

# Thin Film Photovoltaics

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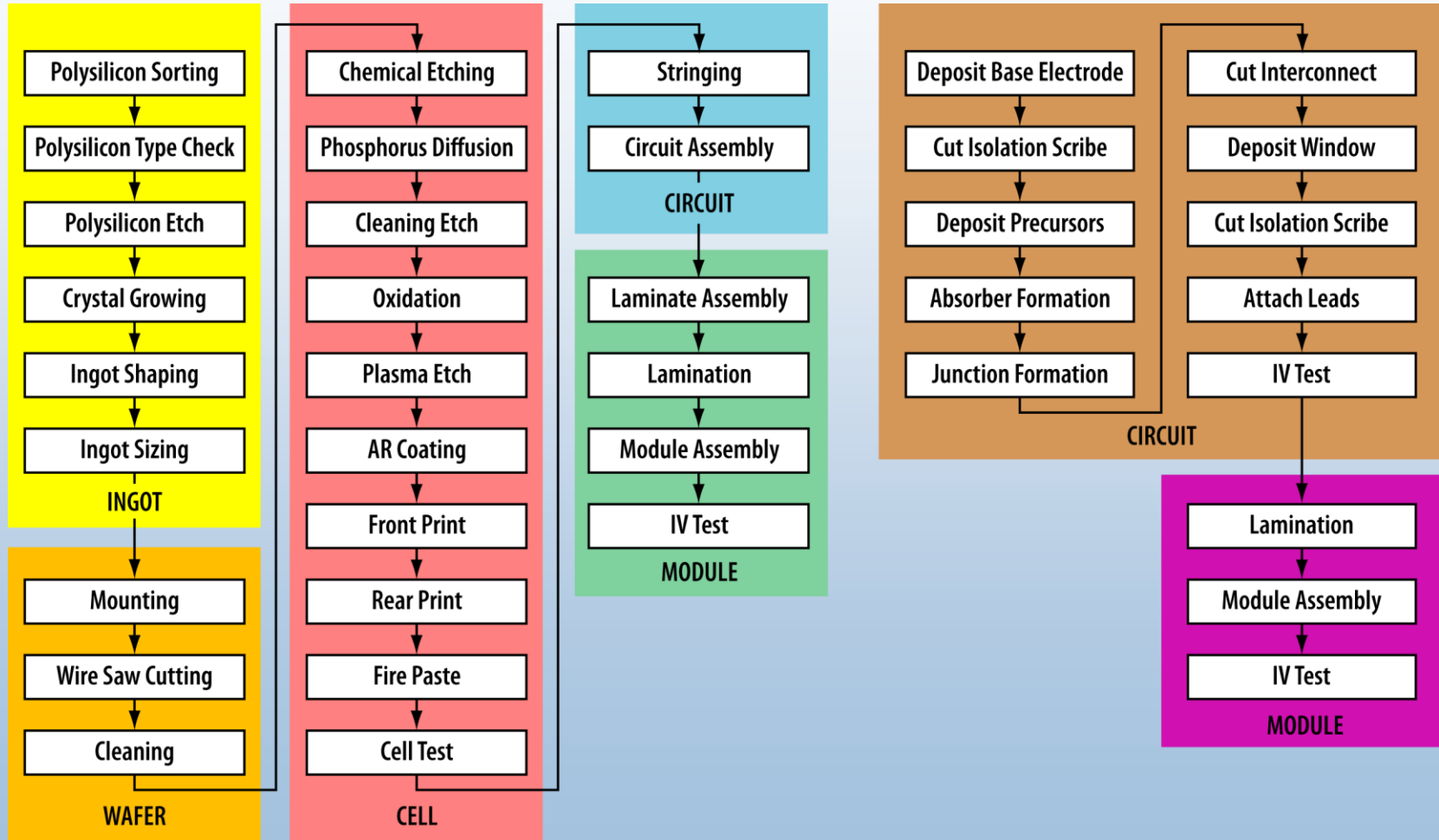
# Why Thin Film PV?

