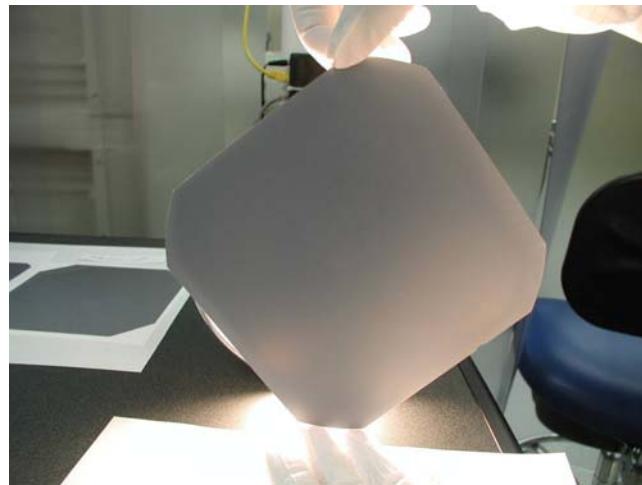


Presented August, 2008



PolyMax™

Enhanced Thin PV Wafers Technology



Thin Wafers Technical Considerations



- **Thin wafer value**
 - Theoretical improvements in CE to 70 μ m thick wafers
 - Poly savings below 100 μ m is primary aspect

- **Thin wafer processing**
 - Must have reduced breakage
 - Micro-crack control will be critical: especially if hidden*

- **New processing conditions are already under development**
 - Improved bowing, texturization, metallization, design - reported*

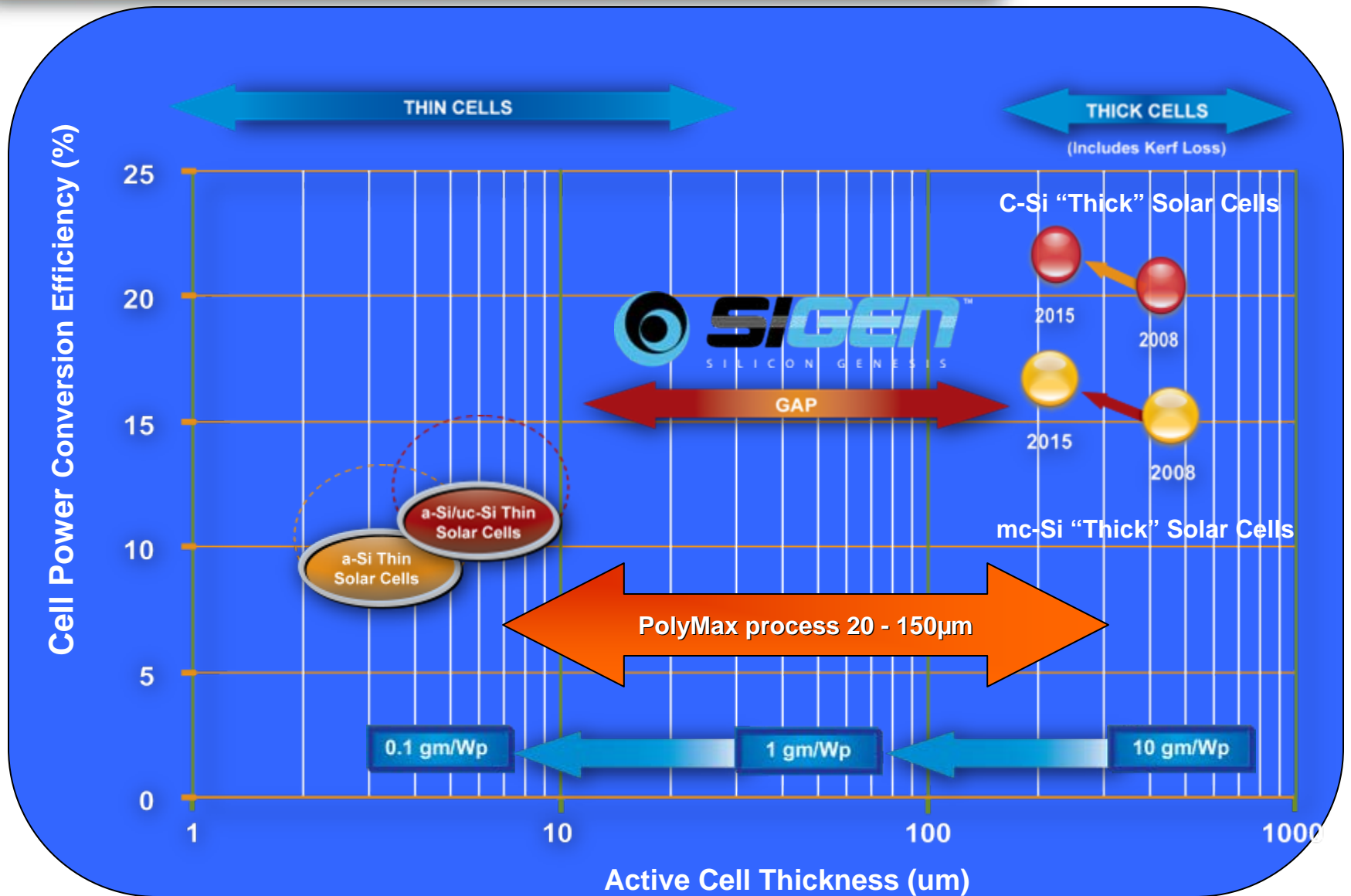
- **Tighter product distribution**
 - Wafer parameter control gives better process control
 - Tighter distribution allows for better matching → lower cost

