Solar at the cost of coal
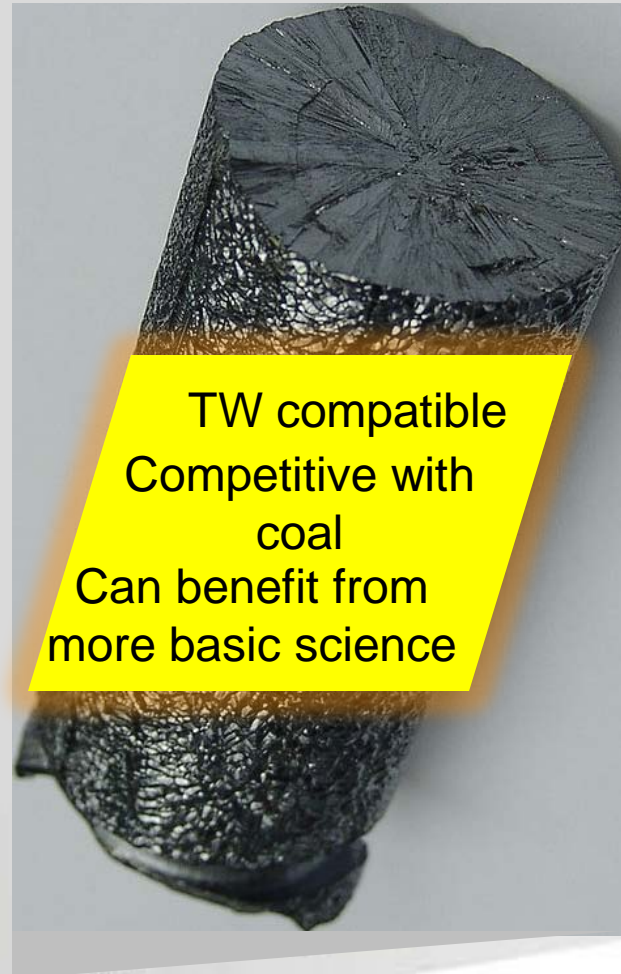
Flux = **1 3 6 6** W/m^2

# IN DEFENSE OF SILICON

a manufacturer's manifesto

TW compatible
Competitive with coal
Can benefit from more basic science

Crystalline Silicon PV

- ~84% market share in 2009
  - Higher in 2010?

- Nothing is wrong it
  - No limits to TW levels
  - Plenty of room to lower costs and reach coal
    - Price spike in 2008/2009 was temporary
  - High efficiencies
  - Uniquely American product
    - Invented here, most feedstock still made here, but need to capture more of downstream market

- Need manufacturing innovation , improved complementary materials, improved cell architectures

Sawn Wafers - Expensive
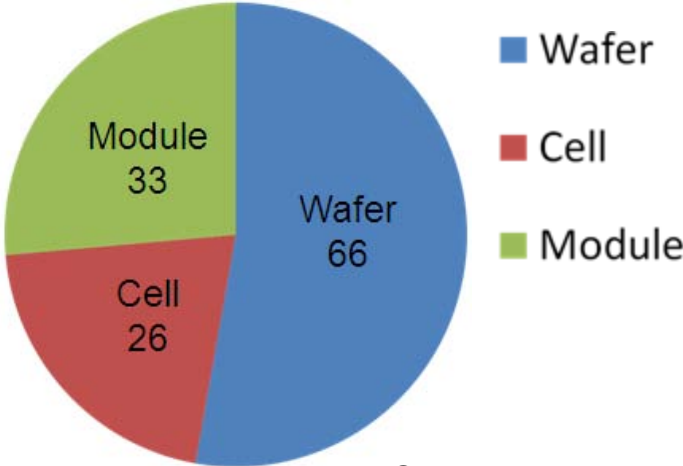
1. Cast Ingot   **2. Cut Brick**   **3. Grind & Polish Brick**   **4. Saw Wafers**
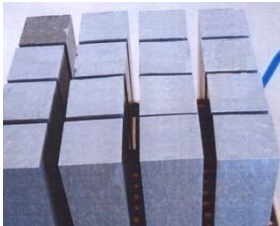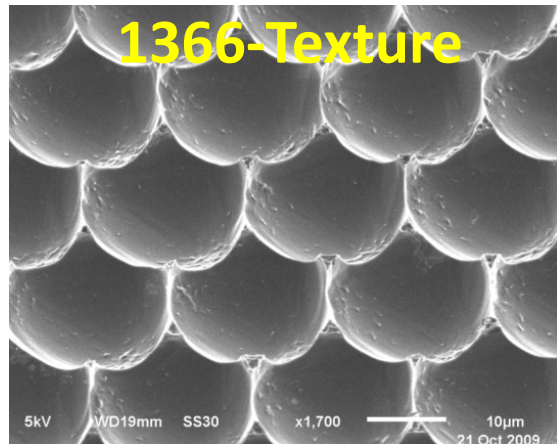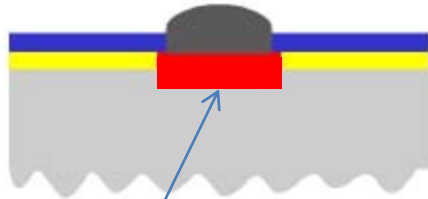
>45% Silicon Wasted

