FINAL REPORT
JUNE, 1996

RESEARCH ON HIGH Tc SUPERCONDUCTING COMPOUNDS

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NASA GRANT NAG 5-2375
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SUMMARY OF RESULTS

This document represents a final report of our research on the grant NAG 5-2375 from NASA during the period October 1, 1993 through March 31, 1996. We successfully performed Mossbauer research using the 21.54 kev resonance radiation of $^{151}$Eu on the high temperature superconductors $\text{Bi}_2\text{Ca}_x\text{Eu}_{0.5}\text{Sr}_2\text{Cu}_2\text{O}_x$ and $\text{EuBa}_2\text{Cu}_3\text{O}_{x}$. For the Bismuth compound the Mossbauer measurements gave a weak signal at room temperature but improved at lower temperatures. Experimental data indicated that europium is located at only one crystallographic site. Isomer shift measurements were $0.69 \pm 0.02$ mm/s with respect to EuF$_3$. The linewidth at room temperature was found to be 2.54 mm/s. This value falls within the values observed by other researchers on Eu based 1,2,3 high-Tc compounds. Our results also show the Eu to be trivalent with no trace of divalent europium present.

Superconducting europium based 1,2,3 compounds were prepared and measurements completed. Our results show the Eu to be trivalent with no trace of divalent europium present. These compounds had an average isomer shift of $0.73 \pm 0.02$ mm/s for all samples made. One of these was irradiated with $3.5 \times 10^{16}$ neutrons and a comparison made of the Mossbauer parameters for the irradiated and non-irradiated samples. Experimental results showed no difference between linewidths but a measurable effect was seen for the isomer shift.
INTRODUCTION

There have been extensive studies on high temperature superconductors, however the exact mechanism for superconductivity in these compounds is not understood. We undertook this scientific investigation in order to gain a better understanding of some of the characteristics of this very important class of compounds. We are pleased to report the successful results of our Mossbauer study on high temperature superconductors. Results from the research have been presented at the 1995 Spring Washington Meeting of The American Physical Society (1), the HBCU Workshop on the Physics of Materials and Materials Science in Washington, DC in October of 1994 (2), and the 1996 March Meeting of The American Physical Society in St. Louis (3). A full length paper is being prepared for submission to Physica C for publishing which includes some of the results from these investigations(4). We are also planning to submit a paper to a the journal, Computer Physics Communications detailing the usefulness of the MATLAB software package in analyzing Mossbauer data.

In addition to the above, we greatly improved our research capability with the addition of new equipment and the development of improved software which was written under the auspices of this grant.

RESEARCH RESULTS

We were highly successful in our attempt to use the Mossbauer Effect to study high temperature superconductors by substituting the Mossbauer active rare-earth element europium. Figure (1) shows the apparatus used to make compounds. Figure (2) shows a block diagram of the experimental set-up of the Mossbauer spectrometer. Work studied by our laboratory during the grant period included a particle size investigation, an irradiation study, and a phonon study. Several 1,2,3 superconductors were made with transition temperatures between 90.8°K and 102.7°K. Table 1 shows the transition temperatures and widths for the samples made. Mossbauer measurements showed all samples to be trivalent, nonmagnetic, and to have an excellent linewidths when compared to the standard EuF3. Results from these investigations were reported previously to NASA in the various annual reports(4,5,6).

<table>
<thead>
<tr>
<th>Pellet</th>
<th>Tc(K)</th>
<th>Transition Width (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCD</td>
<td>92.1</td>
<td>0.2</td>
</tr>
<tr>
<td>BBC</td>
<td>96.1</td>
<td>0.5</td>
</tr>
<tr>
<td>BBB</td>
<td>95.0</td>
<td>1.4</td>
</tr>
<tr>
<td>ABB</td>
<td>102.7</td>
<td>1.0</td>
</tr>
<tr>
<td>BBA</td>
<td>94.4</td>
<td>1.4</td>
</tr>
</tbody>
</table>

3.
Particle Size Study

We were part of a group effort looking at the relationship of starting particle size for the various compounds used to make a superconductor with the final superconductor. Our laboratory did the Mossbauer studies. We looked at the Mossbauer parameters of linewidth and isomer shift. Linewidth renders information about the site locations, and isomer shifts gives information about the electronic structure and s-electron interaction at the Mossbauer active atom. Mossbauer spectra were taken in transmission geometry at room temperature in the constant acceleration mode and fitted by a least squares analysis. Table 2. shows the Mossbauer results for the various superconductors. Europium fluoride was used as a standard for isomer shift calculations and an iron foil was used to calibrate the system. Figures 3 through 7 show the Mossbauer experimental data for the various particle sizes. The experimental results did not show any systematic relationship between the Mossbauer parameters and starting particle size. This is understandable since the Mossbauer effect investigates particles on the atomic level. This also agrees with the results found by Howard et al on their study on relationship between particle size and transition temperature for high Tc compounds(8). A paper is being written which includes our Mossbauer results(9).

<table>
<thead>
<tr>
<th>Sample</th>
<th>L.W. (mm/s) (± .05)</th>
<th>L.W. Ratio</th>
<th>I.S. (mm/s) (± .02)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EuF₃</td>
<td>2.90</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>BBC</td>
<td>2.67</td>
<td>0.92</td>
<td>0.74</td>
</tr>
<tr>
<td>BBA</td>
<td>2.83</td>
<td>0.98</td>
<td>0.77</td>
</tr>
<tr>
<td>BBB</td>
<td>2.92</td>
<td>0.99</td>
<td>0.69</td>
</tr>
<tr>
<td>BAB</td>
<td>2.58</td>
<td>0.89</td>
<td>0.78</td>
</tr>
<tr>
<td>CCD</td>
<td>2.66</td>
<td>0.92</td>
<td>0.70</td>
</tr>
<tr>
<td>ABB</td>
<td>2.61</td>
<td>0.90</td>
<td>0.69</td>
</tr>
</tbody>
</table>

L.W. = line width
I.S. = isomer shift
Irradiation Studies

There has been several investigations to observe irradiation effects in other types of materials using the Mossbauer isotope $^{57}$Fe, but this is the first reported attempt using $^{151}$Eu. Previous researchers discovered that neutron irradiation increased the important critical current density in high Tc superconductors (11). This improvement was attributed to the creation of defects in the material. We undertook this study to see what observables one could identify due to neutron irradiation using $^{151}$Eu Mossbauer spectroscopy. Superconductors were irradiated with $3.5 \times 10^{16}$ neutrons and a comparison made of the Mossbauer parameters for the irradiated and non-irradiated samples. Our experimental results showed no substantial difference between linewidths, but a measurable effect was brought out by the computer fitting for the isomer shift. Figure (8) shows the spectrum for the irradiated superconductor and table 3. summarizes the results of the investigation. No increase in linewidth means that all the europium atoms are found in similar atomic sites. The change in isomer shift due to irradiation implies that there is an increase in the s electron density at the nucleus of the europium atom. This suggests to get a higher current density in superconducting materials, one needs to modify the superconductor to increase its s electron density. Another competing mechanism may be due to the europium absorbing the neutrons and causing a difference in the isomer shift. Europium is sometimes used in control rods in nuclear reactors because of its ability to absorb neutrons. The isomer shift is known to be dependent on the nuclear radius and the absorption of neutrons may cause a detectable change in the nuclear radius which may be what we are observing. If this is true then this effect would have application in nuclear physics. Additional studies need to be done, perhaps with higher dosages to see if the trends cited above are consistent and more pronounced.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Linewidth Ratio</th>
<th>Isomer shift (mm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EuF$_3$</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>EuBa$_2$Cu$<em>2$O$</em>{7-x}$</td>
<td>.90 $\pm$ .05</td>
<td>.82 $\pm$ .01</td>
</tr>
<tr>
<td>EuBa$_2$Cu$<em>2$O$</em>{7-x}$ (Irradiated)</td>
<td>.85 $\pm$ .05</td>
<td>.94 $\pm$ .01</td>
</tr>
</tbody>
</table>
Phonon Studies

We reported on our previously observed phonon anomaly (1) in a Bi high Tc compound at the March 1995 American Physical Society meeting in Washington D.C. This work indicated that other sites besides the commonly accepted copper planes are effected by the superconductivity mechanism. At the time of the presentation this was a unique concept. Since then however there have been other theories that predict the possibility of the superconducting mechanism occurring at other locations besides the copper planes(9). Our results also indicate that the s electron density as shown by isomer shift measurements are similar for the different types (2112 vs 1,2,3) of superconductors.

