



2024 FlexPack PLACE Conference

April 14-17, 2024 • San Diego, CA • Wyndham San Diego Bayside



Extrusion Coatings: Integrating Minerals and Nano particles into the Polymer Matrix for Improved Recycling and Functional Barrier Performance

Presented by:

Chris Tilton, Chief Technology Officer
Smart Planet Technologies, Inc.

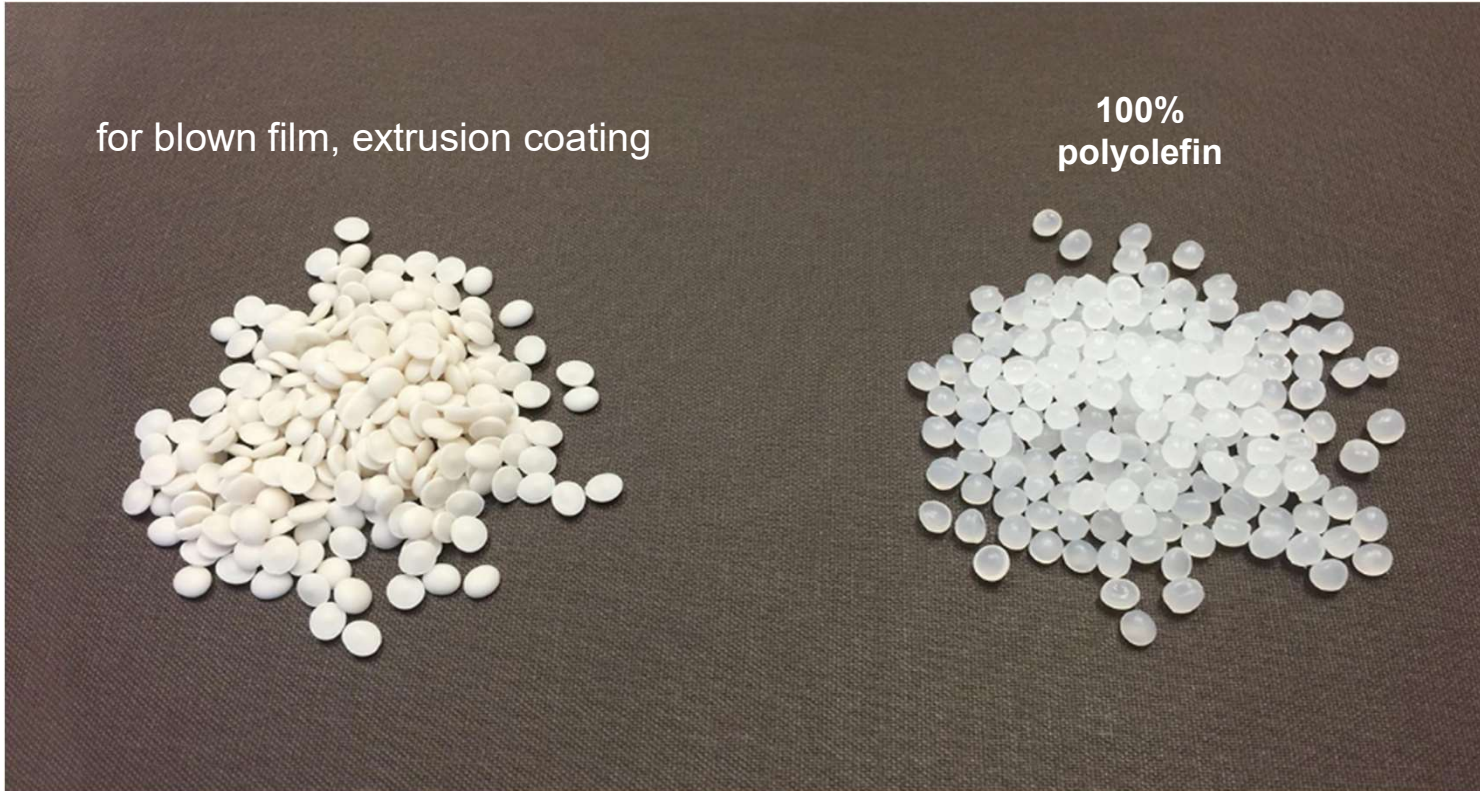
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up to 51% mineralized resins

