PHOTOCURRENT IMAGES OF AMORPHOUS-SILICON SOLAR-CELL MODULES

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State of the Art of a-Si Solar Cells

PERFORMANCE OF BEST REPORTED SINGLE JUNCTION p-i-n AMORPHOUS SILICON SOLAR CELLS

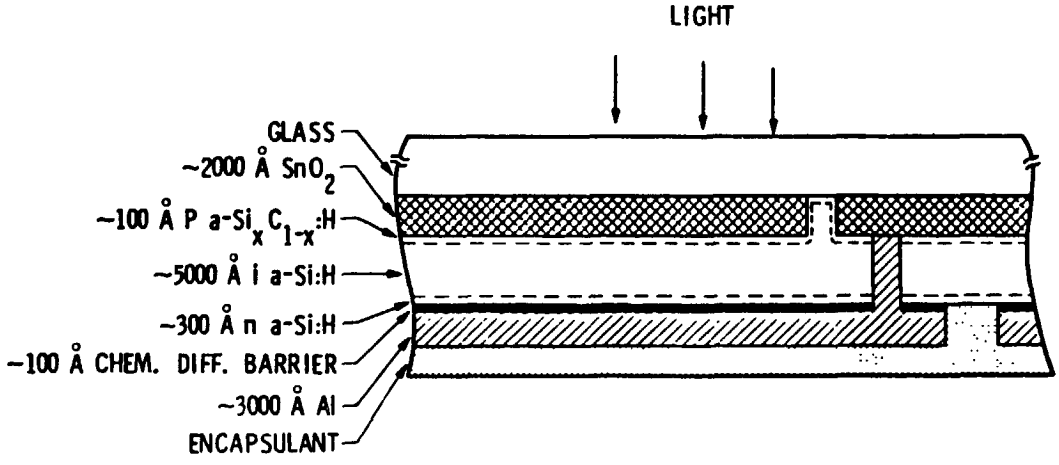
	V_{oc} mV	J_{sc} mA/cm^2	FF %	EFF. %
BEST INDIVIDUAL PARAMETERS	950	16.70	74.0	11.70

- HIGH CONVERSION EFFICIENCY: 7.4 – 11.7%
- DIFFERENT DEVICE STRUCTURES: p - i - n
  n - i - p
- DIFFERENT FABRICATION PROCESS: GLOW DISCHARGE
  REACTIVE SPUTTERING
  CHEMICAL VAPOR DEPOSITION

Commercial Modules

MANUFACTURERS	V_{oc} mV	J_{sc} mA/cm^2	FF	EFF. %
A	0.726	9.59	0.572	3.99
B	0.869	12.60	0.666	7.33
C	0.674	13.20	0.717	6.35

