

THOUSANDS OF PRECISELY CONTROLLED LAYERS

Introduction to Nanolayering

- Nanolayered films improve performance through architecture, not new chemistry.
- Below about 250 nanometers, polymers crystallize into ordered, in-plane layers.
- One process tunes dielectric, thermal, mechanical, barrier and optical properties.
- Built on proven commercial polymers: no new materials, no multi-year R&D cycle.
- Fewer overall materials: no tie layers, adhesives or specialty resins required.
- Backed by 20+ patents and decades of research with DARPA, NRL, DOE and Case Western Reserve University.

WHY NANOLAYER COEXTRUSION

Unlock new film performance from the polymers you already use.

What is Nanolayering?

Nanolayering is a coextrusion process that combines two or more existing polymers into hundreds or even thousands of precisely controlled layers, each as thin as 25 nanometers. Layer order, thickness ratio and composition are all adjustable, so properties like barrier performance, mechanical strength and dielectric behavior are tuned at the layer level instead of settled by a bulk blend.

The Limits of Conventional Films

Traditional film engineering forces performance trade-offs:

- **Single-polymer films:** Limited by the properties of one material.
- **Polymer blends:** Average the properties instead of maximizing each material's strengths.
- **Traditional Multilayer Films:** Tie layers and specialty resins add materials, cost and complexity.

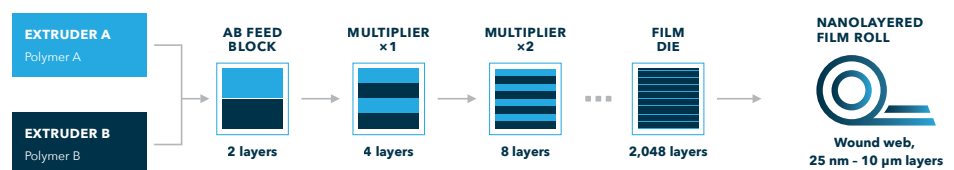
The Nanolayer Advantage

Nanolayer coextrusion removes these trade-offs. It multiplies two or more existing polymers into hundreds to thousands of alternating layers, each 25 nanometers to 10 microns thick, and turns layer order, thickness, ratio and composition into design variables.

The result: Dielectric strength, thermal stability, toughness, barrier and optical properties are tuned to the application, using commercial polymers and fewer overall materials, without developing new base materials.

How Nanolayering Works

Two polymers enter the feed block as two layers. Each multiplier doubles the count, building thousands of layers before the film die forms the final film.



Number of layers = $2^{(n+1)}$ where n = number of multipliers
Example: 10 multipliers = 2,048 layers



The Technology

In conventional films, semicrystalline polymers form randomly oriented spherulites that can create weak points. Below roughly 250 nanometers, there is no room for spherulites to form, so the polymer crystallizes into flat, ordered, in-plane lamellae. In published research, nanolayered films showed 35-40% higher toughness than blended films of identical composition, and in several cases outperformed either polymer alone at elevated temperature. The gain comes from how the materials are architected, not from changing the formulation.

Traditional vs. Nanolayered

	Traditional	Nanolayered
Layer count	3 to 11 layers	Dozens to 4,000+ layers
Properties	Sum of the parts; rule of mixtures applies	Exceed the sum of the parts
Requires	Tie layers and specialty resins	Standard polymers, fewer overall materials
Thickness	10 to 100+ μm per layer	25 nm to 10 μm per layer

Same polymers. Different architecture. Performance engineered for the application.

Cost Impact

Capital equipment	Retrofit instead of rebuild: upgrade existing equipment with a feed block and multipliers for only 5-10% of system cost
Operating cost	No change: same polymers, line speeds, energy and labor
Raw materials	No change or lower: standard commodity polymers, no specialty additives

Why It Matters

Nanolayering gives product teams two paths. Create new films with enhanced function or replace films facing regulatory or recycling pressure with structures built from commercial polymers and fewer overall materials, without starting a new chemistry program.

What This Means by Industry

The same nanolayer architecture, tuned differently, solves performance challenges across industries.

Energy: Densely packed interfaces trap charge and interrupt dielectric breakdown, while heat-resistant layers hold their structure at high temperature, so capacitors run reliably in demanding environments.

Packaging: Continuous, oriented crystalline layers give gas molecules a longer path to travel, improving barrier performance for the food and medical sectors with fewer overall materials in the structure.

Industrial: Nanoscale interfaces deflect and interrupt crack propagation, improving toughness and durability without relying on additives or new resins.

In Market Today

These gains come from a scalable, qualified process built on commercial polymers and existing extrusion lines. The same principles already back NanoPlex™ HDC and LDF capacitor films, qualified in the market today.

Ready to Unlock New Performance With Existing Polymers?

Request a consultation or technical capabilities brief with a polymer architect at <https://www.peaknano.com/nanolayer-coextrusion> or contact sales@peaknano.com.