Software Development

During the period of the grant, we developed many new computer subroutines to reduce the tedious task of analyzing data. Several codes developed were cited in earlier reports to NASA (4,5). Significant codes developed included MOSSL13.BAS which enabled us to modify the software provided by the company who designed our Mossbauer system into software that could feed experimental data directly into another program we developed for curve fitting using the software package MATLAB. The advantage of MATLAB is that one can use a pc instead of a mainframe computer to analyze Mossbauer experimental data. We found this program to give us the same results as that found using the mainframe. This capability frees any Mossbauer research laboratory from the restrictions imposed by using a mainframe computing system. We plan to submit this program for publication in a computer physics journal(7). A copy of this code MOXXX.m is found in Appendix B. An example of the results of this fitting routine is shown for the iron standard used in our experiments in figure (7).

Laboratory Development

We greatly increased our research capability with the addition of new equipment and the development of improved software. The Mossbauer Laboratory now has two research grade Mossbauer spectrometers. Currently there are only three locations in Maryland where Mossbauer spectroscopy can be done. Those three being Morgan State, Johns Hopkins University, and UMBC. As a result of this grant we strengthened our collaborative ties with both Hopkins and UMBC and this cooperation will enhance the state of Mossbauer research in the state of Maryland and the nation and will be of great benefit in this era of decreasing funds for scientific research. Many individuals strengthened their research capability because of working on this grant. Seven students working on the project subsequentially graduated ( 4 graduates, 3 undergraduates). Seven additional undergraduates are still in college in physics or engineering and two high school students have indicated that they will major in physics or engineering when they enter college. A
list of participants and their duties is located in appendix c.

REFERENCES


10. Seifu, D., Oliver, F.W., and Hoffman, E., "Curve Fitting of Mossbauer Data using MATLAB" (to be submitted to Computer Physics Communication).

Setup for the sintering and annealing process for producing superconductors

Figure 1.
BLOCK DIAGRAM OF MOSSBAUER SPECTROMETER

Figure 2.
Superconductor CCD

Figure 4.
Superconductor ABB

Velocity in mm/sec relative to europium fluoride

Figure 7.
APPENDIX A - PAPERS PRESENTED
10:00
110 11 Determination of Gap Distortion and Longitudinal Resonance Frequency in Superfluid $^3$He-B. M.R. RAND, D.T. SPRAGUE, T.M. HAARD, J.B. KYCIA, F.J. HAMOT, Y. LEE, D.M. MARKS, W.P. HALPERIN, Northeastern University. — We have performed pulsed transverse nuclear magnetic resonance in superfluid $^3$He-B. We derived and then numerically solved the Leggett equations for the high field limit. From our experiments and our analysis of the Leggett equations, we have determined the temperature dependence of the longitudinal resonance frequency and the distortion of the energy gap. Numerical solutions show that the tipping angle dependent precession frequency generally differs substantially from the prediction of stationary solutions and depends on the magnitude of the transverse tipping field. However, for tipping angles of $\theta < 60^\circ$ and also for $\theta \approx 125^\circ$, the precession frequency agrees with the stationary solution, being insensitive to the magnitude of the tipping field. This work is supported by the National Science Foundation through grants DMR-9214005 and DMR-9211918.

10:12
110 12 Theory of Pulsed NMR Studies in Solid $^2$H$_2$. T. DINESEN, B. C. SANCTUARY, M. C. GILL, and H. MEYER, Duke U. — Density matrix theory is used to calculate the response signal of $^2$H$_2$ (with rotational angular momentum $J=0$ and nuclear spin $I=2$) in two- and three-pulse NMR experiments. A closed-form method has been successfully applied$^{11}$ to the solid echo properties of $^2$H$_2$ and $^2$D$_2$ ($J=1$ and $I=1$), but had not previously been developed for the $I=2$ spin system. We find, as expected, similar functional dependence upon the experimental parameters of both ortho and para systems and arrive at a detailed account of the intermolecular dipolar field. While this closed-form method considers individual contributions to the echo amplitude, greater physical insight is gained by considering the rotational invariance properties of the line shape. Results from a spherical tensor and product operator basis are then compared with one another as representations of the quadrupolar solid echo response problem. Finally, the predicted solid echo amplitude ratio of the $I=1$ and $I=2$ components, expressed as a function of the time between the pulses and their respective phases $\Phi$, is compared with that observed$^{1}$ for several $^2$H$_2$ crystals of various $J=1$ concentrations. We also discuss the satellite echoes, predicted for the $I=2$ system, which have been observed$^{2}$ in $^2$D$_2$ adsorbed on MgO but not$^{1}$ in solid $^2$D$_2$.


SESSION 111: DAMOP: ATOMIC AND MOLECULAR STRUCTURE AND SPECTROSCOPY
Thursday morning, 20 April 1995
Room 3 at 8:00
R. Pratt, presiding

111 1 Rovibronic Spectroscopy of the Ethoxy Radical in a Supersonic Jet Environment PRABHAKAR MISRA, Howard University. — The ethoxy ($^2$CH$_3$O) radical is generated as a chemical intermediate in combustion and atmospheric processes. It belongs to the C$_3$ point group and has 18 fundamental vibrational frequencies. $^2$CH$_3$O was produced in situ by photolyzing freshly synthesized $^2$CH$_3$ONO in a pulsed supersonic expansion with KrF (248 nm) excimer laser pulses. A frequency-doubled Nd:YAG-pumped dye laser with a nominal linewidth of 0.07 cm$^{-1}$ served as the probe beam for excitation of the radical. Extensive laser excitation spectra of jet-cooled $^2$CH$_3$O have been recorded in the 310-350 nm region with 0.15 cm$^{-1}$ resolution. Wavelength-resolved emission spectra have also been obtained with an Optical Multichannel Analyzer system, which employed CCD detection in conjunction with a 0.275 m monochromator equipped with a 1200 grooves/mm grating that provided a resolution of 0.5 nm. Several new vibrational frequencies have been identified for the $^2$CH$_3$O radical.

111 2 151Eu Mössbauer Investigation on a Bismuth High-$T_c$ Superconductor. F.W. OLIVER, E. HOFFMAN, D. TARLETON, Morgan State University, L. MAY, The Catholic U. of America, C.E. VALENTIN, LLNL, and M.S. SEEBER, West Virginia University. We report on Mössbauer studies on Bismuth high-temperature superconductors with a particular emphasis on our findings on the superconductor Bi$_2$Ca$_2$Cu$_3$O$_{8+}$. Magnetic susceptibility measurements show a transition temperature of 87 K. The Mossbauer measurements were performed between liquid nitrogen and room temperature. Isomer shift measurements show the Eu to be trivalent and is similar to those found for Eu based 1,2,3 high-$T_c$ superconductors. Evidence of phonon softening is observed about the Eu atom during transition to the superconducting state. A discussion on the isomer shift and $f$ factor as a function of temperature will be reported and compared with previous results found in Eu based high-$T_c$ superconductors.

Support by NASA - NAG 5-2375.

8:36
111 4 Quanized Magnetic Flux in Atomic Systems. R.L. COLLINS, retired, HCO1 Box 106C, Rockport, TX 77362. — Magnetic flux within a superconducting ring is quantized in units of $\Phi_0/2\pi$. (1.2) This same flux quantum also plays a role within atomic systems. An oscillating charge "q" creates, about itself, an encircling and transient magnetic field. The Schrödinger equation requires correction of the $<p>$ operator, $\hbar/2m$/$\Psi$ becoming $\hbar/2m$/$\Psi_q$. (where A is the vector potential). Following Feynman (3), a wave function written as $\Psi(r) = \Psi_q(r) \exp(i\Phi(r))$ leads to a current density $j(z) = (\hbar/2m)(V\Phi - \langle 2q(x)\rangle \Phi)$ or $m = (\hbar/2m)(V\Phi - \langle 2q(x)\rangle \Phi)$. On integrating this last equation along the displacement between turning points of the motion, the magnetic flux $\Phi$ is readily obtained. The first term is
were calculated based upon the nucleation rate theory, assuming that
the molecular volume and the surface free-energy of the electrically
active oxygen clusters are not affected by the presence of hydrogen
in the silicon matrix. From the present analysis, it was found that
the activation energies of interstitial oxygen diffusion in silicon
containing hydrogen are between 0.13 and 0.28 eV lower than the
normal value of 2.53 eV. Based upon the result showing a
logarithmic dependence of the activation energy on hydrogen
supersaturation in the silicon matrix, it is proposed that enhanced
oxygen diffusion is governed mainly by hydrogen supersaturation
and not the presence of hydrogen in the matrix alone.

