CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Claire R. Arakelian

Project Number
J0701

Project Title
How Temperature Affects Carbon Resistors

Abstract

Objectives/Goals
Determine how temperature affects carbon resistors' resistance. Preliminary research showed that resistance is directly proportional to temperature, R=R(ref){1+a[T-T(ref)]}, where a is the temperature coefficient of resistance.

Methods/Materials
For five 100 Ohm, 1/4 W resistors, measured each resistor's resistance [R(ref)] at room temperature [T(ref)] and resistance [R] at temperatures [T] of -198, -60, 23.6 (Room Temperature) 50, 100, 150, 200 and 250 degrees C.

Results
My average measured resistance at temperatures -198, -60, 23.6, 50, 100, 150, 200 and 250 degrees C were 103.88, 99.34, 98.26, 97.32 96.1, 95.3, 94.425, and 93.9 Ohms, respectively. I fit this data by use of least squares fit to R=-0.02T+98.74. From the slope, -0.02, determined the temperature coefficient of resistance to be -0.0002 /C.

Conclusions/Discussion
Data didn't support hypothesis - resistance increased as temperature decreased. Further research showed this as typical for carbon - a semiconductor.
Semiconductors have an energy gap between the valence and conductive bands. Heating carbon introduces more electrons in the conductive band decreasing resistance; cooling forces the electrons from the conductive band down to the valence band, increasing resistance. Semiconductor resistors have a negative temperature coefficient of resistance, metal resistors - positive.

Summary Statement
The effect of temperature on carbon resistors' resistance.

Help Received
Father provided materials; Aunt helped with charts and graphs; Professor Ares Rosakis, (Director of Director of Graduate Aeronautics Laboratories at Caltech), and Dr. Dale Conners, (Material Science Department at Caltech), for aiding me in interpreting the results and outcome of my experiment.