- Direct bandgap semiconductors
- Less material usage
- Fewer processing steps
- Process lends itself to automation
- Monolithic integration of thin film modules
- Flexible, rigid, semi-transparent modules
- Independence from shortages of silicon supply
- Better energy output – kWh/kW
- Performs better at lower light levels
- Performs well-diffused and direct sunlight
- Cost reduction potential

# Module Manufacturing Sequence

## Crystalline Silicon Modules

## Thin Film Modules



# Thin Film PV Companies – USA

## a-Si/Thin-Si

Uni-Solar – MI  
Applied Materials – CA  
Power Films – IA  
Energy PV – NJ  
MV Systems – CO  
XsunX – CA  
OptiSolar – CA  
Signet Solar – CA  
Nano PV – NJ  
Xunlight – OH  
Proto Flex – CO  
New Solar Ventures – NM  
Innovalight – CA  
Nanogram – CA  
Soltaix – CA  
Crystal Solar -- CA

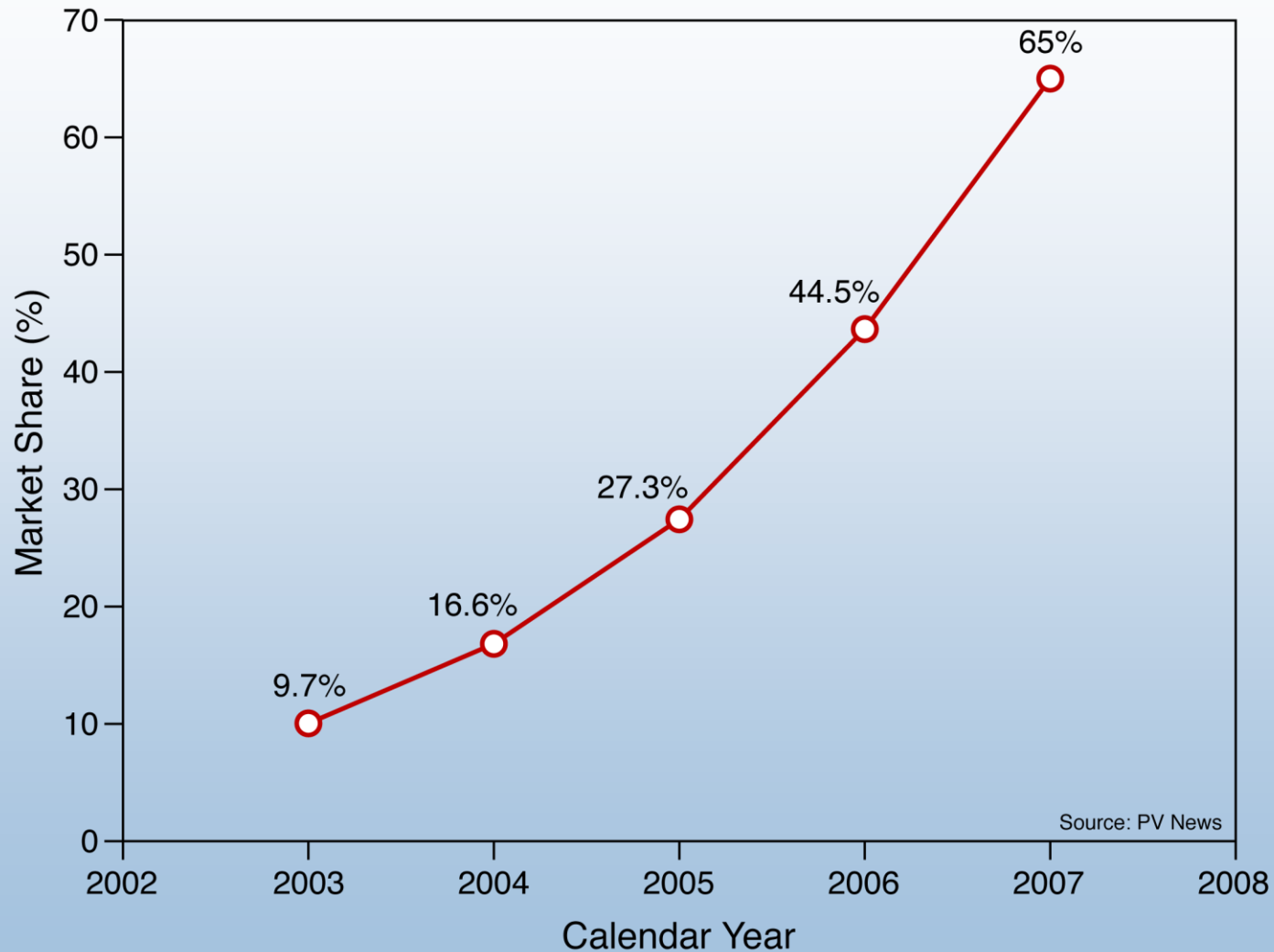
## CdTe

First Solar – OH  
Primestar Solar – CO  
AVA Solar – CO  
Calyxo – OH  
Canrom – NY  
Ascentool – CA  
Nuvo Solar Energy – CO  
Zia Watt Solar – TX  
Solexant – CA  
Sunovia Energy – FL  
W&K Solar – OH  
Bloo Solar -- CA

## CIS

Global Solar – AZ  
Miasole – CA  
Energy PV – NJ  
Ascent Solar – CO  
ISET – CA  
Daystar – NY  
Nanosolar – CA  
Heliovolt – TX  
Solo Power – CA  
Solyndra – CA  
RESI – NJ  
Light Solar – NV  
IBM – NY  
JNL Solar – CA  
Telio Solar -- CA