H31 114
Phase diagrams for structural phase transformation in spinels.
V. F. Shishkin and B. N. N. Achar, The University of Memphis.- We
have investigated the structural phase transformation in spinels on the
basis of a six component order-parameter Landau theory. Phase
diagrams plotted in the plane of two thermodynamic variables can
account for the experimentally observed $\mathrm{O}_2 \rightarrow \mathrm{O}^{\text{e}}$ transformations.

H31 115
Growth Induced Alignment and Assignment of the Vibrational Modes of C in AIGaAs.* J.-F. ZHENG, MICHAEL
STAVOLA, Lehigh University, C. R. ABERNATHY and S. J. PEARTON, University of Florida. - Seven infrared absorption bands
observed in C doped AIGaAs near 600 cm$^{-1}$ have been assigned to the vibrations of $\mathrm{CaS}$.
$^{2,3}$ The complexity of this spectrum has prevented the assignment of the vibrational bands to specific $\mathrm{CaS}$
modes that are associated with different numbers of $\mathrm{Al}$ neighbors, although considerable progress has been made$^{2,3}$ toward
understanding $\mathrm{CaS}$ by studying the C-H complexes in hydrogenated
AIGaAs. We have recently discovered that the vibrational absorption due to $\mathrm{CaS}$ in AIGaAs grown by metalorganic MBE is polarized along
specific $<110>$ directions in the (001) growth plane. A similar growth
induced alignment was discovered previously$^{3}$ for a $\mathrm{CaF}_2$-H complex in epilayer AIGaAs. - We assign the polarized absorption bands
in AIGaAs to $\mathrm{CaS}$ atoms with $\mathrm{Al}$ neighbors that have been aligned along specific directions during growth and use the additional
information that the alignment provides to assign the $\mathrm{CaS}$ modes.

*ONR Grant No. N00014-94-1-0117 and N00014-93-1-0857.

H31 116
Density Functional Theory of Insulators : Exchange-Correlation Electric fields. XAVIER GONZE, PHILIPPE GHOSEZ,
Unité PCPM, Université Catholique de Louvain, Belgium, REX
GODBY. Department of Physics, University of York, United Kingdom
- We examine the density functional theory of periodic, infinite, insulators, obtained either from the limit of a finite piece of matter for increasing volumes, or from Born-von Karman conditions. In the first case, and for solids where the value of the surface charge is not imposed by the symmetry of the bulk solid, a homogeneous exchange-correlation electric field will appear, in order to induce the correct value of the
surface charge. In contrast, in the second case, the topology of the problem precludes a homogeneous exchange-correlation electric field, and the Berry's phase computation of the polarization from the Kohn-Sham orbitals will not give the same value as that derived from the many-body wavefunctions. This effect is exhibited for a model 1-D semiconductor.
The exchange-correlation kernel of the latter is also obtained, and
exhibits a $O(1)$ divergence in the small-wavevector limit, confirming
previous theoretical discussions.


H31 117
Dynamics of rough Ge(001) surfaces at low temperatures. S. JAY CREE, JOSEPH VANNOSTRAND, DAVID G. CAHILL.
Department of Materials Science, University of Illinois, Urbana, IL
- The relaxation of nonequilibrium surface morphologies is studied by
nanometer length scales and at temperatures far below roughening using
in-situ scanning tunneling microscopy. Controlled multilayer surface
roughness is produced by low-energy ion etching of Ge(001) at 270°C;
the characteristic in-plane length scale of the roughness is varied from
37-118 nm. These surfaces are subsequently annealed at temperature in the
range 220-325°C for 10-360 minutes and imaged at room temperature.
The activation energy for surface smoothing is $1.92 \pm 0.25$ eV.
The dependence of the relaxation rate on the in-plane length scale
is consistent with the continuum model of Mullins: the time constant $\tau$
of the smoothing process increases with increasing lateral length scale L
as $\tau \sim L^2$. n=2.2\pm0.4. The results are consistent with a simple model based on step mobility, step-step interactions, and uncorrelated motion of
adjacent steps.

H31 118
Optical Absorption of Chromium in Bismuth Tellurite Bi$_2$Te$_3$O$_5$. L. A. KAPPERS and R. H. BARTRAM. Univ. of Conn.
Storrs, CT. I. FOLDVARI and A. PETER, Research Lab. for
Crystal Physics, Budapest, Hungary. — Bismuth tellurite is a new non-
linear optical material with interesting photorefractive properties
including a long lived signal component [1]. It crystallizes in a permuted
CaF$_2$ structure which contains large numbers of open oxygen positions [2]. This results in unusual coordination numbers of 7 and 8 around Bi
groups [3]. This results in unusual absorption bands in Bi$_2$Te$_3$O$_5$ that covers the visible and near infrared range. White light
exposure and thermal annealing modify the spectrum in opposite
directions. The original spectrum and its changes could only be explained by assuming the presence of $\mathrm{C}_6^{4+}$ and $\mathrm{C}_7^{5+}$ valence states.
The coordination symmetry of the lattice points and the possibility of
filling the open anion positions with excess $\mathrm{O}^{2-}$ ions support this model.
Supported by NSF Grant INT-9222297, Univ. of Conn. Res. Found.,
and Hungarian Res. Found. (OTKA-T-014884).
1. I. Foldvári, M. Liu, R.C. Powell and A. Péter, J. Appl. Phys. 71,
Phys. 9, 467 (1983).

H31 119
A Mössbauer Study of the Effects of Neutron Irradiation on a
High Temperature Superconductor. F. W. Oliver, E. Hoffman, D.
Baltimore, MD. J. Howard, Hofstra University, Hempstead, N.Y., C.
Wynter, Nassau Community College, Nassau, N.Y. It has been found that neutron irradiation of high temperature superconductors change properties of the material. We report on a Mössbauer investigation of neutron irradiated EuBa$_2$Cu$_3$O$_y$ using the 21.53 kev transition of
153Eu. A sample was irradiated with approximately $3.5 \times 10^{15}$
neutrons and a comparison made of the Mössbauer parameters for the irradiated and non-irradiated samples. Experimental results showed no difference between line-widths for this level of radiation but a measurable effect was seen for the isomer shift. A discussion of the isomer shift will be reported and compared with previous results
found on irradiated low temperature superconductors.

Sankar, J. O. Willis, J.R. Coss, and M. Maley, Appl. Phys.
Supported by NASA - NAS 5-2375

HISTORICALLY BLACK COLLEGES AND UNIVERSITIES WORKSHOP ON THE PHYSICS OF MATERIALS AND MATERIALS SCIENCE (HBCU PMMS'94)

Crystal Gateway Marriott Hotel
Washington, D. C.
October 13–15, 1994

Tentative Schedule

Wednesday, October 12, 1994

7:00–9:00 p.m. Registration and Reception, Salon I, Crystal Gateway Marriott Hotel

Thursday, October 13, 1994

7:00–8:30 a.m. Breakfast (Salons H and J) and Conference Registration

8:30–9:00 Opening Ceremony (Salons B and C)

Dr. William T. Oosterhuis, Branch Chief
Division of Materials Sciences, Office of Basic Energy Sciences
United States Department of Energy

Dr. Earl Richardson, President
Morgan State University

Dr. Bill R. Appleton, Associate Director for the Advanced Neutron Source, Oak Ridge National Laboratory

ELECTRONIC AND OPTOELECTRONIC PROPERTIES OF MATERIALS

Session Chairman—Michael D. Williams
AT&T Bell Laboratories

9:00–9:40 Ab Initio Study of the Structural and Electronic Properties of Solid Cubane—Steven L. Richardson, Howard University, and José Luís Martins, INESC, Lisboa, Portugal

20.
Poster Session D: WIDE BAND GAP MATERIALS
4:00–5:30 p.m., Salon C

D1 An FT Raman and FTIR Investigation of PAN-Based Carbon Fibers—Chai-Pei Chang, Georgia Institute of Technology; Subhash C. Bhatia, Spelman College; and Satish Kumar, Georgia Institute of Technology

