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PREFACE

This report contains the document control information and abstracts for SERI Photovoltaic (PV) Program publications resulting from SERI's subcontracted PV research. The information is presented for reports published or distributed from August 1 through December 31, 1990. In the past, copies of the subcontractor reports were distributed to a broad spectrum of researchers in the field of photovoltaics at a considerable cost to the program. In an attempt to reduce costs and ensure that all researchers receive those current publications that are of specific interest to them, this report will outline these publications, organized by technology, on a regular basis. A list of additional publications and sources is included herein to provide the photovoltaic community with other sources of information. All of the documents represented here are available from the National Technical Information Service (NTIS) and can be purchased using the NTIS order form at the end of this document. Further information on a given subcontracted program may be obtained from the SERI technical monitor identified on each Document Control Page.

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Document Control Page	1. SERI Report No. SERI/TP-211-3918	2. NTIS Accession No. DE90000364	3. Recipient's Accession No.
4. Title and Subtitle Research on High-Efficiency, Multiple-Gap, Multi-Junction Amorphous Silicon-Based Alloy Thin-Film Solar Cells, Final Subcontract Report			5. Publication Date August 1990
7. Author(s) S. Guha, Principal Investigator et al			6.
9. Performing Organization Name and Address Energy Conversion Devices, Inc. 1675 West Maple Road Troy, Michigan 48084			8. Performing Organization Rept. No.
			10. Project/Task/Work Unit No.
			11. Contract (C) or Grant (G) No. (C) ZB-7-06003-4 (G)
12. Sponsoring Organization Name and Address Solar Energy Research Institute 1617 Cole Boulevard Golden, Colorado 80401-3393			13. Type of Report & Period Covered Technical Report
			14. 3/1/87 - 2/28/90
15. Supplementary Notes SERI Technical Monitor: B. Stafford, (303) 231-7126			
16. Abstract (Limit: 200 words) This report documents the results of material development, single-junction solar cell research, and high-efficiency multijunction cell development. High-quality a-Si:Ge:H:F alloys were made with optical band gaps as low as 1.3 eV; high-conductivity microcrystalline p ⁺ and n ⁺ doped alloys were developed with optical band gaps greater than 2 eV. A double-layer antireflection coating was developed, and the cell's quantum efficiency at 400 nm improved from 60% to 77%. A novel solar cell structure was developed using band gap profiling in the intrinsic layer to obtain high efficiency. Single-junction solar cells with a-SiGe:H alloys in the intrinsic layer were fabricated with active-area efficiencies of 9.7%. Dual-gap tandem cells were fabricated with active-area efficiencies of 13%, and triple-junction cells were fabricated with active-area efficiencies of 13.7%--the highest reported to date for any thin-film amorphous solar cell. Degradation rates of 12%-17% after 300 hours illumination were measured in triple-junction cells, a significant increase over the degradation of single-junction cells with comparable efficiencies. A triple-junction module with a subaperture area of 818 cm ² was measured at SERI with a conversion efficiency of 8.4%.			
17. Document Analysis a. Descriptors Photovoltaics ; thin films : amorphous silicon ; semiconductor materials ; amorphous silicon-germanium ; multijunction solar cells b. Identifiers/Open-Ended Terms c. UC Categories 271			
18. Availability Statement National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, Virginia 22161			19. No. of Pages 158
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Document Control Page	1. SERI Report No. TP-211-3949	2. NTIS Accession No. DE90000371	3. Recipient's Accession No.
4. Title and Subtitle Amorphous Silicon Solar Cells Prepared at High Deposition Rates Annual Subcontract Report, 1 July 1989 - 30 June 1990			5. Publication Date August 1990
			6.
7. Author(s) D.S. Shen, P.K. Bhat			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Glasstech Solar, Inc. (GSI) 6800 Joyce Street Golden, CO 80403			10. Project/Task/Work Unit No. PV040201
			11. Contract (C) or Grant (G) No. (C)AB-7-06002-1 (G)
12. Sponsoring Organization Name and Address Solar Energy Research Institute 1617 Cole Boulevard Golden, CO 80401-3393			13. Type of Report & Period Covered Technical Report 1 July 1989 - 30 June 1990
			14.
15. Supplementary Notes SERI Technical Monitor: W. Luft			
16. Abstract (Limit: 200 words) This document describes the progress in the research of amorphous silicon solar cells prepared at high deposition rates. By using high excitation frequency (110 MHz) and optimization of deposition conditions, the electronic properties of i-layers deposited from Si_2H_6 or SiH_4 at approximately 2 nm/s approached the properties of low deposition rate films. $\text{B}(\text{CH}_3)_3$ was used as an alternative p-layer doping gas. The results show that $\text{B}(\text{CH}_3)_3$ is a better doping gas than B_2H_6 , due to its better thermal stability and produces a film with better electro-optical properties. The open-circuit voltage, V_{oc} , of the devices has been improved by using a $\text{B}(\text{CH}_3)_3$ p-layer and a better p/i interface layer. The short circuit current density, J_{sc} , has been improved by using an ITO/Ag back reflector. The key for fabricating high-deposition-rate SiH_4 devices has been found to be the p/i interface. As a result, high-deposition-rate cells deposited from both Si_2H_6 and SiH_4 source gases reached 10% efficiencies. A 1-cm ² cell deposited at 2 nm/s from Si_2H_6 reached 10.1% initial efficiency as measured by the Solar Energy Research Institute.			
