply causing it to cut out.

The voltage drop across the connection between the copper busbar and the superconductor was about 14 milliVolts at a current of 100 Amps, hence the resistance of each joint was about 0.14 milliOhms, and a power loss of 1.4 Watts per joint.

Conclusions

Given more time and a bigger power supply, tests would have been done on a larger number of parallel lengths of superconductor to test these effects with larger systems. A big problem throughout the experiment was connecting the superconductor to other parts in the circuit, as there was a significant resistance, and hence power loss, at each joint. This would be an important issue when used in aerospace applications.