



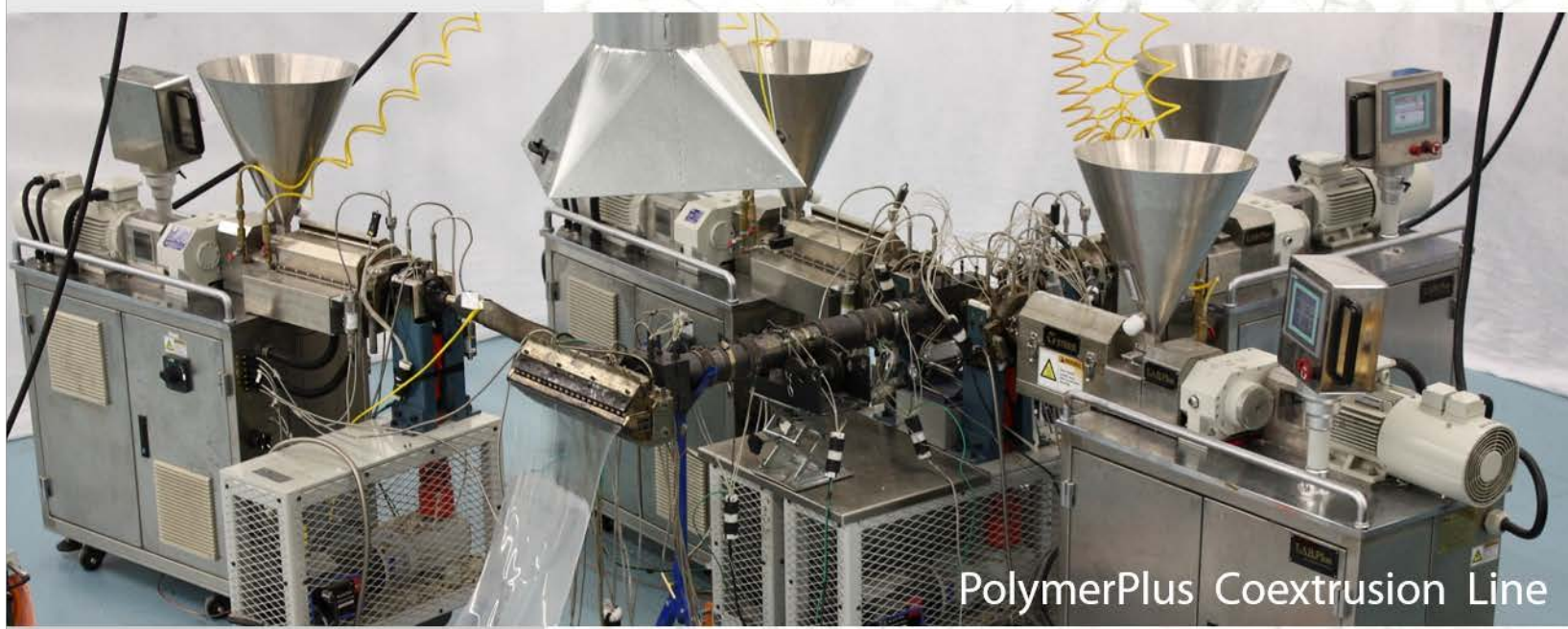
Capacitors

Coextrusion Processing  
Multilayered Films  
Polymer Science

# PolymerPlus LLC



Multilayered services and products

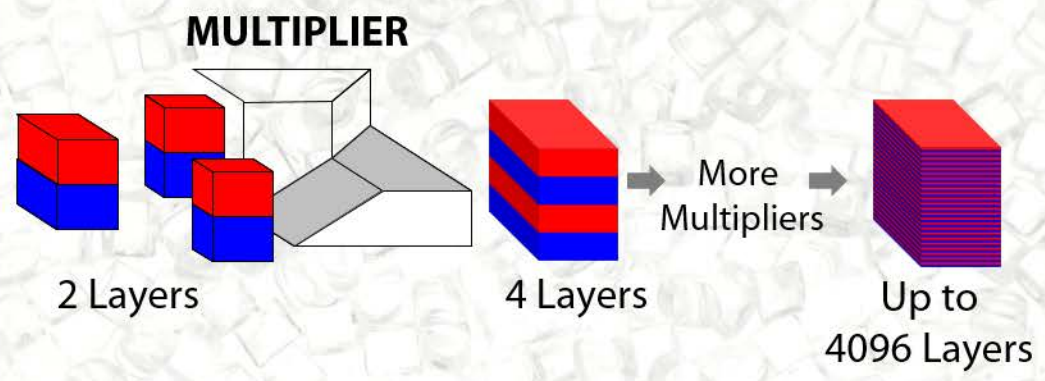


PolymerPlus Coextrusion Line

## Technologies

- Gradient Refractive Index Optics
- Multilayered Dielectric Films
- Fiber/ Filter Media
- Gradient Films
- Reflective Films
- Barrier Films
- Thermoforming
- Lamination
- Mechanical Improvement

## Micro- and Nanolayer Coextrusion



Continuous layer multiplication,  
towards thousands of Layers  
and unique properties



# STRATA

Energy from Nanolayers

## Patented *Strata* Nanolayered Dielectric Film Products

The world's first nanolayered, high dielectric constant & high temperature polymer film

Properties	PolymerPlus <i>Strata</i> Film Products			Commercial BOPP or Mylar
	Strata-S (May-2016)	Strata-C	Strata-CHT	
Dielectric Constant (1 kHz)	5.2	4.0	4.0	2.2-3.1
Operation Temperature	100 °C	100 °C	150 °C	85-100 °C
Energy Density	16 J/cc	13 J/cc	10 J/cc	5-6 J/cc
Thicknesses	4, 6, 8 μm	6, 8 μm	8 μm	3 – 4 μm

**vs.**

<b>Strata Product Format Available</b>	• A4 size film sheets	: For preliminary testing