for blown film, extrusion coating



100%
polyolefin

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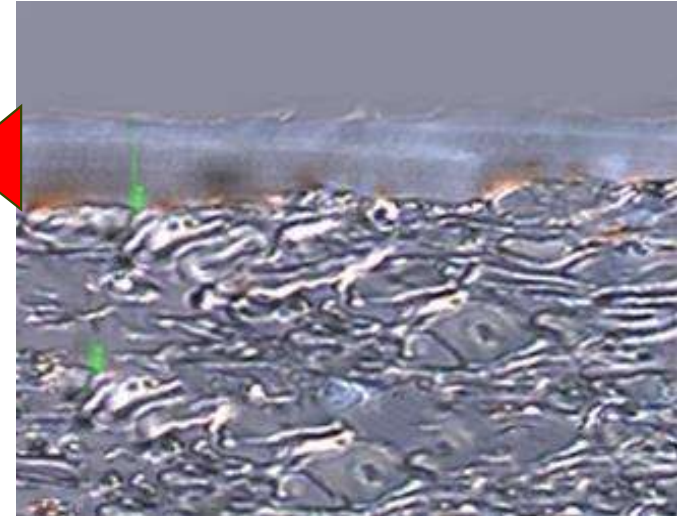
Mineralized Layers: Less Plastic, Equal Performance, Same Coat Weight

