

AD-A079 281

FAIRCHILD CAMERA AND INSTRUMENT CORP PALO ALTO CALIF --ETC F/6 20/12
PROCESS VARIABLE DEPENDENCE AND INTERRELATIONSHIP BETWEEN AVALA--ETC(U)
JUL 79 B E DEAL N00014-79-C-0297

UNCLASSIFIED

NL

[of]

AD
A079281



END

DATE

FORMED

2-80

DDK

12
35

OFFICE OF NAVAL RESEARCH
800 North Quincy Street
Arlington, Virginia 22217

ADA 079281

PROCESS VARIABLE DEPENDENCE AND INTERRELATIONSHIP
BETWEEN AVALANCHE INJECTED AND RADIATION
INDUCED CARRIER TRAPPING IN THERMAL OXIDES.

Progress Report No. 1

1 April 1979 through 30 June 1979

Contract No. N00014-79-C-0297

131

1217

11

July 1979

Fairchild Camera and Instrument Corporation
Research and Development Laboratory
4001 Miranda Avenue
Palo Alto, California 94304

DDC
RECEIVED
DEC 28 1979
RECEIVED

DDC FILE COPY

R.R.R. 7/12/79
Prepared by

Bruce E. Deal
Approved by

-A

405 691

DISTRIBUTION STATEMENT A
Approved for public release
Distribution Unlimited

780

QUARTERLY STATUS REPORT NO. 1

Covering the Period 1 April 1979 through 30 June 1979

This is the first quarterly report on the ARPA sponsored project titled "PROCESS VARIABLE DEPENDENCE AND INTER-RELATIONSHIP BETWEEN AVALANCHE INJECTED AND RADIATION INDUCED CARRIER TRAPPING IN THERMAL OXIDES." This program is carried out in cooperation with the Naval Research Laboratory in Washington, DC. Progress to date includes the modification of our present computerized C-V analysis system to allow for automated avalanche carrier injection measurements and data reduction as well as the preparation of the first group of samples to be used in the program.

Avalanche Carrier Injection System

The modifications proposed for our computerized C-V quasi-static system to convert it to an automated avalanche carrier injection trapping system have been carried out. Figure 1 shows a schematic of the system which is similar in principle to that used by Don Young and co-workers at IBM* and which includes a programmable signal source, a specially designed amplifier, and a Boonton capacitance meter. All hardware and software modifications have been carried out. Basic system operation consists of the device under test being switched from a capacitance/voltage measuring circuit to an avalanche injection circuit. Typical injection times are 90 sec and flatband voltage shifts following injection are measured in less than 5 sec. Average injected current is kept constant by means of computer monitoring of the current at 200 msec intervals and making the necessary changes in the amplitude of the a.c. signal through the programmable signal source. The output generated by the system consists of plots of flatband voltage shift as a function of injection time as shown in Fig. 2.

Sample Preparation--Dry O₂ Structures

N-type (111) silicon wafers, resistivity 0.2-0.3 Ω -cm, and p-type (111) wafers resistivity 0.4-0.7 Ω -cm were oxidized in dry O₂ at 900°, 1000°, and 1100°C to an oxide thickness of approximately 800 Å. Following oxidation the wafers were cooled in oxygen [fast pull (<3 sec), or slow pull (10 min)], or nitrogen (slow pull 2 min), or argon (slow pull 2 min). The oxide was then removed from the back of the wafers, and Al-Cu-Si was deposited by cold flash on both sides of the wafers. Metal dots (30 mils in diameter) were

* We would like to acknowledge the information supplied to us by D. Young on the IBM apparatus.

B

defined by photolithography and one half of each wafer annealed in N_2 at $400^\circ C$ for 10 min while the other half received a post-metallization anneal in a 10% H_2 in N_2 ambient at $400^\circ C$ for 10 min. Table I indicates the various run numbers and the treatment received by each run.

Measurements--Dry O_2 Structures

Due to the delay in the arrival of necessary equipment for the measurement of avalanche injection trapping, only about one third of the 900° and $1000^\circ C$ samples have been measured to date. Data dealing with flatband voltage shifts as well as some data dealing with the increase in interface state density levels as a result of avalanche injection will be tabulated as soon as it becomes available.

Sample Preparation-- H_2O Structures

N-type (111) samples, resistivity 0.2-0.3 Ω -cm, were oxidized in H_2O at $900^\circ C$. Following oxidation the wafers were cooled in H_2O (<30 sec pull) or in nitrogen or argon (<2 min pull) and the back oxide removed. Remaining p- and n-type wafers will be oxidized in the coming quarter.

The program schedule is enclosed and the program is essentially on schedule. Measurements of dry O_2 samples should be concluded at the end of next quarter as well as the preparation of the H_2O structure as outlined in the program schedule.