D2 Optical Emission Analysis of Pulsed-Laser Deposition of Diamondlike Carbon Films—Alessandro Rengan, Central State University

D3 Carrier Velocity in Wide Band-Gap Materials—Craig J. Scott, Ronald Green, and Carl White, Morgan State University, and André D. Cropper, Virginia Polytechnic Institute and State University

D4 Synthesis and Characterization of Homoepitaxial Diamond Films—L. F. Sutcu, Clark Atlanta University; C. J. Chu, R. H. Hauge, and J. L. Margrave, Rice University; and M. P. D’Evelyn, Rensselaer Polytechnic Institute

D5 Fabrication of Beta Silicon Carbide Diodes Using Proton Isolation—J. Coleman and G. L. Harris, Howard University

Poster Session E: HIGH-TEMPERATURE SUPERCONDUCTORS
4:00–5:30 p.m., Salon C

E1 A Possible Mechanism of High-Temperature Superconductivity—J. D. Fan and Y. M. Malozovsky, Southern University and A&M College

E2 Impurity Studies on Some High-Temperature Superconductors—A. B. Kebede, C. Buford, and S. Mtingwa, North Carolina A&T University

E3 Mössbauer Studies on High-Temperature Superconductors—F. W. Oliver, Morgan State University; L. May, The Catholic University of America; and C. E. Violet, Lawrence Livermore National Laboratory


E5 Theory of High-Tc Superconductivity in Cuprates—T. Tsang, Howard University
APPENDIX B - SOFTWARE DEVELOPMENT
i0=1;

x=1:1:nd;

y = reshape(M',1,nd);

for i=1:31;
   ii = i.*16;
   y(ii) = (y(ii-1) + y(ii+1))./2.;
end;

y(512) = y(511);

for i=1:16;
   y(i)=y(17);
end;

'plot(x,y,'o')
end

chisq=1;

ymin = y(i0);
ymax = y(i0);
for i=i0:nd;
   if y(i)<ymin
      ymin=y(i);
      imin=i;
   end
   if y(i)>ymax
      ymax=y(i);
   end
end

yminbs = ymin;
ymaxbs = ymax;

y = (y - ymin)./(ymax - ymin);
x = (x - 1)./(nd-1.);

pp = (pp - 1.)/(nd-1.)
bb = bb/(nd-1.)

hh = 1./(bb.^2)
hhold = hh;

count = 1

while (count) < 24
   count = count + 1
   for i=i0:nd;
      for k=1:L;
         xp(k,i)=x(i)-pp(k);
         xpsq(k,i)=xp(k,i).^2;

23.
qq(k,i) = 1 + hh(k) .* xp(k,i) .* 2;
qqsq(k,i) = qq(k,i) .* 2;
end
d
*tt = zeros(3 + 3*L, nd);
for il = i0 : nd;
for kl = 0 : L - 1;
*tt(1 + 3 * kl, il) = 1 ./ (qq(l + kl, il));
*tt(2 + 3 * kl, il) = xp(l + kl, il) ./ qqsq(l + kl, il); 
*tt(3 + 3 * kl, il) = xpsq(l + kl, il) ./ qqsq(l + kl, il);
end end
for il = i0 : nd;
*tt(4 + 3 * (L - 1), il) = 1;
*tt(5 + 3 * (L - 1), il) = x(il);
*tt(6 + 3 * (L - 1), il) = x(il) .* 2;
end
mm = zeros(3 * L + 3, 3 * L + 3);
for nl = 1 : 3 * L + 3;
for n2 = 1 : 3 * L + 3;
mm(nl, n2) = sum(*tt(n2, :) .* *tt(nl, :));
end end
*nn = zeros(3 * L + 3, 1);
for n3 = 1 : 3 * L + 3;
*nn(n3, 1) = sum(y .* *tt(n3, :));
end
% det(mm)
*zz = inv(mm) .* *nn;
for k2 = 1 : L;
*aa(k2) = *zz(1 + 3 .* (k2 - 1));
*gama(k2) = *zz(2 + 3 .* (k2 - 1)) / (2 .* *aa(k2) .* hh(k2));
*delta(k2) = - *zz(3 + 3 .* (k2 - 1)) / *aa(k2);
end
*ee = *zz(4 + 3 * (L - 1));
*ff = *zz(5 + 3 * (L - 1));
*gg = *zz(6 + 3 * (L - 1));
for k3 = 1 : L;
*hh(k3) = *hh(k3) + *delta(k3);
*pp(k3) = *pp(k3) + *gama(k3);
end
for i = i0 : nd;
*xsq(i) = x(i) .* 2;
for k4 = 1 : L;
xmppsq(k4, i) = (x(i) - *pp(k4)) .* 2;
end end
yy = (aa(1,1)/(1 + hh(1,1).*xmpppsq(1,:))) + (aa(1,2)/(1 + hh(1,2).*xmpppsq(2,:))) + (aa(1,3)/(1 + hh(1,3).*xmpppsq(3,:))) + (aa(1,4)/(1 + hh(1,4).*xmpppsq(4,:))) + (aa(1,5)/(1 + hh(1,5).*xmpppsq(5,:))) + (aa(1,6)/(1 + hh(1,6).*xmpppsq(6,:))) + ee + ff.*x + gg.*xsq;

chisq = sum((yy - yt).^2./nd-L)

yp = ee + ff.*x + gg.*xsq;

xpmin = - ff./((2.*gg));

xpmnsq = xpmin.^2;

ypmin = ee + ff.*xpmin + gg.*xpmnsq;

if (count) <= 2
    y = y - yp + ypmin;
    yt = yt - yp + ypmin;
end

end

delta

gama

pp

hh

bb = 1./sqrt(hh)

baseline = ee + ff.*xpmin + gg.*xpmnsq

for i = 1:16;
    y(i) = baseline;
end;

width = bb.*(nd-L)

peak = pp.*(nd-L) + 1.

c499 = 2.245 ./(((peak(2)-peak(1)) + (peak(3)-peak(2)) + (peak(5)-peak(4)) + (peak(6)-peak(5)))/4.

c499 = (peak(3) + peak(4))/2.

LW499 = bb.*(nd-L).*c499

x = (x - c499./nd).*c4199.*.(nd-L);

y = (y + yinbs.)/(ymaxbs - yinbs.)/(baseline + yinbs.)/(ymaxbs - yinbs.);

yt = (yt + yinbs.)/(ymaxbs - yinbs.)/(baseline + yinbs.)/(ymaxbs - yinbs.);

ppc = (pp - c499./nd).*c4199.*.(nd-L);

Hypfld = ((ppc(2)-ppc(1)) + (ppc(3)-ppc(2)) + (ppc(5)-ppc(4)) + (ppc(6)-ppc(5)))/3.

subplot(2,1,1)

plot(x,y,'o',x,yt);

legend('data','fit')

title('Fe (B600-09)')

xlabel('Velocity [mm/s]')

ylabel('Relative Transmission')