*See IEEE 33rd PV conference session: **Enabling Thin Crystalline Silicon Solar Cells** May 15th, 2008

- **Market driver – lower production \$/W**
 - Lower cost
 - Higher efficiency
 - Better yield

- **SiGen Polymax™ approach to wafering**
 - Lower production cost:
 - ~1\$/wafer less vs. wire-saw
 - Improved utilization of Si: about 2-4x less gm/W vs. wire-saw
 - Potentially higher cell conversion efficiency
 - Improved wafer characteristics for better yield
 - Better TTV, strength, micro-crack control

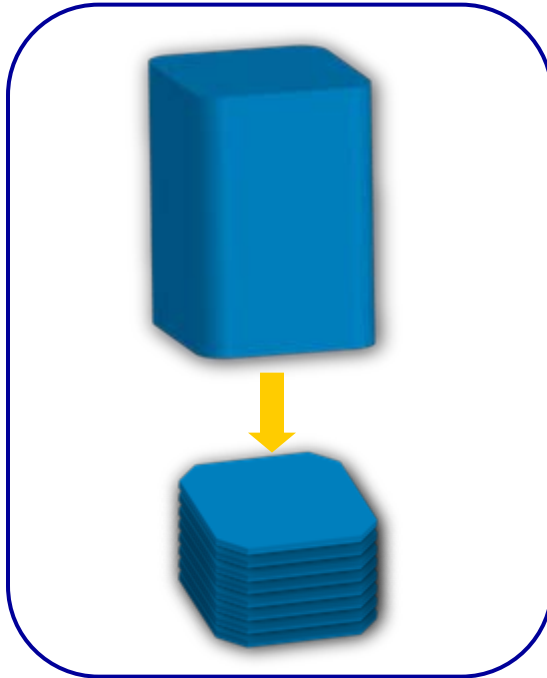
PolyMax™ Bridges the Gap Between Thick & Thin



