SiN_X PASSIVATION OF SILICON SURFACES

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Objectives and Approach

OBJECTIVES

- RELATE SURFACE DENSITY TO SUBSTRATE DOPANT CONCENTRATION
- SURFACE CHARACTERIZATION OF HIGH EFFICIENCY n+/p and p+/n SILICON CELLS
- IDENTIFY DOMINANT CURRENT LOSS MECHANISMS IN HIGH EFFICIENCY CELLS

APPROACH

- MEASURE DENSITY OF STATES ON HOMOGENEOUSLY DOPED SUBSTRATES WITH HIGH FREQUENCY C-V AND Al/SiN_X/Si STRUCTURES
- INVESTIGATE DENSITY OF STATES AND PHOTORESPONSE OF HIGH EFFICIENCY N+/P and P+/N CELLS.
- CONDUCT I-V-T STUDIES TO IDENTIFY CURRENT LOSS MECHANISMS IN HIGH EFFICIENCY CELLS

Presentation Outline

1. SURFACE PASSIVATION
   - —SiN_X DEPOSITION
   - —HOMOGENEOUSLY DOPED SUBSTRATES
   - —PHOTORESPONSE OF N+/P AND P+/N CELLS
2. SOLAR CELL STUDIES
   - —MINP CELL WITH TEXTURED SURFACE
3. CURRENT LOSS MECHANISMS
   - —LIGHT INDUCED CURRENT LOSS MECHANISM
   - —Mg MIS CONTACTS
   - —NEUTRON ACTIVATION
4. FUTURE WORK
   - —PASSIVATION OF P+/N CELLS
   - —FINAL REPORT CONCERNING SiN_X PASSIVATION OF SILICON

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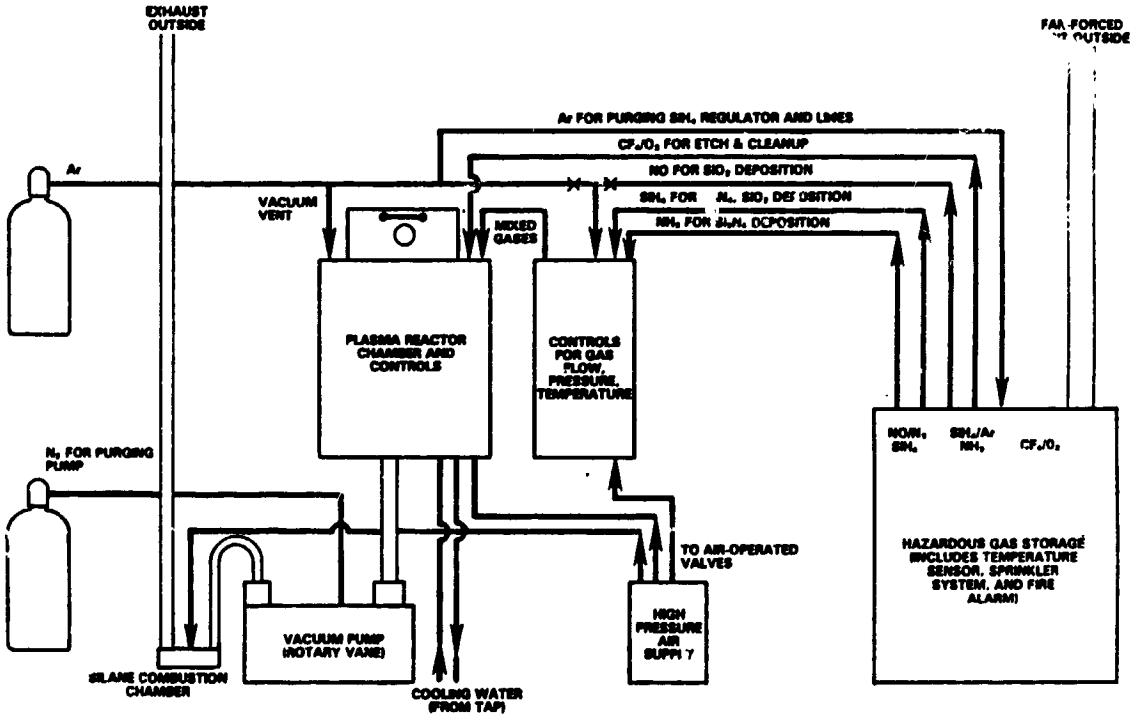
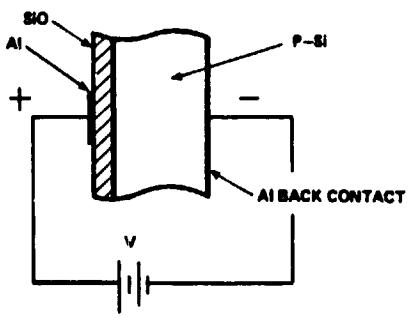
Schematic of PECVD System

