FAR INFRARED AND THERMAL STUDIES
ON LOW TEMPERATURE MATERIALS

MASTER

Progress Report
for the period July 1, 1979 - March 15, 1980

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ABSTRACT:

The progress report herein will deal with our major progress in setting up the facility for the modulation far infrared spectroscopy as well as experimental results in thermal studies of V_3Si crystalline samples.

REPORT:

In our laboratory there are two major research activities being supported by the contract DE-AC02-79ER-10461.A000 from the Department of Energy. The first project is far infrared spectroscopy. We have started to test the Michelson interferometer, which was bought from Grubb Parsons & Co. Ltd. The insert to hold the sample and the detector inside the new Janis 5RD research dewar is almost complete in our machine shop. In this system a doped-Ge bolometer, cooled to 0.35 K by a ^3He cryostat, will sit inside an integrating cavity. Meanwhile the sample holder with three sample slots available has a separate vacuum space which can be either connected to or separated from the vacuum space for the detector. In this design, the sample temperature can vary from 0.4 K up to 250 K. Consequently, the same system will be suitable for studying both superconductors ($T \leq 25$ K) and superionic conductors ($T \approx 200$ K for $RbAg_4I_5$). Also a computer program to perform the fast Fourier transformation in our LSI-11 computer has been developed. By doing so, we should be able to acquire the spectrum directly from the output of the minicomputer.

The second part of this research project involves thermal studies. In technical aspect, significant improvement has been accomplished in both the signal to noise ratio and data acquisition using the LSI-11 computer. With this achievement, the specific heat of a transforming V_3Si crystal has been

measured from 6 to 30 K in both zero and 52.3 kG magnetic fields. Based on the properties of the second-order phase transition from the normal to the superconducting state in zero magnetic field, various physical parameters characterizing the superconducting and normal states have been derived from thermodynamics and the BCS weak coupling theory. The most important parameter obtained in this analysis is $2\Delta(0)/kT_c = 3.46$, which indicates a weak coupling in our transforming V_3Si crystalline sample. A further check on this result will be carried out by thermal conductivity and far infrared measurements. Another V_3Si crystalline sample has been under extensive study also. For this sample as received, it did not have a structural phase transformation and had an atomic percentage of silicon very close to the boundary between the transforming (with higher silicon content) and nontransforming sample (with less silicon). The exact same sample was first annealed at high temperature ($\sim 900^\circ C$) and in high vacuum ($\lesssim 3 \times 10^{-8}$ torr) for 120 hours. The transforming property did not change. Afterward, it was again annealed at high temperature ($T \sim 900$ K) but in a silicon-rich environment. Then the sample became transforming. This is the first direct evidence that the silicon content has an intimate relation with the transforming properties of V_3Si crystalline samples. Research along this line is continuing.

PUBLICATIONS:

- 1) "Specific Heat of a Transforming V_3Si Crystal," C. C. Huang, A. M. Goldman, and L. E. Toth, Solid State Commun. 33, 581 (1980).
- 2) "Heat Capacity Studies of V_3Si Crystals," C. C. Huang, Bull. Am. Phys. Soc. 25, 333 (1980).
- 3) "The Effect of Si Contents on the Structural Phase Transition in V_3Si ," C. C. Huang, to be published.

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