print('plot.ps')
10 REM MOSSPLOT.BAS
15 COLOR 1, 11
20 CLS : KEY OFF
22 LOCATE 2, 1
25 PRINT "Adapted from a program by R.L. Collins, Austin Science Associates, Inc.,"
30 PRINT "Austin TX 78745"
40 PRINT " Fall, 1995, version by E.J. Hoffman, Morgan State University Physics Dept."
60 PRINT "Welcome to": PRINT
65 PRINT "M O S S P L O T"
70 CLS
72 ON KEY(10) GOSUB 10100: KEY(10) ON: REM Setting F10 for returning to the menu at any time
73 PR = 0
74 ON KEY(5) GOSUB 10160: KEY(5) ON: REM Setting F5 for use of the line printer
75 LOCATE 10, 12: PRINT "IF YOU WISH THE LINE PRINTER TO RECORD THE OPERATION,"
76 PRINT : PRINT : PRINT "PRESS FUNCTION KEY F5"
77 BEEP; GOSUB 10050: GOSUB 10050: CLS
78 LOCATE 25, 8
79 PRINT "TO RETURN TO THE MENU AT ANY TIME PRESS FUNCTION KEY F10 (Enter)"
80 NUTEMS = "": NEWFILES = "": DATS = "": BOXS = ""
82 LOCATE 1, 35
84 PRINT "MENU:": PRINT
85 PRINT "1) Plot a theoretical curve from parameters given by the"
86 PRINT "MOSS curve-fitting program (on the"
87 PRINT "VAX$):": PRINT
90 PRINT "2) Print out the data from 512-channel *.smf files created"
91 PRINT "by the ASA-modified The Nucleus PCA": PRINT
95 PRINT "3) Create a .inp file for input into the"
96 PRINT "M O S S program:": PRINT
100 PRINT "4) For a *.smf file, calculate velocity"
101 PRINT "from interferometer data;"
102 PRINT "4') For a *.smf file run without the interferometer,"
103 PRINT "5) Overplot a fitted curve from parameters"
104 PRINT "given by the MOSS program:": PRINT
107 PRINT "6) Plot data points and overplot the fitted curve from a DAT"
108 PRINT "file downloaded from the VAX$:": PRINT
110 PRINT "7) Exit MossPlot"
120 PRINT : INPUT "Enter your choice from the menu by number: ": NUTEMS
124 ITEMS = NUTEMS
125 ON ERROR GOTO 10300
126 IF ITEMS <> "7" AND PR=1 THEN LPRINT : LPRINT "";
127 ON ERROR GOTO 0
129 NUTEMS = 512: REM Item 6 may alter this
130 IF ITEMS = "1" THEN CLS : GOTO 6000
131 IF ITEMS = "2" THEN CLS : GOTO 1000
135 IF ITEMS = "4" THEN VELSTDS = " by interferometry";
136 IF ITEMS = "5" OR ITEMS = "4" THEN CLS : GOTO 6000
170 IF ITEMS = "5" THEN CLS : BOXS = "DRAWN": GOTO 6180
180 IF ITEMS = "6" THEN CLS : GOTO 2000
190 IF ITEMS = "7" THEN CLS : GOTO 600
200 GOTO 130
600 CLS
605 LOCATE 25, 2
610 INPUT "Exit MOSSPLOT (yes, no)"; EX$" 620 IF EX$ = "Y" OR EX$ = "y" THEN GOTO 720
720 DIM X(4000): PRINT : PRINT : PRINT
730 INPUT "Name of *.smf file (you may type without the .smf extension): ": NEWFILES
732 PRINT : PRINT
740 DGT = 1: REM Initializing at the first digit
745 WHILE CHS <> CHR$(46) AND DGT < (LEN(NEWFILES$) + 2): REM Up to the dot if there is one
750 CHS = MID$(NEWFILES$, DGT, 1): REM Filename character
755 DGT = DGT + 1
760 WEND
762 NEWFOS = LEFT$(NEWFILES$, DGT-2): REM Filename without dot or extension
764 IF NEWFOS = FQS THEN RETURN
765 FQ$ = NEWFOS
765 FSS = FQS + ".smf"
767 ON ERROR GOTO 10175
768 rem error 53
770 OPEN FSS FOR RANDOM AS #1 LEN = 64
772 ON ERROR GOTO 0
775 FIELD #1, 64 AS A$
780 GET #1, 1
785 FOR J = 9 TO 40
790 GET #1, 1
800 FOR J = 1 TO 64
810 K = 64 * (I - 1) + J
820 A$ = MID$(AS, J, 1)
830 X(K) = ASC(A$)
840 NEXT J
845 NEXT I
850 FOR I = 1 TO PNTS$
860 N = 504 + 4 * I
870 Y(I) = X(N + 1) + 256 * (X(N + 2) + 256 * X(N + 3))
880 NEXT I
883 CLOSE #1
885 FOR I = 1 TO 512
886 IF Y(I) <> 0 GOTO 890
887 NEXT I
888 ERROR 53
889 ERROR GOTO 0
890 IF PR=1 THEN LPRINT : LPRINT "Data File Loaded: ": FSS$: LPRINT
900 RETURN
1000 REM Raw data printout routine
1010 GOSUB 700
1440 FOR I = 1 TO 512 STEP 8
1449 ON ERROR GOTO 10300
1450 LPRINT USING "#####": I;
1451 ON ERROR GOTO 0
1460 FOR J = 0 TO 7
1465 DIM A$(512)
1470 A(J) = Y(I + J)
1480 LPRINT USING "#####": A(J); 1490 IF J = 7 THEN LPRINT "";
1500 NEXT J
1510 NEXT I
1520 GOTO 70
2000 REM Processing a *.dat file
2005 INPUT "Name of source (downloaded *.DAT) file: ",
DAT$;
2010 PRINT
2015 FSS = DAT$;
2020 ON ERROR GOTO 10200;
2020 OPEN DAT$ FOR INPUT AS #2
2021 ON ERROR GOTO 0
2025 ENDJUNK$ = "AL DATA": REM For experimental points
2030 GOSUB 2800
2035 GOSUB 2700: REM For baseline
2055 PRINT: PRINT "Is this a europium run or an iron run?";
(Answer ";" ; CHR$(34); "E"; CHR$(34); " or " ; CHR$(34); "F"; CHR$(34); " Y")
2057 IF PR=I THEN FS$ = FS$ + ", calibrated using " + STDFE$;
2060 LPRINT: LPRINT "Data File: "; FS$:
2065 GOTO 12000;
2070 IF FS$ = "F" OR FS$ = "f" THEN VELSTD$ = " relative to iron";
STDEU$ = "GOTO 2100
2071 VELSTD$ = " relative to europium fluoride"
2075 GOTO 12000
2080 IF STDFE$ <> "" THEN INPUT "Want to use the same Fe
standard run for calibration?"; REPEATSTD$;
2085 IF REPEATSTD$ = "Y" OR REPEATSTD$ = "y" THEN GOTO 2110
2090 PRINT: PRINT "Name of Fe standard run for calibration"
2110 PRINT " (" ; CHR$(34); "Enter" ; CHR$(34); "; INPUT 
"if no calibration desired:" ; STDFE$;
2115 PRINT: PRINT
2120 IF FS$ = "F" THEN GOTO 2410
2130 IF FS$ = "F" THEN GOTO 2410
2135 ITEMS = "CAL";
2140 IF FS$ = "F" THEN PRINT GOTO 2287
2147 DIM PK(10)
2150 REAPPK$ = STDFE$: GOSUB 2600
2155 CALIBRF = PEAK;
2160 IF VELSTD$ = " relative to iron" AND STDFE$ <> "" THEN FSS = FSS + ", calibrated using " + STDFE$;
2165 IF STDFE$ <> "" THEN FSS = FSS + "", calibrated using " + STDEU$ + " and " + STDFE$;
2170 IF PR=1 THEN LPRINT: LPRINT "Data File: "; FS$;
2180 IF STDFE$ <> "" AND PR=1 THEN LPRINT "Peak of the Eu
standard run is at channel "; CALIBREU
2185 GOSUB 2800
2190 REM hyperfine splitting calculation follows
2195 IF N = 6 THEN HFS = ((PK(6) - PK(4)) + (PK(3) - PK(1)))/4
2200 IF N = 4 THEN HFS = ((PK(5) - PK(4)) + (PK(3) - PK(2)))/2
2205 LPRINT: LPRINT "Peak of the Fe standard run is the 
average of "; N ; " positions = Channel "; CALIBREU
2210 IF PR=1 THEN LPRINT: LPRINT "Peak of the Fe 
standard run is the average of "; N ; " positions = Channel "; CALIBREU
2220 PRINT "The hyperfine splitting is the average of 
the spacings"
2225 PRINT "between peaks 1-2, 2-3, 4-5, and 5-6 
= "; HFS ; " channels"
2230 IF PR=1 THEN LPRINT: LPRINT "The hyperfine splitting is 
the average of the spacings"
2235 IF PR=1 THEN LPRINT: LPRINT "between peaks 1-2, 2-3, 4-5, and 5-6 
= "; HFS ; " channels"
2240 IF PR=1 THEN LPRINT: LPRINT "The hyperfine splitting is 
the average of the spacings"
2245 IF PR=1 THEN LPRINT: LPRINT "between peaks 1-2, 2-3, 
4-5, and 5-6 = "; HFS ; " channels"
2250 HFSSTD = 2.245: REM Standard HFS in mm/s
2260 B = HFSSTD / HFS: REM Slope of the velocity vs.
channel no. curve
2265 PRINT "The calibration constant is "; HFSSTD;
2270 IF PR=1 THEN LPRINT: LPRINT "The calibration constant is "; HFSSTD;
2275 IF PR=1 THEN LPRINT: LPRINT "The calibration constant is "; HFSSTD;
2280 IF PR=1 THEN LPRINT: LPRINT "The calibration constant is "; HFSSTD;
2285 B = B * (mm/s)/channel"
2287 PRINT: PRINT IF PR=1 THEN LPRINT: LPRINT IF FS$ = "F" OR FS$ = "f" THEN ISSTD = CALIBREU
2290 IF FS$ = "F" OR FS$ = "f" THEN ISSTD = CALIBREU
2295 A = -B * ISSTD: C = 0: REM V = A + BX + CX^2;
2300 A = -B * ISSTD: C = 0: REM V = A + BX + CX^2;
2305 linearity assumed here
2325 REM To get the isomer shift for the sample
2330 READPK$ = DAT$;
2335 IF FS$ = "F" OR FS$ = "f" THEN GOSUB 12600
2340 IF FS$ = "F" OR FS$ = "f" THEN GOSUB 12600
2345 IS = B*(PEAK - ISSTD)
2350 PRINT: PRINT "Isomer shift"; VELSTD$: "; ISSTD "; ";
2360 PRINT: PRINT "ISSTD "; ";
2370 PRINT: PRINT " Would you like to re-use 
the same"
2380 PRINT "Absorption axis scaling as in 
the 
last plot, rather than an 
auto-"
2390 PRINT " input 
ically-maximized scale (y, 
"
); REPEATCS$;
2400 PRINT: PRINT
2410 GOSUB 6029
2420 REM OPEN DAT$ FOR INPUT AS #2
2430 ENDJUNK$ = "CAL FIT": REM For theoretical points
2440 GOSUB 2800
2450 CLOSE #2
2460 PRINT: PRINT " 
Do you want an extra 
and y scale, ";
2470 PRINT: PRINT " channel number and for 
counts,";
2480 PRINT: PRINT " (answer "; CHRS$(34); " n";
2490 PRINT: PRINT " for a plot being"
2495 PRINT: PRINT
2500 PRINT: PRINT " 
Open for publication"
2510 PRINT " (y, n)"; SCALES$;
2520 IF SCALES$ = "n" OR SCALES$ = "N" THEN ITEMS = "MBR$"
2530 IF YS = 0 OR SCALES$ = "y" OR SCALES$ = "Y" THEN GOTO 2410
2540 PRINT " Would you like to re-use 
the same"
2550 PRINT "Absorption axis scaling as in 
the 
last plot, rather than an 
auto-"
2560 PRINT " input 
ically-maximized scale (y, 
"
); REPEATCS$;
2570 PRINT: PRINT
2580 GOSUB 6029
2590 REM Reading peak positions and calculating average 
2600 ON ERROR GOTO 10225
2610 JUNK$ = ";
2620 WHILE RIGHTS(JUNKS, N) <> "TO 0.5" 
2630 WEND 
2640 PRINT: PRINT: PRINT " 
Would you like to re-use 
the same"
2650 PRINT: PRINT "Absorption axis scaling as in 
the 
last plot, rather than an 
auto-"
2660 PRINT " input 
ically-maximized scale (y, 
"
); REPEATCS$;
2670 PRINT: PRINT
2680 GOSUB 6029
2690 REM Reading peak positions and calculating average 
2695 ON ERROR GOTO 10225
2699 RETURN
27.
REM Reading the converged baseline value
JUNKS$ = ""
WEND
INPUT #2, JUNK$ 
LINES #2, JUNK$
RETURN