packed
micro
CaCo₃ layer



fiber layer

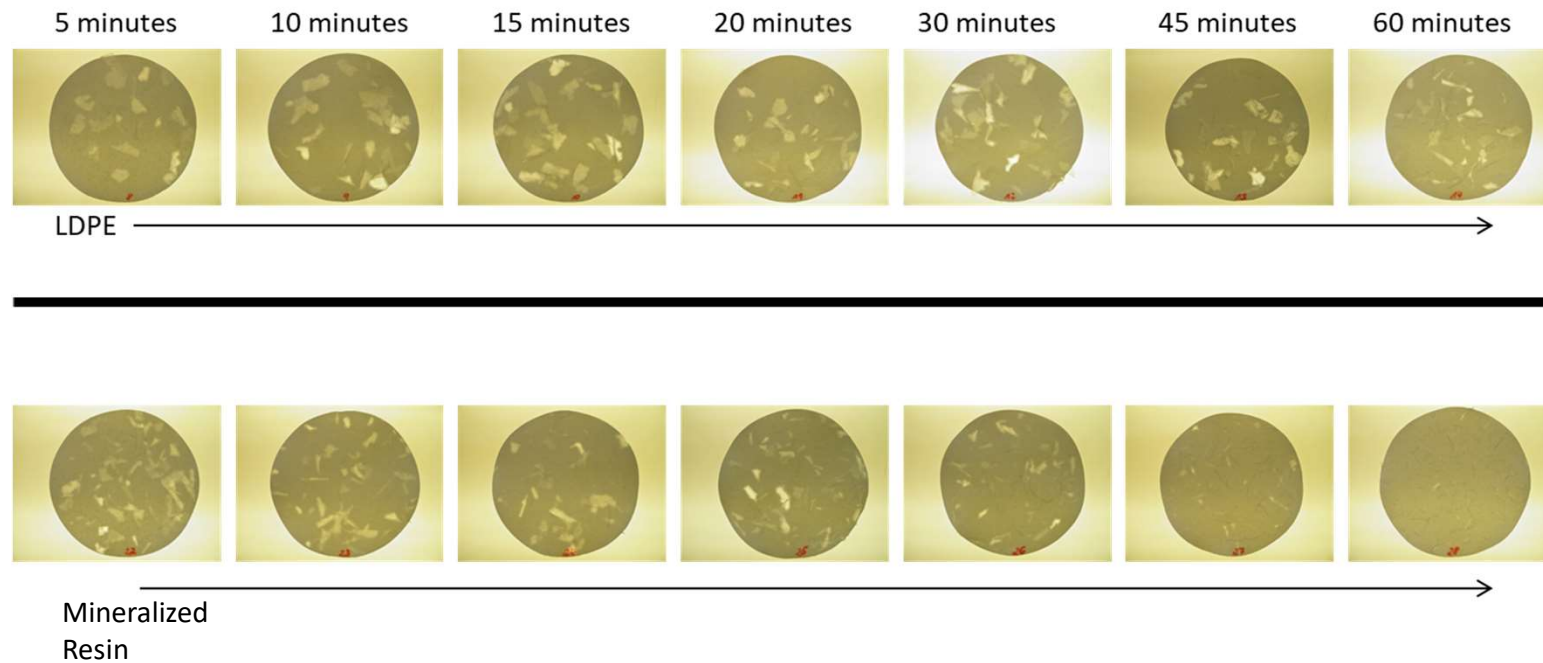
100%
plastic



fiber layer



Coating Behavior in Pulper: 40% Mineralized Resin Versus Neat PE



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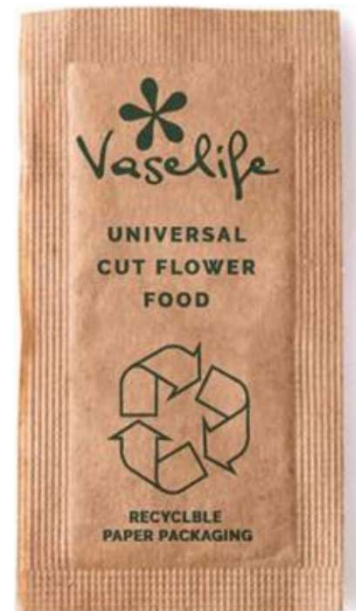


45% mineralized flexible packaging coating

Next Step: nanocomposites for exceptional polyolefin barrier performance




Vaselife



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Next Step: Nanocomposites for Exceptional Food Packaging Barrier Performance



40% mineralized coffee packaging



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[“Nanocomposites Improve Package Properties”](#) by Sherry Hildebrandt

- next great frontier of packaging science
- greatly improved gas barrier
- highly efficient for extended shelf -life products

Nanocomposites Improve Package Properties

Sherry Hildebrandt

Undergraduate Student, Packaging Engineering

Key Words: nanocomposites, nanotube, PET

Abstract: *Nanocomposite technology has been described by some as the next great frontier of material science in packaging. This technology was developed to improve barrier performance pertaining to gases such as oxygen and carbon dioxide. It also enhances the barrier performance to ultraviolet rays, as well as adding strength, stiffness, dimensional stability, and heat resistance. New plastics created with this technology demonstrate an increased shelf life and are less likely to shatter. Once perfected, these plastics will offer these improved characteristics at competitive prices. It will also make them attractive for use in food and beverage packaging and pharmaceutical packaging applications.*

Introduction

