N85-32435

SILICON DENDRITIC WEB GROWTH

WESTINGHOUSE ELECTRIC CORP.

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Technology	Report Date
Single crystal ribbon growth	10/3/84
Approach Silicon dendritic web growth **Contractor** Westinghouse Electric Corp. Advanced Energy Systems Division JPL Contract 955843	**Status** • 6 ½ meters of uninterruped, continuously melt replenished web growth has been achieved with three different growth configurations • Steady-state web growth of 8 cm^2/min has been achieved • Major improvement in web growth reproducibility has been achieved • Concepts for higher growth rate have been developed
Goals For 1984 • Demonstrate 10 meter length of continuously melt replenish web crystal growth • Demonstrate 10 square centimeters per minute steady-state web growth	

Principal Activities This Period

- Grow Long Web Crystals From Continuously Replenished Melt
- Develop Temperature Distribution In Web And Melt
- Improve Reproducibility Of Growth
- Develop Configurations For Increased Growth Rates (Width And Speed)
- Develop New Growth System Components As Required For Improved Growth
- Evaluate Quality Of Web Grown

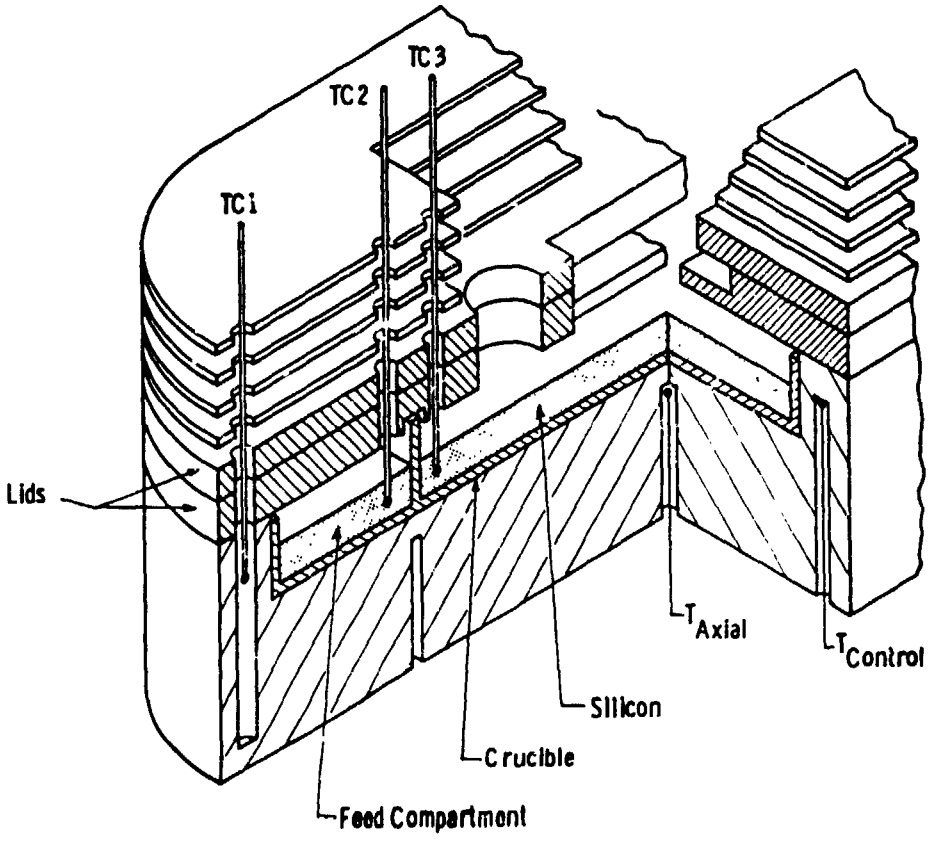
Continuously Melt-Replenished Web Growth

Three Web Growth Configurations Have Achieved Long Growth (Approx. 6 Meters)

