RAYTHEON COMPANY
Research Division
131 Spring Street
Lexington, MA 02173

RF VACUUM MICROELECTRONICS

Quarterly Progress Report

RAY/RD/S-4922

16 September 1993

Contract No. MDA972-91-C-0032
ARPA Order No. 8162

Sponsored by

Advanced Research Project Agency
Defense Sciences Office

1.0 EXECUTIVE SUMMARY

Stress in evaporated and sputtered moly metalization reduced.

Two chips evaluated at moderate current levels (6 devices/chip) and coated with 200 angstroms of silicon and zirconium carbide respectively.

High frequency alumina redesigned.

Masks for optical lithography for low resolution steps obtained for increased throughput.

2.0 MILESTONES STATUS

	Completion Date Original	Act/Est
1. Utilize features of new evaporator to improve moly tips	2/94	---
2. Capacitance issue	9/92	---
3. Lower work function	4/94	---
4. High frequency design/fab #3	3/94	---
5. Source pull measurements	2/94	---
6. Load pull measurements	4/94	---

3.0 TECHNICAL PROGRESS

3.1 Technical Progress

1. Moly is deposited by both sputter and evaporation in our tip process. The moly can build up large stresses during these processes that can cause bowing and peeling of the wafer. We have found ways of decreasing the stresses during sputtering by controlling the power level and base pressure. In the evaporated moly, it was found that using ion-beam assisted deposition, the

tensile stress can actually be converted to a compressive stress.

2. More on-wafer microwave measurements have been performed. The device to device variation on a given chip is quite high. It is also noted that turn on voltage can vary a large amount within a given chip. We plan to investigate to see if these two quantities (capacitance and turn on voltage) are in any way correlated.

3. Two sapphire chips with six devices per chip were evaluated at moderate current levels. These devices were vented to air, and then rebaked out and retested. This was to insured that no changes occurred from this type of handling. The chips were then coated with silicon and zirconium carbide respectively. The coating is 200 angstroms thick and is over the whole chip, not just at the tip. The coating process preserves stoichiometric. These chips will be tested in September.

4. There were some problems with the test stand for the planar triode chips. The original alumina design for the gate leads was with ungrounded coplanar tapered lines from the cable to the chip. It was found that a grounded configuration was important for suppressing some of the anode resonances. The taper has been redesigned for a grounded coplanar geometry. Also, quotes have been received for another high frequency test flange for improved turn around time in testing.

Tasks 5-6 Not started.

3.2 Other

In the basic portion of the contract, stepper lithography was used for all the process steps. This was convenient because the stepper was on site at the Research Division. This spring the stepper was moved to another Raytheon plant for use in a major government program. The unit is available to RD personnel for the

first half of the first shift. To minimize the impact of this on the contract, all the lithography that does not need the stepper is now being done with optical contact masks. These masks were ordered and received, and this hybrid approach has been tested and confirmed to work. Only the first step (to provide alignment makers) and the lithography for the holes now use the stepper.

A basic measurement for evaluating the microwave performance of the devices is that of S-parameters. The equipment we currently have allows only for a CW measurement while better performance may be obtained at a reduced duty cycle. After consultation with the manufacturers representative, we have purchased the necessary modulator to run our vector network analyzer in pulsed mode. We will test in pulsed mode next quarter.

4.0 FISCAL STATUS

IV FISCAL STATUS

CONTRACT NO: MDA972-91-C-0032
CONTR. TITLE: RF VACUUM MICROELECTRONICS-OPTION
CONTRACTOR: RAYTHEON CO., RESEARCH DIV.

DATE PREPARED: 09-Sep-93
REPORT PERIOD: 08/02/93-08/29/93

FUNDS AND MANHOUR EXPENDITURE REPORT

CONTRACT VALUE:	$467,710
CURRENT FUNDING (sel):	$467,710
NEG. FEE RATE:	0.0%
% FUNDING SPENT & COMMITTED:	11.3%

	CONTRACT VALUE	REPORTING MO. EXPEN-DITURES	CUMULATIVE EXPEND. TO DATE	% $ VALUE	COST TO COMPLETE ESTIMATE	LATEST COST ESTIMATE	PREVIOUS COST ESTIMATE
A	B	C	D	E	F	G	H
TOTAL PRIME LABOR HOURS	4,794	281	519		4,275	4,794	0
TOTAL PRIME LABOR	$133,120	$8,410	$15,278		$117,842	$133,120	$0
LABOR OVERHEAD	$228,935	$14,584	$26,495		$202,440	$228,935	$0
TOTAL LABOR & OVERHEAD	$362,055	$22,994	$41,773		$320,282	$362,055	$0
MATERIALS	$29,000	$3,033	$3,033		$25,967	$29,000	$0
ODC	$0	$22	$22		($22)	$0	$0
IWR	$0	$0	$0		$0	$0	$0
PRODUCT COST	$391,055	$26,049	$44,828		$346,227	$391,055	$0
G & A	$62,031	$3,893	$6,701		$55,330	$62,031	$0
COM	$14,624	$689	$1,326		$13,298	$14,624	$0
TOTAL COST LEVEL	$467,710	$30,631	$52,855		$414,855	$467,710	$0
FEE	$0	$0	$0		$0	$0	$0
TOTAL CONTRACT PRICE	$467,710	$30,631	$52,855	11.30%	$414,855	$467,710	$0
OUTSTANDING COMMIT		$148	$148				
TOTAL COMMIT & EXPEND	$467,710	$30,779	$53,003	11.33%		$467,710	$0

EXPENDITURES THIS QUARTER:	$259,262
TOTAL EXPENDITURES TO DATE:	$52,855
PROJECTED EXPENDITURES:	
09/93 - 11/93:	$186,045
12/93 - 02/94	$142,800
03/94 - 05/94	$80,000
06/94 - 08/94:	$6,010
TOTAL EXPENDITURES TO DATE:	$52,855
PROJECTED ADDITIONAL EXPENDITURES:	$414,855
1) IS CURRENT FUNDING SUFFICIENT (Y/N):	YES
2) WHAT IS FY93's FUNDING REQUIREMENT?:	$467,710
3) IS ALL DATA CROSS REFERENCED?:	YES

5.0 PROBLEM AREAS

None

6.0 VISITS AND TECHNICAL PRESENTATIONS

Raytheon presented at the Vacuum Electronics Annual Review, June 30, 1993, in Arlington, Virginia.