In 2001, nearly 100,000 pounds of nanocomposite materials were used in the packaging industry; by 2011, the market in the United States is expected to be around 100 million pounds for rigid and flexible packaging (“Nanocomposites for packaging,” 2002). “Polymer nanocomposites consist of resins [either thermoset or thermoplastics] that have fillers added with a least one dimension measured in nanometers. These fillers fall into three categories: nanotubes, nanoscale oxides and metals, and nanoclays” (Brauer, 2003, ¶ 2).

Nanotube-based nanocomposites are used for electrostatic dissipation applications; nanoscale oxides and metals are used for abrasion-resistant films; and nanoclay-based nanocomposites are used for barrier packaging applications (Scott & Wood, 2003). “Nanocomposites have received considerable attention over the past decade because of their potential to achieve property enhancements significantly greater than that attainable using conventional fillers or polymer blends” (Dean, Abadalla, & Ganguli, 2003, p. 12). The use of nanoclay-based nanocomposites in food and beverage packaging applications, and the properties that make them superior to conventional plastics, will be focused on.

Background

Nanocomposites were first referenced in the 1950s and polyamide nanocomposites were reported around 1976. In the early 1980s Toyota’s® Central Research and Development

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"Polymer/Clay Nanocomposites: An Emerging Material Class"

by Dr Trevor J Hutley, Nitin Borse

- New class of materials with improved properties
- Dispersing nano particles into the polymer matrix forming polymer/clay nanocomposites
- Polymer/clay nanocomposites used food and industrial packaging applications.

