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 elements
- 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 than 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 Metalization

- 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

- **NOT STRAPPED**
- **STRAPPED**

**Axes:**
- **POWER LOSS, mW/cm²**
- **CELL SIZE, cm**

**Legend:**
- NOT STRAPPED
- STRAPPED
Low-Resistivity Cell Behavior

A Proposed High-Efficiency Design
PLENARY SESSIONS

Process Development Required for Proposed Design

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