RERF Proposal Title: High Temperature Oven for Hall Measurement System
Instrument: LakeShore Model 75016 High Temperature Oven & accessories

PI: Janet Tate
Department of Physics
College of Science

RERF award, Spring 2012
$28,867 from RERF funds.

Final budget statement describing how the RERF funds were expended.
Funds were expended as summarized in the table below and detailed in the quote on the following page:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
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<tbody>
<tr>
<td>$41,867 total</td>
<td></td>
</tr>
<tr>
<td>$13,000 match (Department and grant sources)</td>
<td></td>
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<tr>
<td>$28,867 (RERF)</td>
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Additional funds were needed because of a miscommunication with LakeShore; these were provided from departmental and grant sources.

A high-temperature probe (Fig. 2) plus pumping and vacuum accessories were purchased to add on to the existing Hall Measurement System in Weniger 481 (Fig 1).

The equipment was
• ordered from LakeShore within 3 weeks of the RERF notification;
• delivered 11/8/2012, about 1 month after the promised 15/10/2012 date, and the
• installation and training was 1/7/2013. The system was not properly functional at that time, and it took 2 months to ship and repair the damaged parts to properly reconfigure the equipment.
• Final satisfactory installation was on or about March 7, 2013. Final bills have been paid.

Fig. 1. Existing LakeShore 7504 Hall Measurement System in Weniger 481.

Fig. 2. Recently-Acquired LakeShore High Temperature Oven add-on to HMS.
For product for export—commodities, technology, or software are exported from the United States in accordance with the Export Administration Regulations. Diversion contrary to U.S. law is prohibited.

Lead time before shipment, subject to change without notice.

Your inquiry number: 1902
Expiration date: 4/12/2012

FOB Origin

Dept of Physics
Weniger Hall 301
Corvallis Oregon 97331

Lake Shore Cryotronics, Inc. • 575 McCorkle Blvd.
Westerville, OH 43082 • sales@lakeshore.com
Phone: (614) 891-2244 • Fax: (614) 818-1600

Thank you for your interest in Lake Shore products. We look forward to serving your needs.
A brief summary of the scholarly work/activities made possible as a result of the RERF funding.
The equipment has been functional for 4 months. We have investigated four materials systems so far. Jason Francis included some results in his PhD thesis. Rodney Snyder is an undergraduate working on his Honors senior thesis project, studying the transport properties of novel semiconductors. The base system is used by several other groups who will receive training on the new capability upon request.

• SnSe/TaSe \(_2\) multilayers in collaboration with David Johnson at the University of Oregon. This system exhibits an interesting charge-density wave phenomenon that we hoped to see. These data were acquired with a home-built probe while the purchased system was being repaired. The results were tantalizing, but we were not confident that the home-built system was able to keep oxygen out of the measurement system because we changed the character of the sample as temperature changed. We plan to pursue the collaboration again with the new system.

• SnS – SnS resistance vs. temperature these results were used in the PhD thesis work of Jason Francis. Carrier concentration is not measureable in this system.

• BiCuOSe – this material was studied by Jason Francis for his PhD work. The Hall oven was not ready in time to perform the Hall measurements; they were conducted by Rodney Snyder and will be incorporated in his senior thesis.

• In\(_2\)O\(_3\):Sn: This well-known degenerate semiconductor is our test case and is being used as a bench mark. Preliminary results (below) indicate that the resistivity (blue) increases with temperature, carrier concentration (red) depends only weakly on temperature, giving a mobility (green) that has a power-law temperature dependence that is roughly consistent with an optical phonon scattering mechanism. Interestingly, although In\(_2\)O\(_3\):Sn is a very common semiconductor, the literature has very little information on high-temperature mobility, so these “test-case” results may be publishable.

![Figure 1. Transport properties of In\(_2\)O\(_3\):Sn (indium-tin-oxide or “ITO”) measured with the high-temperature Hall oven by Rodney Snyder.](image.png)

A brief summary of any additional scholarly activities the RERF funding made possible for the investigator(s).
I have informed all participants who contributed project suggestions in the RERF proposal of the availability of machine:
• ME455, Experimental Techniques in Materials Science (Warnes, MIME) order/disorder phase transitions in metal alloys e.g. in AuCu\(_3\) at 400°C
• EFRC (Keszler, CH; Wager EECS; Energy Frontier Research Center funded by DoE)
• Ambipolar semiconductors (Tate, PH; Keszler, CH; funded by NSF DMR)
• Lead-free piezoelectric thin films (Brady Gibbons, MIME, funded by NSF CAREER)
• Relaxor Dielectrics (Cann, MIME, funded by USDOE)
• The system has also been advertised to CSMC and MASC users.

List all external funding requests that have been developed and submitted as a result of the RERF funding (i.e. proposals).
None so far, but it will be included in facilities for all future proposals that list MASC facilities.