ACADEMIA

Polymer/Clay Nanocomposites: An Emerging Material Class

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Abstract

Polymer/clay nanocomposites are materials composed of a polymer matrix and nanometer size clay particles. They exhibit significant improvements in tensile modulus and strength, reduced permeability to gases and liquids compared to the pure polymer. These property improvements can be realized while retaining clarity of the polymer without a significant increase in density. Polymeric nanocomposites hold the potential to replace conventional plastics and plastic composite materials in many applications such as automotive components, packaging, appliances, electrical/electronic parts, and building and construction products. This paper reviews the background and growth of nanocomposite technology, presents some of the data on property enhancement, and evaluates the future of this emerging class of polymer material.

Introduction

From an engineering perspective, polymer materials have relatively low modulus and strength. Polymer composites have therefore been developed - starting during WWII - to combine the high modulus and high strength of a variety of reinforcing (glass, carbon or aramid) fibers with a number of thermoset matrix polymers. Such structural polymer composites typically

acicular or platelet minerals such as wollastonite, or mica, talc and clay, are particulate composites. Such high aspect ratio fillers, even when microfine, need to be used at 20 - 40% by mass to provide significant mechanical property enhancement. Such improvements often come at the expense of flow and impact strength, and of course density.

The traditional composites are therefore diverse because they allow one to tailor the properties of the material to specific needs. However improving one property often means compromising other important properties, e.g. improving the mechanical properties by incorporating glass fibers increases density significantly. These are some of the serious drawbacks of traditional polymer composites.

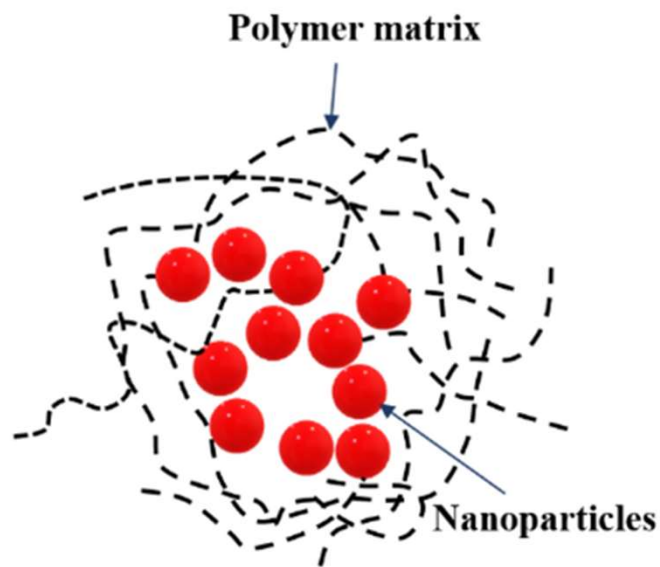
Polymer/clay nanocomposites are new composite materials composed of a polymer matrix and nanometer size clay particles. They exhibit significant improvements in tensile modulus and strength, reduced permeability to gases and liquids as compared with the pure polymer. These property improvements can be realized while retaining clarity of polymer without any significant increase in density, since the typical loading is 2-5%.

Background

Polymer-clay nanocomposites have their origin

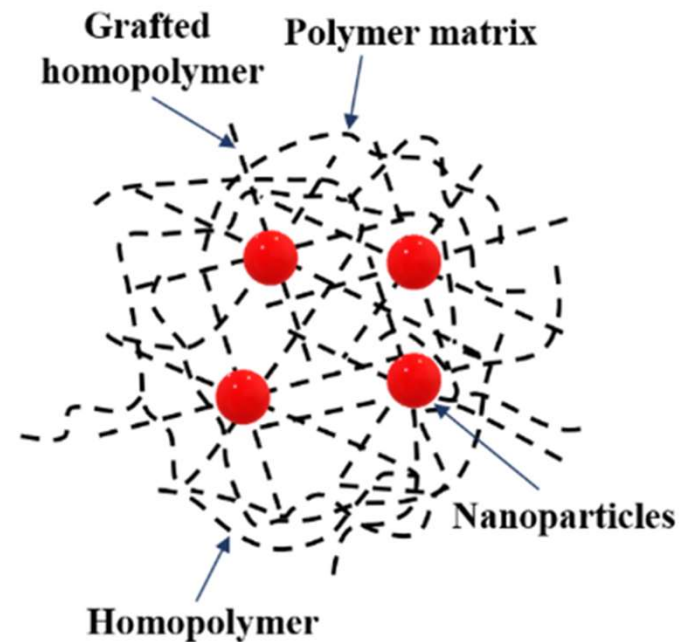
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Microcomposite

