“Creating a brighter, more durable, more secure, and cleaner future”
3M Film Technologies

3M Strategy for Solar

- Fabrication
- Installation
- Conversion Efficiency
  - Light Management
  - Encapsulation
  - Thermal management

Reduced costs

Increased energy output

Cost kWh

- c-Si
- Thin Film
- CPV
- CSP
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3M Solar Light Management Technologies

Platforms | Products | Market Segments
---|---|---
Light Concentration | SMF 1100 | CSP
 | Multilayer Mirror Films | Concentrated Solar Power Electricity Generation
 | Structural Panels | Solar Thermal
 | Surface Structured Films/coatings | Low X CPV
 | Anti-Soil Coatings | Flat Panel
 | | Concentrated PhotoVoltaic Electricity Generation
 | | PhotoVoltaic and Solar Thermal
 | | Weatherable Front and Back Surface Films

Light Capture
Films
Tapes
Adhesives
3M Films/Tapes/Adhesives for c-Si Photovoltaic

Junction Box Bonding
Die cut of 3M™ Solar Acrylic Foam Tape
or
Bead of 3M™ PV 1000 Adhesive/Sealant

Encapsulating
3M™ Scotchshield™ Film 17T
(backside barrier film)

Cosmetic Applications
3M™ Specialty Tapes

Cell Positioning
3M™ Specialty Tapes

Frame Bonding
3M™ Solar Acrylic Foam Tape

Identification Solution
3M™ Performance Label Materials
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Multi-layer Optical Mirror Films

¼ Wave Constructive Interference

– 100-1000 layers
– 15-200 nm thick
– Alternating layers of Bi-refringent and Isotropic polymer pairs
– Tunable reflection bands
Background

- At every interface between two different refractive indices (RIs), some light is reflected and some transmitted (neglecting absorption)
- When layers of differing RIs alternate, there is constructive interference for some wavelengths
- Nature has numerous examples of interference colors (rainbow trout scales, beetles, morpho butterflies, etc.)
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Multilayer Optical Films - Applications

- Thermoformed Shapes
- Highly reflective mirrors ~98% reflectivity
- Tunable reflection bandwidth mirrors
  - UV Mirror (350-400nm)
  - VIS Mirror (400-800nm)
  - Near IR Mirror (800-1600nm)
  - UV/VIS/IR Mirror (350-1600nm)
  - Reflective Polarizers

IR blocker for transparent credit cards
The Solar Spectrum

☉ Not all the light from the Sun can be seen, some is invisible.

☉ Ultraviolet light causes sunburns, infrared light is pure heat.

☉ Silicon photovoltaic cells only use visible and near infrared light.

Solar Power vs. Wavelength

Silicon photovoltaic cells use light in this part of the solar spectrum to make electrical energy.

Electrical power output of silicon photovoltaic cells decreases linearly with increasing cell temperature.

Wavelength is a measure of color, but we only see a narrow range of wavelengths. Beyond colors like red, orange, green, blue and violet there are invisible colors like infrared and ultraviolet. We can’t see them but we can still feel their effects.
This Concentrated Photovoltaic (CPV) system uses mirrors to direct extra sunlight onto photovoltaic cells and generate more electricity.

When mirrors cost less than photovoltaic cells, replacing cells with mirrors will lower the cost of generating electricity.

Infrared light not used by the photovoltaic cell creates heat, lowers cell efficiency and reduces the amount of electricity generated.

3 Cool Mirror Film reflects 97% of the useful sunlight onto the photovoltaic cell but lets the unwanted infrared light pass through to be directed away from the cell.
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Durable Solar Mirror Films – near IR Cool Mirror

MORE LIGHT = MORE ENERGY
» Uses all available light
» “Cool” reflection increases total energy production
» 50% increased Watts peak

ENERGY PRODUCTION PER ROOF

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tenKsolar | Conventional
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Durable Solar Mirror Films

Cool Mirror LCPV demonstration at Science Museum of Minnesota
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Concentrated Photovoltaics made better with 3M Mirror film technology

* Using thermoformed polymers and Cool Mirror technology
3M has 45 Core Technology Platforms…

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Successful New Product Growth Builds On Uncommon Connections