17. Document Analysis a. Descriptors amorphous state ; thin films ; photovoltaic cells ; solar cells b. Identifiers/Open-Ended Terms c. UC Categories 271			
18. Availability Statement National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, Virginia 22161			19. No. of Pages 32
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Document Control Page	1. SERI Report No. SERI/TP-211-3967	2. NTIS Accession No. DE91002115	3. Recipient's Accession No.
4. Title and Subtitle Research on Stable, High-Efficiency, Large-Area Amorphous Silicon Based Modules - Task B		5. Publication Date October 1990	
		6.	
7. Author(s) K. W. Mitchell, D. R. Willet		8. Performing Organization Rept. No.	
9. Performing Organization Name and Address Siemens Solar Industries 4650 Adohr Lane Camarillo, CA 93010		10. Project/Task/Work Unit No. PV040201	
		11. Contract (C) or Grant (G) No. (C) ZB-7-06003-3 (G)	
12. Sponsoring Organization Name and Address Solar Energy Research Institute 1617 Cole Blvd. Golden, CO 80401		13. Type of Report & Period Covered Technical report	
		14.	
15. Supplementary Notes SERI technical monitor: W. Luft			
16. Abstract (Limit: 200 words) This report documents progress in developing a stable, high-efficiency, four-terminal hybrid tandem module. The module consists of a semi-transparent, thin-film silicon:hydrogen alloy (TFS) top circuit and a copper indium diselenide (CuInSe ₂) bottom circuit. Film deposition and patterning processes were successfully extended to 0.4-m ² substrates. A 33.2-W (8.4% efficient) module with a 3970-cm ² aperture area and a white back reflector was demonstrated; without the back reflector, the module produced 30.2 W (7.6% efficient). Placing a laminated, 31.6-W, 8.1%-efficient CuInSe ₂ module underneath this TFS module, with an air gap between the two, produces 11.2 W (2.9% efficient) over a 3883-cm ² aperture area. Therefore, the four-terminal tandem power output is 41.4 W, translating to a 10.5% aperture-area efficiency. Subsequently, a 37.8-W (9.7% aperture-area efficiency) CuInSe ₂ module was demonstrated with a 3905-cm ² aperture area. Future performances of single-junction and tandem modules of this size were modeled, and predicted power outputs exceed 50 W (13% efficient) for CuInSe ₂ and 65 W (17% efficient) for TFS/CuInSe ₂ tandem modules.			
17. Document Analysis a. Descriptors photovoltaics ; solar cells ; amorphous silicon ; large area ; modules ; high efficiency b. Identifiers/Open-Ended Terms c. UC Categories 271			
18. Availability Statement National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, VA 22161		19. No. of Pages 39	
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Document Control Page	1. SERI Report No. SERI/TP-211-3990	2. NTIS Accession No. DE90000387	3. Recipient's Accession No.
4. Title and Subtitle Improvement of Bulk and Epitaxial III-V Semiconductors for Solar Cells by Creation of Denuded Recombination Zones		5. Publication Date November 1990	6.
7. Author(s) D. Wong, H. K. Kim, A-Z Li, T. E. Schlesinger, A. G. Milnes		8. Performing Organization Rept. No.	
9. Performing Organization Name and Address Carnegie Mellon University Pittsburgh, Pennsylvania		10. Project/Task/Work Unit No.	11. Contract (C) or Grant (G) No. (C) XB6-06005-3 (G)
12. Sponsoring Organization Name and Address Solar Energy Research Institute 1617 Cole Boulevard Golden, Colorado 80401-3393		13. Type of Report & Period Covered Technical Report	14. 9/1/86 - 6/30/90
15. Supplementary Notes SERI Technical Monitor: C. Leboeuf, (303) 231-1066			
16. Abstract (Limit: 200 words) Increases in hole diffusion lengths of up to a factor of three were obtained in commercially grown liquid encapsulated Czochralski (Te-doped) and Si-doped horizontal Bridgman GaAs. This was achieved by application of a technique involving proximity annealing of the material in sealed silica ampoules. The short wavelength photoresponse of the cells was also enhanced. This was achieved by passivation of the surfaces of the cells with a simple chemical treatment using ammonium sulphide. Defect studies with deep level transient spectroscopy and photoluminescence revealed that the dominant recombination center in the material studied is a hole trap we have termed HCX ($E_v + 0.29$ eV). This is believed to be a native defect, perhaps associated with excess arsenic. Defect suppression was achieved in molecular beam epitaxial films by isoelectronic doping (with In and Sb). It was also shown that the defect structure in the films was affected by the choice of growth parameters such as growth rate and temperature.			
17. Document Analysis a. Descriptors III-V semiconductors ; recombination zones ; gallium arsenide ; solar cells ; photovoltaics ; b. Identifiers/Open-Ended Terms c. UC Categories 272			
18. Availability Statement National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, Virginia 22161		19. No. of Pages 148	20. Price A07

