Tuesday, December 6, 2022

4:00 PM - 4:30 PM

The Extruder as a Reactor for Advanced Mechanical Recycling Using 1.5-Nanometer Titanates and Zirconates

Compounding

Sal Monte

The Extruder as a Reactor for Advanced Mechanical Recycling Using 1.5-Nanometer Titanates and Zirconates

Salvatore J. Monte
President | Kenrich Petrochemicals, Inc.

201-823-9000 | sjmonte@4kenrich.com | www.4kenrich.com

Presentation Outline – Key Points

- Titanium/Aluminum coupling and catalysis applications are demonstrated in Advanced Mechanical Recycling.
- Ziegler, Natta & Kaminisky used Titanium and Aluminum catalysts to produce Addition Polymers – PP & HDPE are Addition polymers;
- Titanate catalysts produce Condensation Polymers such as PET;
- Heteroatom Titanates couple fillers & catalyze Polymers in the melt;
- Monte uses Ti/Al in powder/pellet form to recycle complex multiple Polymer/Filler mixtures in the extruder melt or shear mixer.
- Multiple polymer & filler compatibilization is desirable in recycle art.

Biography:

Salvatore J. Monte, President of Kenrich Petrochemicals, Inc.; Bachelor Civil Engineering-Structures, Manhattan College; M.S.-Polymeric Materials, NYU Tandon School of Engineering; Member Plastics Hall of Fame 2021; BOD-The Plastics Academy; Society Plastics Engineers Fellow & Honored Service Member; Licensed P.E.; S&E Innovative Technologies, LLC – Principal Member; Plastics Industry Association Recycle Subcommittee-Compatibilizers; Board of Governors, Plastics Pioneers Association-MTS Newsletter Chair; 32-U.S. Patents – most recent US Patent 2020/0071230 A1 dated Mar. 5, 2020; Lectured Worldwide on Titanate & Zirconate Coupling agents; 450-American Chemical Society CAS Abstracts of published “Works by S.J. Monte”; Classified Top Secret for Solid Rocket Fuel and Energetic Composites Patents for the Insensitive Munitions Program; Lifetime member of the National Defense Industrial Association; Lifetime Member of the BOD-SPE ThermoPlastics Materials & Foams Division – Annual Scholarship named: Salvatore J. Monte Thermoplastic Materials & Foams Division Scholarship; External Advisory Committee-UCF NanoScience Technology Center; former Chairman of the NYRG-ACS Rubber Division; former President of the SPE P-NJ Section; Testified several times before Congress on Trade and IP Protection; Business Man of the Year 2015-Bayonne Chamber of Commerce; Federated Society Coatings Technology C. Homer Flynn Award for Technical Excellence; Recipient of the Albert Nelson Marquis Lifetime Achievement Award; Rotary Paul Harris Fellow; UA Million Miler; Member PIA, ACMA, SPE, ACS, ACS Rubber Division, ASCE, AIChE, SAMPE, the GRAPHENE COUNCIL, the Vinyl Sustainability Council.

July/Aug. 2022 5-page article

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NEWS

TRADESHOWS, CONFERENCES, AND PRESS ARTICLES

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Sal Monte continues to challenge conventional thinking about coupling agents and catalysts

Read Article

PLASTICS ENGINEERING MAGAZINE JULY-AUGUST 2022

Kenrich featured in 5-page July-August issue of Plastics Engineering Magazine: CHAMPION OF CHANGE.

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COMPATIBILIZERS AID RECYCLING & UPCYCLING OF MIXED RESINS

Compatibilizers are proving their worth in boosting critical properties such as impact/stiffness balance of PCR and PIR blends of polyolefins and other plastics.

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CHAMPION FOR CHANGE

Sal Monte continues to challenge conventional thinking about coupling agents and catalysts

BY PAT TOENSMEIER

In 1979, shortly before his 40th birthday, a hard-charging chemical executive named Sal Monte attended a communications development seminar in White Plains, a suburb just north of New York City.

During a break, he discussed his business with one of the speakers, James Cusimano. Monte told Cusimano that he helped his company, Kenrich Petrochemicals Inc. of Bayonne, N.J., develop organometallic coupling agents for titanate, zirconate and aluminate technologies. The additives, which also have value as catalysts, improved the properties and processability of numerous materials, such as thermoplastics, composites, color concentrates, coatings, adhesives and rubber.

Monte, who was vice president of the company at the time, believed the coupling agents were suitable for use with all sorts of materials, not just plastics and rubber, and had the potential to upgrade resin properties in diverse applications. Cusimano probably didn't follow all the technical aspects of the conversation, but he did recognize Monte's enthusiasm for and commitment to the products.

"Sal Monte," Cusimano said, "what if I told you your mission in life is to teach people how to use raw materials more efficiently through titanium? Does that mean anything to you?"

For Monte it sounded like affirmation of the work he started in 1973. "The Holy Spirit gave me a message, and

Sal Monte and wife, Erika, strike a familiar pose while promoting Kenrich products at yet another trade show or conference: this time at ANTEC 2013. Photos courtesy of Sal Monte

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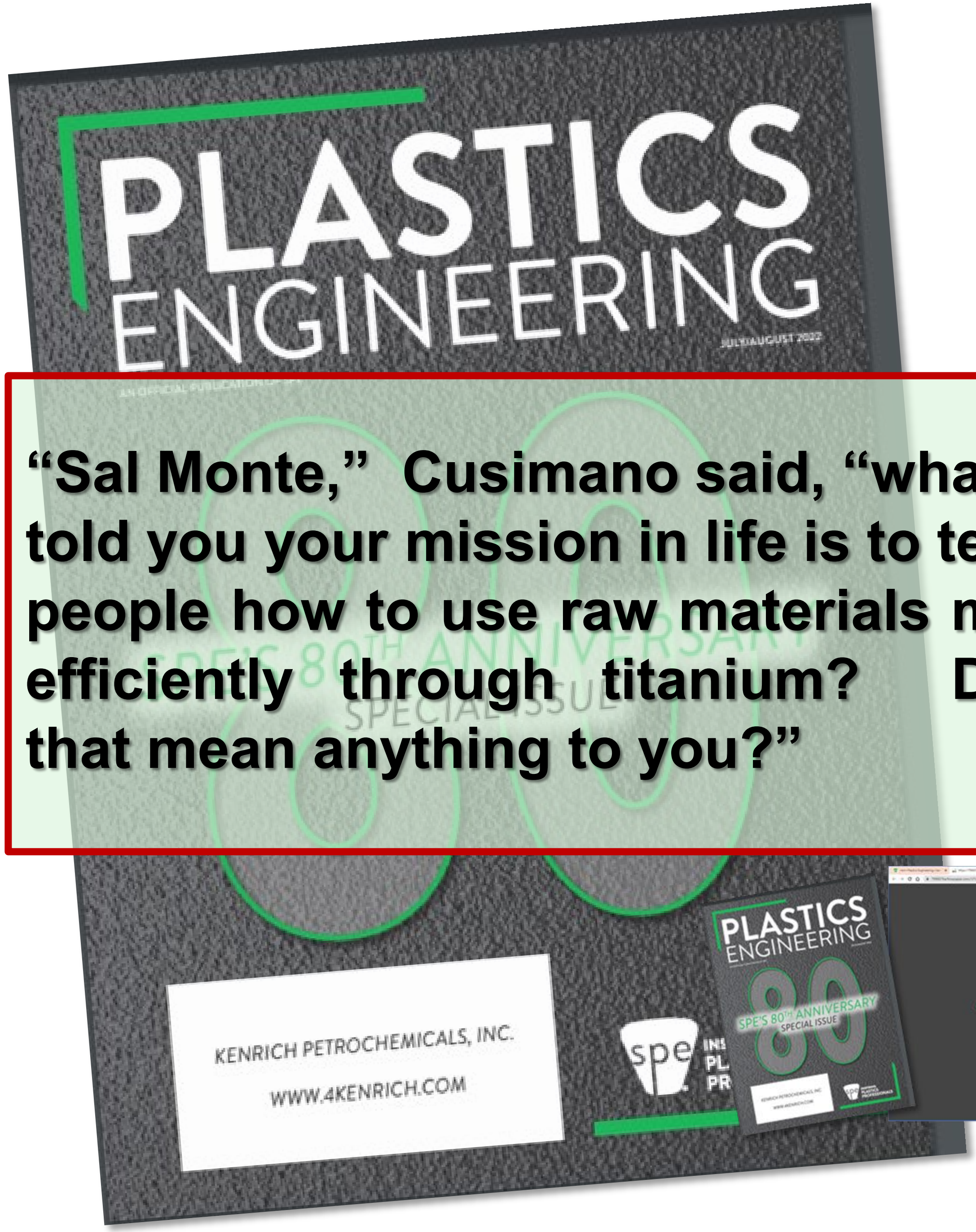