# Thin Film PV Market Share – USA



# Thin Film PV Capacity (2008-2010)

| Group       | Material             | Present (MW) | Additional (MW) | Total (MW) | Group | Material           | Present (MW) | Additional (MW) | Total (MW) | Totals | Grand Total |      |
|-------------|----------------------|--------------|-----------------|------------|-------|--------------------|--------------|-----------------|------------|--------|-------------|------|
| USA         | First Solar          | CdTe         | 135             | –          | 135   | AVA Solar          | CdTe         | –               | 120        | 120    | 1446        | 6874 |
|             | Uni-Solar            | a-Si         | 60              | 240        | 300   | Nano PV            | a-Si         | –               | 4          | 4      |             |      |
|             | MiaSole              | CIS          | 5               | 50         | 55    | OptiSolar          | a-Si         | –               | 40         | 40     |             |      |
|             | Global Solar         | CIS          | 40              | 100        | 140   | Primestar Solar    | CdTe         | –               | 20         | 50     |             |      |
|             | EPV                  | a-Si         | 2               | 25         | 27    | SoloPower          | CIS          | –               | 20         | 20     |             |      |
|             | Daystar Technologies | CIS          | 1               | 10         | 11    | ISET               | CIS          | –               | 3          | 3      |             |      |
|             | Power Film           | a-Si         | 1               | 10         | 11    | Xunlight           | a-Si         | 3               | 25         | 28     |             |      |
|             | Ascent Solar         | CIS          | 2               | 25         | 27    | Heliovolt          | CIS          | –               | 20         | 20     |             |      |
|             | Nanosolar            | CIS          | –               | 430        | 430   | X Sun X            | a-Si         | –               | 25         | 25     |             |      |
|             | JAPAN                | Kaneka       | a-Si            | 20         | 50    | 70                 | MH1          | a-Si            | 14         | 56     |             |      |
| Showa Shell |                      | CIS          | 20              | 60         | 80    | Kanto Sanyo        | a-Si         | 7               | –          | 7      |             |      |
| Sharp       |                      | a-Si         | 15              | 1000       | 1015  | Honda              | CIS          | 3               | 27         | 30     |             |      |
| Fuji        |                      | a-Si         | 15              | 25         | 40    |                    |              |                 |            |        |             |      |
| EUROPE      | First Solar          | CdTe         | 160             | –          | 160   | Next Solar         | a-Si         | –               | 30         | 30     | 1206        | 6874 |
|             | CSG Solar            | Thin-Si      | 10              | 15         | 25    | AMI                | a-Si         | –               | 160        | 160    |             |      |
|             | Würth Solar          | CIS          | 3               | 15         | 18    | Johanna Solar Tech | CIS          | –               | 30         | 30     |             |      |
|             | Antec Solar          | CdTe         | 10              | –          | 10    | Sonter             | a-Si         | –               | 60         | 60     |             |      |
|             | Schott Solar         | a-Si         | 3               | 27         | 30    | Solisbro           | CIS          | –               | 30         | 30     |             |      |
|             | ICP Solar Tech       | a-Si         | 3               | –          | 3     | Global Solar       | CIS          | –               | 35         | 35     |             |      |
|             | Solar Cells          | a-Si         | 1               | –          | 1     | Helio Grid         | a-Si         | –               | 50         | 50     |             |      |
|             | Free Energy          | a-Si         | 1               | –          | 1     | SunFilm            | a-Si         | –               | 60         | 60     |             |      |
|             | Solar Plus           | a-Si         | –               | 5          | 5     | T. J. Solar        | a-Si         | –               | 40         | 40     |             |      |