Document Control Page	1. SERI Report No. SERI/TP-211-3905	2. NTIS Accession No. DE90000359	3. Recipient's Accession No.
4. Title and Subtitle Electronic Processes in Thin Film PV Materials, Final Subcontract Report		5. Publication Date August 1990	
		6.	
7. Author(s) P.C. Taylor, G.A. Williams, W.D. Ohlsen		8. Performing Organization Rept. No.	
9. Performing Organization Name and Address Department of Physics University of Utah Salt Lake City, Utah 84112		10. Project/Task/Work Unit No.	
		11. Contract (C) or Grant (G) No. (C) XB-5-05009-2 (G)	
12. Sponsoring Organization Name and Address Solar Energy Research Institute 1617 Cole Boulevard Golden, Colorado 80401-3393		13. Type of Report & Period Covered Technical Report	
		14. 9/1/86 - 5/31/89	
15. Supplementary Notes SERI Technical Monitor: C. Leboeuf, (303) 231-1066			
16. Abstract (Limit: 200 words) This report describes research to study the effects of defects, impurities, and interfaces on the performance of photovoltaic (PV) devices, particularly hydrogenated amorphous silicon (a-Si:H) and related alloys. The studies of a-Si:H and related alloys involve understanding the metastabilities using various analysis techniques, characterizing the defects lying deep within the gap (such as Si dangling bonds) and the general density of electronic states throughout the gap, and understanding interfacial effects, especially as they relate to interfaces important in PV devices. Accomplishments include understanding the kinetics of light-induced defects in films, identifying trapped molecular hydrogen and discovering molecular hydrogen diffusion along the microvoids in a-Si:H, investigating the behavior of the defect photoluminescence band in Si-Ge alloys, discovering an E'-type defect at some a-Si:H/SiO ₂ interfaces, initially characterizing some paramagnetic defects induced by rapid thermal quenching, developing a new technique to measure low levels of absorption in films and discovering a peak in the below-gap absorption spectrum that may be interface related, using subgap excitation of electron spin resonance and photoluminescence to probe deep defects, and developing a bistable optical switch based on thermal modulation of the index of refraction in films.			
17. Document Analysis a. Descriptors Photovoltaics ; thin films ; amorphous silicon ; glow discharges b. Identifiers/Open-Ended Terms c. UC Categories 271			
18. Availability Statement National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, Virginia 22161		19. No. of Pages 40	
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Document Control Page	1. SERI Report No. SERI/TP-211-3864	2. NTIS Accession No. DE90000345	3. Recipient's Accession No.
4. Title and Subtitle Novel Thin-Film CuInSe ₂ Fabrication, Final Subcontract Report		5. Publication Date September 1990	
7. Author(s)		6.	
9. Performing Organization Name and Address University of Arkansas Fayetteville, Arkansas University of Colorado Boulder, Colorado		8. Performing Organization Rept. No.	
		10. Project/Task/Work Unit No.	
		11. Contract (C) or Grant (G) No. (C) XL-8-18017-1 (G)	
12. Sponsoring Organization Name and Address Solar Energy Research Institute 1617 Cole Boulevard Golden, Colorado 80401-3393		13. Type of Report & Period Covered Technical Report	
		14.	
15. Supplementary Notes SERI Technical Monitor: R. Mitchell, (303) 231-1379			
