SOLUTION BRIEF

PEAK NANOPLEX™ LDF CAPACITOR FILMS FOR MAGNETIC CONFINEMENT FUSION

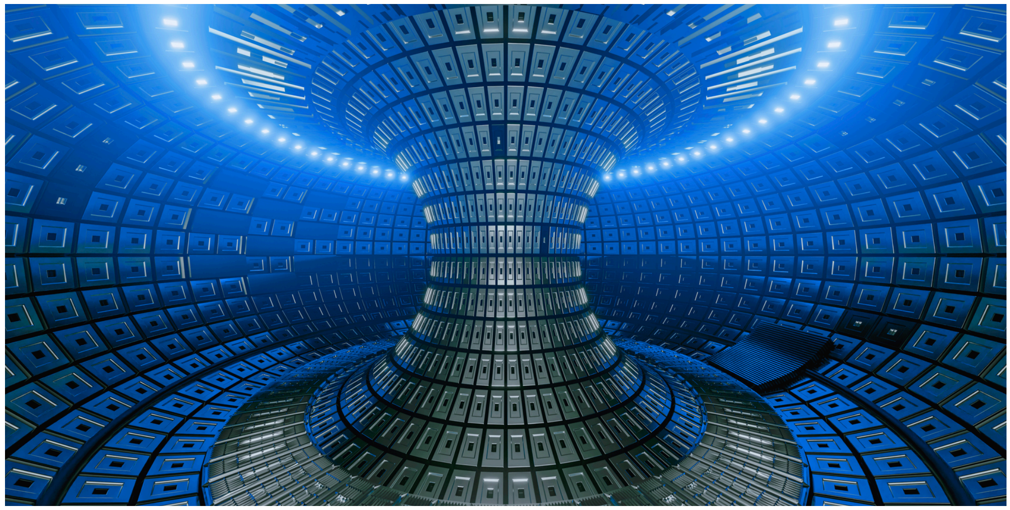
NanoPlex LDF At a Glance

- **100% U.S. engineered** and sourced from allied nations for supply chain security
- **3-5x** longer capacitor lifetime vs. BOPP
- **135°C** operating temperature – 35°C to 50°C above conventional films
- **50% lower dissipation factor** for superior electrical stability
- Supports **tokamaks, stellarators, and magnetic mirror** architectures

"Building resilient domestic capacity for critical components like capacitors is essential if the United States is going to lead in fusion energy. This partnership is a strong example of how innovative materials companies and specialized manufacturers can close key gaps across the industry to enable fusion to scale."

Andrew Holland | CEO
Fusion Industry Association

FUSION
INDUSTRY ASSOCIATION



As magnetic fusion scales toward commercial power, its pulsed power systems must run faster and hotter without losing capacity.

NanoPlex LDF Supports the Future of Magnetic Confinement Fusion

Fusion is the most ambitious energy project in human history. The process of magnetic confinement fusion (MCF) works by superheating hydrogen nuclei into a plasma state exceeding 100 million degrees Celsius – hotter than the core of the sun – and containing that plasma within precisely engineered magnetic fields long enough to sustain fusion and produce usable energy. Achieving this requires decades of advances in plasma physics, superconducting magnet technology, and materials engineering operating at the edge of what physics allows.

That progress is now attracting serious capital. In 2025, private investment in fusion surpassed $15 billion globally, with more than 53 companies actively developing MCF technologies. The first commercial power plants are projected to come online between 2030 and 2035.

The Materials Challenge Behind MCF

Turning that investment into delivered electricity starts with the infrastructure behind the plasma. MCF facilities depend on high-performance electrical infrastructure to power and sustain its magnetic systems. Superconducting coils, power conditioning units, and capacitor banks must operate with exceptional stability, thermal resilience, and long service life, and the primary limitation on capacitor performance is thermal, specifically, the inability of conventional films to survive repeated charge-discharge cycles and heat accumulation.

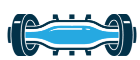
Conventional capacitor films, including the industry-standard biaxially oriented polypropylene (BOPP), were not designed for the thermal and electrical demands of modern fusion environments. Above 85°C, BOPP begins to lose significant energy storage capacity and physically degrade, which forces operators to install expensive liquid nitrogen cooling systems, add capacitors to compensate, and absorb more frequent replacement costs. The result is a larger footprint, higher operating expense, and less reliable uptime for systems that cannot afford any of those trade-offs.

3 Leading Approaches to Magnetic Confinement Fusion

NanoPlex LDF performs across the three leading MCF architectures:

Tokamak: A toroidal magnetic chamber using superconducting magnets for compact, high-field plasma confinement.

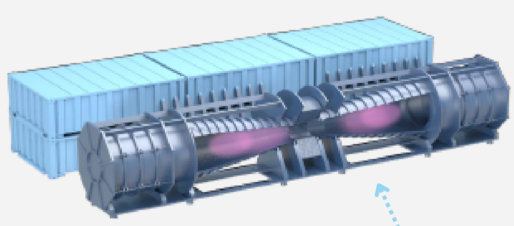
Stellarator: A three-dimensional magnetic geometry optimized for long-pulse, steady-state operation.



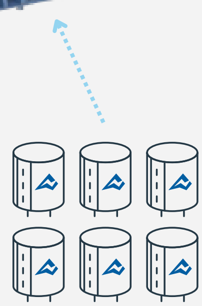
Magnetic Mirror: A linear, open-ended configuration that confines plasma between two high-field regions.

All rely on high-performance capacitor banks and power conditioning systems where NanoPlex LDF delivers measurable advantages.

Magnetic Mirror Fusion Machine



NanoPlex™ LDF film capacitors form the pulsed banks that energize a fusion machine's magnetic coils, delivering fast, repeatable high-current pulses with no derating up to 135°C.



The Solution: 4 Ways NanoPlex LDF Supports MCF

Peak NanoPlex Low Dissipation Factor (LDF) capacitor film was built for exactly these conditions, delivering superior thermal stability, longer service life, and a reliable U.S.- and allied-based supply chain for the programs that need it most. This occurs across four critical performance dimensions:

1 | Optimize Machine Up-Time

NanoPlex LDF-based capacitors deliver a service life up to 3–5x longer than BOPP-based capacitors, reducing maintenance cycles and keeping fusion systems operational longer.

2 | Higher Thermal Performance

NanoPlex LDF-based capacitors maintain full energy capacity up to 135°C without derating – withstanding the extreme thermal cycling demands of high-duty-cycle fusion operations without derating or performance loss.

3 | Improve Power Generation Efficiency

Nanoplex LDF-based capacitors improve fusion energy gain, producing more usable power per unit consumed, lowering cost per kilojoule, and strengthening the economic case for commercial-scale fusion energy.

4 | Lower Total Cost of Ownership

NanoPlex LDF-based capacitors reduce the cost of operating and maintaining fusion power infrastructure, extending service life, improving uptime, and reducing the physical footprint required to house power conditioning systems.

Advanced Materials for Fusion Energy

Peak Nano is a U.S.-based manufacturer of nanolayered metamaterial films engineered for high-energy and high-reliability applications. All NanoPlex™ films are designed and engineered domestically and with allied-nation partners, strengthening the U.S. materials supply chain for fusion research and next-generation energy infrastructure.

NanoPlex LDF films are engineered for magnetic fusion applications, delivering superior dissipation factor, 3–5x longer capacitor lifetimes, and exceptional thermal tolerance compared to conventional polymer films.

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