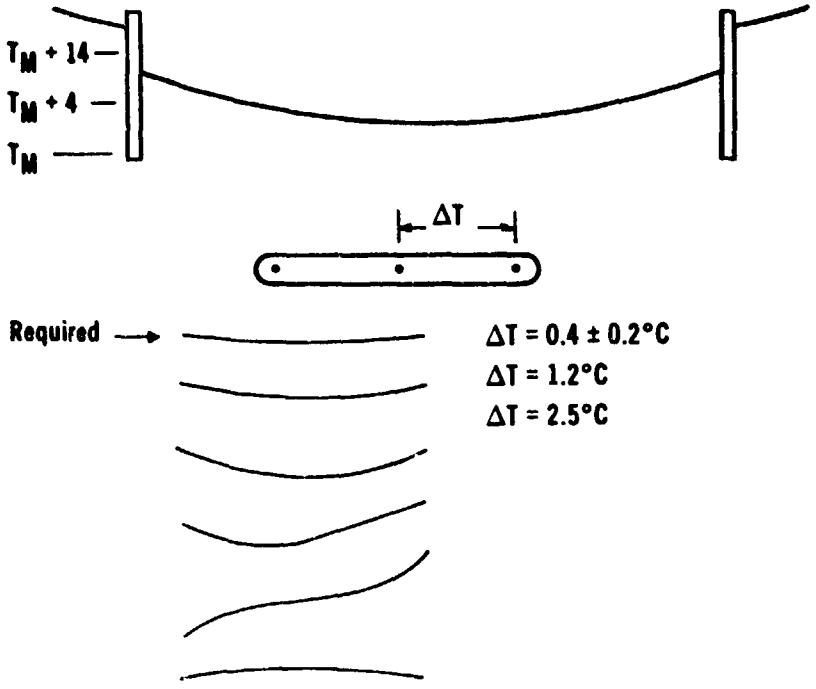
J435 (3.3 cm width)
J460L (4.1 cm width)
J460LS (5.1 cm width)

Critical Regions of Temperature Distribution in Silicon Web Growth

- **Between Crucible Compartments (Growth And Melt Replenishment Compartments)**
- **Within The Growth Compartment**
- **Vertical Profile Within The Growing Web**
- **Horizontal Profile Within The Growing Web**



Melt Temperature Distribution

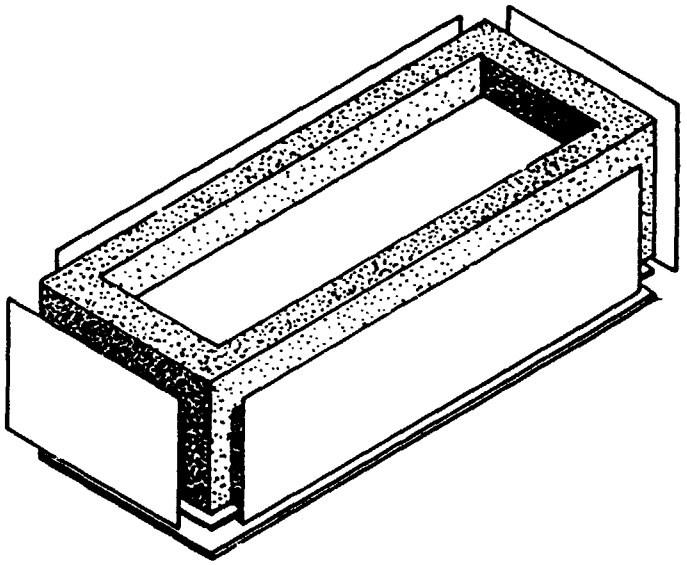


Principal Methods for Control of Melt Temperature Distribution

- Stationary Shield Configuration
- Dynamically Positionable Shield Configuration
- Dynamically Positionable Work Coil
- Design Of The Barrier Which Separates Crucible Compartments

Susceptor Shields

For Control Of Melt Temperature Distribution Includes Both Fixed And Adjustable Shields



Temperature Distribution Within the Growing Web

- **Determined By Design Of The Susceptor Lids And Top Shields**
- **Predicted By Computer Model**
- **Lid And Shield Temperatures Measured In Growth System**

Reproducibility of Web Growth

Improvements This Period

- Crucible Re-Designed For Better Susceptor Fit And Improved Thermal Transfer
- Rectangular Work Coil Fabricated With Precision Dimensions
- Perimeter Shields Re-Designed For Reproducible Spacing
- Mated Parts Fitted For Uniform Thermal Transfer

Configurations for Increased Growth Rates (Width and Speed)

- Concepts Are Generated Through Computer Modeling
- Initial Design Specification Derived From Models
- Design Is Verified Through Experimental Web Growth
- Experimental Web Growth And Measurements Provide Data For Additional Input To Model

Growth System Component Development

Major Examples Of Component Development In This Reporting Period:

New Crucibles

Improved Crucible Barriers

New Induction Heating Work Coils

New Furnace Cover Plate For Higher Growth Rate

Improved Feeder For Polysilicon Pellets

Thermal Elements For New Growth System Designs

Instrumentation For Monitoring Dendrite Thickness (Incomplete)