Accession For	
NTIS Grant	6
DOC TAB	
Unannounced	
Justification	
by <i>Attles on file</i>	
Project Number	
Availability	
Stat	Special
A	

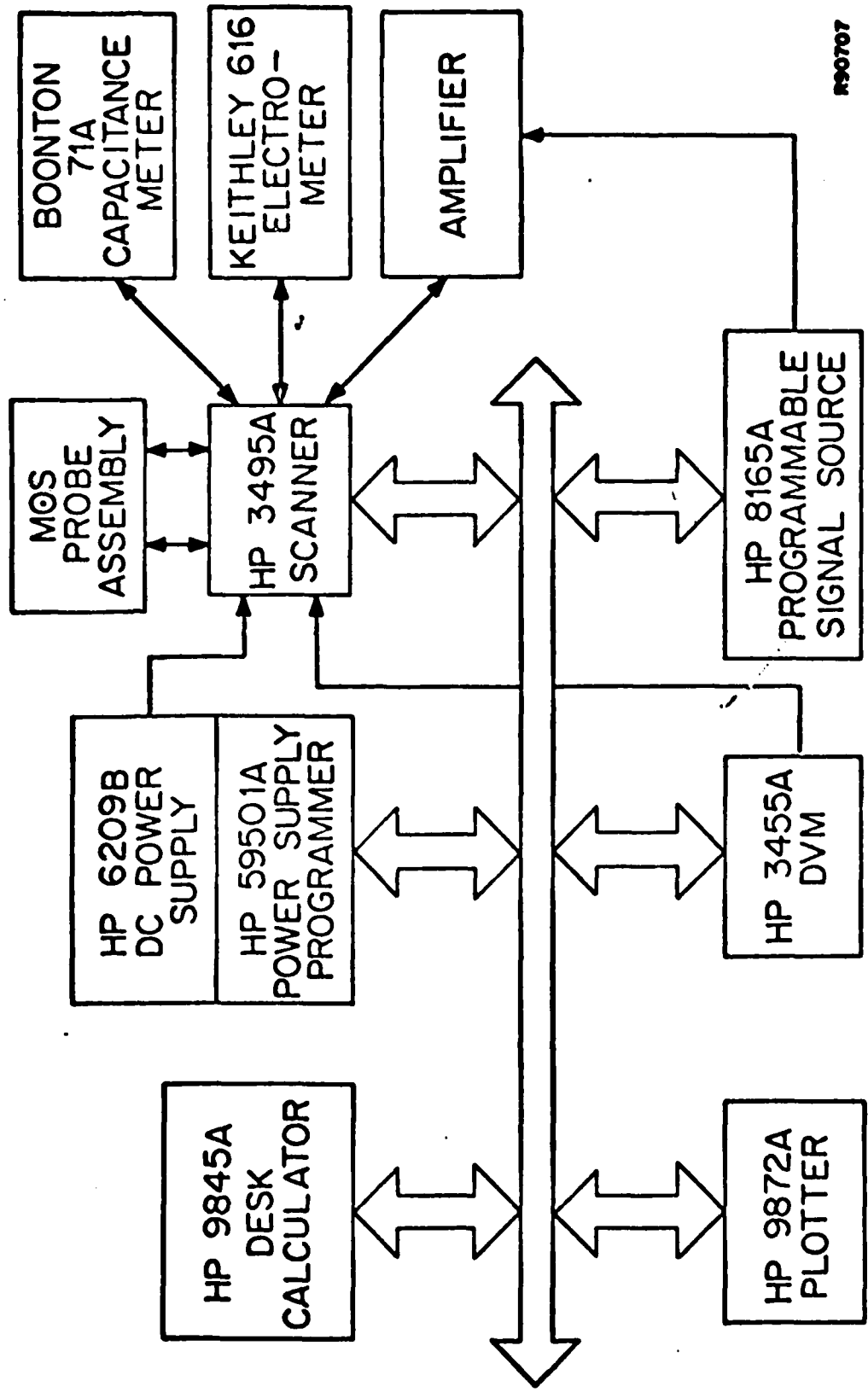


Fig. 1. Schematic of computerized system for avalanche injection and trapping of carriers in thermal oxides.

