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Work by J. Melngailis and his collaborators is summarized here.

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"Focused Ion Beam Implantation"

Progress Report

July 1, 1989 - Dec. 31, 1989

by

John Melngailis

ARO (DARPA)

Contract No. DAAL03-88-K-0108

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PROGRESS REPORT

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   K. Ismail, W. Chu, R.T. Tiberio, A. Yen, H.J. Lezec, M.I. Shepard, C.R. Musil, J. Melngailis, D.A. Antoniadis, and H.I. Smith, "Resonant Tunneling Across and Mobility Modulation Along Surface-Structured Quantum Wells". J. Vac. Sci. Technol. B7, 2025 (1989).

8. SCIENTIFIC PERSONNEL SUPPORTED BY THIS PROJECT AND DEGREES AWARDED DURING THIS REPORTING PERIOD:

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Brief Outline of Research Findings

During the latter half of the 1989 we have used the focused ion beam to implant new tunable Gunn diodes, CMOS transistors in circuits, and CCD's. Most of these devices have also been tested.

1. Tunable Gunn diodes were fabricated in GaAs and InP. The tunability is produced by implanting a gradiant of doping between the contacts. The gradiants were engineered based on simulations of our previous devices. The test results were impressive: tunability from 9-23 GHz was observed and output power was -3 to -5 dBm over all of the tuning range. In addition visible light was observed to be emitted from the region in which the Gunn domain propagates i.e. as the bias (and frequency) was changed the region of light emission sharply changed in size.

In addition, 3 terminal Gunn diodes were fabricated. The third electrode was positioned much like a gate electrode. By changing the bias on this third electrode the Gunn oscillations could be tuned over a similar range. The three terminal operation may be more convenient since it separates the DC bias and the frequency tuning electrodes.

Frequency tunable Gunn diodes were also observed in InP, with similar output power levels and frequency tunability.

2. The channels CMOS transistors were implanted with both B and As in a variety of doses, dose gradients, and geometries. Previously we had implanted NMOS devices and observed a 20 fold increase in open circuit gain with a special focused ion beam implanted stripe next to the source. In these experiments some of the transistors were connected in oscillator circuits so as to take advantage of this enhanced performance.

3. CCD's were implanted with gradients of doping under each of the gate electrodes. Previous simulations have indicated that this type of gradient results in a built in field which would tend to push carriers out of each channel increasing the speed. Unfortunately, the first set of devices could not be tested because of an error in the conventional fabrication. Another implantation is being planned. 4. The channels of GaAs MESFET's have been implanted with various doses and dose geometries. Some of these MESFET's will have submicron length gates fabricated by the focused ion beam. A procedure for preventing unwanted implantation of the channel by the ions used in resist exposure has been developed and tested. An SiN film is deposited over the channel to stop the ion penetration and lattice damage.

<u>Contacts with Army Labortory Personnel</u>:

Dr. Michael Stroscio visited our Laboratory at MIT in May 1989.