Web Quality Evaluation

Sources

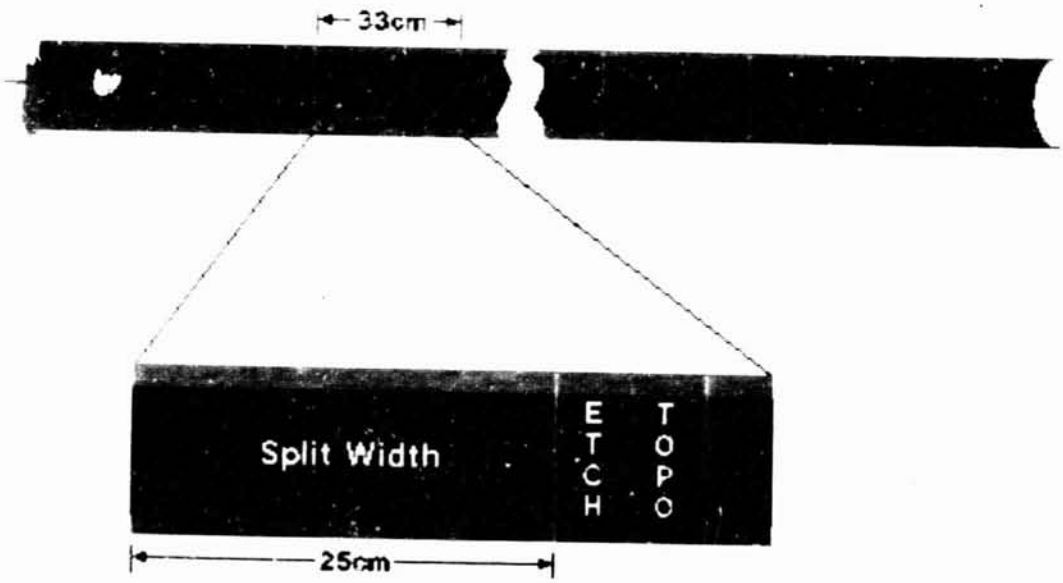
From This Program

- Residual Stress Via Web Split Width Measurements
- Dislocation Density Via Etch Pit Counting
- Defect Type, Distribution And Structure Via X-Ray Topography