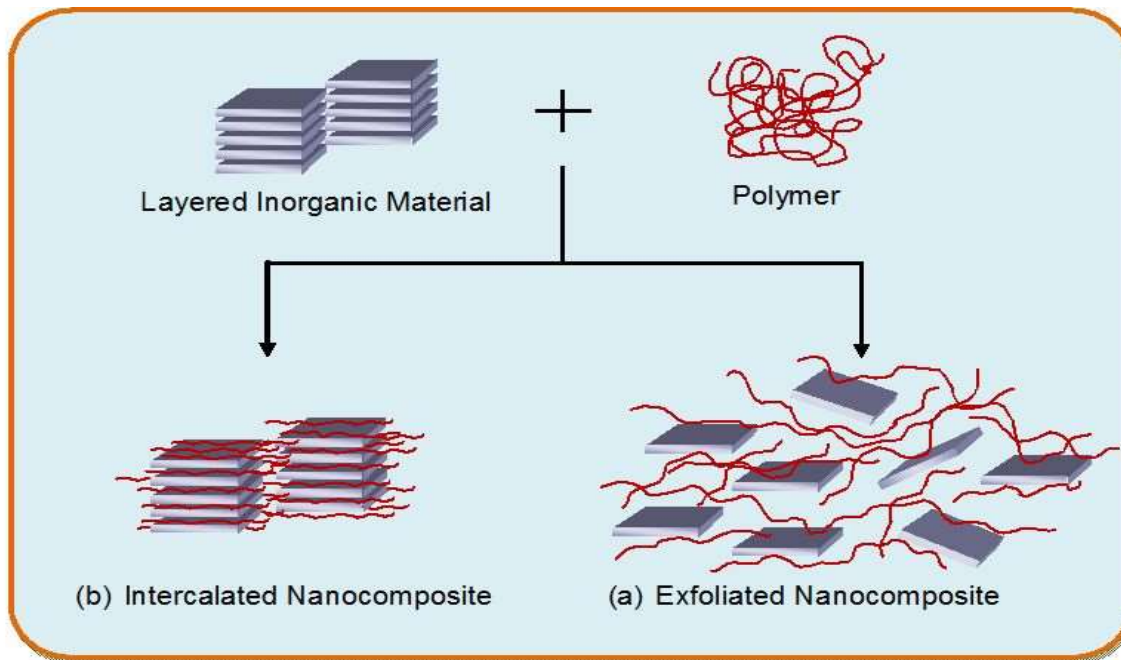
Agglomerates of particles



Nanocomposite

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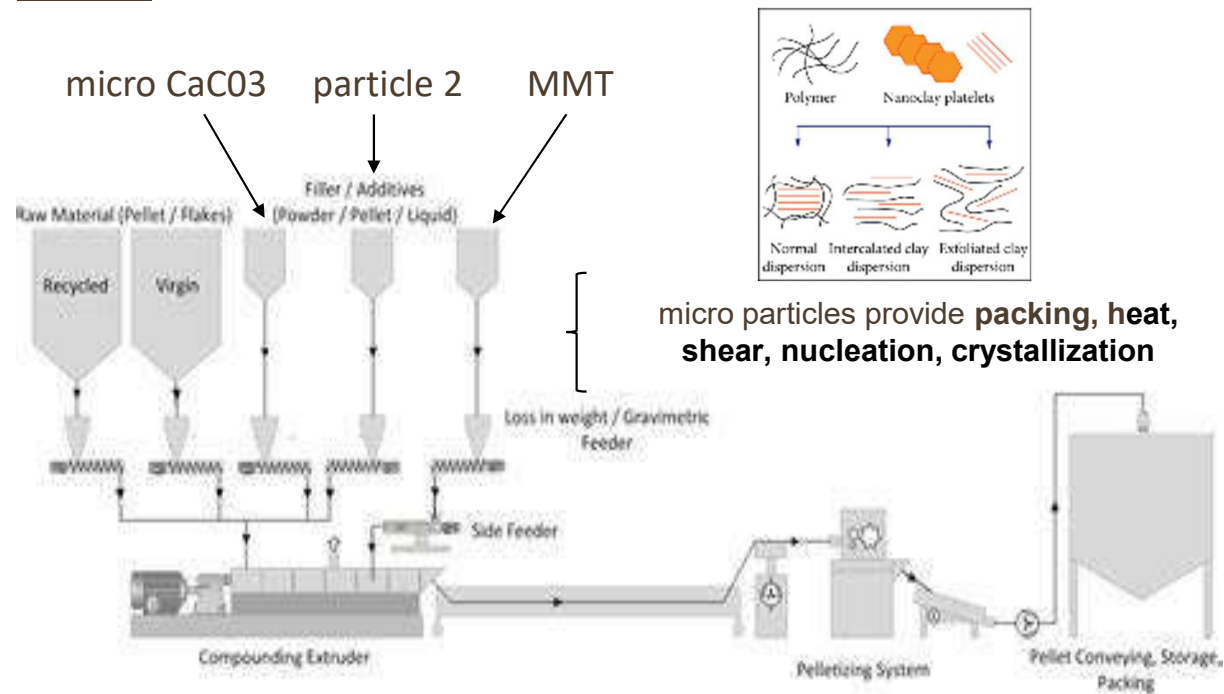


Binary and Ternary Nanocomposites
dispersed micro + nano particles



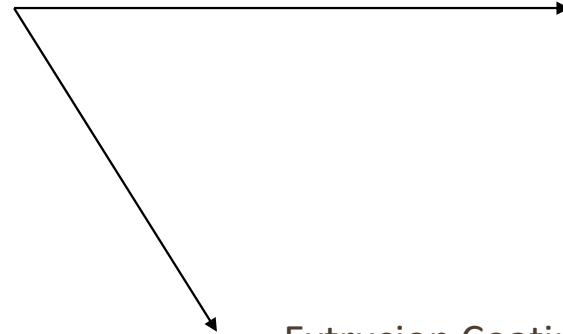
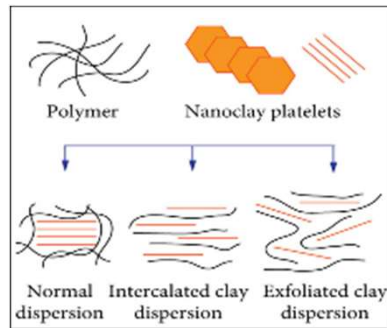
Nanocomposite: Particle Packing:

