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Final Report to

Naval Research Laboratory

ON

QUANTUM DEVICES

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Department of Electrical Engineering
University of Minnesota
Minneapolis, MN 55455

Principal Investigator:
Professor Marshall I. Nathan
(612) 625-2319

The purpose of this project was to study novel quantum effects in microstructrures, which might have electronic device potentials.

The effects we chose to study are in one-dimensional (1-D) wires, i.e., wires with transverse dimensions small compared to coherence lengths. We have completed the mask design which will allow us to study current flow in 1-D wires. Transverse dimensions are varied by making wires with different transverse dimensions lithographically. Up to the present time, transverse dimension variation has been accomplished by changing the voltage means split gate Schottky contacts along the wire.[1] Steps can be observed in the IV curves of wries.[2] The advantage lithographic definition of the wires is that wire dimensions can be measured directly and quality of the lithography can be assessed.

A second experiment on the mask will allow us to study exchange effects of electrons in two wires. Ruden and Wu[3] have predicted that the exchange effect between two coupled 2-D gases can be appreciable can cause the lowest energy state to be the state with all the electrons in one channel rather half the electrons in each channel might be expected. For 2-D gases the effect is small and is expected to be observable only in the liquidate temperature range. More recently, Ruden and Wu[4] calculated the exchange energy between electrons in two closely spaced 1-D wires. The same effect is observed, but it is much larger - on the order of 20 meV for two 1-D wires spaced about 500A apart. Thus, it should be observable at or close to room temperature. Our mask has a series of wires with spacings between 200 and 1000A. The wires will be made by mesa etching AlGaAs/GaAs modulation doped wafer with will 2-D gas in it. To observe the effect it is desirable to have depleted semiconductor material between the channels rather than air because the higher dielectric constant will increase coupling. Therefore, the slot etched between the wires should ideally less deep than etched area around the wires. It is anticipated that wet etching may naturally produce this pattern if the wires are defined lithographically. In any case the etching step for this pattern will be very critical.

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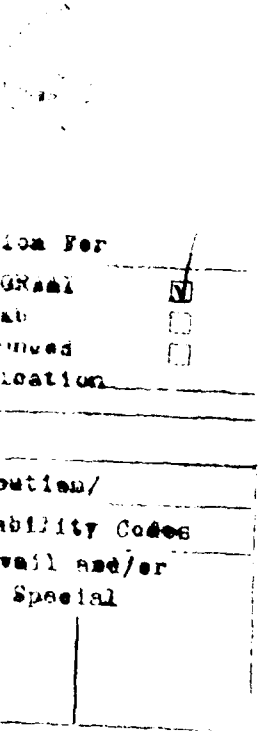

Statement A per telecon
Dr. Martin Peckeran NRL/Code 6804
Washington, DC 20375-5000

NWW 3/23/92

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