

N85-32422

SENSITIVITY ANALYSIS OF HIGH-EFFICIENCY SILICON SOLAR-CELL DESIGN PARAMETERS

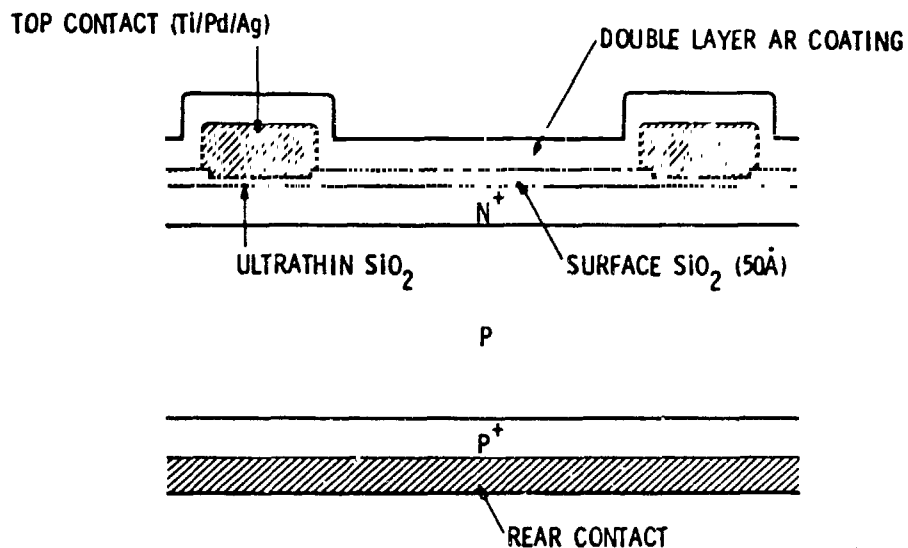
JET PROPULSION LABORATORY

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Outline

- EXPERIMENTAL VS SIMULATION RESULTS
- DOPING PROFILE MODIFICATIONS
- SENSITIVITIES OF CRITICAL PARAMETERS
- CONCLUSIONS

Cross Section of the Silicon Solar Cell Considered for Sensitivity Analysis

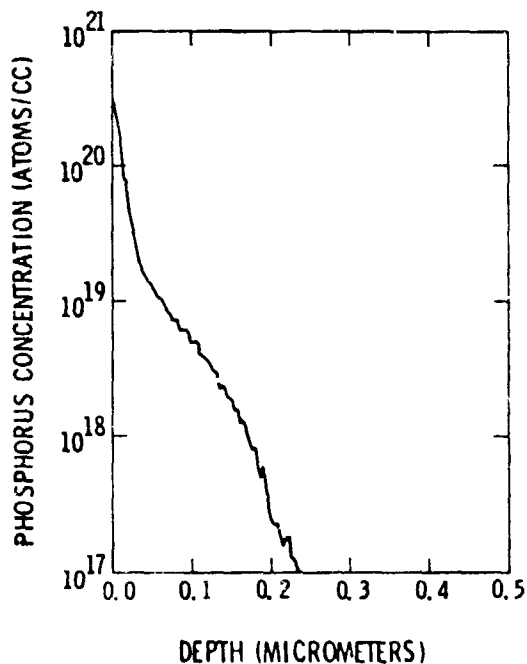


REF: IEEE TRANSACTIONS ON ELECTRON DEVICES, VOL ED-31, NO. 5, MAY 1984

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HIGH-EFFICIENCY SILICON SOLAR CELL RESEARCH

Doping Profile of the Silicon Solar Cell



Solar-Cell Parameters

- BULK RESISTIVITY - $0.2 \Omega\text{-cm}$ ($2.0 \times 10^{17}/\text{cm}^3$, B)
- MINORITY-CARRIER LIFETIME - $20.0 \mu\text{sec}$
- CELL THICKNESS - $280.0 \mu\text{m}$
- FRONT JUNCTION DEPTH - $0.23 \mu\text{m}$
- FRONT SURFACE DOPING CONC. - $2.8 \times 10^{20}/\text{cm}^3$ (PHOS)
- FRONT SURFACE RECOMBINATION VELOCITY - $1,000 \text{ cm/sec}$
- BACK SURFACE CONTACT - ohmic