16. Abstract (Limit: 200 words) This report describes work to study the feasibility of fabricating CuInSe ₂ (CIS), to be used in photovoltaic cells, by rapid annealing processes including laser processing and rapid thermal processing (RTP). Presently, the chalcopyrite phase of CIS is obtained by thermally annealing elemental Cu and In layers in H ₂ Se gas. This process is hazardous because of the high toxicity of the hydrogen selenide gas, making the process unattractive for large-scale production. The ability to form the desired chalcopyrite structure with favorable optical and electrical properties by rapid annealing processes would be safer and more conducive to large-scale production. Initial studies of the feasibility of laser annealing the elemental layered structures have been performed using CW argon and Nd:Yag lasers on films fabricated by thermal resistance evaporation in a vacuum of 10 ⁻⁶ torr. Characterization of the post-annealed films by x-ray diffraction analysis has shown encouraging results. The laser annealed films have all contained the chalcopyrite phase of CIS, although the percentage of the chalcopyrite phase has been small. Undesirable binary compounds have also formed. To produce higher-quality films, future work will concentrate on increasing the percentage of the desirable phase and eliminating all binary compounds.			
17. Document Analysis a. Descriptors Photovoltaics ; thin films ; solar cells ; indium selenide b. Identifiers/Open-Ended Terms c. UC Categories 273			
18. Availability Statement National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, Virginia 22161		19. No. of Pages 12	
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Document Control Page	1. SERI Report No. TP-211-3950	2. NTIS Accession No. DE90000372	3. Recipient's Accession No.
4. Title and Subtitle Analysis of Loss Mechanisms in Polycrystalline Thin Film Solar Cells Final Subcontract Report, 1 April 1988 - 31 March 1990			5. Publication Date August 1990
7. Author(s) J.R. Sites			6.
9. Performing Organization Name and Address Colorado State University Fort Collins, Colorado 80523			8. Performing Organization Rept. No.
			10. Project/Task/Work Unit No. PV040301
			11. Contract (C) or Grant (G) No. (C) XL-8-18080-1 (G)
12. Sponsoring Organization Name and Address Solar Energy Research Institute 1617 Cole Boulevard Golden, Colorado 80401-3393			13. Type of Report & Period Covered Technical Report
			14.
15. Supplementary Notes SERI Technical Monitor: H.S. Ullal			
16. Abstract (Limit: 200 words) Our goal for thin-film polycrystalline solar cell analysis was to increase the useful information extracted from relatively straightforward electrical measurements. The strategy was to (1) systematize measurements and reporting, (2) organize results in terms of quantitative values for individual sources of current and voltage loss, and (3) evaluate possible analytical techniques to enhance precision and avoid pitfalls, and (4) insist on a viable physical explanation of each loss mechanism. Current-voltage, quantum efficiency, and capacitance measurements on CuInSe ₂ and CdTe solar cells from a variety of sources were analyzed. In many cases, losses were identified that may be lessened relatively easily. However, the operating voltage loss because of excessive forward recombination current throughout the depletion region remains the primary obstacle to efficiencies competitive with single crystal cells.			
17. Document Analysis a. Descriptors polycrystalline thin films ; photovoltaic cells ; solar cells ; loss mechanisms b. Identifiers/Open-Ended Terms c. UC Categories 273			
18. Availability Statement National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161			19. No. of Pages 40
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Document Control Page	1. SERI Report No. SERI/TP-211-3952	2. NTIS Accession No. DE91002112	3. Recipient's Accession No.
4. Title and Subtitle High-Efficiency Cadmium and Zinc Telluride-Based Thin Film Solar Cells		5. Publication Date October 1990	
		6.	
