

DuPont™ Kapton®

polyimide films

High performance flexible films for photovoltaic substrates



DuPont™ Kapton® polyimide films enable today's leading edge flexible and thin film photovoltaic technologies.
Photo courtesy of Solarion AG.

Look to DuPont and Kapton® as well for a future of breakthroughs ahead, with a range of enhanced film properties in development to help increase the efficiency and lifetime of photovoltaic modules, lower overall system costs and help the industry reach grid parity sooner.

Future Directions for Thin Film Photovoltaics

DuPont is putting science to work to accelerate the development of additional Kapton® polyimide films for the flexible and thin film PV industry. Reinforced polyimides with higher temperature processing capability and dimensional stability are expected to provide increased efficiency in CIGS PV applications, while maintaining the desirable properties of a polymeric substrate.

Introduction

DuPont has been a leading materials provider to the photovoltaic (PV) industry since its inception over 20 years ago and continues its tradition of innovation with the introduction of DuPont™ Kapton® polyimide films engineered for Amorphous Silicon (a-Si) and Copper Indium Gallium Selenide (CIGS) photovoltaic substrates. Kapton® polyimide films have set the standard for long term reliability and high performance in the electronics industry for over 45 years, and their superior durability, flexibility and temperature tolerance have also made them ideal materials for use in today's high growth flexible and thin film photovoltaic markets.

Kapton® Advantages

In thin film a-Si modules and CIGS applications, the mechanical properties and dimensional stability of the substrate at elevated deposition temperatures are critical to producing cells with maximum efficiency and yields. The low coefficient of thermal expansion, high glass transition temperature and low shrinkage of Kapton® polyimide films help minimize stress at the interface with other materials of construction, both during processing and during end use in temperature extremes. The thermal stability of Kapton® films is excellent and allows processing temperatures in excess of 400°C.

Product Offerings

DuPont has developed several key high performance products for thin film and flexible photovoltaic substrates:

- DuPont™ Kapton® PV9101 polyimide film for ease of manufacturing and robust mechanical performance
- DuPont™ Kapton® PV9102 polyimide film for ease of manufacturing and increased productivity
- DuPont™ Kapton® PV9103 polyimide film for maximum productivity
- DuPont™ Kapton® PV9202** polyimide film for high temperature processing (up to 500°C)

**Development Product

Polyimide Film Comparison

In the table below, typical properties were tested at high temperatures representative of actual processing conditions.

Typical Property	DuPont™ Kapton® PV9101 (50 µm)	DuPont™ Kapton® PV9102 (38 µm)	DuPont™ Kapton® PV9103 (25 µm)	DuPont™ Kapton® PV9202** (38 µm)
Modulus MD @50°C (GPa) (DMA)	5.9	6.1	6.0	8.9
Modulus MD @450°C (GPa) (DMA)	0.4	0.3	0.2	2.7
CTE (ppm/C) 50-350°C MD /TD (2nd scan)	14 / 8	15 / 4	14 / 4	4-5 / 6-8
Tg (°C, DMA, tan delta)	370	370	375	417
Isothermal Weight Loss (%) TGA @ 500°C, ~30 minutes*	<1	<1	<1	<1

*TMA CTE, DMA Tg and modulus, and TGA Isothermal weight loss are preformed in a nitrogen environment

**Development Product

DuPont™ Kapton® Capabilities

DuPont has additional capabilities which may be suitable for PV technology developments in the future, including:

- Near-transparent films for superstrate PV configurations such as Dye Sensitized Solar Cells (DSSC), Organic PV (OPV), and Cadmium Telluride (CdTe)
- Casting or laminating polyimide onto a range of metals, including copper, stainless steel, aluminum and titanium
- Products specifically formulated to have higher thermal durability, improved physical properties at processing temperatures and surface suitable for direct deposition

Complementary System Products

Kapton® polyimide films are part of a broad and growing portfolio of products represented by DuPont Photovoltaic Solutions, which connects science and technology from across the company on a global scale to help support the dramatic growth in the photovoltaic industry.

For more information about Kapton® or other DuPont Photovoltaic Solutions:

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Caution: Do not use in medical applications involving permanent implantation in the human body. For other medical applications, see "DuPont Medical Caution Statement: H-51459 or H-50102-2"

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