July/Aug. 2022 5-page article

CHAMPION *FOR* ***CHANGE***

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CHAMPION *FOR* CHANGE

SPE_PEMagazine_JulyAug22_SM (1) CHAMPION FOR CHANGE.pdf

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the chemistry of the additives mechanical recycling can be as effective at repolymerizing/copolymerizing commingled waste streams generated by curbside collection as advanced recycling (also called chemical recycling) that uses depolymerization processes. Mechanical recycling also does not require huge processing plants and large amounts of energy like advanced recycling does. More on this later.

Monte has been a tireless promoter of Ken-React coupling agents and catalysts, detailing their benefits to audiences worldwide.

that was my job—and I stuck to it," he says.

Forty-three years later, Sal Monte, now president of Kenrich Petrochemicals, still enthusiastically promotes the benefits of titanate, zirconate and aluminate technologies in many forums—conferences, trade shows, meetings with potential clients and R&D personnel, as well as the occasional interview and article in industry publications.

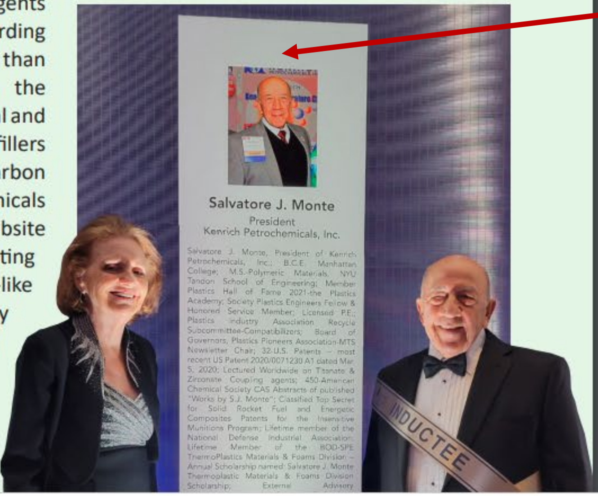
Applications for the technologies, meanwhile, continue to grow. The coupling agents and

The Ken-React titanate, zirconate and aluminate coupling agents come as powders, liquids or pellets. According to the Kenrich website, they form a less than 2-nanometer monomolecular layer on the surface of any organic or inorganic material and chemically bridge non-silane reactive fillers such as calcium carbonate ($CaCO_3$), carbon black, silica, metal oxides and other chemicals with polymers. As an example, the website notes that an organotitanate nano coating on carbon black will act as a metallocene-like catalyst in a polymer and lower Mooney viscosity, resulting in increased flow and greater mechanical properties.

The benefits of using the additives are considerable. According to the website, adding just 0.2 to 0.6 phr of titanate to

or more; mechanical properties improve; high filler loadings of carbon black, $CaCO_3$, ATH and magnesium hydroxide can be used with no tradeoffs in processability or part flexibility; polymer adhesion to aramids, polyamides, graphite and glass-fiber reinforcements increases significantly; and part smoothness, pigmentation and paintability improve.

These may sound like miracle materials, but there's nothing miraculous about them; it's all nano-chemistry, and their development owes to Monte's original idea in the early 1970s that transesterification of isostearic acid with a tertraalkoxy titanium compound



PLASTICS *Hall of Fame*

July/Aug. 2022 5-page article

CHAMPION *FOR* *CHANGE*

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Salvatore J. Monte Inducted Into The Plastics Hall of Fame

MAY 2, 2022

Aqua Blu Hotel CHICAGO

PLASTICS

Hall of Fame

Plastics Hall of Fame

MAY 2, 2022

PLASTICS Hall of Fame

PLASTICS INDUSTRY ASSOCIATION **Voting Member & Recycle Sub-Committee**

SPE SOCIETY OF PLASTICS ENGINEERS **SPE Fellow & Honored Service Member**

PPA Plastics Pioneers Association **PPA Board of Governors – Newsletter Chair**

SCIENCE IP The CAS Search Service **450- ACS CAS Abstracted Works by S.J. Monte**

32-US Patents Filed Worldwide

Classified TOP SECRET for U.S. DOD IMEM Program

Report: Prioritize mechanical recycling to meet climate goals

By Steve Toloken
Plastics News Staff

"As an industry, we are totally supporting the hierarchy of waste — that is, if it can be mechanically recycled, then it should [be]. We support that as an industry."

John Sewell
Chemical Recycling Europe

Using pyrolysis-based chemical recycling to meet plastic recycled-content targets could emit up nine times the greenhouse gases compared with traditional mechanical recycling, according to a new study from the environmental group Zero Waste Europe.

The Sept. 27 stu...
look...

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launch... study in a Sept. 27

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"We see that there's an opportunity for us to fit and work to-

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"The revision of the PPWD should serve as a lever to make the packaging sector more cir-

But Sewell said it could prove difficult to meet any new targets without chemical recycling. He suggested it's not possible to "wave a magic wand" and have mechanical recycling solve problems processing complex mixtures of plastic waste.

As well, he said that chemical recycling technologies can produce cleaner streams of recycled plastics that could go take food packaging plastic waste and reuse it more easily back into new food-contact plastic.