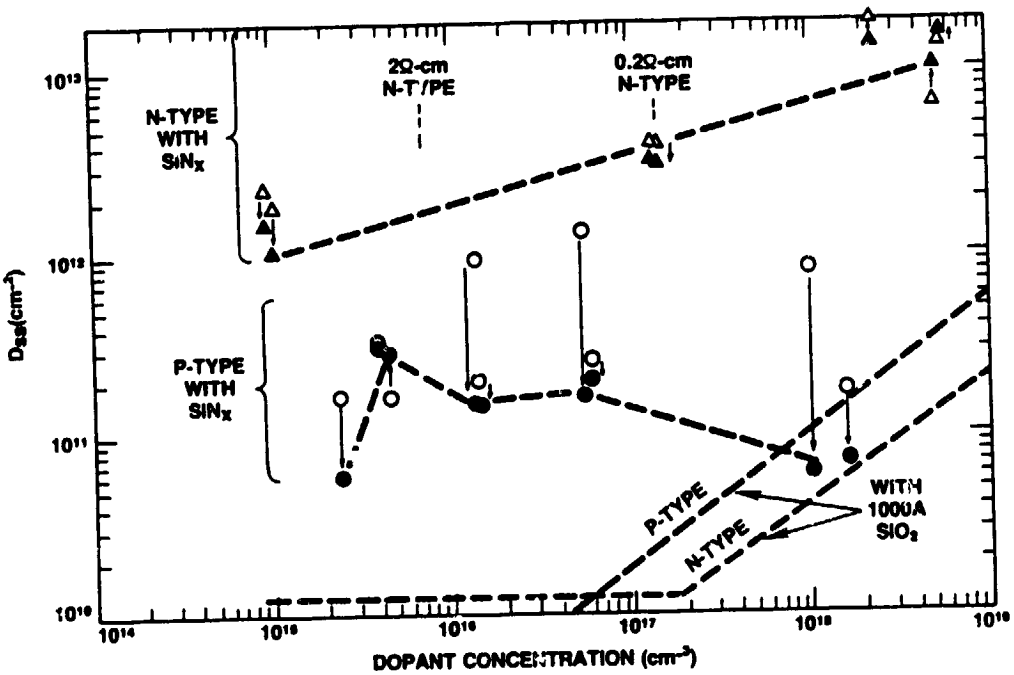


Fabrication of Al/SiN_X/Si MIS Structures

- CLEAN SILICON SUBSTRATES WITH RCA PROCESS
- SUBJECT SUBSTRATE TO NITRIDING STEP (LOW RF POWER WITH NH_3 @ 70 SCCM)
- DEPOSIT ≃100 A SiN_X WITH SUBSTRATE AT 270°C AND RF POWER @ 212 W/cm²
- DEPOSIT ≃ 600 A SiN_X WITH POWER @ 1225 W/cm²
- DEPOSIT ALUMINUM