COMPUTERIZED C-V ANALYSIS SYSTEM

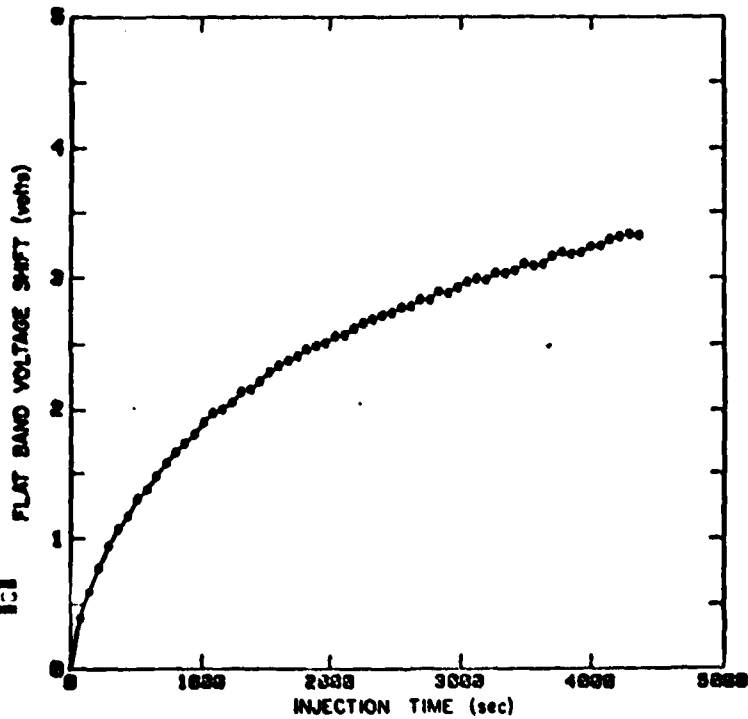
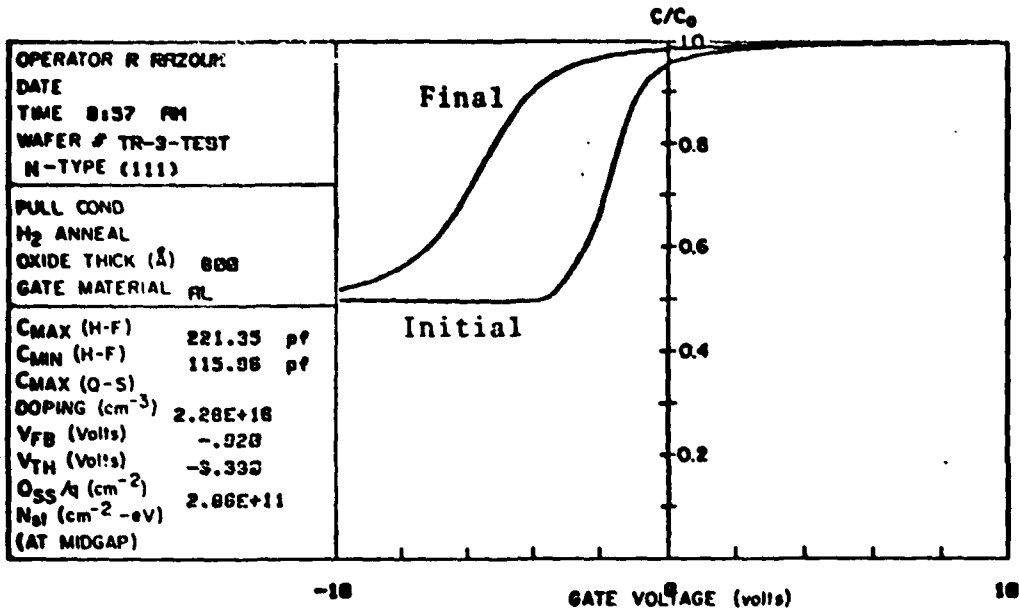


Fig. 2. Typical output from the automated avalanche carrier injection and trapping system.

TABLE I

Values of Fixed Oxide Charge (Q_{ss}) and Interface State Density (N_{st}) For N-Type (111) Silicon Wafers Oxidized in Dry Oxygen

Run No.	Oxidation Temp. (°C)	Ox./Anneal Ambient	Ox./Anneal/Cool Time*(min)	Cool Condition**	Oxide Thickness (µm)	Q_{ss}/q ($10^{11}/\text{cm}^2$)	Midgap N_{st} ($10^{11}/\text{cm}^2\text{-eV}$)	
							N_2 Anneal	H_2 Anneal
TR-1	900	O ₂ /-	300/0/0	O ₂ FP	0.079			
TR-2	"	O ₂ /-	300/0/10	O ₂ SP	0.081			
TR-3	"	O ₂ /N ₂	300/10/2	N ₂ SP	0.079			
TR-4	"	O ₂ /Ar	300/10/2	Ar SP	0.081			
TR-5	1000	O ₂ /-	84/0/0	O ₂ FP	0.081			
TR-6	"	O ₂ /-	84/0/10	O ₂ SP	0.087			
TR-7	"	O ₂ /N ₂	84/10/2	N ₂ SP	0.084			
TR-8	"	O ₂ /Ar	84/10/2	Ar SP	0.084			
TR-9	1100	O ₂ /-	28/0/0	O ₂ FP	0.079			
TR-10	"	O ₂ /-	28/0/10	O ₂ SP	0.088			
TR-11	"	O ₂ /N ₂	28/10/2	N ₂ SP	0.081			
TR-12	"	O ₂ /Ar	28/10/2	Ar SP	0.082			