"Would you not agree with me that you don't want to wave a magic wand and say that mechanical recycling can solve all

cineration. But he suggested it would compare favorably.

"Of course, there are some benefits of chemical recycling compared to new plastics," Betz said. "And there's also a benefit of chemical recycling vs. incineration.

"We should use chemical recycling up to a certain point, but this point has to be very, very, very small as chemical recycling has not as much benefit as mechanical recycling," Betz said.

Another panelist, Fanny Rateau, a program manager with the Environmental Coalition on Standards, noted that the study found the biggest overall GHG benefit from a reduction in overall single-use packaging, of 20 percent, combined with enhancements to mechanical recycling.

"What is most important for packaging is to eliminate unnecessary packaging and transition from single-use to reusable plastic packaging," she said. "What's important is to prioritize mechanical recycling."

Sewell said the chemical recycling group also favored pri-

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Extrusion 2022

A Plastics Technology Event

December 6-8, 2022

Omni Charlotte Hotel | Charlotte, North Carolina

"... - that is, if it can be mechanically recycled, then it should [be]...." = Extrusion

The words in the presentation title have a specific technical meaning:

The Extruder as a Reactor for Advanced Mechanical Recycling Using 1.5-Nanometer Titanates and Zirconates

The words in the presentation title have a specific technical meaning:

Extruder as a Reactor … Reactive Compounding

For Advanced Mechanical Recycling … because we use an Extruder & not a Chemical Plant

Using 1.5-Nanometer Titanates and Zirconates … Polymers are made with Ti/Al Catalysts

The words in the presentation title have a specific technical meaning:

Advanced Recycling … is DEPOLYMERIZATION

Advanced Mechanical Recycling … is REPOLYMERIZATION

with Titanate Catalysts/Coupling Agents …

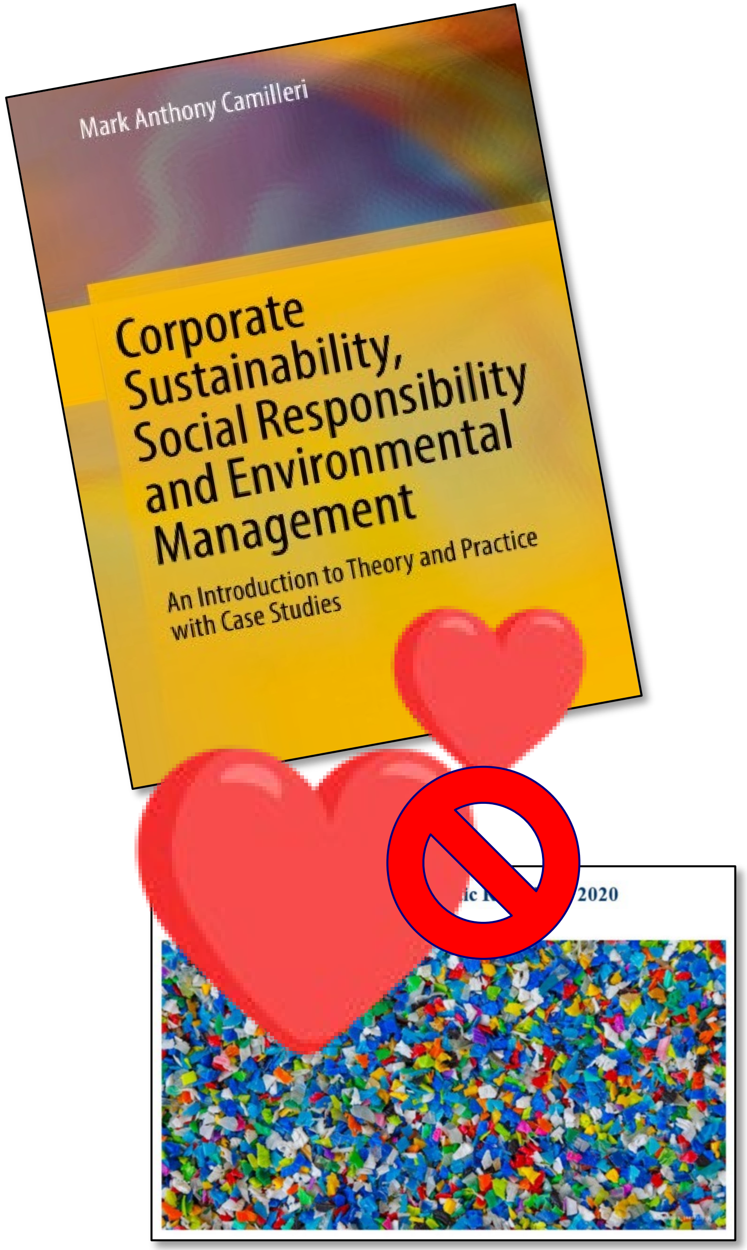
INORGANIC & ORGANIC PIGMENTS, METAL OXIDES, METAL CARBONATES, MINERAL FILLERS, CARBON BLACK, etc.

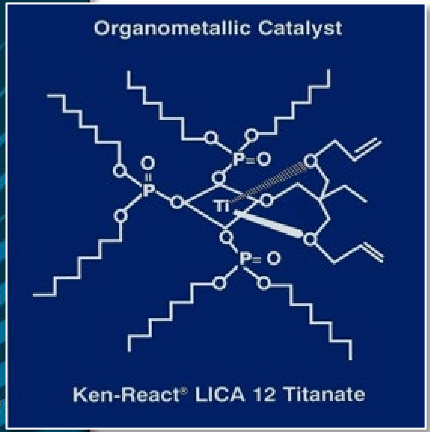
ARE NO LONGER CONTAMINANTS IN PLASTIC RECYCLE

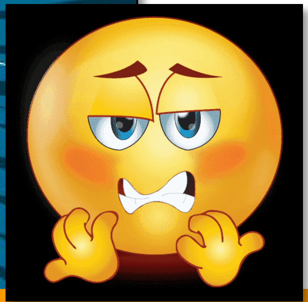
Advanced Solutions Are in Titanium & Aluminum Chemistry

Monte states: Sustainability Goals such as a Circular Economy using <u>Curbside Recycle</u> in new plastic parts is technically not possible with current industry practices – unless one uses the same chemistry that made the polymers:

