



DuPont™ Hybrid Membrane Technology (HMT)

NANOFIBER ENERGY STORAGE SEPARATORS



The miracles of science™

DuPont™ HMT offers thin, lower ionic resistance separators with higher temperature stability, and potentially provides higher power density, higher energy density and improved safety in energy storage devices.



DuPont™ HMT goes beyond the limits of traditional nonwovens and microporous membranes to provide thinner separators with lower ionic resistance and high temperature stability for use in a wide variety of energy storage devices. Made by a proprietary new spinning process, DuPont™ HMT nanofiber sheets contain continuous polymeric filaments in a thin, uniform web of randomly oriented nanofibers that are ideal for separators.



The first DuPont™ HMT nanofiber separator available in commercial quantities is based on nylon 6,6 and is designed for use in capacitor applications. Additional DuPont™ HMT nanofiber separators are currently under development. At DuPont, we are dedicated to continually leveraging our innovative nanofiber technology and polymer expertise to create optimal products for energy storage devices that will better meet the world's evolving needs.

Uses and applications

DuPont™ HMT is well-suited for wound and prismatic cell designs found in a broad range of advanced energy storage devices, including:

- Electrochemical double layer capacitors**
- Aluminum electrolytic capacitors**
- Lithium ion batteries**
- Lithium primary batteries**
- Alkaline batteries (e.g., NiMH, Zn-MnO₂, etc.)**



Superior performance

DuPont™ HMT offers versatile, high-value solutions for improving performance and safety, while reducing total system costs in energy storage devices. Using the innovative DuPont™ HMT process, we are developing separators that will enable manufacturers to:

POWER

Design smaller devices that pack more power

Thinner separators with lower ionic resistance occupy less space and offer higher energy density. Thus, energy storage devices made with DuPont™ HMT nanofiber separators can be smaller while delivering increased power.

RELIABILITY

Achieve higher yields and improve reliability

Random orientation of fibers creates uniform properties in both directions. The superior uniformity, high surface area and small pore size of DuPont™ HMT nanofiber separators increase manufacturing yields and improve reliability by helping to prevent failures and shorts.

SAFETY

Improve safety

High temperature stability means that DuPont™ HMT nanofiber separators will not shrink or melt in manufacturing or use, thus reducing the possibility of electrodes touching each other and causing thermal runaway.

FLEXIBILITY

Gain greater design flexibility

With its long list of superior properties, including high temperature stability, low ionic resistance and high surface area, and compatibility with a variety of coatings and additives, DuPont™ HMT nanofiber separators offer increased functionality, especially for challenging applications where other materials fail.

VERSATILITY

Benefit from increased manufacturing versatility

Superior chemical stability, combined with exceptional dimensional and mechanical stability make DuPont™ HMT well-suited for use in many types of manufacturing processes used for energy storage devices. What's more, wettability in typical organic and aqueous electrolytes makes DuPont™ HMT adaptable to these processes for increased efficiency. In addition, DuPont™ HMT can withstand winding under tension in high-speed automatic winders where separators and electrodes are wound together.



Energy storage devices are critical for powering a host of products ranging from notebook PCs and DVD players to cellphones, digital cameras and "green" automobiles—both hybrid electric vehicles and electric vehicles—to name just a few.

Current product offering

The DuPont™ HMT nanofiber separator made with nylon 6,6 is the first commercially available offering for energy storage devices. Ideal for use in aluminum electrolytic capacitors and electrochemical double layer capacitors, this separator gives manufacturers a long list of important benefits, including: higher capacitance, higher power, improved safety and ease of manufacturing.

Additional products are currently under development, including DuPont™ HMT nanofiber separator for lithium ion and NiMH batteries, which will be introduced soon.



Typical property data

thickness	20–70 μm
porosity	40–90%
pore size	<1μm
ionic resistance	0.3–1.2 ohms/cm ² in 2 M LiCl/methanol
frazier air permeability	<5 cfm/ft ² at 125 Pa
shrinkage	<5% at 180°C for 2 hours
wettability	wets in typical aqueous/organic electrolytes

Proprietary technology

Unlike traditional electrospinning, the innovative manufacturing process for DuPont™ HMT delivers a uniform web at high throughput. Commercially available today, DuPont™ HMT nanofiber separators made with nylon 6,6 can be produced in a range of different thicknesses and porosities to meet various energy storage requirements in terms of design parameters, performance and cost.



Proprietary manufacturing technology at our Korean facility allows us to provide thin, uniform, nanofiber separators in a broad range of thicknesses and porosities to meet performance requirements in diverse applications.

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