7. Author(s) A. Rohatgi, C. J. Summers, A. Erbil, R. Sudharsanan, and S. Ringel		8. Performing Organization Rept. No.	
9. Performing Organization Name and Address School of Electrical Engineering Georgia Institute of Technology Atlanta, Georgia 30332		10. Project/Task/Work Unit No. PV040301	
		11. Contract (C) or Grant (G) No. (C) XL-7-06031-1 (G)	
12. Sponsoring Organization Name and Address Solar Energy Research Institute 1617 Cole Blvd. Golden, CO 80401		13. Type of Report & Period Covered Technical report	
		14.	
15. Supplementary Notes SERI technical monitor: R. Mitchell			
16. Abstract (Limit: 200 words) Polycrystalline $\text{Cd}_{1-x}\text{Zn}_x\text{Te}$ and $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$ films with a band gap of 1.7 eV were successfully grown on glass/ SnO_2 / CdS substrates by molecular beam epitaxy (MBE) and metal-organic chemical vapor deposition (MOCVD), respectively. Polycrystalline $\text{Cd}_{1-x}\text{Zn}_x\text{Te}$ films grown by MBE resulted in uniform composition and sharp interfaces. However, polycrystalline $\text{Cd}_{1-x}\text{Mn}_x\text{Te}$ films grown by MOCVD showed nonuniform compositions and evidence of manganese accumulation at the $\text{Cd}_{1-x}\text{Mn}_x\text{Te}/\text{CdS}$ interface. We found that manganese interdiffuses and replaces cadmium in the CdS film. By improving the CdTe/CdS interface and, thus, reducing the collection function effects, the efficiency of the MOCVD CdTe cell can be improved to about 13.5%. MBE-grown CdTe cells also produced 8%-9% efficiencies. The standard CdTe process was not optimum for ternary films and resulted in a decrease in the band gap. Recent results indicate that $\text{CdCl}_2 + \text{ZnCl}_2$ chemical treatment may prevent the band-gap reduction, and that chromate etch (rather than bromine etch) may provide the solution to contact resistance in the ternary cells.			
17. Document Analysis a. Descriptors photovoltaics ; solar cells ; thin films ; cadmium telluride ; graded band gap ; high efficiency b. Identifiers/Open-Ended Terms zinc telluride c. UC Categories 270			
18. Availability Statement National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, VA 22161		19. No. of Pages 90	
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Document Control Page	1. SERI Report No. SERI/TP-211-4033	2. NTIS Accession No. DE91002116	3. Recipient's Accession No.
4. Title and Subtitle Low-Cost CdZnTe Devices for Cascade Cell Applications		5. Publication Date November 1990	
		6.	
7. Author(s) Bulent M. Basol, Vijay K. Kapur		8. Performing Organization Rept. No.	
9. Performing Organization Name and Address International Sol Electric Technology 8635 Aviation Blvd. Inglewood, CA 90301		10. Project/Task/Work Unit No. PVC40601	
		11. Contract (C) or Grant (G) No. (C) XL-7-06074-2 (G)	
12. Sponsoring Organization Name and Address Solar Energy Research Institute 1617 Cole Blvd. Golden, CO 80401		13. Type of Report & Period Covered Technical report	
		14.	
15. Supplementary Notes SERI technical monitor: R. Mitchell, (303) 231-1379			
16. Abstract (Limit: 200 words) This report describes a research program to develop a low-cost technique for producing $Cd_{1-x}Zn_xTe$ devices for cascade solar cell applications. The technique involves a two-stage process for fabricating such devices with a band gap of about 1.7 eV and a transparent contact layer of low-resistivity ZnTe. In the first stage, thin films of Cd, Zn, and Te are deposited in stacked layers as $Cd_{1-x}Zn_xTe$. The second stage involves heating and reacting the layers to form the compound. At first, electrodeposition was used for depositing the layers to successfully fabricate $Cd_{1-x}Zn_xTe$ thin-film devices. These films were also intrinsically doped with copper. For the first