	• Film roll samples	: 250 - 3000 ft. length x 8" width
	• Metallized film	X 8 μm thickness
	• Capacitor prototypes	: 50 mm width x custom length
		: Custom sizes available

Dielectric multilayered films (MLF) technology enables up to a ½ reduction in capacitor volume by replacing BOPP or Mylar while extending usage temperatures to 160 °C.

Nanolayer Dielectric Film



3000 ft. length, 8" width

Metallized Film



2" roll width

Capacitor Prototypes



21 and 37 μF Capacitors

## GRIN Optics

### Night Vision Goggle eyepiece



GRIN

Glass

- GRIN offers compact optical design
- GRIN System: 2 GRIN + 1 glass lens
- Commercial system: 5 glass lenses
- GRIN offers a 3.5x volume reduction and a 7.5x weight reduction
- 24% wt reduction in PVS14 eyepiece

## Fiber Filter Media

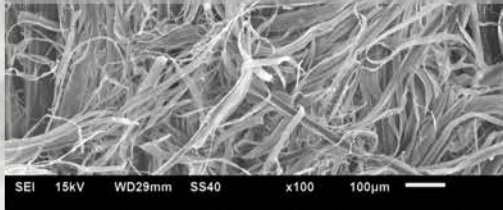
Media



Filters

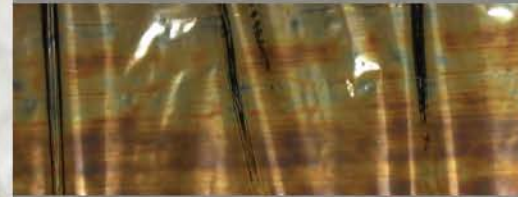


Fiber Image



- Multilayered films with thousands of layers
- Micro- and nano-scale fibers by melt processing
- Solvent-free processing
- Composite fibers and media

## Reflective Films



- Structural colors through layered interference
- No pigments required
- Tunable colors in visible wavelength range