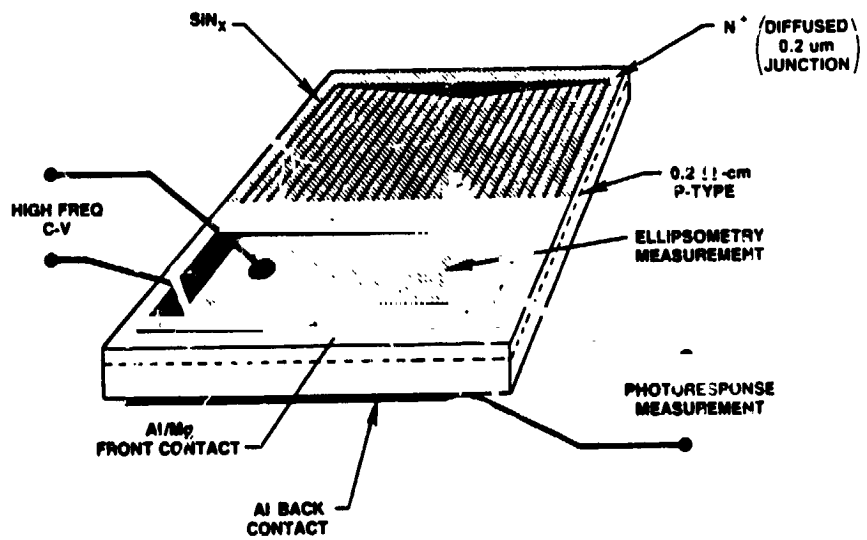


Midgap Interface State Density Versus Dopant Concentration

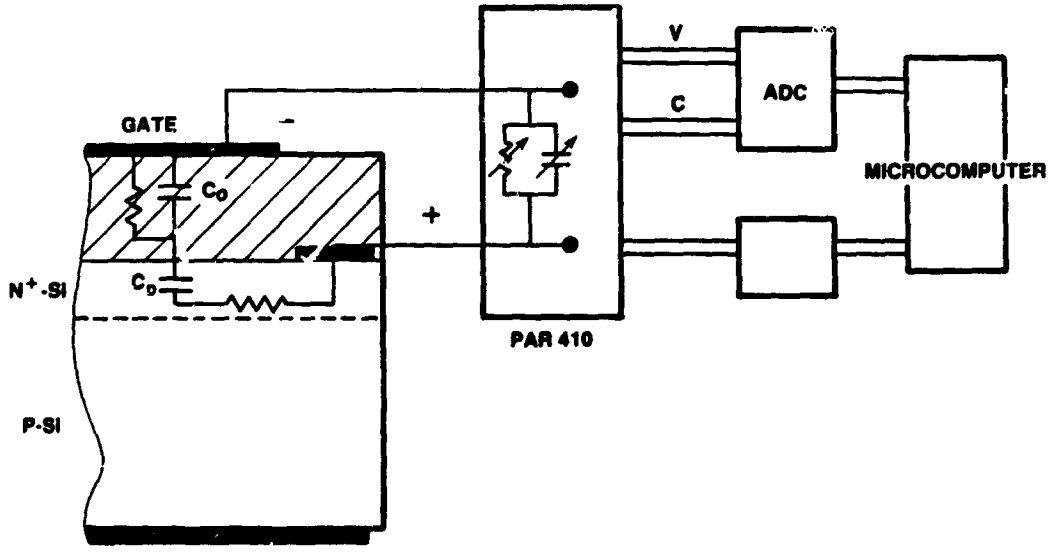


△,○ AS DEPOSITED
▲,● AFTER HEAT TREATMENT @ 450°C

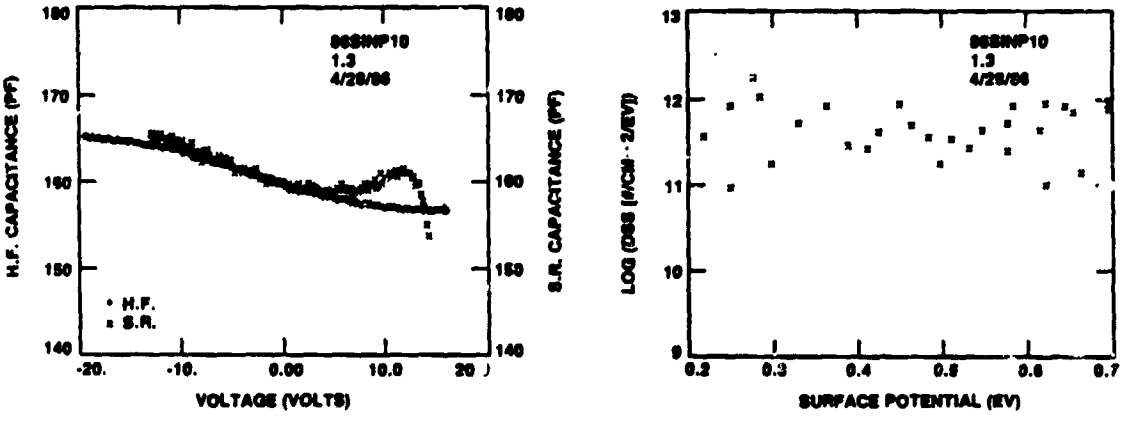