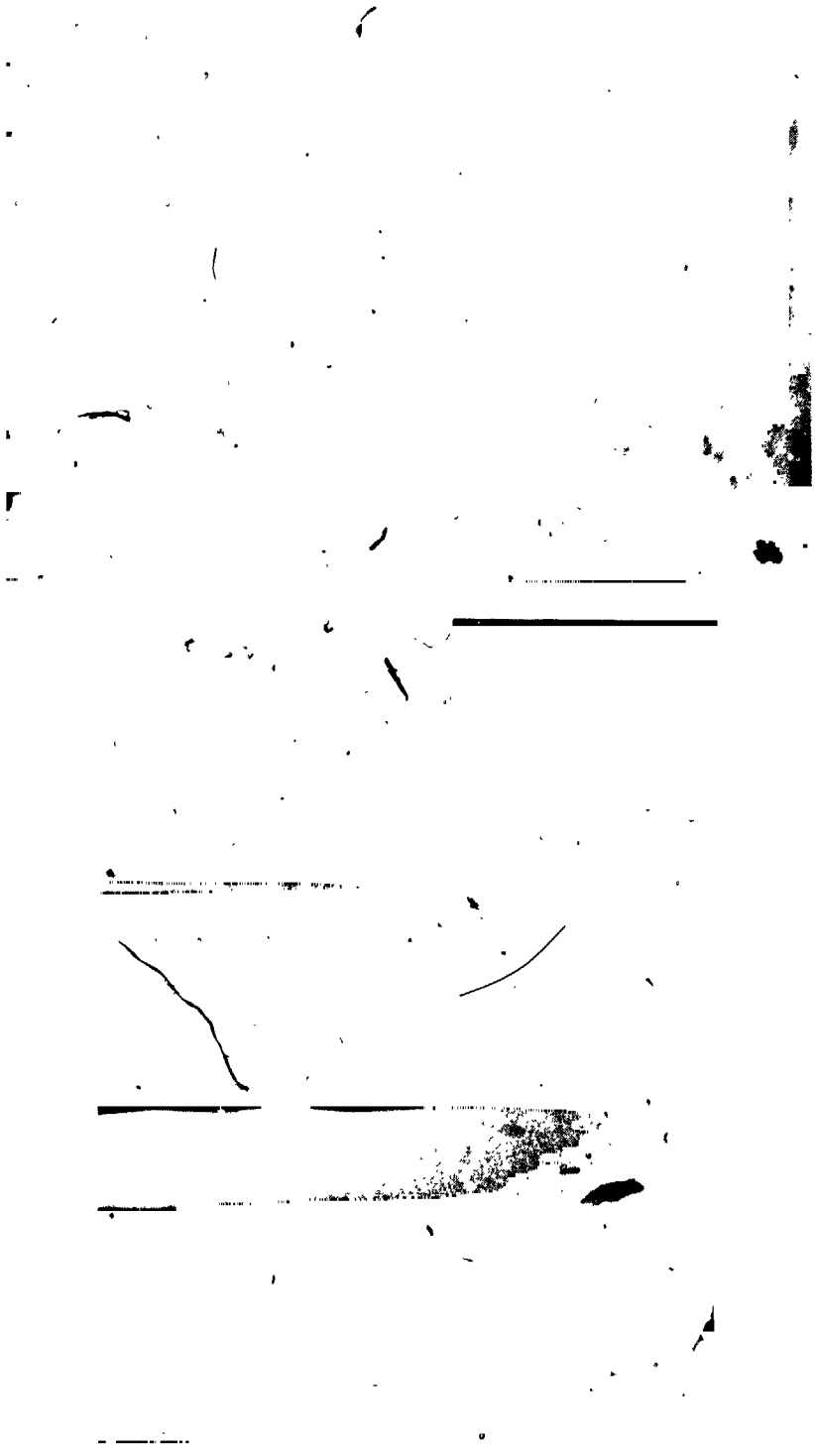
a-Si:H Solar-Cell Structure With Enlarged Section of Electrode Coupling Portion of Integrated a-Si Cell



