A. Goals:

The goal of this program is to investigate new dielectrics, metals and processes for the fabrication and characterization of multi-chip modules (MCM) which hold the promise of excellent performance, cost and yield for high frequency MCMs.

B. Significant Results:

First, the processes for using noble metals (gold and silver) as the interconnection metallization in the module have been investigated. Noble metal processes can have fewer processing steps (particularly for gold) than the equivalent copper process and are potentially lower cost, particularly when high reliability is important. The silver process has been developed so that the silver maintains its bulk conductivity (highest of conventional metals) and has low residual stress during high temperature processing. The commercialization of the silver process is being considered.

Second, a unique adhesion material has been investigated and is currently being investigated for commercial use. We are in the process of evaluating the process and with n-Chip and transferring the technology to them.

Third, numerous low dielectric constant insulators have been evaluated through the fabrication of in-situ test structures using noble metals. Through-plane properties are of particular importance. Rapid processing techniques for several polymers have been developed which significantly shorten the processing time. The investigation of new, low cost, low dielectric constant polymers are begun. In-situ measurements of
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dielectric constant and loss at frequencies up to 10 GHz are being measured to verify
the dielectric properties.

C. Future Plans:
We plan to work on the completion of several of the tasks. We have also
added two tasks to the original statement of work. The test wafers used by
ourselves and Mayo, for evaluation of materials and processes will be fabricated
and tested. The tests include high frequency testing, and physical measurements
(CTE, moisture, etc).

The development of specific test structures for evaluation of in-plane and
through-plane CTE, modulus and dielectric constant will be completed.

We have added tasks based on our interactions with n-Chip. The use of
the low cost adhesion layers will be extended to include tantalum. There is a
great deal of interest in evaluation silver for interconnections. Silver is the highest
conductivity material at room temperature, however, it has had reliability
problems due to ionic migration. There are several reasons to revisit the issues
based on the reported failure mode.
1. Papers Published in Refereed Journals:


2. Non-Refereed Publications:


3. Invited Presentations


3b. Contributed


F. Participants and Their Status.

Ph.D

Thomas Hodge
Advising Began: Winter 1990
Comprehensive Examination Passed: Summer 1991
Graduation Date: Spring 1995
Thesis Title: Microstructures for Measuring Mechanical and Thermal Properties of Thin Polymer Structures.

Anne Sullivan
Advising Began: Winter 1990
Comprehensive Examination Passed: Summer 1991
Graduation Date: Spring 1995

Kirkland Vogt
Advising Began: Winter 1989
Comprehensive Examination Passed: Summer 1990
Graduation Date: Spring 1994
Thesis Title: Low Temperature Chemical Vapor Deposition of Metal Nitride Films for III-V Semiconductor Passivation.

Kirk Laursen
Advising Began: Fall 1991
Comprehensive Examination Passed: Summer 1992
Graduation Date: Winter 1994 (M.S.)
Thesis Title: High Frequency Electrical Measurements

Nicole Grove (co-advisor with Sue Ann Bidstrup)
Advising Began: Fall 1993
Comprehensive Examination Passed:
Graduation Date: Spring 1998
Thesis Title: Polyolefins as use as Interlevel Dielectrics

M.S.

Bilal Sinno
Advising Began: Fall 1991
Comprehensive Examination Passed: Summer 1992
Graduation Date: Winter 1994 (M.S.)
Thesis Title: Low Temperature Interlevel Dielectrics

Martin Cellier
Advising Began: Fall 1991
Comprehensive Examination Passed: M.S. only.
Graduation Date: Fall 1993
Thesis Title: Inorganic Dielectrics for GHz Multi-Chip Modules
Geneva Tatem
Advising Began: Fall 1992
Comprehensive Examination Passed:
Graduation Date: Unknown
Thesis Title: Electromigration and Moisture Studies in GHz Multi-Chip Modules

Undergraduates

George Williams, Spring 1991, "Statistical Process Control"
Todd Cloud, Spring 1991 to Present, "Photosensitive Polyimides"
Ralph Redd, Fall 1991 to Present, "Semiconductor Metallization"
Ajay Patel, Winter 1992, "Surface Topography of Etched GaAs"
Cosandra Farmer, Summer 1992-Present, "Photolithography"
Christine Roberts, Fall 1992 to present, "Chemical Etching"
Carnley Norman, Winter 1993 to present, "Reactive Ion Etching"
George Obath, Winter 1993-present, "Electroplating"
Clifford Henderson, Spring 1993-present, "Rapid Processing of Materials"
Tim Huskey, Fall 1992-present, "Electroless Plating of Gold"

G. Other Sponsored Research

   E-Systems Inc. (Prime contractor to DARPA)
   Amount Funded, $375,000 (10/16/91 to 10/15/94)
   Time Spent on Project: 1/6 time.
### H. SUMMARY OF FY93
**PUBLICATIONS/PATENTS/PRESENTATIONS/HONORS/PARTICIPANTS**
(Number Only)

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Enclosure (4)