Step 1

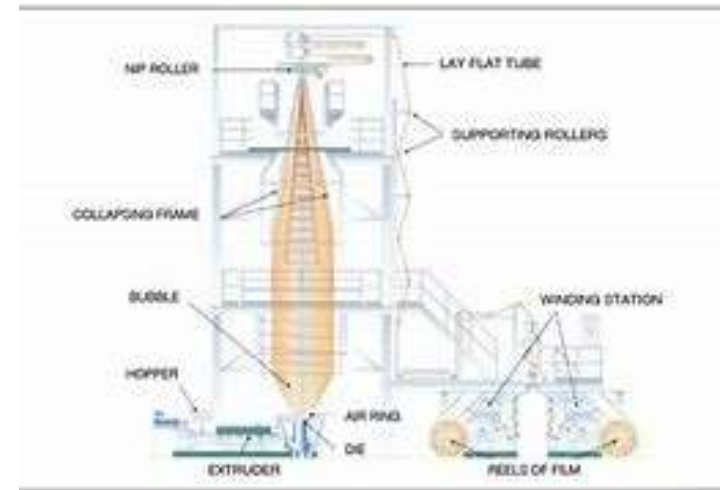




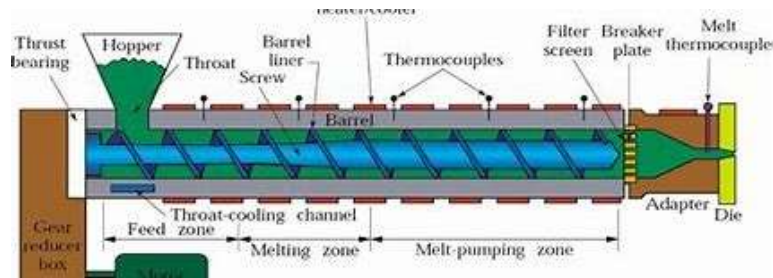
Nanocomposite: Particle Packing: Step 2



Blown Film



Extrusion Coating



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flexible packaging: 30-micron coating monolayer on kraft papers +-5%

MVTR (50% RH)	1.78 g/24 hr/m ² Tappi T448
Cobb water	2.36 g/m ² Tappi T441 24 hour
Oxygen (50% RH)	300-650 cc/(m ² day) ASTM D3985
Kit test	0% permeation

Heat Seal	100% fiber tear @ 275 F 2 seconds @ 60 psi
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monolayer extrusion coated paper



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flexible packaging: 75 micron coating monolayer, kraft paper +-5%

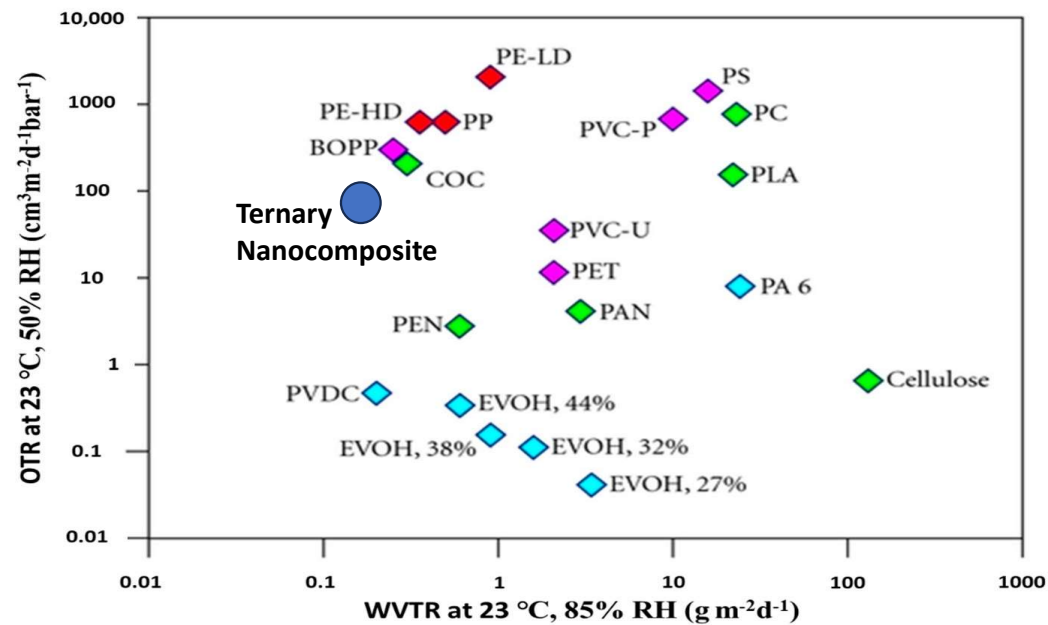
MVTR (50% RH)	.60-.90 g/24 hr/m2 Tappi T448
Cobb water	0% permeation T 441 (24 hour)
Oxygen (50% RH)	125-200 cc/(m2 day) ASTM D3985
Kit test	0% permeation

Heat Seal	100% fiber tear @ 275 F 2 seconds @ 60 psi
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ternary nanocomposite paper coatings vs. conventional barriers



oxygen permeability (OP) and water vapor transmission rate (WVTR) normalized to a thickness of 100 μm for different polymers. Source: Fraunhofer



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thank you

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