OVERVIEW OF PROCESSING ACTIVITIES AIMED AT HIGHER EFFICIENCIES AND ECONOMICAL PRODUCTION

JET PROPULSION LABORATORY

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Outline

- **Background**
- **Process development concerns**
- **High efficiency elemen**
- **Sensitivities**
- **A proposed design**
- **Process development for proposed design**

Background

- **Historically, JPL process development dealt with minimizing $/watt**
- **Current focus on achieving cell efficiencies greater tha: 18%**

Process Development Concerns

- **Less than optimum Si sheet**
- **Control of yield**
- **Large area cells**

High-Efficiency Elements Requiring Process Development

- **Bulk material perfection**
- **Very shallow junction**
- **Front surface passivation**
- **Finely detailed metallization**

Bulk Material Perfection

- **Maintain minority carrier lifetime**
- **High doping levels add concern**
- **Large area**

Very Shallow Junction

- **Sensitive to metallization punch-through**
- **Series resistance problems**
- **Control dopant leaching during passivation**

Front-Surface Passivation

- **Mechanical integrity**
- **Optical characteristics**
- **Electrical requirements**
- **Process selection**
  - **Thermal oxidation**
  - **Thermal CVD**
  - **Plasma CVD**
  - **Sputtering**
  - **Evaporation**

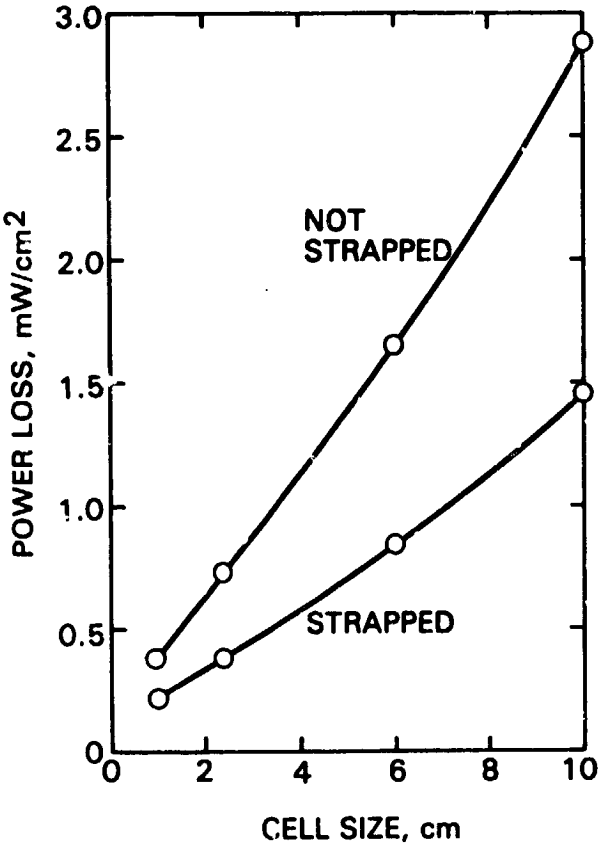
Finely Detailed Metallization

- **Aspect ratio (thickness/width)**
- **Laser processing**
- **Electrochemical deposition**

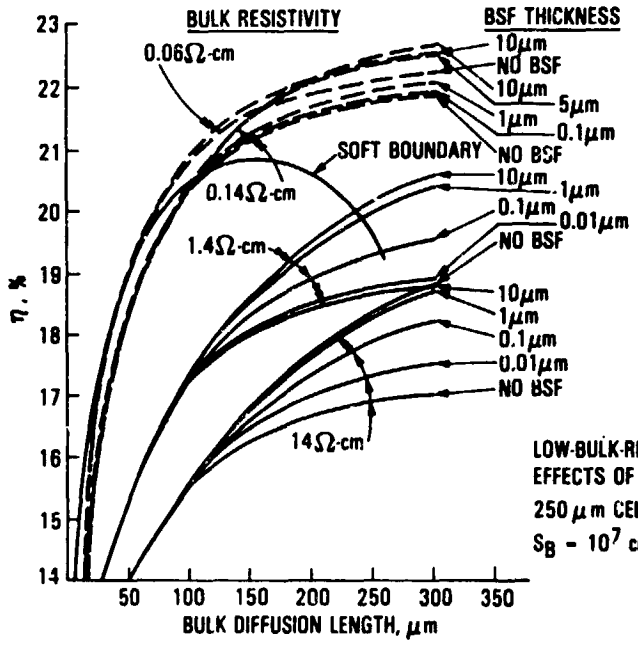
Determining Sensitivity to Processing

- **Use of mathematical modeling**
  - **Cell model SPCOLAY from University of Pennsylvania**
  - **Metal pattern optimization CELCAL from JPL**
  - **Processing models in SUPREM from Stanford University**
- **Experimental lab work**
  - **Individual process steps**
  - **Combine into process sequences**

Power Loss vs Cell Size

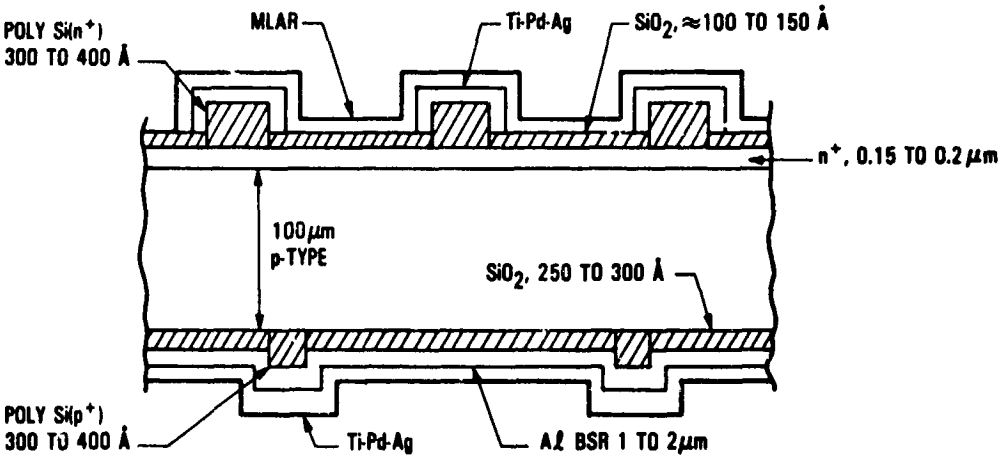


Low-Resistivity Cell Behavior



LOW-BULK-RESISTIVITY CELL BEHAVIOR: EFFECTS OF BACK-SURFACE FIELD; 250 μm CELL; $S_F = 10^4$ cm/s; $S_B = 10^7$ cm/s; $X_j = 0.3$ μm; AM0

A Proposed High-Efficiency Design



Process Development Required for Proposed Design

- **Thinning process**
- **BSR optics**
- **Patterned doped silicon**
- **Metal grid alignment**