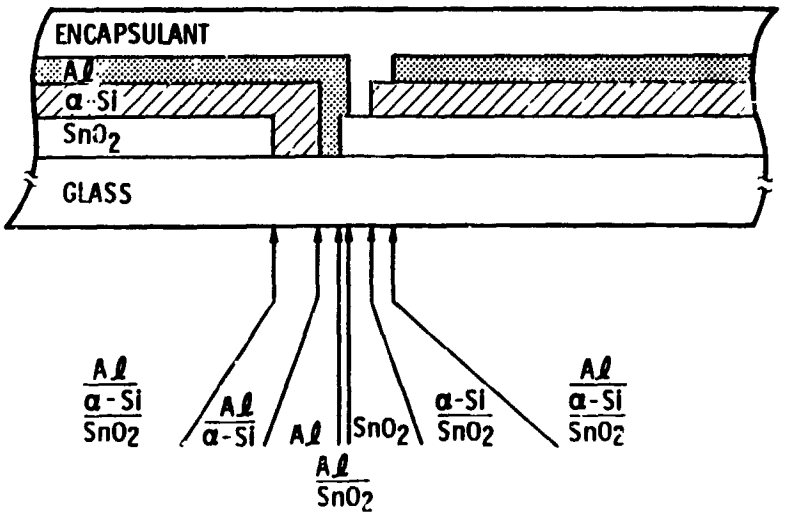
Module A and Its Cell Intercoupling

Module B and Its Cell Intercoupling

Module C and Its Cell Intercoupling



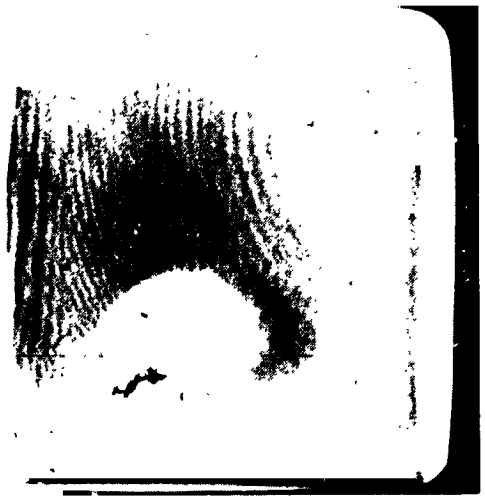
a-Si:H Solar-Cell Structure With Enlarged Section of Masked Cell Intercoupling Portion



Failure Modes

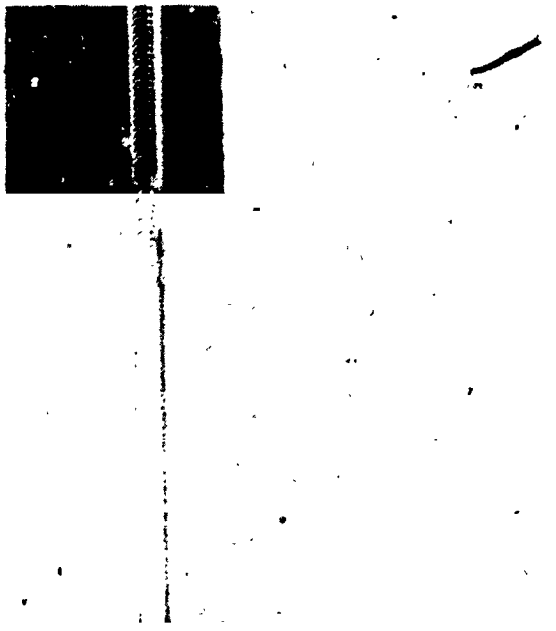
- ELECTRICAL SHORTS
- FILM INHOMOGENITY
- CELL INTER-COUPLING WORKMANSHIP
- EFFICIENCY DEGRADATION
- WEATHERING DUE TO:
  - TEMPERATURE
  - HUMIDITY
  - CORROSION
  - ETC.