REM Read-in loops
JUNKS$ = ""
WEND
LINES #2, JUNK$
RETURN

REM The following are 14-digit Lines
CHAN% = 16 TO PNTS% STEP 16
EXIT

REM Routine for handling 7-digit counts
Y = STR$(Y(I))
LEN(YI$) = 2
NEXT I
RETURN

REM To save the data as a .inp file suitable for input into the MSS program
FRS = "FILE$", "INP": REM New filename is the same with "INP" instead of "SMP".
PRINT : PRINT "A file is being saved suitable for input into the MOSS program."!
PRINT #1, USING "The new filename will be ": FRS
IF PS <= "" THEN GOTO 3700
PRINT "Type any description you wish to add to the filename (< 64 characters)::"
PRINT #1, USING "How many lines in the spectrum": N
PRINT #1, PRINT "Enter estimated parameters (ENTER for zero spacers)": GOSUB 5100
OPEN FFR$ FOR OUTPUT AS #1
LSET EORFS = CHR$(13) + CHR$(10): REM Carriage retn.
LINE FEED
JYJS = STR$(Y(105)): REM Counts in channel 105 used as a sample
REM The next line strips the space added by STR$ from the left
IF LEN(JYJS) = 7 THEN GOSUB 3500: REM For stripping off the first 1
PRINT #1, "1 (1077.0)"
PRINT #1, CHR$(35); FRS$; " ": DESCR$ 
PRINT #1, USING "###.###": PNTS%; (15 + INT(PNTS% - 51/16)); N; (3*N + 1); 0; 0; 1; 1; 1; 0; 0; YADD$; 
PRINT #1, " "; 
PRINT #1, USING "###.###.###": B3; 
FOR I = 1 TO N
AREA(I) = ABS(AREA(I))
PRINT #1, USING "###.###.###": AREA(I); 
IF (I+1) = 7 THEN PRINT #1, EORFS
NEXT I
4310 IF X < A9 THEN 4330
4320 GOTO 4340
4330 M = -M
4340 N = N + 1
4350 AO = AO + X
4360 A1 = A1 + X * X
4370 A2 = A2 + M
4380 A3 = A3 + X * X * X
4390 A4 = A4 + X * M
4400 A5 = A5 + X * X * X * X
4410 A6 = A6 + X * X * M
4420 NEXT X
4430 REM NOW TO FIND PARAMETERS IN VEL(X)=A+B*X+CX
4480 IF PR=1 THEN LPRINT "VEL(X)=A; X="; C:
4490 PRINT " Use the UltraLin program for easy adjustment of the ultra linear control."
4500 RETURN: REM To line 6078