Device Structure for Surface Recombination Study



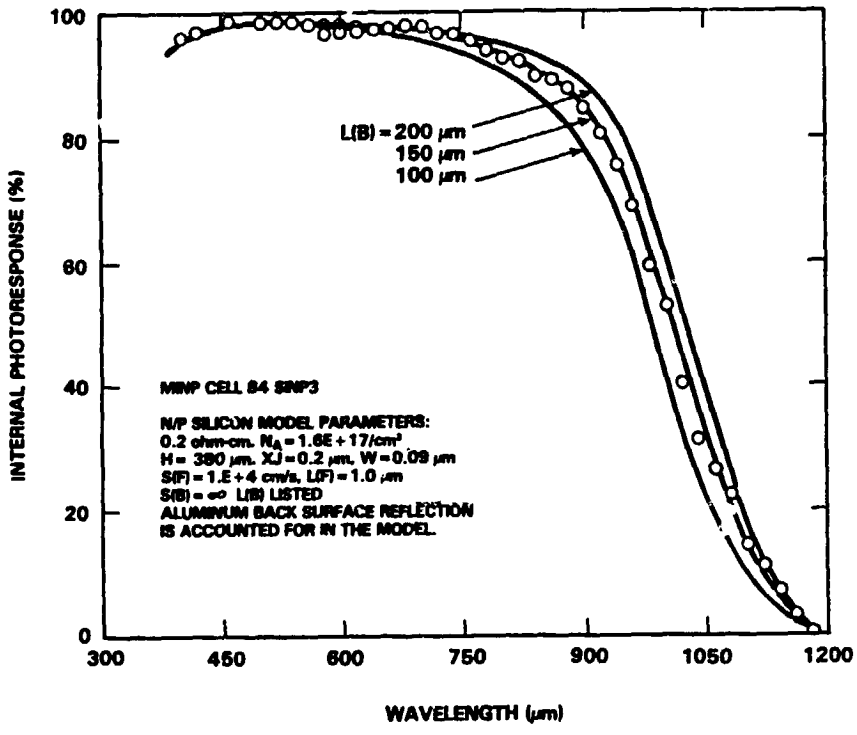
C-V Measurement of Interface Density at N^+ Surface of N^+/P Cell



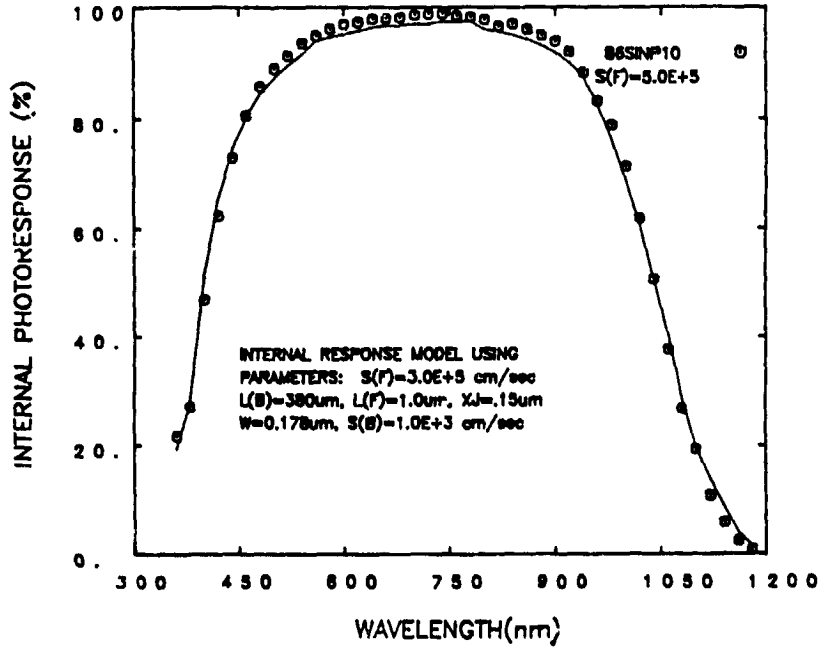
Density of States of Surface of P^+/N Cell