Electrical Short

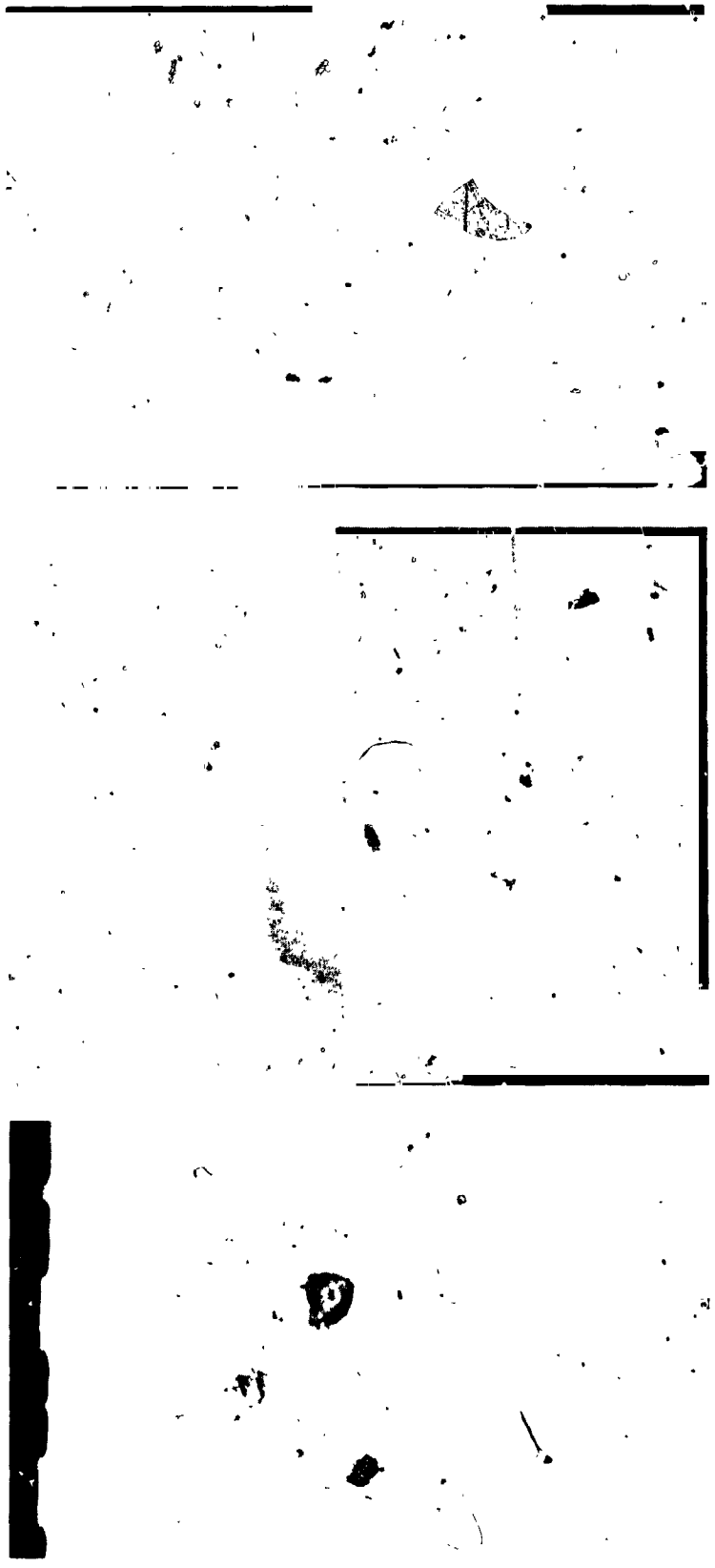


Masking Problem

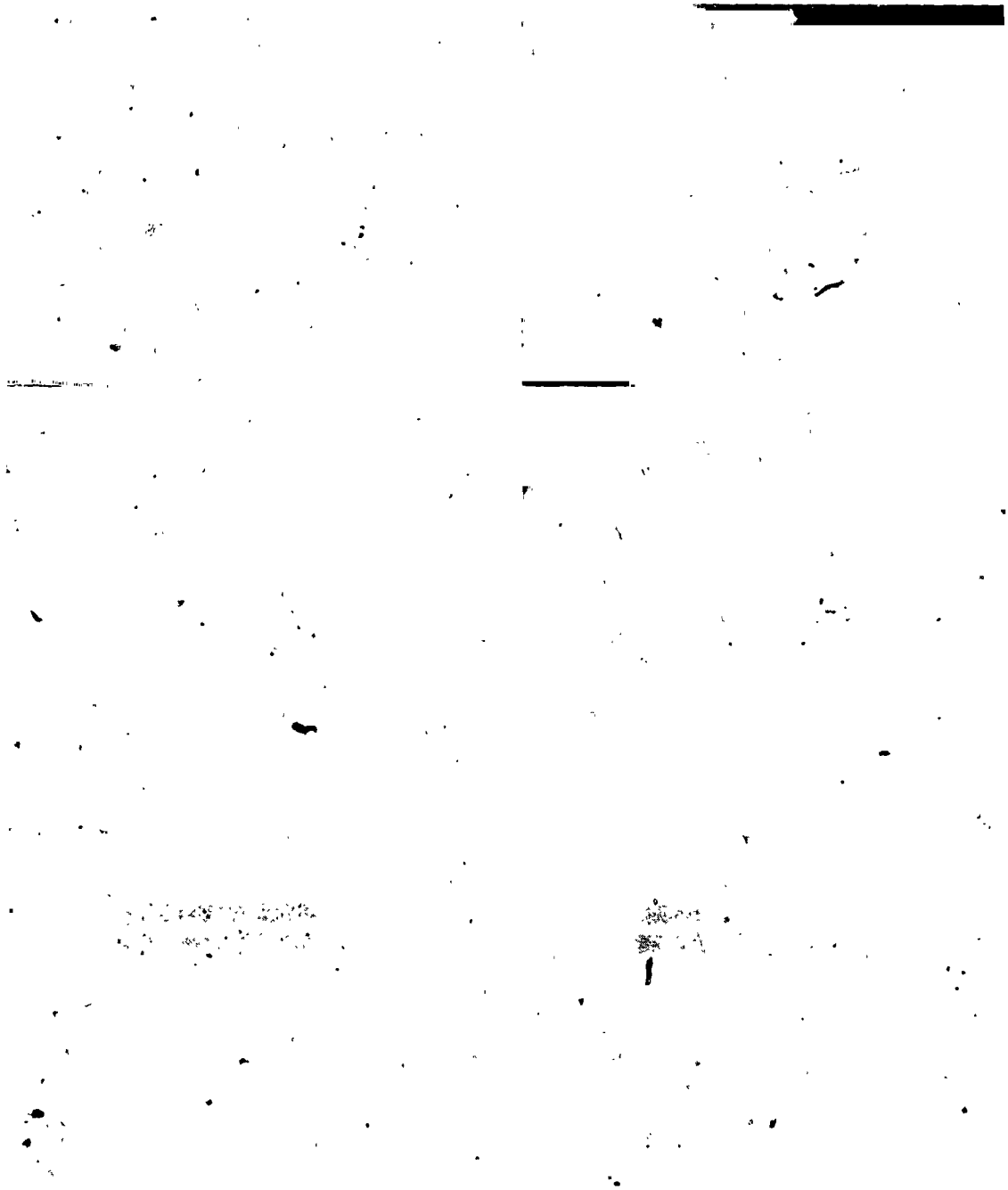
Non-Uniform Laser Scribing