5000 REM Routine for calculating Y(X), the fitted curve
5001 CLS
5005 N1% = 5: N2% = 511
5010 PRINT: PRINT: INPUT " How many lines in the spectrum?": N
5020 P1% = 4 * ATN(1): REM Pi = 4 * arctan(1)
5030 PRINT: PRINT " Enter values from the converged curve fit: "
5040 DIM YY(3 * N): DIM BB(3 * N): DIM ZZ(3 * N): DIM G(3 * N): DIM AA(3 * N, 6 * N)
5050 DIM NRG(1): DIM AERG(1): DIM LW(1)
5060 PRINT: PRINT " Enter the baseline "; B3
5070 IF PR=1 THEN LPRINT " "
5080 IF PR=1 THEN LPRINT " "
5090 IF PR=1 THEN LPRINT " "
5100 IF PR=1 THEN LPRINT " "
5110 IF I = 1 TO N
5112 IF N = 1 THEN PRINT: GOTO 5120
5115 PRINT: PRINT " For Line No. "; I; "=";
5120 PRINT: PRINT " "
5130 PRINT: PRINT " "
5140 PRINT" "
5150 PRINT" "
5160 IF N = 1 THEN GOTO 5180
5170 IF PR=1 THEN LPRINT: LPRINT " "
5180 IF X < A9 THEN PRINT: GOTO 5120
5190 IF X < A9 THEN PRINT: GOTO 5120
5200 IF X < A9 THEN PRINT: GOTO 5120
5210 IF X < A9 THEN PRINT: GOTO 5120
5220 IF X < A9 THEN PRINT: GOTO 5120
5230 IF X < A9 THEN PRINT: GOTO 5120
5240 IF X < A9 THEN PRINT: GOTO 5120
5250 IF X < A9 THEN PRINT: GOTO 5120
5260 IF X < A9 THEN PRINT: GOTO 5120
5270 IF X < A9 THEN PRINT: GOTO 5120
5280 IF X < A9 THEN PRINT: GOTO 5120
5290 IF X < A9 THEN PRINT: GOTO 5120
5300 IF X < A9 THEN PRINT: GOTO 5120
5310 IF X < A9 THEN PRINT: GOTO 5120
5320 IF X < A9 THEN PRINT: GOTO 5120
5330 IF X < A9 THEN PRINT: GOTO 5120
5340 IF X < A9 THEN PRINT: GOTO 5120
7022 REM G(X), no interf. calibr.
7023 G(X) = 1000 + 8000 * (X - T1%) / (PNTS% - T1%)
7025 G(X) = INT(G(X))
7027 GOTO 7520
7030 REM G(X) for interferometer-calibrated points
7031 'print "At line 7031 P6 = "; P6
7040 REM The next line skips the laser data
7050 IF (X - 16) / 16 = INT(X - 16) / 16 THEN X = X + 1
7060 IF P6 = ABS(V(X)) >= 0 THEN G(X) = 5000 + INT(8000 * V(X) / F3)
7561 'print "At line 7561, X = "; X; "; V(X) = "; V(X); ";, and G(X) = "; G(X)
7562 'while inkey$ = ""
7563 'wend
7570 GOTO 7520
7572 YF = Y(X) * CF83 / B3; REM CF83 = OldB3/YS (see line 11410)
7573 M(X) = IDN + (((IUP - IDN) / (CFUP - CFDN)) * (YF - CFDN))
7574 NEXT X
7575 IF ITEMS="I" OR ITEMS="S" THEN PRINT #1, "SP4;":GOSUB 10000: REM Pen 4 for curve
7576 FOR X = T1% TO PNTS%: REM Plotting
7577 IF M(X) > 6000 OR M(X) < 2000 GOTO 7580
7578 IF G(X) < 1000 OR G(X) > 9000 THEN 7580
7579 IF ITEMS = "6" OR ITEMS = "4" OR ITEMS = "G" OR ITEMS = "CAL6" OR ITEMS = "DB6" THEN PRINT #1, "PA";
G(X); M(X); "PD PU":; GOTO 7580: REM For points
7579 PRINT #1, "PA"; G(X); "PD": REM for curve
7580 NEXT X
7580 PRINT #1, "PU";
7590 REM Box drawing
7591 IF BOX$ = "DRAWN" THEN GOTO 7607
7597 PRINT #1, "PA 1000 2000 PR PD 0 4000 8000 0 -1000 -8000 0 P6 PA;": REM Box drawing
7605 BOX$ = "DRAWN"
7607 PRINT #1, "SPD;"
7608 CLOSE #1: CLOSE #2
7610 IF ITEMS = "6" OR ITEMS = "CAL6" OR ITEMS = "DB6" THEN RETURN: REM to 2500
7610 ERASE YY, BB, ZZ, GG, AA, AREA1, LW1, NRG1: GOTO 70
8600 REM Subroutine from 6324 for lower x axis labelling in mm/s
8610 I = 5000 + (8000 * (P6 - P2) / F3)
8620 IF I < 1000 OR I > 9000 THEN RETURN
8630 PRINT #1, "PA"; I; 2000; "PD"; I; 2100; "PU"
8640 PRINT #1, "PA"; I - 100; 1800; "D11,0"; "LB"; P6; ""
8650 GOSUB 10000
8660 GOSUB 10000
8670 RETURN
8700 REM Subroutine from 6352 for upper x axis labelling in Ch. No.
8710 I = 5000 + (8000 * (V(X) - P2) / F3): REM Same as 8905, but no "INT"
8720 IF I < 1000 OR I > 9000 THEN RETURN
8730 PRINT #1, "PA"; I; 6000; "PD"; I; 5900; "PU"
8740 PRINT #1, "PA"; I - 250; 6200; "D11,0"; "LB"; P6; ""
8750 GOSUB 10000
8760 GOSUB 10000
8770 RETURN
8800 REM Subroutine from 6351 for lower x axis labelling in Ch. No.
8810 I = 1000 + (8000 * (X - T1%) / (PNTS% - T1%))
8820 IF I < 1000 OR I > 9000 THEN RETURN
8830 PRINT #1, "PA"; I; 2000; "PD"; I; 2100; "PU"
8840 PRINT #1, "PA": I - 100; 1800; "D11,0": "LB": X;
8850 GOSUB 10000
8860 GOSUB 10000
8870 RETURN

8900 REM Collins' subroutine (unused) from line 6330 for lower x axis labelling in mm/s
8905 I = 5000 + INT(8000 * (VX) - P2) / F3
8910 IF I < 1000 THEN 8950
8920 IF I > 9000 THEN 8950
8930 PRINT ", "PA": I; 2000; "PD": I; 2100; "PU":
8940 PRINT #1, "PA": I - 100; 1800; "D11,0": "LB": P6;
8945 GOSUB 10000
8946 GOSUB 10000
8950 P6 = P6 + P5
8970 RETURN

9000 RESTORE: REM READING plotter codes
9005 FOR X = 1 TO 6
9010 READ K$;
9020 PRINT #1, K$;
9030 NEXT X
9040 RETURN
9050 DATA CHR$(27).CHR$(64);0:
9060 DATA CHR$(27).CHR$(164);17:
9070 DATA CHR$(27).CHR$(19);
9080 DATA CHR$(27).J
9090 DATA IN
9110 DATA DT
10000 FOR J = 1 TO 10000
10005 NEXT J
10010 RETURN
10050 FOR J = 1 TO 30000!
10060 NEXT J
10070 RETURN
10075 FOR J = 1 TO 1000
10080 NEXT J
10085 RETURN

10100 REM F10 key event handler from line 72
10110 LOCATE 25, 1;
10120 INPUT "Return to menu (yes, no)": akey$;
10130 IF akey$ = "Y" OR akey$ = "y" THEN ERASE Y(J), BB, ZZ,
10140 LOCATE 25, 1: PRINT: REM Deletes prompt
10150 RETURN
10160 REM F5 key event handler from line 74
10165 PR = 1: RETURN

10175 REM error handler for FS$ (line 770)
10180 BEEP: PRINT: PRINT " FILE NOT FOUND";
10185 PRINT " (F10 to return to menu)"
10190 PRINT: RESUME 730
10200 REM error handler for DAT$ (line 2020)
10205 BEEP: PRINT: PRINT " FILE NOT FOUND"
10210 PRINT " (F10 to return to menu)"
10215 PRINT: RESUME 2005
10225 REM error handler for READPK$ = STD$ (line 2605)
10230 BEEP: PRINT: PRINT " FILE NOT FOUND"
10235 PRINT " (F10 to return to menu)"
10240 PRINT: IF EFS = "e" OR EFS = "e" THEN RESUME 12070

10245 PRINT: IF EFS = "F" OR EFS = "f" THEN RESUME 2105
10250 REM error handler for STEDES$ (line 12605)
10255 BEEP: PRINT: PRINT " FILE NOT FOUND"
10260 PRINT " (F10 to return to menu)"
10265 PRINT: RESUME 12050
10275 REM error handler for OPENing plotter (line 6183)
10280 CLS: LOCATE 9, 20
10285 BEEP: PRINT "plotter not responding: check switch box and connectors" 10290 RESUME 6095

10300 REM error handler for printer (line 126 and 1450)
10305 CLS: LOCATE 9, 20
10310 BEEP: PRINT " Printer not responding: check paper, power switch, connectors, etc." 10315 PRINT: PRINT " Press the p key and RETURN when ready" 10317 PRINT: INPUT " RETURN only if you don't want the printer to record your operation", PRINT$ 10320 IF PRINTS = "p" OR PRINTS = "P" THEN RESUME 10321 IF PRINTS = "n" OR PRINTS = "N" THEN PR = 0: RESUME

10325 CLOSE #3: REM Error handling from line 2636
10340 PRINT: PRINT " FAULTY Fe STANDARD RUN!"
10345 PRINT: PRINT " SHOWS F; S; lines and a total of "; N; " lines and paper, etc."
10350 PRINT " Choose an Fe standard run with 4 or 6 lines."
10355 PRINT: PRINT " Press F10 if you wish to return to the menu"
10360 PRINT: PRINT: PRINT: CLOSE #5: GOTO 2410

11000 REM The y axis scales: REM from line 6210
11005 REM Setting the baseline to maximum counts
11100 MAXCNT = 0
11105 'print: print " At 11039 T1%, PNTS%, MINCNT, 11094 FOR I = 1 TO PNTS%
11040 PRINT " i = e 11045 PRINT " I(Y) > MAXCNT THEN MAXCNT = I(Y)
11050 PRINT " I(Y) = "; I; " I(Y) = ";
11051 PRINT " MAXCNT = "; MAXCNT
11052 'gosub 10050: gosub 10050: GOSUB 10050
11060 NEXT I

11065 IF REPEATSC$ = "R" OR REPEATSC$ = "r" THEN GOTO 11060
11070 'gosub 10050: gosub 10050
11071 'gosub 10050: gosub 10050
11072 FOR I = 1 TO PNTS% STEP 16
11080 FOR J = 1 TO (I + 14)
11085 IF J > PNTS% THEN GOTO 11120
11090 IF Y(J) < MINCNT THEN MINCNT = Y(J)
11091 PRINT " MINCNT = "; J; "; I; " I(J) = "; Y(J); " MINCNT = "; mincnt
11092 'gosub 10050: gosub 10050: GOSUB 10050
11100 NEXT J
11105 'print: print " For I = "; I; " and J = "; J; " I(J) = "; Y(J)
11110 'print: Print " For I = "; I; " and J = "; J; " I(J) = "; Y(J)
11115 'print: Print " For I = "; I; " and J = "; J; " I(J) = "; Y(J)
11120 'print: Print " For I = "; I; " and J = "; J; " I(J) = "; Y(J)
11125 'print: Print " For I = "; I; " and J = "; J; " I(J) = "; Y(J)
11130 'print: Print " For I = "; I; " and J = "; J; " I(J) = "; Y(J)

31.