Kerfless Wafers
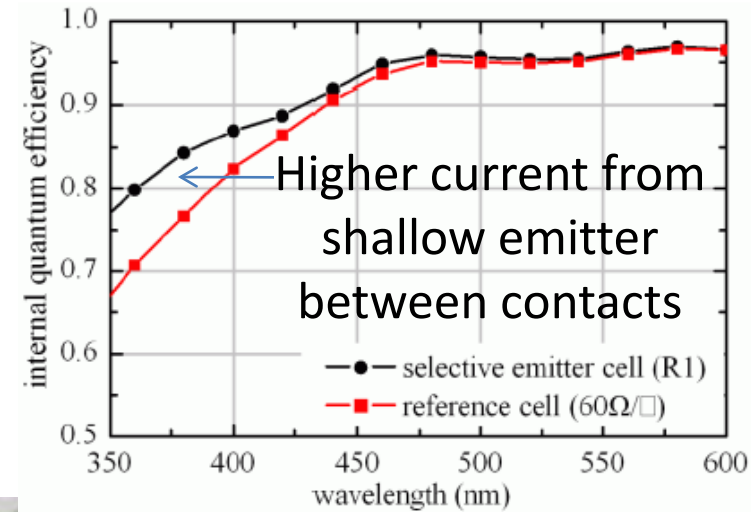
- Challenges
  - Minimizing defects
  - Passivating defects
  - Minimize nucleation of small grains
  - Minimizing stress
  - Cost effective texturing

1366-Texture

evergreensolar. Think Beyond.

SIGEN SILICON GENESIS

VARIAN

Direct Wafer

Selective Emitter

Deeper emitter under contacts

Higher current from shallow emitter between contacts

New Centrotherm FlexLine

Laser groove cleaning

Laser ablation
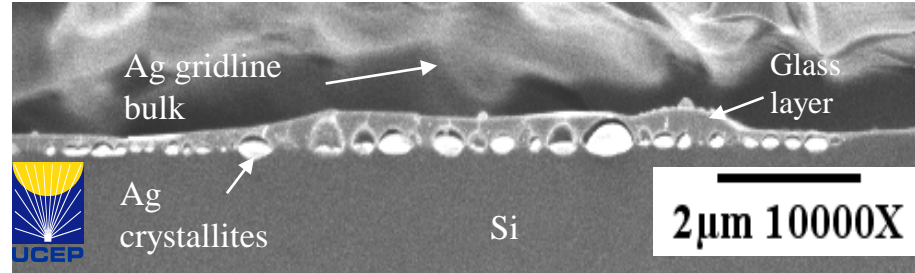
Masking layer generation

centrotherm photovoltaics

- Several additional steps
- Simpler solution – improve pastes to contact shallow emitters

Pastes and Thermal Processing

Ag gridline bulk
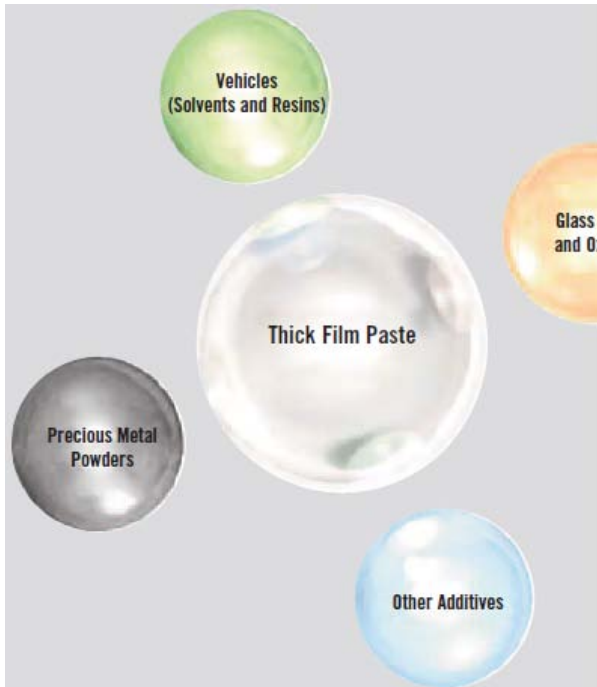Glass layer
Ag crystallites
Si
2μm 10000X

Vehicles (Solvents and Resins)
Glass Frits and Oxides
Thick Film Paste
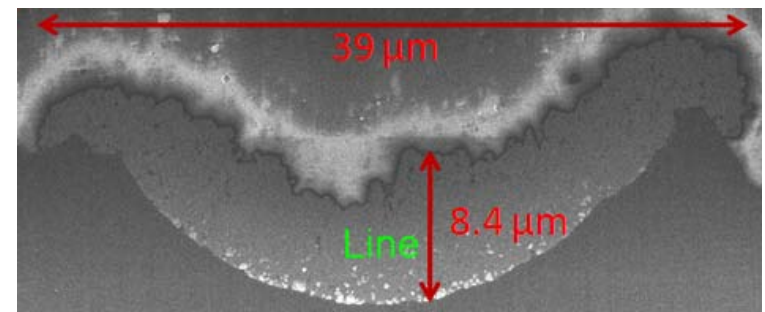Precious Metal Powders
Other Additives

- Challenges
  - Better burnthrough agents and particle shape/size distributions
  - Fine line compatibility (rheology, particle size)
  - Optimize for seed layer only
  - Improved thermal processing

Replace Ag: Fine-line Plated Cu

- Ag problems – cost, availability
- Challenges
  - Diffusion barriers
  - SiN pinhole plating
  - Opening up SiN if all-plated
  - Self aligned if selective emitter
  - Ohmic contacts
  - Adhesion
  - Shunting
  - High throughput

1366-Metallization

8.4 μm

Line

The Winning Team!

Don't bet against the rock