Masking Workmanship



Y-Modulation for Better Display



NORMAL

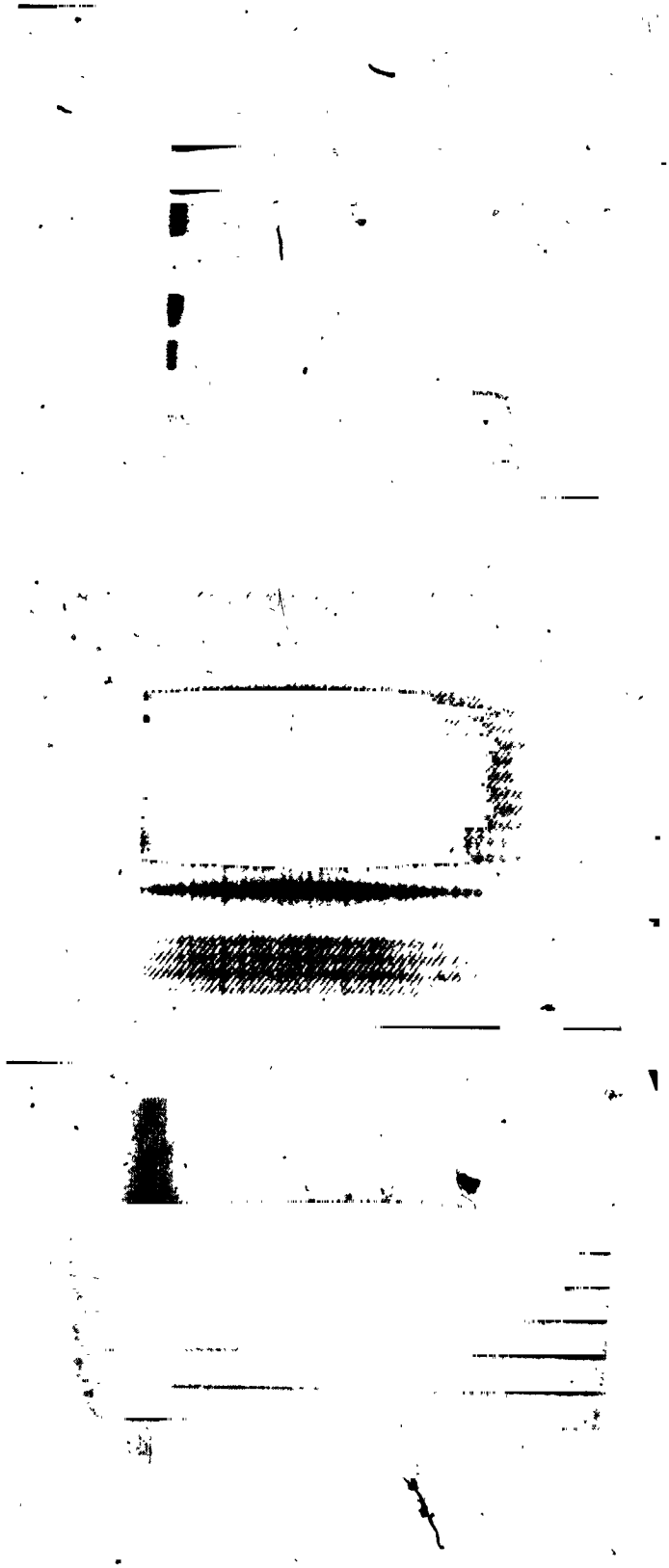
Y-MODULATED

Solar-Cell Laser Scanner Images

MODULE A