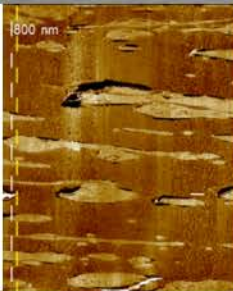
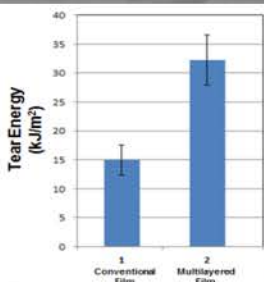
## Gradient Films

Thick Layers

Thin Layers

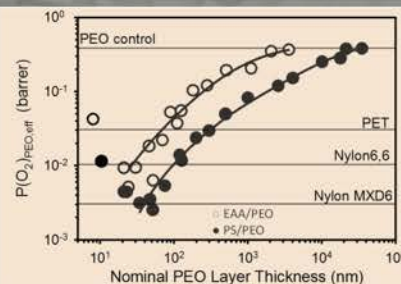
- Up to 10X gradient in film thickness and custom gradient distributions
- Applications in optical filters & controlled transport or diffusion

## Mechanical Improvement



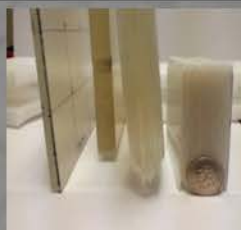
- Improved mechanical properties via layering
- Stronger, tougher and thinner films using thermoplastics
- Oriented blends via layering
- Compatibilizing dissimilar materials
- Improving layer adhesion

## Barrier Films



- Improved film barrier properties by controlled crystallization
- Up to 100 times improvement in the barrier properties

## Thermoforming



Composite polymer sheets & parts

## Lamination



- Vacuum thermoformer lamination of various substrates
- Substrates - glass, carbon fiber, metal, wood, etc.



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## Development Models

Contract Research  
Services

Lab Scale  
Coextrusion Trials

Joint Development  
Projects

Pilot Scale  
Coextrusion Trials

Material Testing &  
Characterization

## Research & Development Services

### General Polymer Science

- Structure-property analysis, crystallization and thermal analysis
- Polymer interactions, miscibility, interphase materials, blends

### Polymer Processing Capabilities:

- Micro- and nanolayer film processing, single screw/twin screw blending, compression molding, thermoforming

### Material Testing

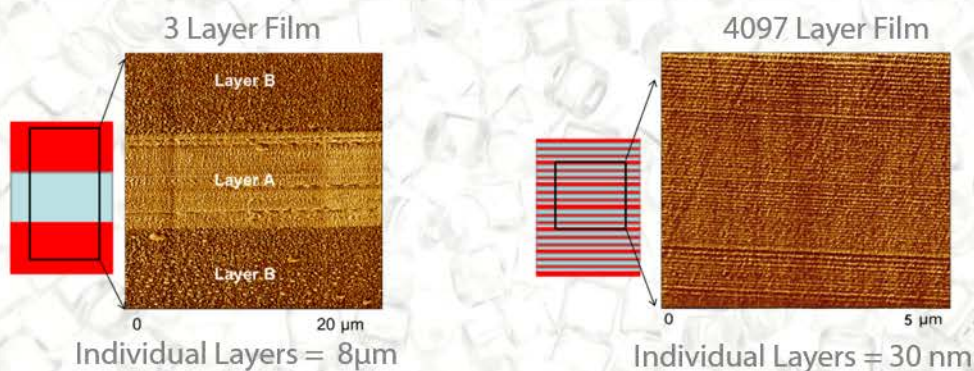
- Mechanical: tensile/flexural, failure, impact testing
- Transport: O<sub>2</sub> and H<sub>2</sub>O permeation, controlled release
- Thermal: DSC and TGA
- Electrical: energy storage, breakdown, hysteresis
- Optical microscopy, atomic force microscopy, scanning electron microscopy

**Optical Characterization:** Transmission / reflectance, dispersion, interferometry and profilometry, refractive index , birefringence measurements

### Scale-up and Commercialization of R&D work

- Transition R&D technology to commercial application
- Prototype fabrication
- Scale-up and supply chain development

## Multilayered Films Examples



## Various Film Structure Possibilities

