CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

S1819

Project Title

YBCO Superconductor Magnet Repulsion Force: Vortex/Flux Pinning in Type-II Superconductors

Abstract

Objectives/Goals

Superconductors have "zero" resistance in electric current flows. When they are subjected to an external magnetic field, the surface eddy currents are persistent without any loss (superconducting). Thus, superconductors cancel the external magnetic fields and expel magnetic fields. This is called "Meissner effect".

Our experiment's goal was to estimate the magnitude of the force between superconductors and magnets due to the Meissner effect, and possibly how vortex/flux pinning could be observed between magnets and superconductors.

Methods/Materials

In my procedure, we accelerated down a ramp a cart with a magnet attached to the front towards a superconductor. The independent variable was the speed of the cart, and the dependent variable was the stopping distance of the cart.

Materials:YBCO (Yttrium, Barium, and Copper Oxide) Superconductors, Liquid Nitrogen (LN2), PVC pipes for LN2 reservoir, Plumber's putty, Neodymium magnets, Ramp, Low-friction track, Guiding rails, Carts

Results

By accelerating the cart down each position on the ramp and observing whether the magnet contacted the superconductor or not, we saw that the threshold for the repulsive force between the magnet and superconductor was when the cart was accelerated from the position of 2.5 inches from the start of the ramp. Out of 30 trials,the moving magnet struck the conductor 13 times, and was repelled 17 times. The average stop-gap distance (the distance from the superconductor at which the cart stopped moving) for the cart from position 2.5 was 5.5 mm.

Conclusions/Discussion

The force of the superconductor could be estimated by determining the work done by the force between the magnet and superconductor and the stopping distance of the cart. The force function within the magnetic field was defined as B^2/2mu0. Therefore, we could estimate the force between the magnet and superconductor as 11.6 Newtons. We are currently testing a two superconductor setup to observe and estimate the effects of vortex/flux pinning on a moving magnet.

Summary Statement

To observe and calculate the Meissner effect force between moving magnets and superconductors, and the effects of vortex/flux pinning.

Help Received

My Father helped construct the apparatus.