MODULE B

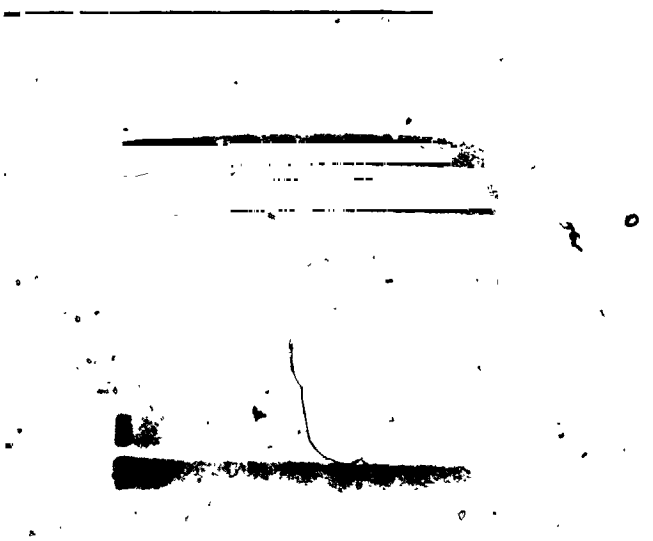
MODULE C



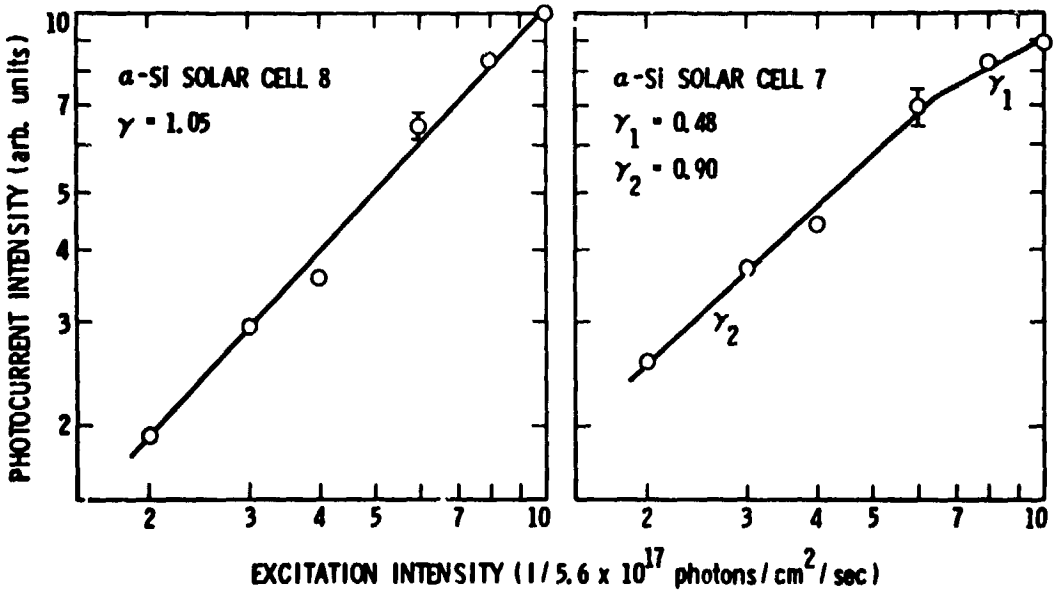
Effects of Excitation Intensity on Photocurrent Response