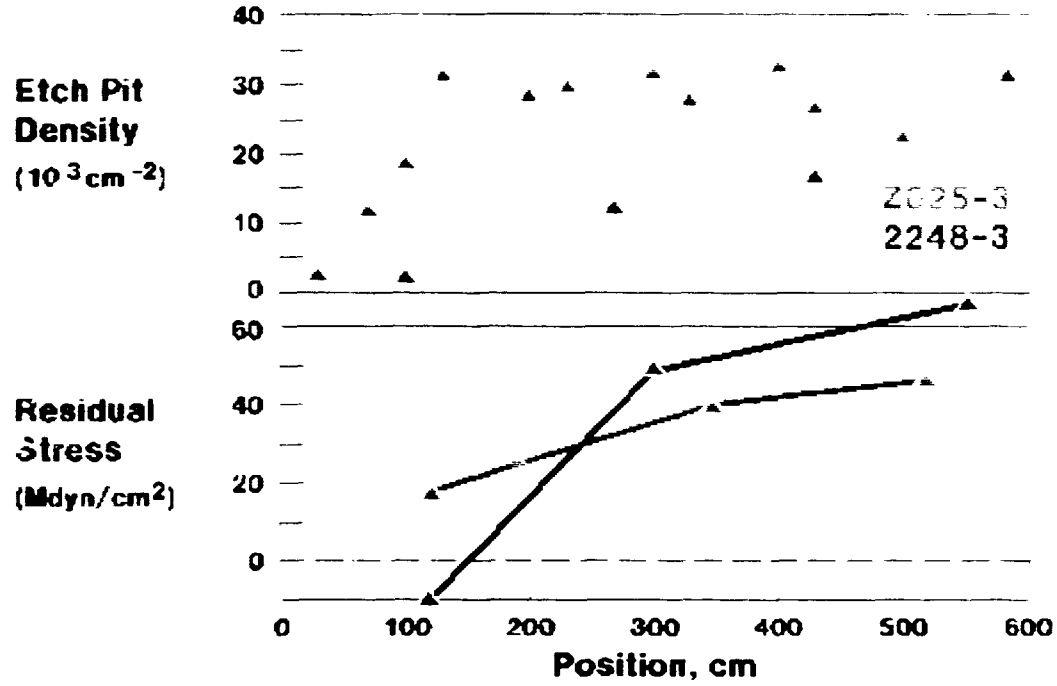
From Associated Programs

- Impurity Evaluation
- Electrical Properties
- Solar Cell Data

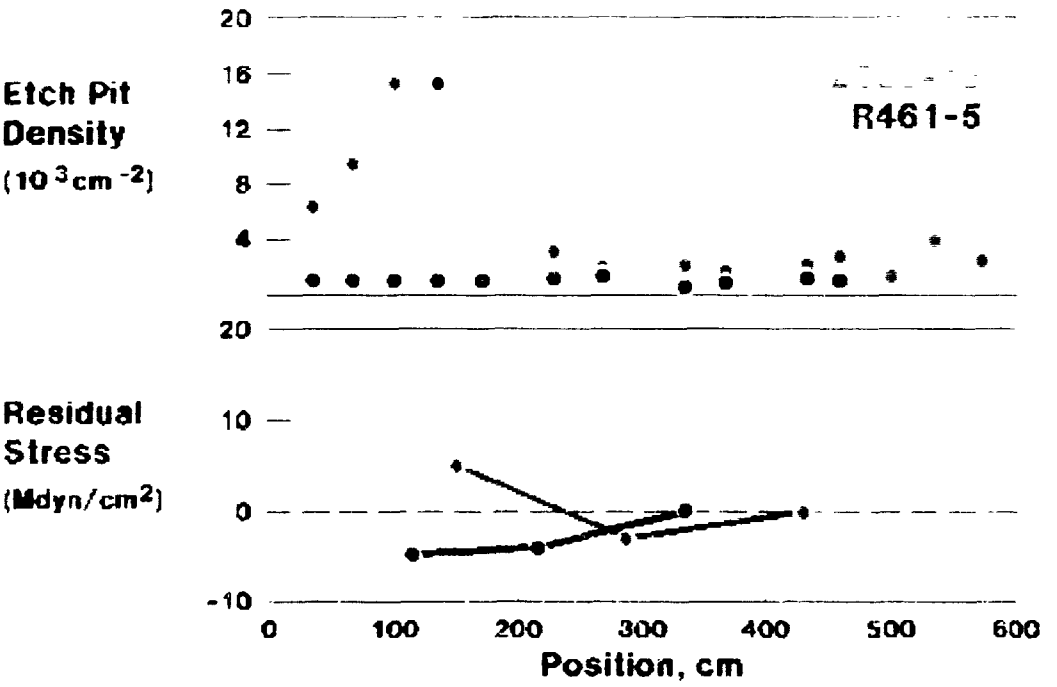
WEB SAMPLES FOR
STRUCTURE ANALYSIS

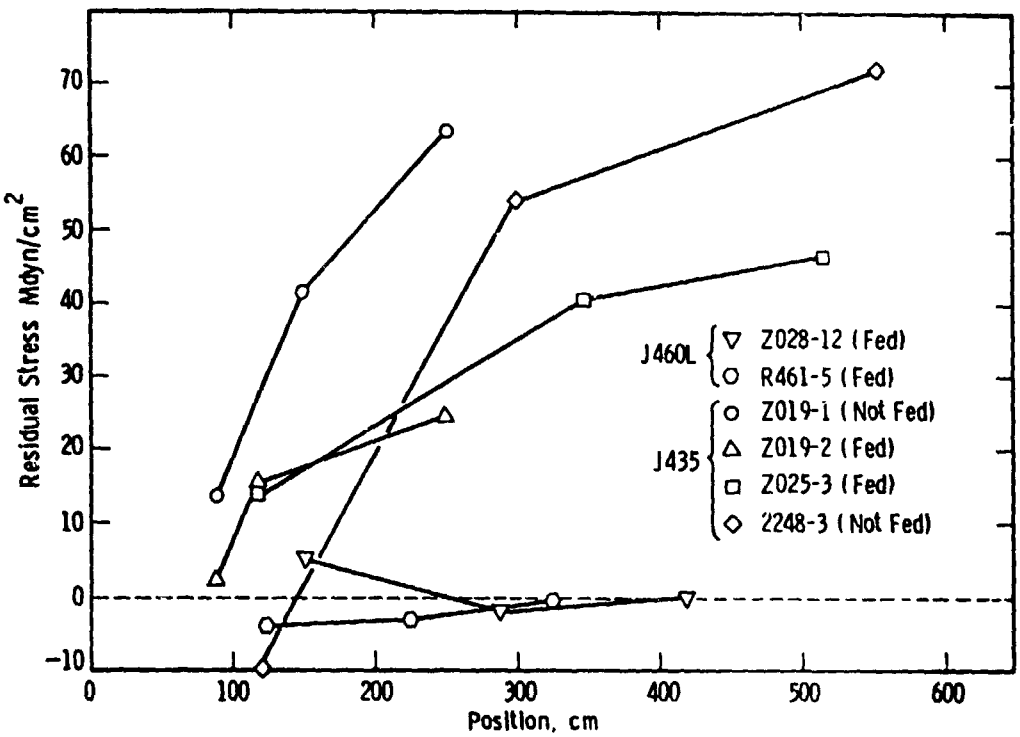


J435 Lid Configuration



J460 Lid Configuration





Problems and Concerns

Calendar Schedule Of Goals Is Tight

Summary

- **Technology And Direction Of Development Sufficient To Surpass Goals When Fully Developed**
- **Major Improvement Achieved In Length Of Continuously Melt Replenished Crystal Growth**