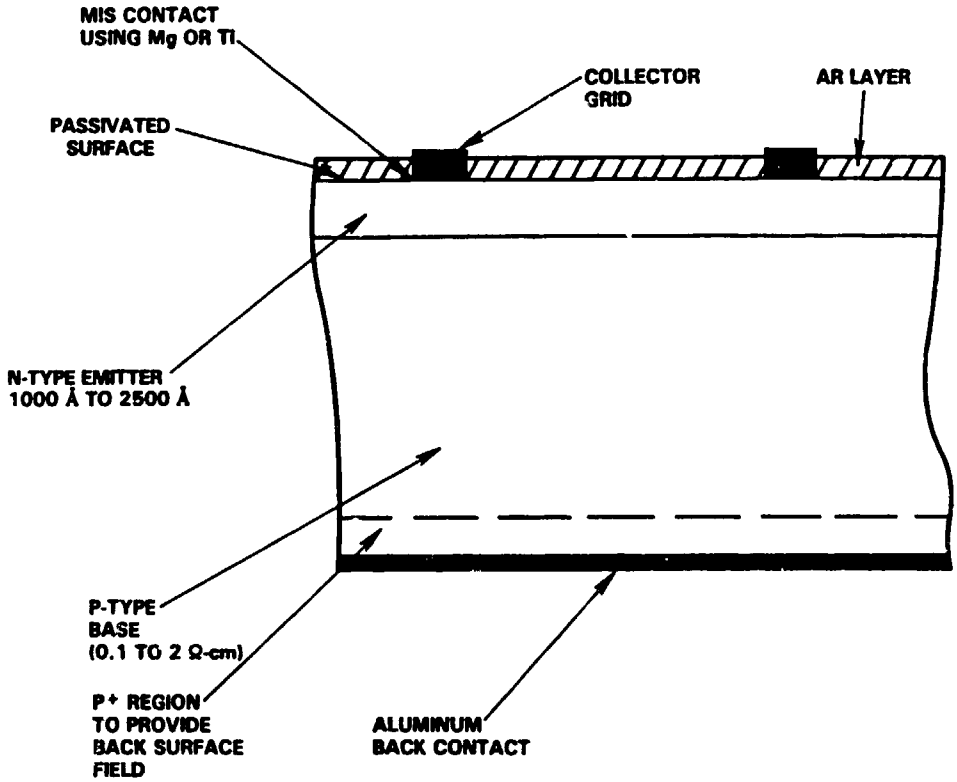
Internal Photoresponse for 0.2 ohm-cm MINP Cell