You Need Nano-TITANATE Atomic Compatibilization

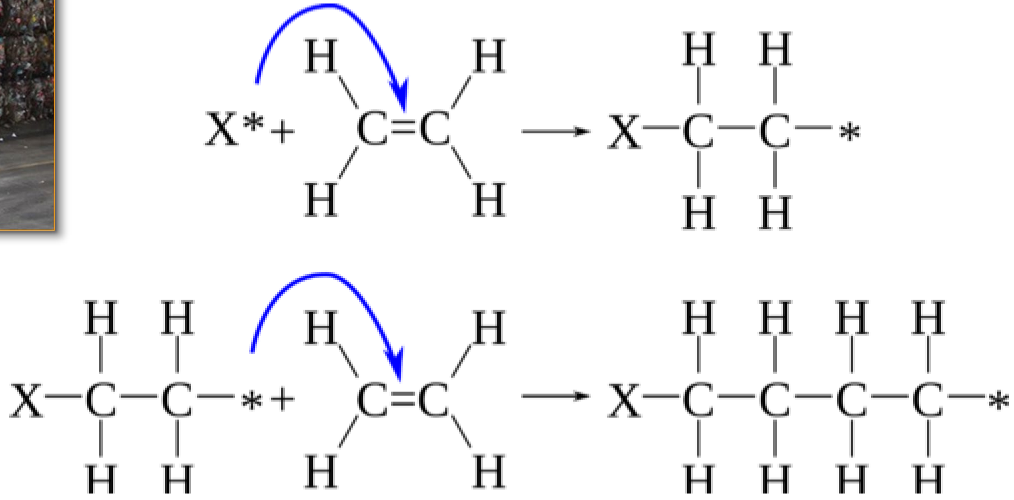


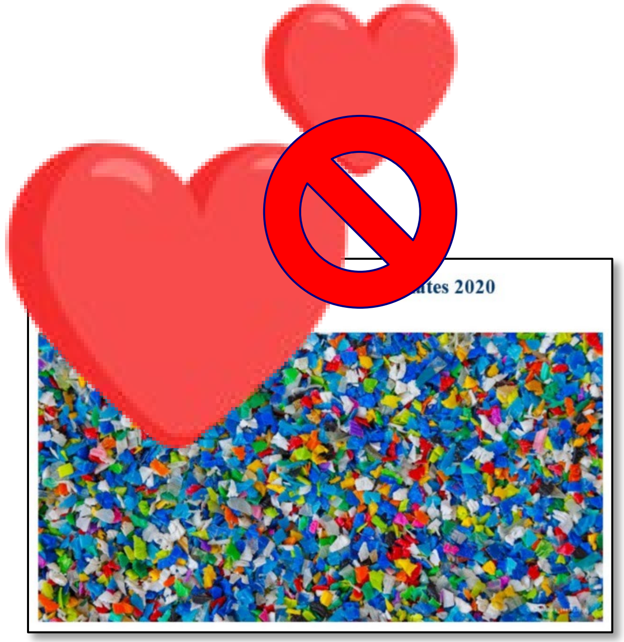


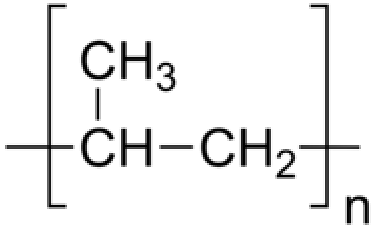


Plastics #1 to #7 are incompatible with each other

HDPE & PP Are Incompatible

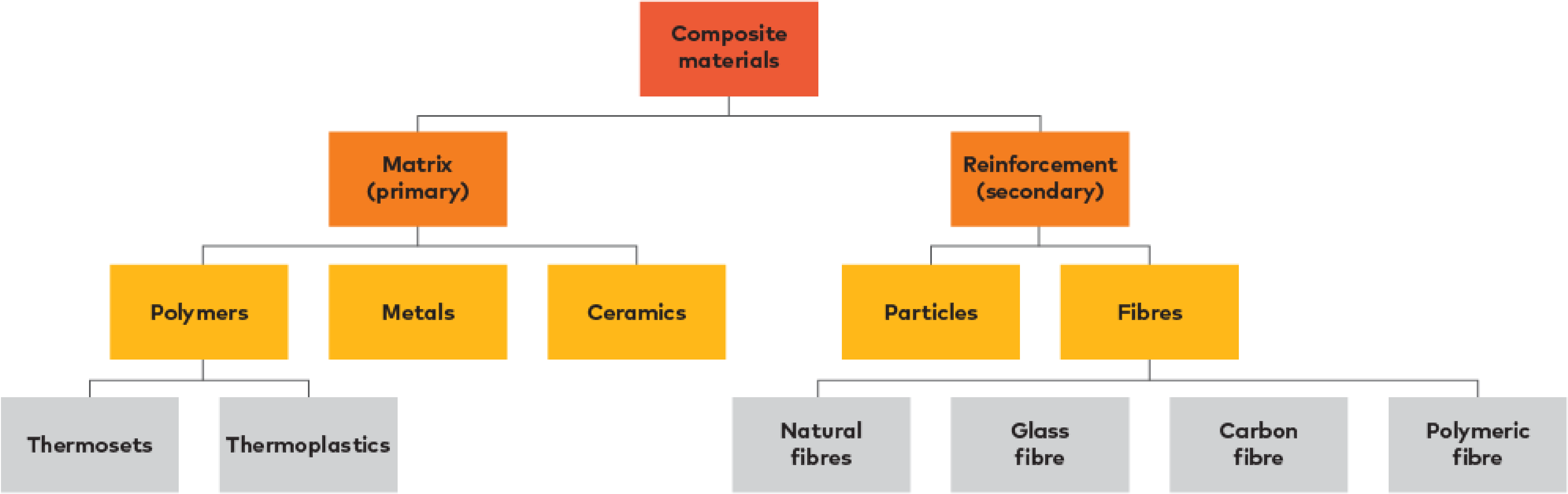






Many Materials in Recycled Polymer Composites Are Incompatible

Types of Composites Classified by Matrices and Reinforcements



RECYCLING is Complicated

In simple terms,

- There's Advanced Recycling using depolymerization and chemical techniques such as pyrolysis to remake virgin-like recycled polymers with known properties.

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- **There's Mechanical Recycling that relies on collecting, sorting, separating, cleaning, and size reduction of Post-Consumer Recycle to make a feedstock that is either baled, or granulated for making large parts such as furniture, or <u>worked off at low percentages</u> with virgin polymers.**

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- There's Mechanical Recycling that relies on collecting, sorting, separating, cleaning, and size reduction of Post Consumer Recycle to make a feedstock that is

- **There's Post-Industrial Mechanical Recycling that relies on large supplies of known materials employing maleated polymers or thermoplastic copolymers for compatibilization.**

RECYCLING is Complicated

https://www.plasticsindustry.org/sites/default/files/Compatibilizers%20Whitepaper%20%28Version%201.0%29_0.pdf

