TITLE: Non-Reciprocal Superconducting Microwave Devices

DESCRIPTION: One of the major issues revolving around high temperature superconducting (HTS) microwave technology is that, while researchers have applied it to components of various systems, far fewer integrated systems have been designed; such integrated designs are essential for HTS technology to be successfully implemented for practical applications.

A variety of HTS microwave components (such as filters and delay lines) have been demonstrated that perform better, weigh less, and occupy less space than state-of-the-art non-superconducting components; however, practical microwave systems also require compatible non-reciprocal devices (such as circulators and isolators) to reduce performance-limiting interactions between the individual components. By applying HTS technology to these non-reciprocal components and integrating them into a system, a complete HTS integrated microwave circuit can be produced.

Researchers at Neocera (College Park, MD) and the David Sarnoff Research Center (Princeton, NJ) are developing HTS non-reciprocal devices such as microwave circulators and isolators, that will make possible the fabrication of miniature integrated microwave circuits with reduced interconnect losses. Such enhancements will significantly improve performance over current technology.

Neocera is applying its expertise in pulsed laser deposition and metal-oxide materials for this project. To make these devices, researchers at the company have found a way to deposit HTS thin films of yttrium barium copper oxide (YBCO) onto ferrimagnetic substrates such as yttrium iron garnet (YIG). (Ferrimagnetic materials can be magnetized by applying a sufficiently strong magnetic field. They differ from ferromagnets such as iron on a microscopic level.) High quality YBCO thin films with near single crystalline epitaxy must be used to achieve the desired size reduction and enhanced performance; however, the structural and chemical characteristics of technologically important ferrimagnetic substrates in the past have not permitted microwave-quality YBCO to be grown in contact with the substrate.

Through lattice engineering, Neocera has successfully developed a proprietary multilayer technology using one or more buffer layers that permit microwave-quality YBCO to be grown on ferrimagnetic substrates. To facilitate the growth of the multilayer thin film structures, Neocera has enhanced its pulsed laser deposition equipment through the development of the Automated Target Carrousel Flange Assembly.

BMD APPLICATION: Neocera, Inc. started a 2-year Phase II BMDO SBIR in September 1992 to develop thin films for microwave circuits. David Sarnoff Research Center, as a subcontractor, is providing expertise in microwave circuit fabrication and testing.

SPINOFF APPLICATIONS: High-quality HTS superconductors deposited onto ferrimagnetic and related substrates within the garnet family can be applied to a variety of technologies, including radar, radio frequency and cellular communications, microelectronics, and sensors.

In addition, the pulsed laser deposition equipment developed under this project can be used to deposit a variety of complex materials, including oxides, nitrides, sulfides, carbides, and alloys. Technology areas where such coatings are in demand range from semiconductor manufacturing to medical implants.

COMMERCIALIZATION: Neocera, Inc. is a 12-employee company located within the Technology Advancement Program (TAP) at the University of Maryland. The company works closely with researchers at the University, including the Center for Superconductivity Research. The State of Maryland, through TAP, supports start-up companies to foster its high technology industrial base.

Neocera is currently marketing thin films and pulsed laser deposition hardware. Many of these items have been developed through research on SBIR contracts funded by BMDO and other agencies. In 1993, product sales accounted for over 12 percent of total revenue as compared to under 4 percent in 1992. The company anticipates that this figure will approach 30 percent in 1994.

One way that Neocera markets its products is through exhibits at conferences including the Materials Research Society, Conference on Lasers and Electro-Optics, and American Vacuum Society. Neocera maintains excellent relationships with leaders in complementary industries such as Lambda Physik, the leading manufacturer of excimer lasers in the world, and the Kurt J. Lesker Company, a leading supplier of vacuum deposition equipment to the R&D community. Neocera and Lambda Physik have cooperated in three demonstrations of pulsed laser deposition at equipment exhibits, and Neocera has participated in Lesker displays at two additional exhibits. These exhibits have led to the sales of at least three automated Target Carrousel Assemblies (which retail for about $18,000); there is considerable interest from other researchers as well.

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Reports and Presentations:

HTS Film Devices for Microwave and Millimeter Wave Systems ... E. Belohoubek; David Sarnoff Research Center/Neocera, Inc., Superconductivity TA Review VuGraphs, December 1992, 23 pp.

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PUBLIC INFORMATION RELEASE

Please take a few moments to review the attached description of the work you have done on a Ballistic Missile Defense contract. We plan to submit this write-up for publication to our Spinoff Notebook and other outside publications. During your review, check the write-up for accuracy and ensure that it contains no proprietary information. After doing so, please sign and date this form in the space provided to acknowledge public release of this information.

If you have any questions, please do not hesitate to call Leslie Aitcheson at the National Technology Transfer Center, Washington Operations which assists the BMDO Office of Technology Applications in promoting the transfer of BMD-funded technologies. The phone number at NTTC is (703) 518-8800 and its fax number is (703) 518-8986. Thank you for your cooperation.

Office of Technology Applications
Ballistic Missile Defense Organization

I acknowledge release of this information for the purposes stated above.

Signature: _____ for EB

Date: 4/22/94

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS ELECTRONIC SYSTEMS CENTER (AFMC)
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9 September 1994

MEMORANDUM FOR BMDO/TRI

FROM: ESC/PAM

SUBJECT: Security Review (ESC 94-1142)

1. The attached BMDO description entitled "Non-Reciprocal Superconducting Microwave Devices" has been reviewed by ESC for security, military critical technology transfer considerations and export restrictions.

2. ESC has no objection to public release.

3. This review does not satisfy any requirement for submission to the Directorate for Freedom of Information and Security Review, OASD(PA) for final clearance.

Doris M. Richards

DORIS M. RICHARDS
Security & Policy Review Officer
Office of Public Affairs

Attachment:
ESC 94-1142

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