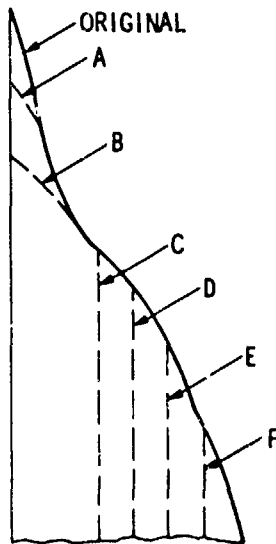
Experimental vs Simulation Results

TYPE	V _{oc} (mV)	I _{sc} (mA)	FF	EFFICIENCY (%)
EXPERIMENTAL*	641.11	35.48	0.8220	18.70
SIMULATION (X)	638.76	35.08	0.8334	18.53

• MARTIN GREEN'S MINP CELL

(X) SOLAR CELL ANALYSIS PROGRAM IN 1 DIMENSION (SCAP1D)
DEVELOPED BY PURDUE UNIVERSITY FOR SANDIA LABORATORY

Doping Profile Modification



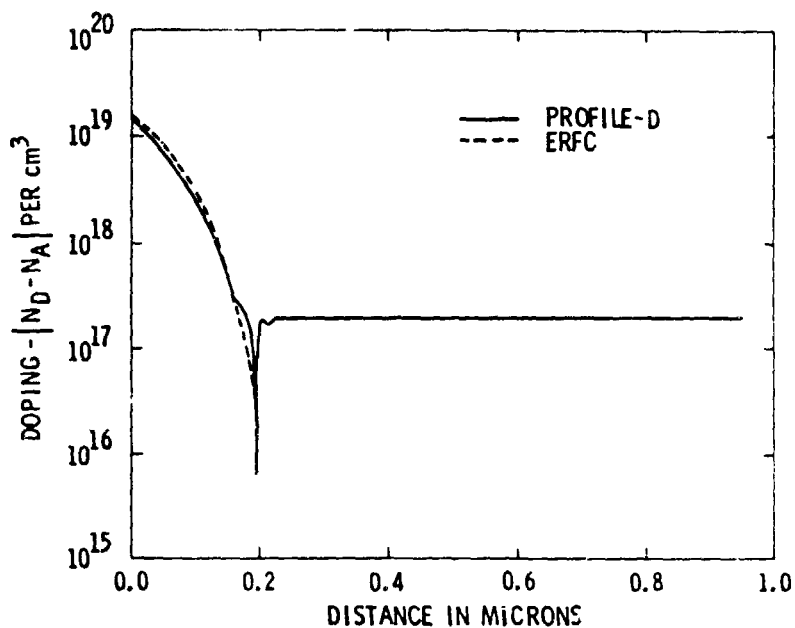
TYPE	FRONT SURFACE CONC.	FRONT JUNCTION DEPTH	EFFICIENCY (%)
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ORIGINAL	2.8×10^{20}	0.23 μm	18.53
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A	5.0×10^{19}	0.23 μm	19.21
B	2.0×10^{19}	0.23 μm	19.24

C	1.8×10^{19}	0.21 μm	19.27
D	1.6×10^{19}	0.19 μm	19.29
E	1.1×10^{19}	0.17 μm	19.28
F	7.5×10^{18}	0.15 μm	19.27

