Magnetic Mapping of Current Distribution in Two-Dimensional Electronic Devices

Dr. Wikso, Jr.

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ANNUAL REPORT

MAGNETIC MAPPING OF CURRENT DISTRIBUTIONS IN TWO-DIMENSIONAL ELECTRONIC DEVICES

AFOSR-87-0337

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September, 1988

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Publications


Abstracts of Papers Presented


Presentations


Manuscripts in Preparation


"Current Injection into Two-Dimensional Anisotropic Bidomains," N.G. Sepulveda, B.J. Roth, and J.P. Wikswo, Jr. (Submitted for publication)


Patent Disclosures


Work in Progress

We have hired Dr. Yu Pei Ma from Boston University/Bitter Lab to work as a research associate on the project, and Mr. Carlos Trenary as half-time staff-member to work on this project. Licheng Li has been hired as a part-time draftsman/mechanical engineer.

The 4-channel, high-resolution SQUID magnetometer system has been ordered from Biomagnetic Technologies, Inc. This system will have a spatial...
resolution of approximately 1 mm, and should be received in December, 1988.

The motors for the three-axis, non-magnetic positioning system have been obtained from Burleigh Instruments, after lengthy discussions with Burleigh to eliminate magnetic components from their motors. We are presently incorporating these motors into a sample positioning system.

We are proceeding to assemble the equipment required for the prototype sub-millimeter SQUID system. We have obtained the temperature controller for the existing Janis continuous flow cryostat, and a Cooke 3-inch vacuum system.

We have obtained all of the analog and digital hardware and are presently completing the software for the microcomputer controls of the temperature controller, the pumping system, and the data acquisition system.

We have developed the analytic models required to interpret two-dimensional magnetic field maps in terms of the current distributions that produce them.

We have completed the detailed mechanical design for a 6-foot by 5-foot by 3-foot, four-layer, magnetically shielded enclosure. There will be two layers of one-half inch thick aluminum, each lined with a 0.062-inch thick layer of mumetal. The total shielding factor is expected to be $10^7$ at 60 Hz and $10^4$ at dc. We are just now sending the drawings out for bid and expect that the shield will be completed before the magnetometer arrives. Over half of the funds for the shield have been obtained from grants from Vanderbilt University.

**Work Planned for the next 12 months**

We will complete the continuous-flow cryostat and its associated magnetometer to allow us to begin several experiments:

- Assessing the sensitivity of the SQUID for detecting microcracks.
- Mapping current distributions in conductor configurations typical of simple electronic microcircuits.
- Mapping current pathways in conducting aggregates near the percolation threshold.
- Examination of effects of stress on the magnetic properties of ferromagnetic materials.
- Mapping trapped flux distributions in high temperature superconductors.

We will then proceed to refine our instruments and models and then study more complicated problems in non-destructive evaluation. We expect to have a conceptual design for a second-generation SQUID NDE instrument within 12 months.

**Anticipated Problems**

None

**Revisions to Research Plan**

None, other than to consider extending our studies to include mapping of current distributions in percolating systems such as granular superconductors.