SiGen PolyMax™ vs. Wire Saw Process

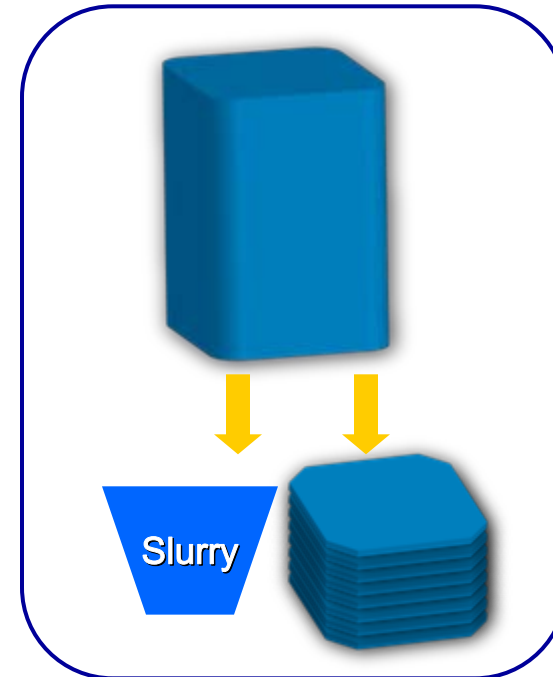


SiGen PolyMax™



- Enhanced c-Si wafers
- 2x to 4x more wafers
- Reduction: ~\$1/wafer
- No Kerf-loss

Wire Saw



- Poor TTV, micro-cracks
- No roadmap to <math><100\mu\text{m}</math>
- High cost of consumables



■ Unique Characteristics:

- Thickness uniformity – TTV at 5%
- Superior mechanical strength – 10X stronger
- No hidden micro-cracks for downstream failures
- Scalable thickness - 20μm - 150μm

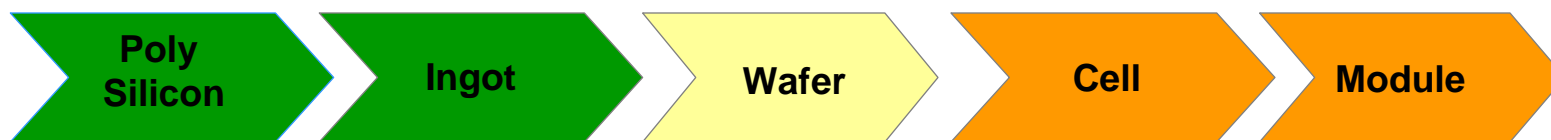
PolyMax™ benefits cascade to all links in the PV production chain



Value throughout the PV Chain



Adds value to the full chain → Lower \$/W



Context

Ingots and wafers represent the biggest portion of the value chain with respect to capital and materials costs

Need to reduce breakage and improve TTV and micro-cracks for: yield and reliability

PolyMax™ Value

Greater wafer capacity from a given plant

- No kerf loss
- No consumables
- No hidden micro-cracks
- Superior mechanical strength
- Better TTV

- No hidden micro-cracks and superior mechanical strength
 - Lower breakage
 - Higher yield
- Better TTV
 - Higher yield
 - Enables improved cell design