Complementary Error Function vs Profile-D

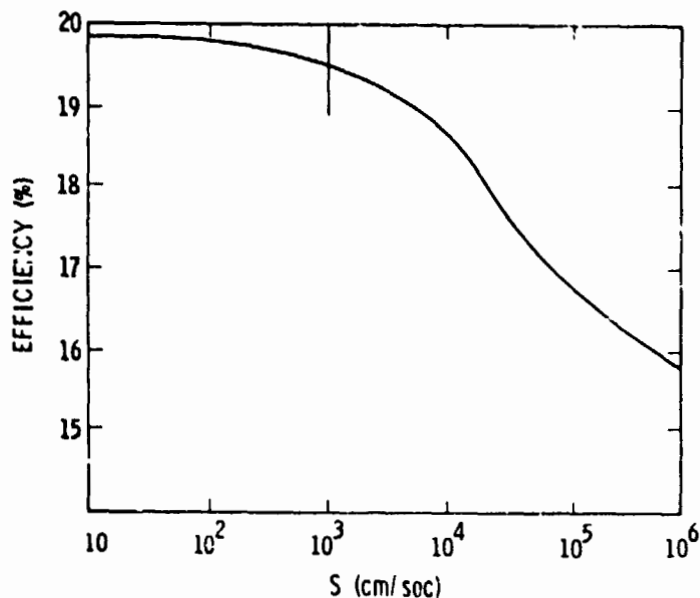


Sensitivity Analysis

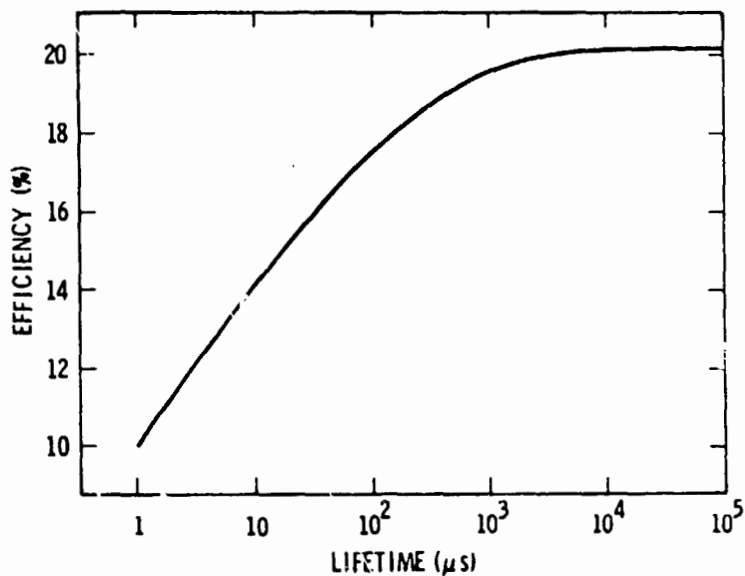
CRITICAL PARAMETERS

- SURFACE RECOMBINATION VELOCITY
- MINORITY-CARRIER LIFETIME
- CELL THICKNESS
- BACK SURFACE FIELD

Front-Surface Recombination Velocity Sensitivity

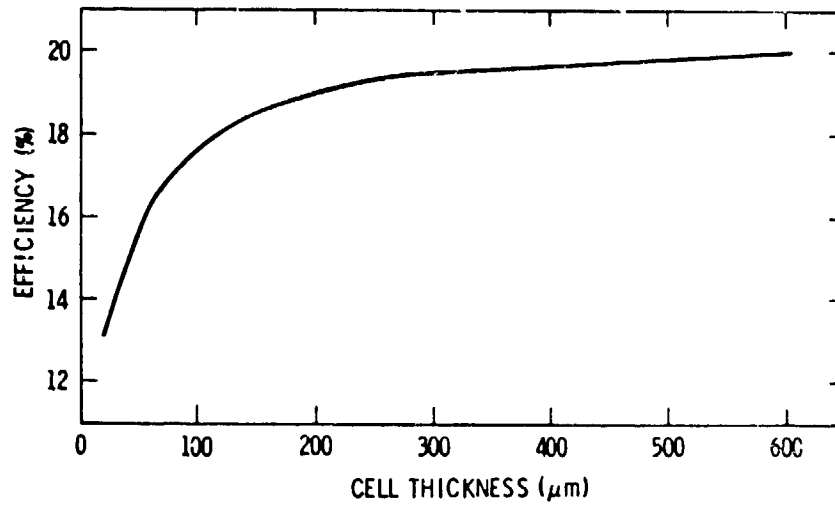


Minority-Carrier Lifetime Sensitivity



HIGH-EFFICIENCY SILICON SOLAR CELL RESEARCH

Cell Thickness Sensitivity



Effect of Back-Surface Field

BACK SURFACE CONC.	BACK JUNCTION DEPTH (μm)	EFFICIENCY (%)
2×10^{17}	0	19.55
	10	19.63
1×10^{18}	2	19.57
	5	19.59
	10	19.63
1×10^{19}	2	19.61
	5	19.68
	10	19.76
1×10^{20}	2	19.67
	5	19.74
	10	19.78

HIGH-EFFICIENCY SILICON SOLAR CELL RESEARCH

Conclusions

- THERE IS GOOD AGREEMENT BETWEEN EXPERIMENTAL AND SIMULATION RESULTS
- SHEET MATERIAL QUALITY IMPROVEMENT IS NEEDED FOR HIGH EFFICIENCY CELLS
- 20% CELL OF THIS DESIGN IS FEASIBLE WITH 10 ms BULK LIFETIME MATERIAL
- FOR ACHIEVING EFFICIENCIES HIGHER THAN 20% NEW CELL DESIGNS INCLUDING THIN CELLS WITH LIGHT TRAPPING AND BACK SURFACE FIELD SHOULD BE CONSIDERED