



An Energy Storage Revolution

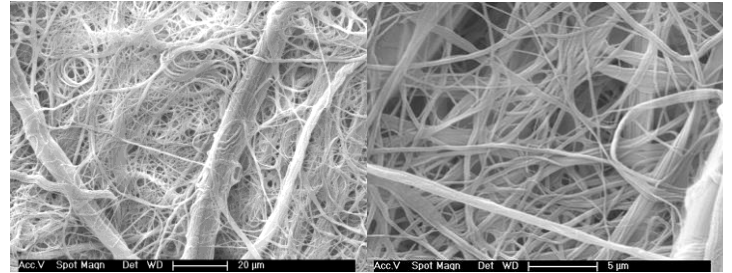
Dreamweaver nonwoven nanofiber separators, made from a blend of nanofibers and microfibers, provide:

- **Higher Power:** Higher ionic conductivity results in greater electrode utilization at high rates, improving available power in regenerative braking, signal conditioning and other high performance applications.
- **Lower ESR:** Reduced internal resistance lowers energy dissipation, increasing efficiency.
- **Higher Energy Density:** Higher separator surface area and more efficient ion transfer gives higher capacitance, increasing energy density.

Due to these attributes our Dreamweaver Titanium separator allows for **thinner, lighter and smaller** cells. In addition **cost reductions** result from less expensive separator and Supercapacitor manufacturing costs.

Nanofibers and Microfibers

Dreamweaver's patented technology is based on a combination of microfibers and nanofibers. The microfibers provide scaffolding with high strength and an open structure, as can be seen in the SEMs below. The nanofibers drape over the microfibers so the pore size is low and the pore size distribution is narrow, while the porosity is high.

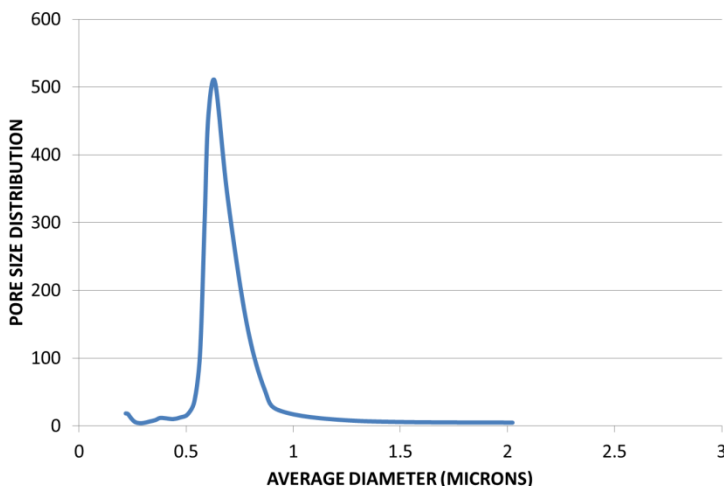


Microfibers: Microfibers by themselves leave a pore size of at least several microns, much too large to be used in supercapacitor separators.

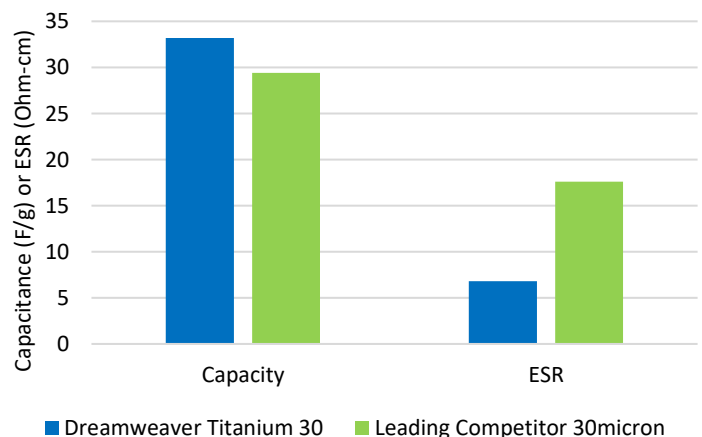
Nanofibers: Nanofibers by themselves can blind and have high resistance to the flow of liquids or ions. They also make extraordinarily weak webs, without the strength required in a high speed manufacturing process.

Combined: Combined, the strength and openness of the microfiber scaffolding is attained, while Dreamweaver's proprietary processing ensures that the nanofibers drape over the microfibers strategically, closing down the pore size while maintaining a high permeability to ions.

PORE SIZE DISTRIBUTION VS AVERAGE DIAMETER



Supercapacitor Comparison



PRODUCT INFORMATION

Name

Dreamweaver Titanium™

Description

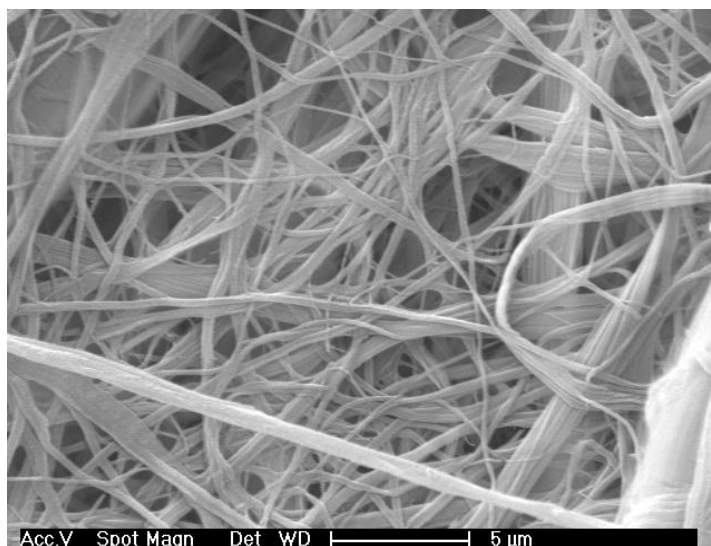
15µm, 17µm, & 30 µm nanofiber membrane

Primary Application

Supercapacitors, ultra-capacitors, alkaline aqueous electrolyte batteries and capacitors, including zinc air, nickel zinc, NiMH, alkaline cells, and others.

Product Features

- High porosity in a uniform, stable sheet
- Excellent alkaline resistance
- Uniform pore structure with narrow pore size distribution
- Excellent wettability; materials wet in just seconds, reducing processing time and increasing uniformity
- Thermally stable above 190C; materials do not melt or shrink, reducing shrinkage induced shorts
- Low electrical impedance and high porosity provide high rate capabilities



Technical Features (Typical Properties)

Membrane Property	Units	Titanium™ 15P	Titanium™ 17P	Titanium™ 30
Thickness (15 psi)	µm	15	18	32
Thickness (25 psi)	µm	15	17	30
Gurley (JIS)	seconds	170	100	39
Porosity	%	33%	44%	61%
Pore Size	µm	0.57	0.63	0.9
TD Shrinkage @ 90 C	%			0%
MD Shrinkage @ 90 C	%			0%
TD Shrinkage @ 150 C	%			1%
MD Shrinkage @ 150 C	%			1%
TD Strength	Kgf/cm ²	225	170	125
MD Strength	Kgf/cm ²	400	270	185
Elongation	%	1.8%	1.9%	1.9%
Young's Modulus	Kgf/cm ²	35,000	25,000	16,000
Puncture Strength	g			330

Materials may contain up to 6% moisture. Please dry thoroughly before testing; we suggest 120 C for 1 hour for hand sheets and 24 hours for rolls. Due to higher porosity, additional electrolyte may be required. Low electrolyte content may cause high resistivity or shorting.

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