time, transparent ZnTe films of low resistivity were obtained in a two-stage process; preliminary solar cells using films with low Zn content were demonstrated. A second phase of the project involved growing films with higher Zn content (>15%). Such films were grown on CdS-coated substrates for fabricating devices. The effects of the solar-cell processing steps on the $Cd_{1-x}Zn_xTe$ and CdS/ $Cd_{1-x}Zn_xTe$ interfaces were studied; results showed that the nature of the interface depended on the stoichiometry of the $Cd_{1-x}Zn_xTe$ thin film. A sharp interface was observed for the CdS/CdTe structures, but the interface became highly diffused as the Zn content in the absorber layer increased above 15%. The interaction between the CdS window layer and the $Cd_{1-x}Zn_xTe$ absorber layer was found to result from an exchange reaction between Zn in the absorber layer and the thin CdS film.			
17. Document Analysis a. Descriptors photovoltaics ; solar cells ; thin films ; cascade cells b. Identifiers/Open-Ended Terms c. UC Categories 273			
18. Availability Statement National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, VA 22161		19. No. of Pages 27	
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Document Control Page	1. SERI Report No. SERI/TP-211-4034	2. NTIS Accession No. DE91002117	3. Recipient's Accession No.
4. Title and Subtitle High-Efficiency Large-Area CdTe Panels			5. Publication Date October 1990
			6.
7. Author(s) Scot P. Albright, Rhodes R. Chamberlin, John F. Jordan			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Photon Energy, Inc. El Paso, TX			10. Project/Task/Work Unit No. PV040301
			11. Contract (C) or Grant (G) No. (C) ZL-7-06031-3 (G)
12. Sponsoring Organization Name and Address Solar Energy Research Institute 1617 Cole Blvd. Golden, CO 80401			13. Type of Report & Period Covered Technical report
			14.
15. Supplementary Notes SERI technical monitors: K. Zweibel and R. Mitchell, (303) 231-1379			
16. Abstract (Limit: 200 words) This report describes a three-year project to develop an improved materials technology and fabrication process to produce 1-ft ² and 4-ft ² CdS/CdTe photovoltaic modules. The stability objective for the project was to develop techniques to provide a ten-year life extrapolation with an efficiency degradation of not more than 10%. First, CdS/CdTe devices were analyzed; electrical and optical measurements were taken to characterize the effect that process variations had on cell behavior and to better understand current flow at the junction. Second, device and module efficiency improvements were quantified. Photovoltaic devices of various sizes were analyzed. Small-area devices achieved active-area efficiencies of up to 12.3%, and other, lower-current devices exhibited fill factors as high as 72%. Efficiencies in excess of 14% are expected by improving the fill factor on higher-current devices. Finally, encapsulation and life testing studies were carried out on devices made with a doped-graphite electrode (which proved to be more stable than the Te-based electrodes). Thermal cycling on 1-ft ² and 4-ft ² modules revealed no delamination modes. Encapsulated submodules were life-tested outdoors for more than 270 days and showed no observable degradation. Detailed conclusions and a recommended future direction are also presented.			
17. Document Analysis a. Descriptors photovoltaics ; solar cells ; thin films ; large area ; modules ; high efficiency b. Identifiers/Open-Ended Terms c. UC Categories 273			
18. Availability Statement National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, VA 22161			19. No. of Pages 46
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ADDITIONAL PUBLICATIONS AND SOURCES