|             | Sulfur Cells         | CIS          | 5               | –          | 5     | Signet Solar       | a-Si         | –               | 20         | 20     |             |      |
|             | Aleo Solar           | CIS          | –               | 30         | 30    | Clyxo              | CdTe         | –               | 60         | 60     |             |      |
|             | Ersol                | a-Si         | –               | 40         | 40    | Avancis            | CIS          | –               | 20         | 20     |             |      |
|             | Inventux             | a-Si         | –               | 33         | 33    | Oderson            | CIS          | –               | 30         | 30     |             |      |
|             | Solarion             | CIS          | –               | 25         | 25    | Scheuten Solar     | CIS          | –               | 10         | 10     |             |      |
|             | Pramac               | a-Si         | –               | 30         | 30    | EPV                | a-Si         | –               | 25         | 25     |             |      |
|             | Corupo Uni Solar     | a-Si         | –               | 5          | 5     | Avendi             | CdTe         | –               | 15         | 15     |             |      |
| Masdar      | a-Si                 | –            | 110             | 110        |       |                    |              |                 |            |        |             |      |
| OTHER       | First Solar          | CdTe         | –               | 704        | 704   | GET                | a-Si         | –               | 40         | 40     | 2910        | 6874 |
|             | Bangkok Solar        | a-Si         | 7               | –          | 7     | Nanowin Tech       | a-Si         | –               | 35         | 35     |             |      |
|             | Sinonar              | a-Si         | 15              | 35         | 50    | Moser Baer         | a-Si         | –               | 20         | 20     |             |      |
|             | T. J. Solar Cell     | a-Si         | 2               | –          | 2     | Solar Morph        | a-Si         | –               | 20         | 20     |             |      |
|             | Soltech              | a-Si         | 15              | –          | 15    | Topray Solar       | a-Si         | 20              | –          | 20     |             |      |
|             | Suntech Power        | a-Si         | –               | 50         | 50    | Sun Well Tech      | a-Si         | –               | 60         | 60     |             |      |
|             | Weihai BTP           | a-Si         | 5               | 5          | 10    | Sunner Solar       | a-Si         | –               | 25         | 25     |             |      |
|             | Nex Power            | a-Si         | –               | 50         | 50    | Auria              | a-Si         | –               | 60         | 60     |             |      |
|             | CSP                  | a-Si         | –               | 50         | 50    | HHV                | a-Si         | –               | 6          | 6      |             |      |
|             | Aleo Solar           | CIGS         | –               | 50         | 50    | Kenmos PV          | a-Si         | –               | 5          | 5      |             |      |
|             | Sunvim               | CIGS         | –               | 30         | 30    | QS Solar           | a-Si         | –               | 25         | 25     |             |      |
|             | BESA                 | a-Si         | –               | 40         | 40    | Formosun Tech      | a-Si         | –               | 15         | 15     |             |      |
|             | C G Solar            | a-Si         | –               | 100        | 100   | Mosel Vitelic      | a-Si         | –               | 20         | 20     |             |      |
|             | Masdar               | a-Si         | –               | 100        | 100   | ASP                | CdTe         | –               | 25         | 25     |             |      |
|             | Best Solar           | a-Si         | –               | 1000       | 1000  | Baoding Tianwei    | a-Si         | –               | 46         | 46     |             |      |
|             | CSF Solar            | a-Si         | –               | 150        | 150   |                    |              |                 |            |        |             |      |
|             | China Singyes        | a-Si         | –               | 100        | 100   |                    |              |                 |            |        |             |      |