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INSTR(MINCNT$, ",")
11140 IF MAXPNT% = 0 THEN MAXEXP% = LEN(MINCNT$) - 1 ELSE MAXEXP% = MAXPNT% - 2
11150 IF MINPNT% = 0 THEN MINEXP% = LEN(MINCNT$) - 1 ELSE MINEXP% = MINPNT% - 2

11170 IF MAXEXP% <> MINEXP% THEN GOTO 11250
11180 MAXDIG% = 1: MINDIG% = 1: J = 0
11185 WHILE MINDIG% = MAXDIG%
11190 J = J + 1
11195 HAXDIG% = VAL(MID$(MAXCNT$, J, 1)): MINDIG% = VAL(MID$(MINCNT$, J, 1))
11200 WEND

11210 REM
11213 IF (MAXDIG% - MINDIG%) <= 1 THEN Q% = 4: GOTO 11225
11215 IF (MAXDIG% - MINDIG%) <= 2 THEN Q% = 3: GOTO 11225
11220 IF (MAXDIG% - MINDIG%) <= 4 THEN Q% = 2 ELSE Q% = 1
11225 YS = 10

11230 CFUP$ = LEFTS(MINCNT$, J + Q% + 1): CFUP = VAL(CFUP$)
11240 CFDN$ = LEFTS(MINCNT$, J + Q% + 1): CFDN = VAL(CFDN$) + 1
11260 CFUP$ = LEFTS(MINCNT$, J + Q% - 1): CFUP = VAL(CFUP$) + 1
11280 CFDN$ = LEFTS(MINCNT$, 1): CFDN = VAL(CFDN$)

11290 UIP = 5500: REM Highest tic on the right y axis (counts)
11300 IDN = 2500
11305 REM IUP - IDN = 3000
11310 REM (IUP - IDN)/(CFUP - CFDN) = 3000/10 = 300
11315 IF ITEMS = "PUB" THEN GOTO 11400
11317 CFSTEP = (CFUP - CFDN)/4
11318 CFSTEP = INT(CFSTEP)
11320 FOR CF = CFDN TO CFUP STEP CFSTEP: REM Right y axis (counts)
11321 I = IDN + (((IUP - IDN) / (CFUP - CFDN)) * (CF - CFDN))
11330 PRINT #1, "PA"; 9000: I; "PD"; 9000: I; "PU";
11340 PRINT #1, "PA"; 9020; (I - 10); "D11.0"; "LB";
11350 (CF * YS); ""
11355 GOSUB 10000
11360 NEXT CF
11370 GOSUB 10000

11400 REM Left y axis (per cent absorption)
11410 ABSNUP2 = 1 - (YS * CFDN / 83)
11413 IF ABSNUP2 <> .02 THEN ABSNUP3 = .02: GOTO 11470
11417 IF ABSNUP2 < .05 THEN ABSNUP3 = ABSNUP2: GOTO 11470
11420 ABSNUP3 = 0: K = 1
11430 WHILE ABSNUP3 = 0
11440 ABSNUP3 = (INT(ABSNUP2 * (10 * K))) / (10 * K)
11450 K = K + 1
11460 WEND
11470 ABSN = (ABSNUP3) / 4
11480 CF3 = 83 / YS
11485 CFUP3 = (CF3) * (1 - ABSNUP3)
11490 IUP3 = IDN + (((IUP - IDN) / (CFUP - CFDN)) * (CFUP3 - CFDN))
11495 IF ABSNUP3 > .02 AND IUP3 > 2400 THEN ABSNUP3 = ABSNUP3 + ABSN
11500 ABSN = 0
11510 WHILE ABSN = ABSNUP3
11520 CF = (CF3) * (1 - ABSN)
11530 I = IDN + (((IUP - IDN) / (CFUP - CFDN)) * (CF - CFDN))
11535 IF I > 5800 OR I < 2200 THEN 11570
11540 PRINT #1, "PA"; 1000; I; "PD"; 1100; I; "PU";
11550 PRINT #1, "PA"; 440; I; "D11.0"; "LB"; (100 * ABSN); ""
11560 GOSUB 10000
11570 ABSN = ABSN + ABSN
11575 IF ABSNUP3 > .02 THEN ABSN = (CINT(100*ABSN))/100: REM ABSN sometimes is ragged
11580 WEND
APPENDIX C - PERSONNEL SUPPORTED
PERSONNEL INVOLVED

Frederick W. Oliver
Professor - Physics Department
Principal Investigator.

Eugene Hoffman
Assistant Professor - Physics Department
Research Scientist
Professor Hoffman was responsible for developing computer codes for plotting on a PC the data fit by the mainframe computer. He also assisted with many of the administrative duties of the grant.

Clive Wynter
Professor - Chemistry Department-Nassau Community College
Research Scientist
Professor Wynter made the superconducting compounds and coordinated writing of scientific papers.

Richard Lockhart
Professor - Prince Georges Community College
Research Scientist
Professor Lockhart worked on the project during the summer of 1995. He was responsible for ordering equipment and setting up the laboratory for making superconducting compounds.

Jeyasingh Nithianadam
Lecturer - Electrical Engineering
Research Associate
Professor Nithianadam worked on the project during the summer of 1994. He developed software and assisted with instrumentation.

Christopher Brown
Graduate student - UMCP
Mr. Brown was responsible for assisting in the laboratory to make superconducting samples.

Dereje Seifu, Lecturer - Physics Department
Research Associate
Dr. Seifu, a theoretical physicist, worked on developing software for analyzing experimental data on the mainframe computer.

Zarfar Kureishy
Research Associate
Mr. Kureishy assisted with the many technical and administrative tasks associated with carrying out the objectives of the research.

Freydoun Borhani-Research Technician
Received M.S. in science in May of 1994.
Mr. Borhani analyzed experimental data.
The students below assisted with analyzing data, writing software, and preparing samples for experimental measurements.

Laura Gardner - M.S. Science (Currently in graduate school - Environmental Engineering, Johns Hopkins University).

Aaron Bowman - Undergraduate physics student (senior)

James Chavis - B.S. Engineering Physics, May 1996 (Currently in graduate School, Science Morgan State University)

Grace Gregory - Undergraduate physics student (junior)

Mia Nicholson - Undergraduate physics student (junior)

Takisha Miller - Undergraduate physics student (senior)

Lester Richardson - B.S. Engineering physics (currently in graduate school - Physics, Hampton University)

Xavier Preston - B.S. Physics, May 1995 (currently employed at U.S. Patent Office)

Evan Tolson - Undergraduate physics student (junior)

Daryle Strickland - Undergraduate electrical engineering student (senior)

Carolyn Cox - M.S. Science, 1995 (currently employed as a high school science teacher in Baltimore)

William Evans - M.S. Science, 1995 (currently employed at Veterans Hospital as a Biomedical engineer)

Ernest Jackson - Graduate student (currently employed as a high school science teacher in Baltimore)

Mohammad Ranjbar - M.S. Science, 1994

Dacia Tarleton - Undergraduate electrical engineering student (senior).

Farrah Pulce - High School student, NASA Sharpe Program.

Fritz Pierre - High school student, NASA Sharpe Program.