The following publications were produced under the DOE Photovoltaics Program or are widely available publications in which substantial DOE-supported work is reported. Those that are available from the National Technical Information Service (NTIS) can be purchased with the NTIS order form provided hereafter.

Annual Report, Photovoltaic Measurements and Performance Branch, FY 1988. (January 1989). SERI/PR-213-3590. 160 pp. Available NTIS: Order No. DE89009500.

Annual Report, Photovoltaic Measurements and Performance Branch, FY 1989. (May 1990). SERI/TP-213-3712. 226 pp. Available NTIS: Order No. DE90000324.

Annual Report, Photovoltaic Program Branch, FY 1988. (March 1989). SERI/PR-211-3483. 302 pp. Available NTIS: Order No. DE89000898.

Annual Report, Photovoltaic Program Branch, FY 1989. (March 1990). SERI/TP-211-3643. 279 pp. Available NTIS: Order No. DE90000318.

Annual Report, Solid State Photovoltaic Research Branch, FY 1988. (July 1989). SERI/PR-212-3494. 265 pp. Available NTIS: Order No. DE89009463.

Annual Report, Solid State Photovoltaic Research Branch, FY 1989. (September 1990). SERI/TP-212-3675. 288 pp. Available NTIS: Order No. DE891002128.

Conference Record of the Twentieth IEEE Photovoltaic Specialists Conference - 1988; Las Vegas, Nevada; September 26-30, 1988. (1988). New York: The Institute of Electrical and Electronics Engineers, Inc.; 2 Volumes, 1664 pp. Available from IEEE, 345 E. 47th St., New York, NY 10017.

Current Abstracts: Photovoltaic Energy, Electricity from Sunlight. Prepared by the Office of Scientific and Technical Information for the Office of Conservation and Renewable Energy, U. S. Department of Energy. Nov.-Dec. 1989, PB89-933006. Available from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831.

Current Abstracts: Photovoltaic Energy, Electricity from Sunlight. Prepared by the Office of Scientific and Technical Information for the Office of Conservation and Renewable Energy, U. S. Department of Energy. Jan.-Feb. 1990, PB90-933001. Available from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831.

Luft, W. (1990). "Photovoltaic Applications for Silicon Carbon Films and Microcrystalline Silicon Films". Applied Physics Communications. Vol. 9, No. 4, pp. 329-357.

Mitchell, R. L.; Zweibel, K.; Ullal, H. S. (November 1990). Research on Polycrystalline Thin-Film Materials, Cells, and Modules. SERI/TP-211-4061. 7 pp. Available NTIS: Order No. DE91002124.

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