- PROCESS V.S. CELL QUALITY
- NONDESTRUCTIVE DIAGNOSIS ON PROCESSING PARAMETERS

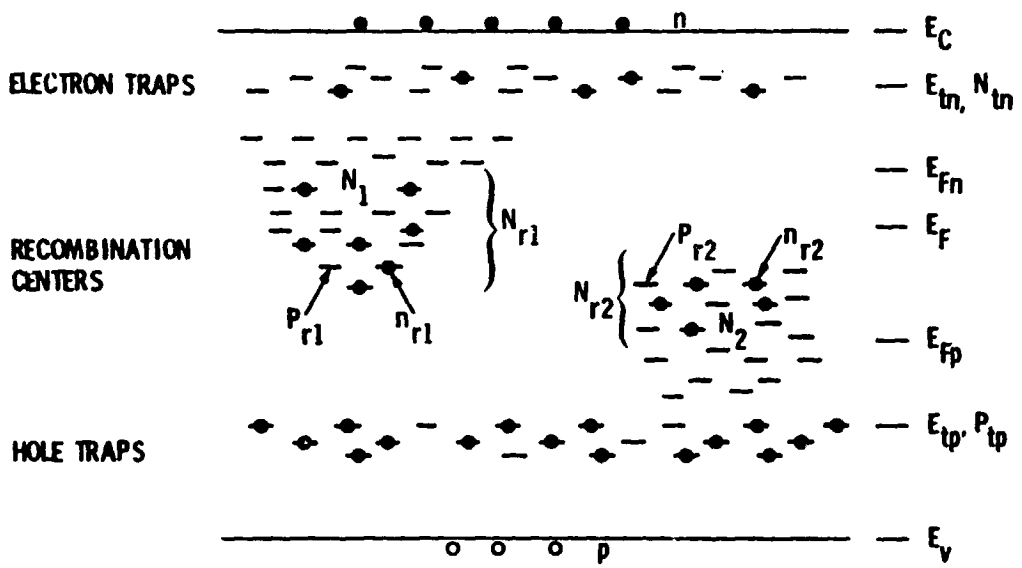
SCLS Image of Module 1 Using 4579 Å Argon Laser Line



Photocurrent Dependence on Excitation Intensity



Schematic Energy-Band Diagram and Distribution of Gap States in a-Si:H



n_r = RECOMBINATION CENTERS OCCUPIED BY ELECTRONS

P_r = RECOMBINATION CENTERS EMPTY OF ELECTRONS

$$n_r + P_r = N_r$$

Free Carrier Electron Transport Model

$1 \geq \gamma \geq \frac{1}{2}$: MONOMOLECULAR RECOMBINATION

$$I \propto F^{\gamma}$$

$\gamma = \frac{1}{2}$: BIMOLECULAR RECOMBINATION

(DIRECT RECOMBINATION BETWEEN EITHER FREE OR TRAPPED CARRIERS)

Whisker Signal

- DEVICE PARAMETER RELATED
- PROCESS RELATED

Conclusion

- SOLAR CELL LASER SCANNER CAN BE EFFECTIVELY USED TO NONDESTRUCTIVELY TEST NOT ONLY ACTIVE DEFECTS BUT ALSO THE CELL QUALITY AND INTEGRITY OF ELECTRICAL CONTACTS.

Plans for a-Si Solar Cells

- UPGRADE SCLS CAPABILITY TO PROBE PHOTOCURRENT RESPONSE IN DIFFERENT LAYERS OF THE DEVICE.
- EVALUATE AND CHARACTERIZE MODULE DEGRADATIONAL PHENOMENA IN THIN-FILM AMORPHOUS SILICON SOLAR CELLS WITH PARTICULAR EMPHASIS ON MICRO AND MACROSCOPIC DEFECTS/FLAWS.
- DEVELOP METHODS TO ANALYZE FAILURE MODES RESULTING FROM DEGRADATION DUE TO ENVIRONMENTAL EFFECTS SUCH AS OPTICAL, THERMAL, MECHANICAL AND MOISTURE.
- ANALYZE CELL INTER-COUPLINGS.

Photocurrent Signal of Module 1 Across the Nine Cells in Series Coupled Module Scanned by a He-Ne Laser (3.0 mW)