Traditional PV Wafer Fabrication

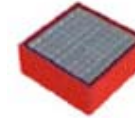


Mono Si



Poly Si

Growing/Casting



Cropping

Squaring/Bricking



WireSaw



PolyMax™ Wafer Manufacturing Flow



Mono Si



Growing/Casting



Cropping



Squaring/Bricking



Edge Grinding

5

c-Si Ingot Preparation



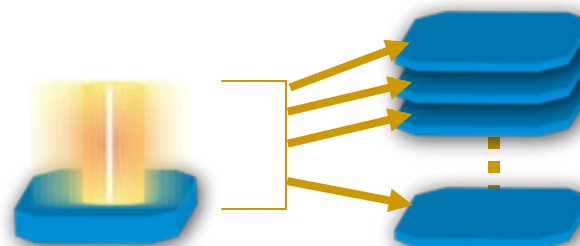
Cut to Tiles



Planarization
& Polish

6

Detach and Singulate



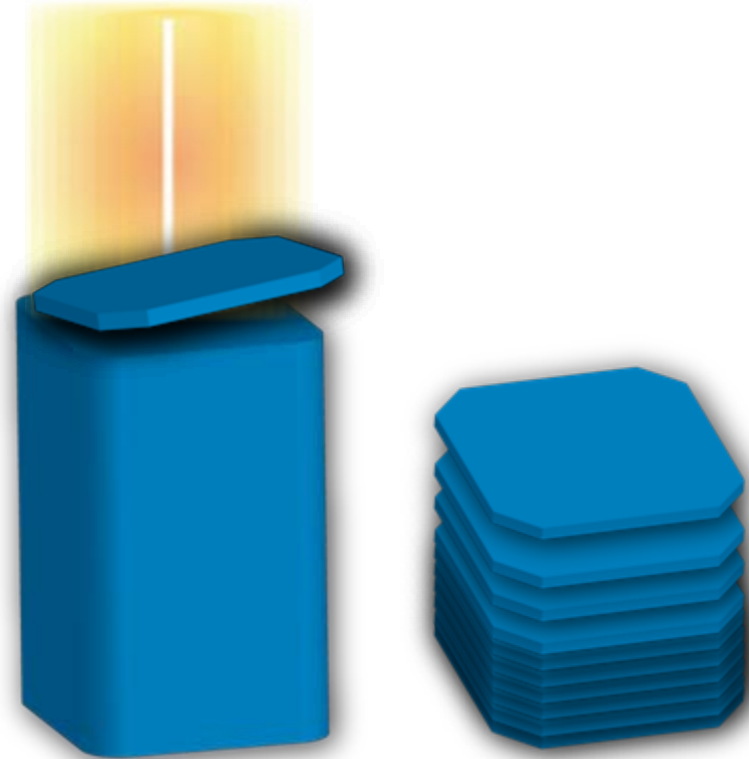
■ Two-Step Process: Implant & Cleave

- ✓ Eliminates kerf loss
- ✓ Eliminates consumables
- ✓ SiC, Slurry, Wire

■ Eliminates other systems

- ✓ Gluing
- ✓ Singulation
- ✓ Cleaning
- ✓ Less damage Etch

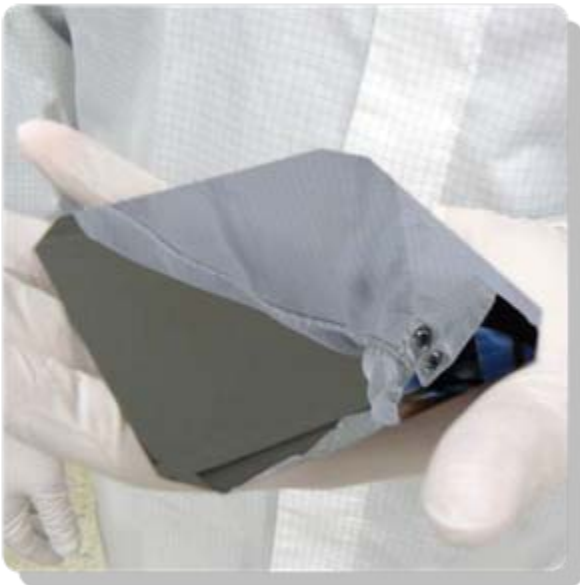
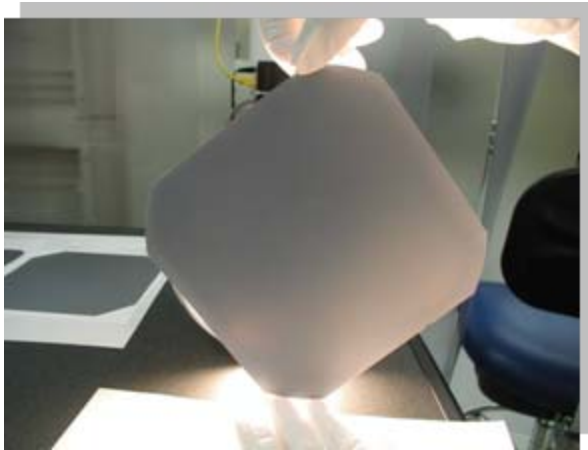
Direct Cleave Process



Silicon Boule

Cleaved Wafers

SiGen PolyMax™ is the Solution



-
- Enhanced c-Si wafers
 - 2x – 4x more wafers
 - Reduction: ~\$1/wafer
 - No kerf loss
-