PLASTICS
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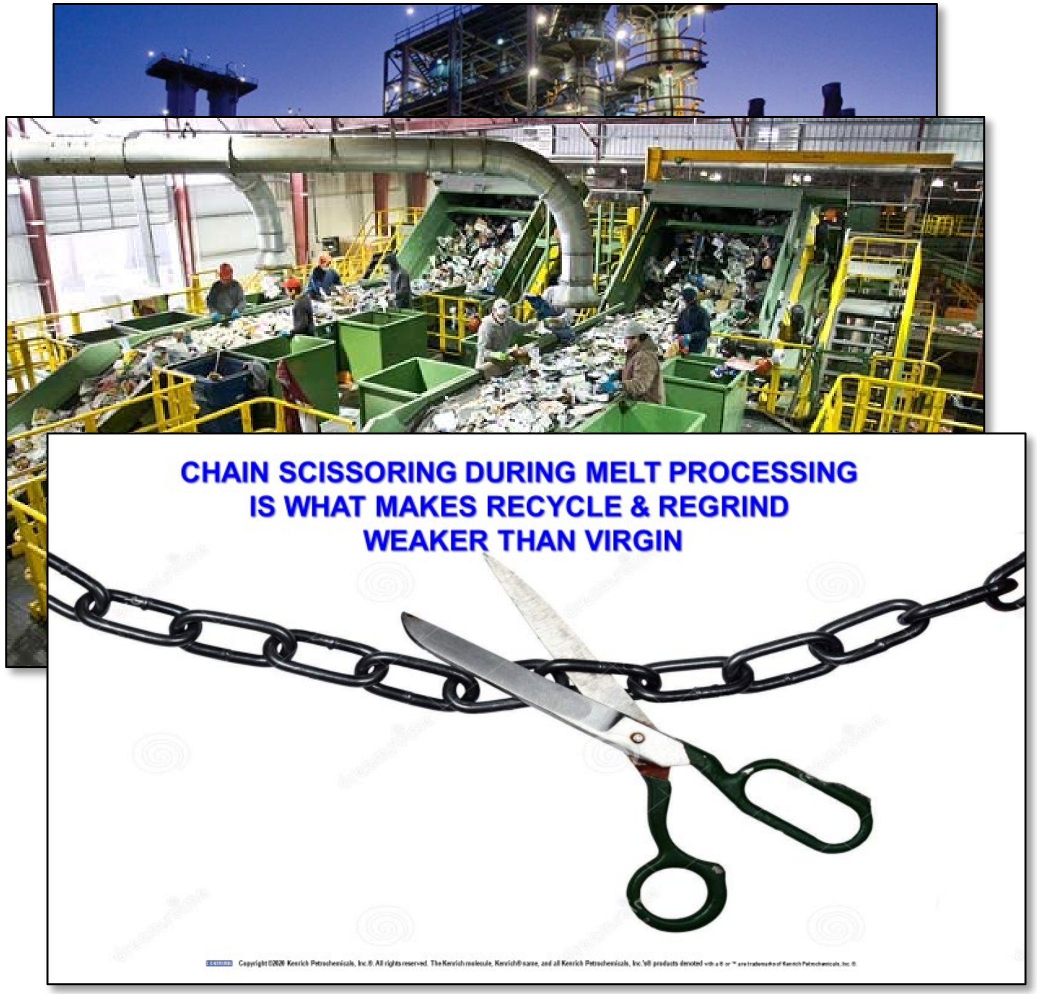
A PLASTICS Industry report dated May 2015 has a comprehensive listing of Compatibilizers based on Maleated Polymers & Thermoplastic Copolymers for Post-Industrial Recycle

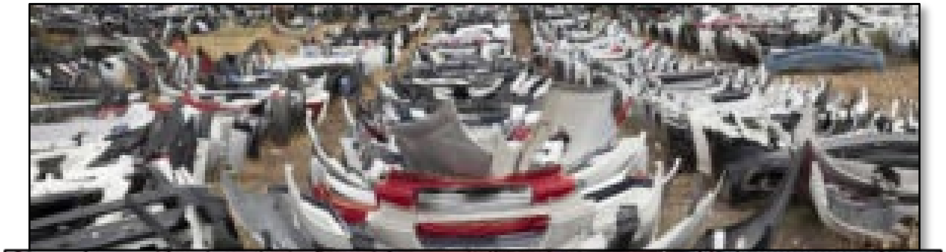

TPO Car Bumpers

RECYCLING is Complicated



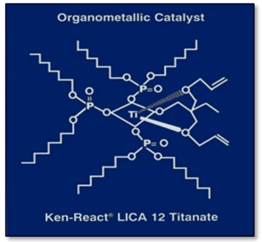
- There are many technical issues such as: intrinsic polymer incompatibility of addition polymers (olefins) and condensation (nylon, PC, PET) polymers; lower mechanical properties due to chain scissoring; negative impact property effects of uncoupled fillers; etc.

RECYCLING is made LESS Complicated



Monte offers Advanced Mechanical Recycling using titanium/aluminum chemistry of filler COUPLING and in situ polymer CATALYSIS in the polymer melt just as titanate catalysts are used to make Condensation polymers and the *Kaminski-Titanocene* and *Ziegler-Natta Ti-Al* catalysts used in the polymerization of Addition polymers.

Ti-Al pellet additive



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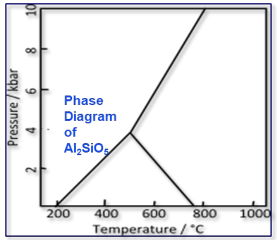
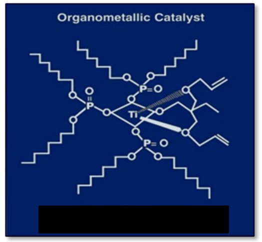


RECYCLING is made LESS Complicated

The rocket science reduces to adding the Ti-Al pellet additive at 1.50% to 1.75% by weight of all recycle materials and adjust mixing conditions such as 10% lowering of temps. to maintain reactive compounding shear.

Ti-Al pellet additive – Ken-React® CAPS® KPR® 12/LV



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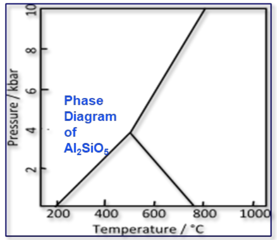

RECYCLING is made LESS Complicated

T-Al Catalyst
Synergistic with:
- **Copolymer Compatibilizers**
- **Maleic anhydride-PP**

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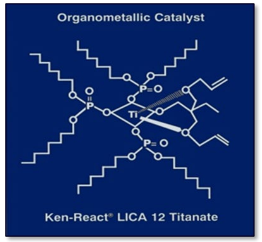

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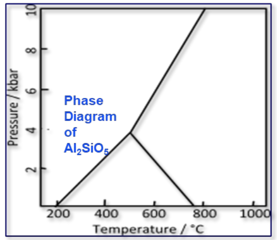

RECYCLING is made LESS Complicated

T-Al Catalyst Advantages
Synergistic with:
- **Copolymer Compatibilizers**

Use much less additive.
Less sorting.
- **Maleic anhydride-PP**

Does not Depolymerize PET

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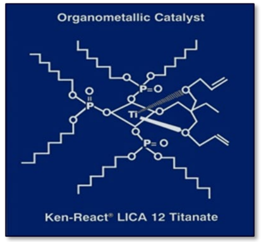

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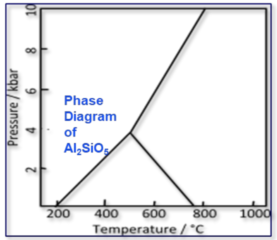

RECYCLING is Complicated – GOOGLE tried to wrap its arms around it:

Google Report: "Closing the Plastics Circularity Gap"