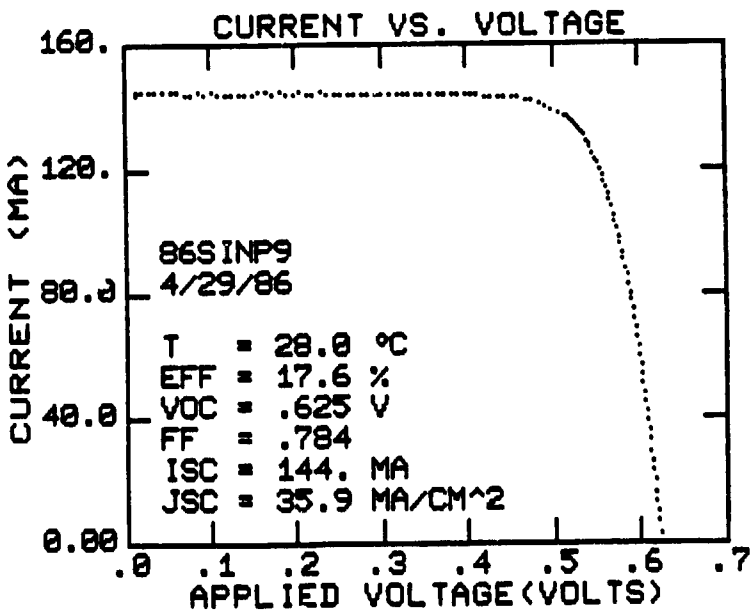
Internal Photoresponse for 0.2 ohm-cm P$^+$/N Cell



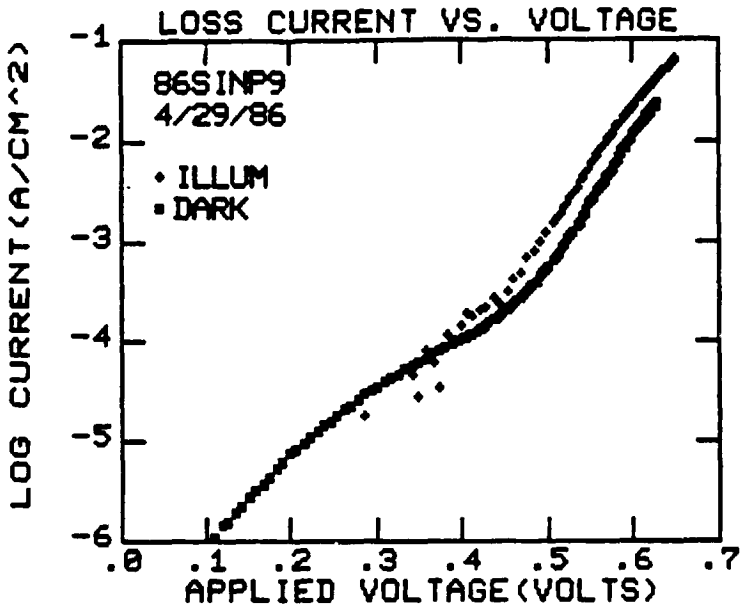
MINP Cell Concept



AM1 Characteristics of Textured MINP Cell



Loss Current Versus Voltage for Illuminated and Dark Characteristics of Textured MINP Cell



Neutron Activation Measurement of Impurity Concentration

SAMPLE	Au (ppma)	Co (ppma)	Sc (ppma)	Hg (ppma)	Fe (ppma)	COMMENT
AS RECEIVED	< 3E-6	< 2E-3	-	<3E-4	< 2.5	AS RECEIVED FROM WACKER
AFTER DIFFUSION	<1.6E-5	3.8 E-3	-	<3E-4	< 2.0	AFTER P-DIFFUSION BY ASEC
84 SINP4	1.2 E-4	11 E-3	4.4 E-3	<3E-4	< 2.5	DARK: Jo = 1.0 E-13 A/cm² n = 1.00 ILLUM:Jo = 2E-11 A/cm² N = 1.16
85 SINP20	5.7 E-5	8.1 E-3	-	30 E-4	< 2.5	L≈35μm COMTAMINATE DIH_2O
85SINP40	9.0 E-5	7.5 E-3	-	<3E-4	< 2.5	L≈220μm GOOD TRANSLATION

Mg MIS Contact Study

METAL COVERAGE	HIGH VOLTAGE MECHANISM	
	J_0 (A/cm²)	n
62%	1.5×10^{-12}	1.03
3.6%	1.2×10^{-12}	1.01
1.5%	1.8×10^{-12}	1.03

BASE RESISTIVITY = 0.2 Ohm-cm
JUNCTION DEPTH = 0.2 μm