* oxidation time/anneal time in N₂ or Ar/Pull time

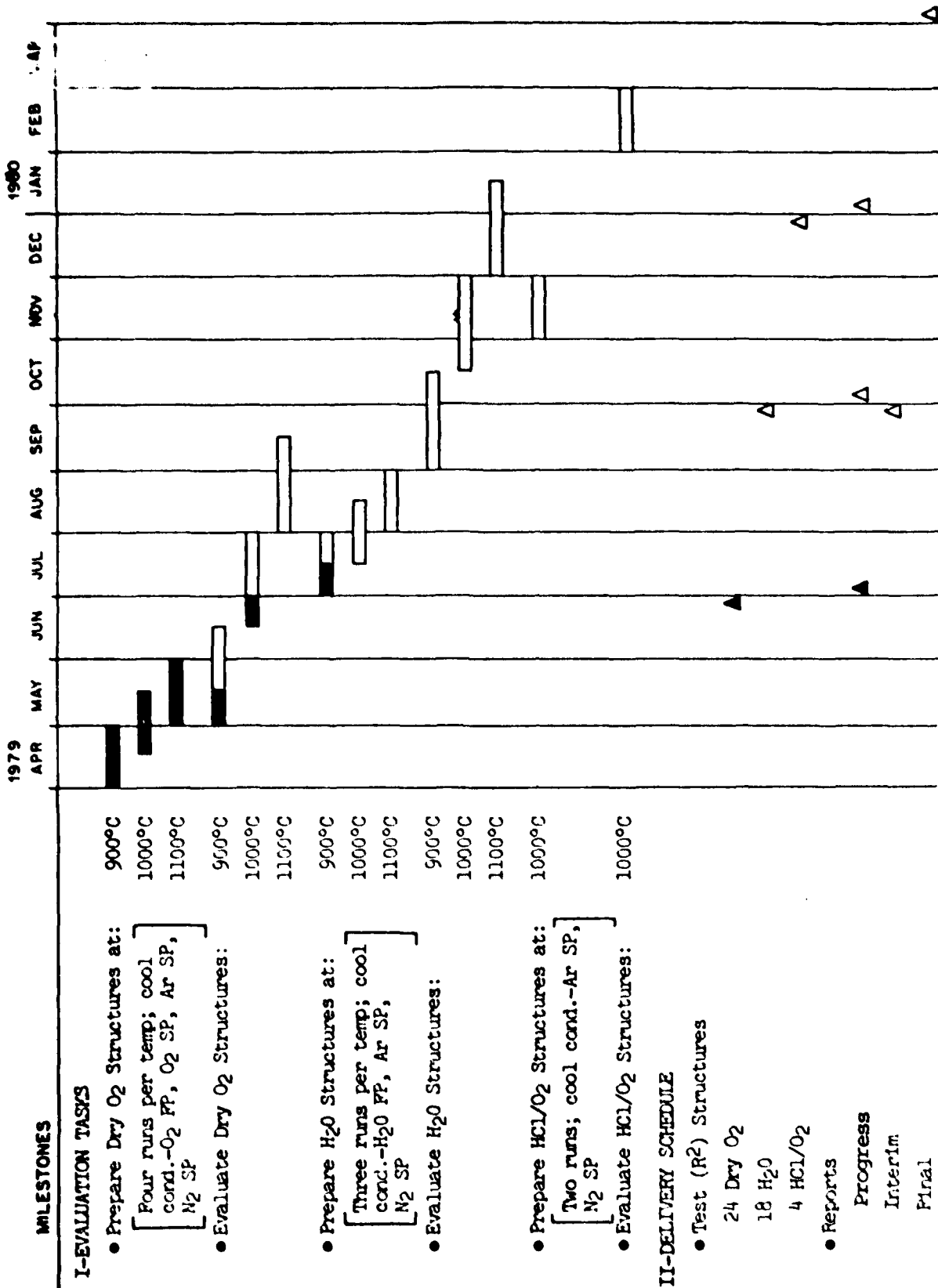
** O₂ FP = fast pull (<3 sec) in O₂

O₂ SP = slow pull (10 min) in O₂

N₂ SP or Ar SP = slow pull (2 min) in N₂ or Ar

RRR 6/21/79

PROGRAM SCHEDULE



1 5 1