PLASTICS RECYCLING UPDATE
A Resource Recycling, Inc. publication

Google explores how to capture 4.5 billion tons of plastic

Published: August 18, 2021
Updated: August 18, 2021
by Colin Staub

Politopoulos Surname Origin, Me | Google explores how to capture

resource-recycling.com/plastics/2021/08/18/google-explores-how-to-capture-4-5-billion-tons-of-plastic/?utm_medium=email&utm_source=internal&utm_campaign=Jan+5+PRU

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RECYCLING is Complicated – GOOGLE tried to wrap its arms around it:

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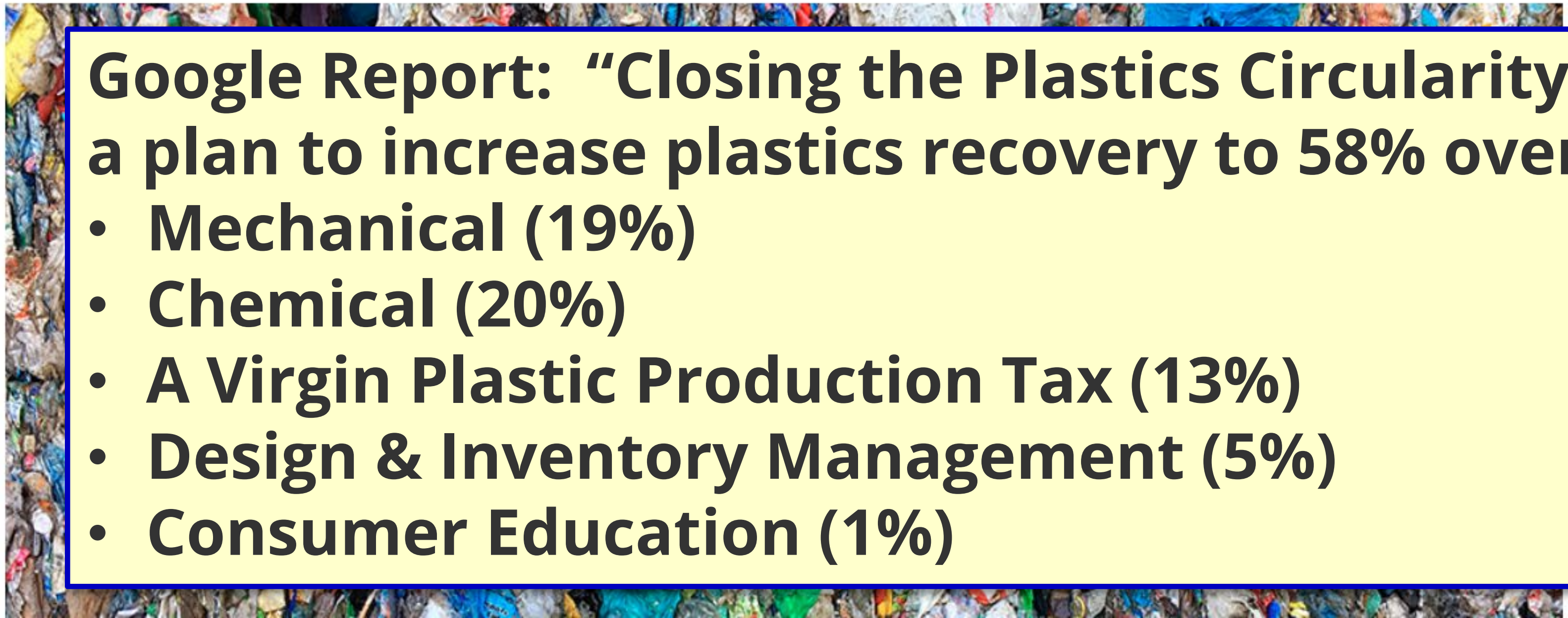
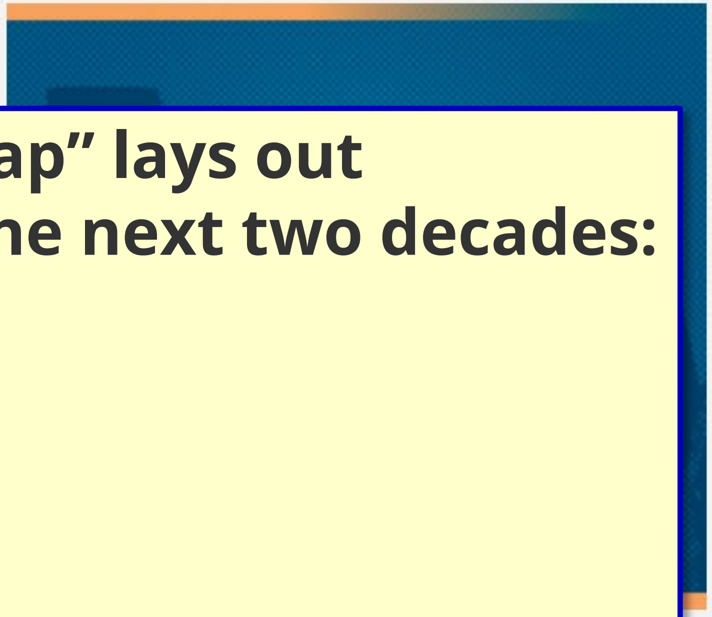


Google Report: "Closing the Plastics Circularity Gap" lays out a plan to increase plastics recovery to 58% over the next two decades:

- **Mechanical (19%)**
- **Chemical (20%)**
- **A Virgin Plastic Production Tax (13%)**
- **Design & Inventory Management (5%)**
- **Consumer Education (1%)**



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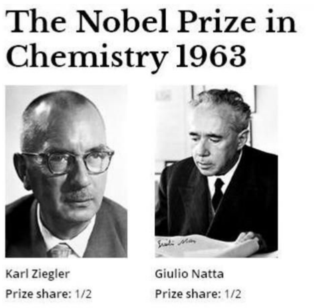
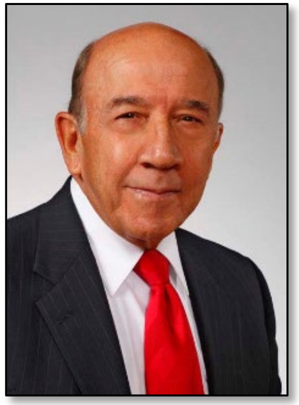
- **Consumer Education (1%)**

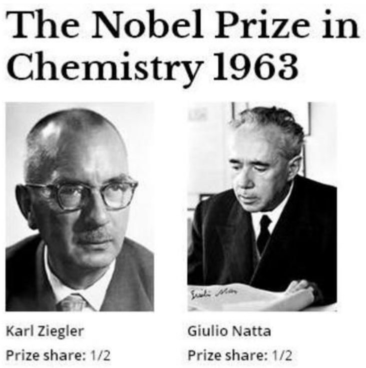
Advanced Solutions Are in Titanium & Aluminum Chemistry





- If Ziegler, Natta & Kaminisky used Titanium & Aluminum catalysts to produce Addition Polymers;
- If Titanate catalysts are used to produce Condensation Polymers;
- If heteroatom Titanate coupling agents compatibilize Fillers with Polymers;
- Why not use Titanate and Aluminum as a catalyst and coupling agent for compatibilizing the Fillers and Polymers (both Addition and Condensation) used in the Plastic to be Recycled.

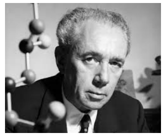
Advanced Solutions Are in Titanium & Aluminum Chemistry



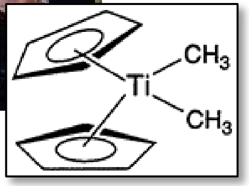
German **Karl Ziegler**, for his discovery of first **titanium-based catalysts**, and Italian **Giulio Natta**, for using them to prepare stereo regular polymers from **propylene**, were awarded the **Nobel Prize in Chemistry** in 1963.

Ziegler–Natta catalysts have been used in the commercial manufacture of various polyolefins since 1956.

- Ziegler showed a combination of $TiCl_4$ and $Al(C_2H_5)_2Cl$ useful for the production of polyethylene.



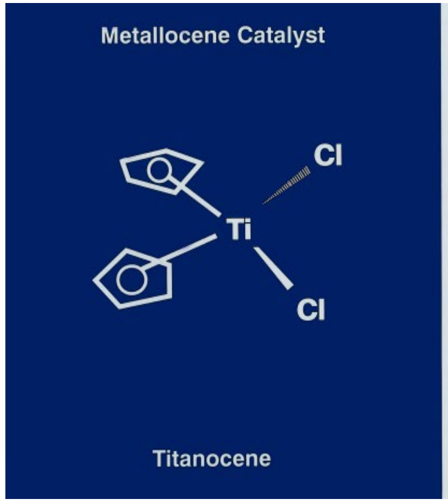
- Natta used crystalline α-$TiCl_3$ in combination with $Al(C_2H_5)_3$ to produce the first isotactic polypropylene.

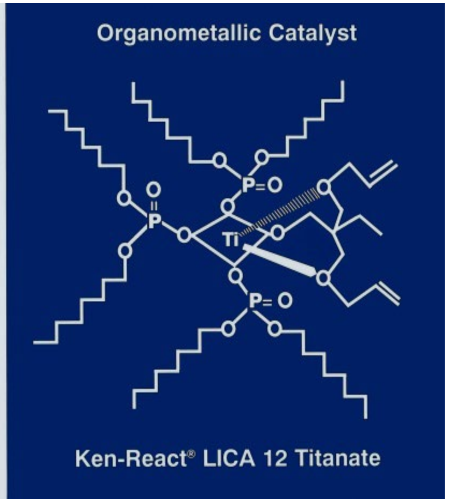


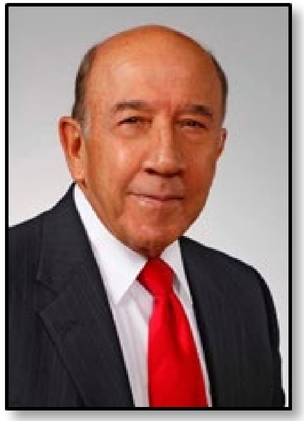
- Kaminsky discovered that titanocene and related complexes emulated some aspects of these **Ziegler-Natta catalysts** but with low activity.

He subsequently found that high activity could be achieved upon activation of these metallocenes with **methylaluminoxane** (MAO) −[O−Al(CH3)]n.

Titanium and Aluminum Additive Chemistry

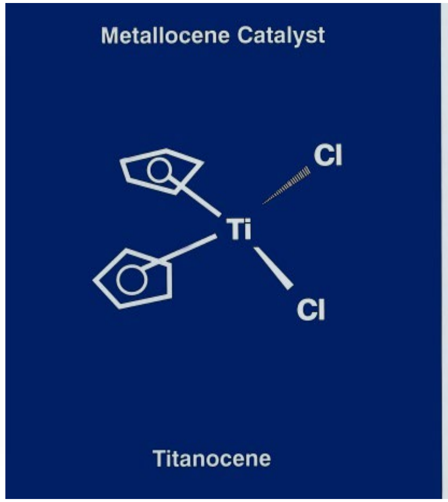


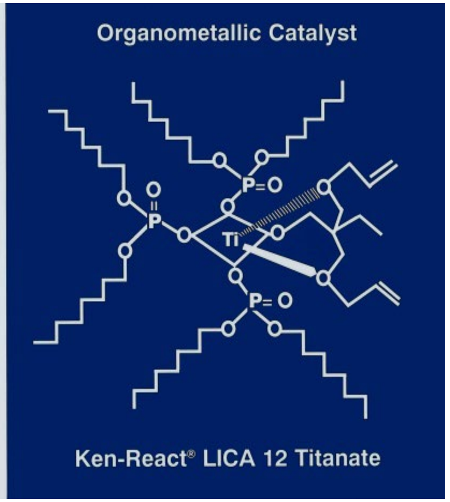


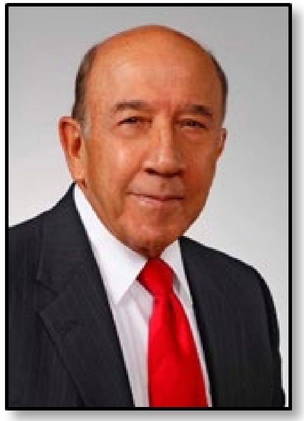


- **Monte uses Neoalkoxy Titanate in combination with Al_2SIO_5 mixed metal catalyst in Powder & Pellet forms for In Situ Macromolecular Repolymerization and Copolymerization in the melt – i.e. Polymer Compatibilization… AND … The Neoalkoxy Titanate proton coordinates with inorganic fillers and organic particulates to couple/compatibilize the dissimilar interfaces at the nano-atomic level reducing the need for expensive sorting of materials in Recycled Plastics.**

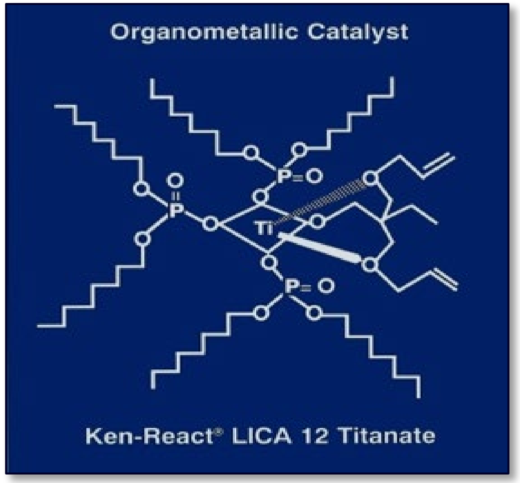
Kamininsky Titanocene – Monte Titanate







New Titanium and Aluminum Additive Chemistry



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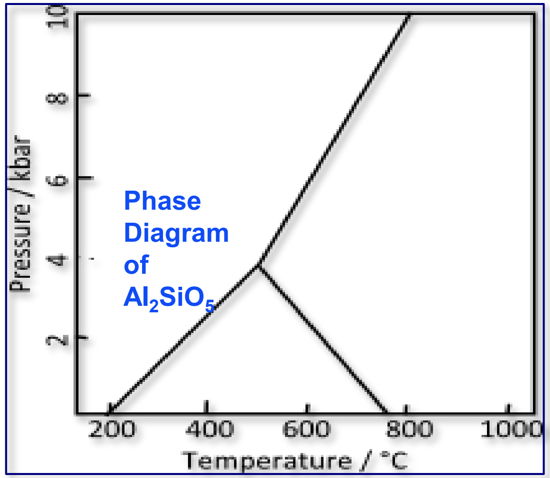
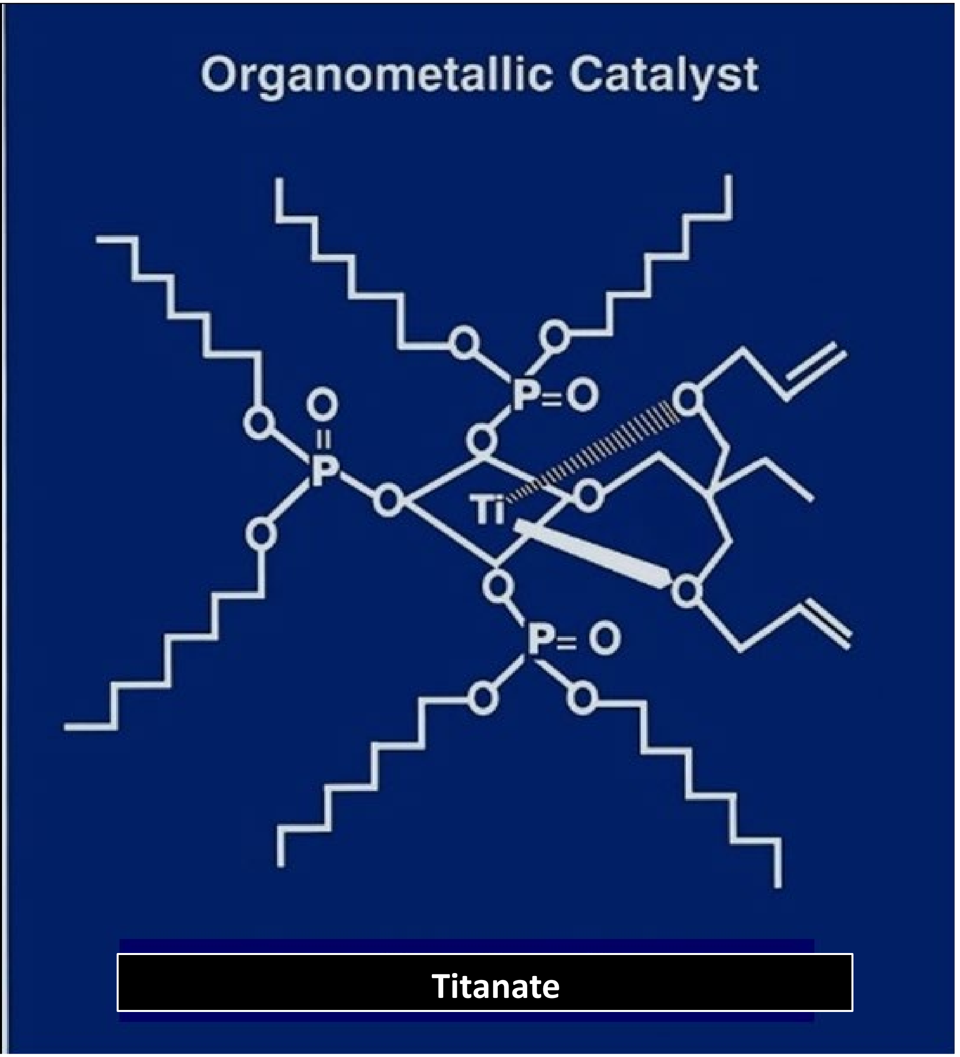


Introducing Titanium & Aluminum Additive Chemistry

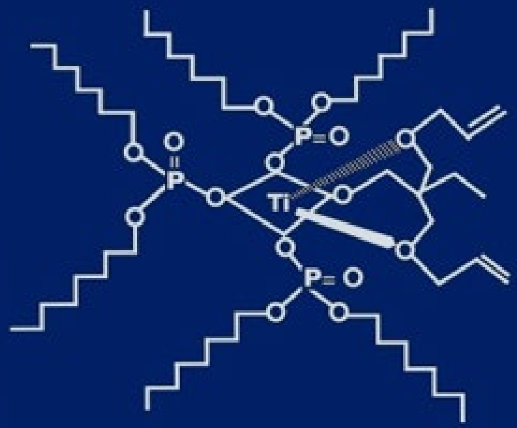
This
is
The
Titanium
Catalyst
Portion



Introducing Titanium & Aluminum Additive Chemistry

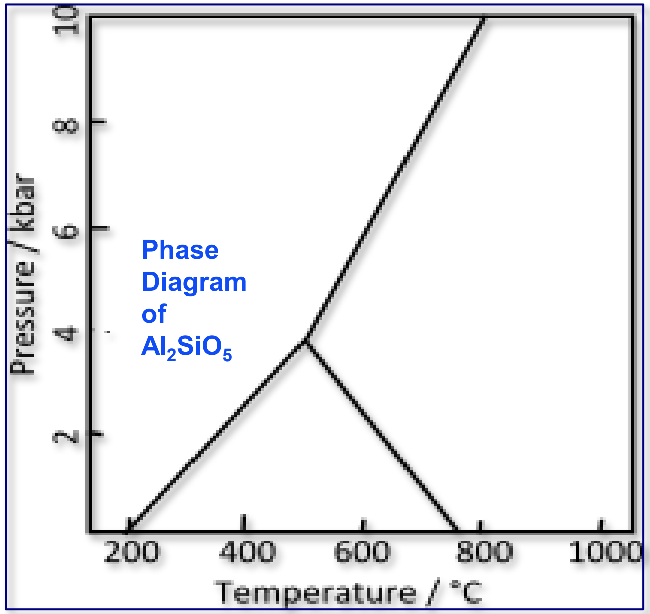
This is The Titanium Catalyst Portion

Organometallic Catalyst



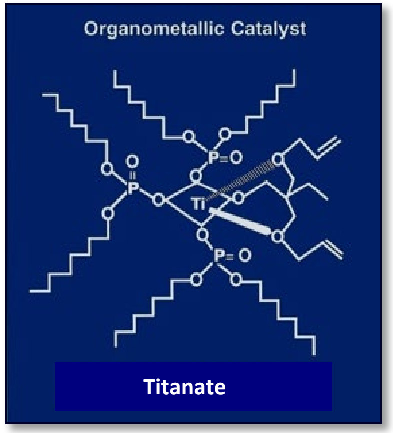
Ken-React® LICA 12 Titanate

+



This is The Mixed Metal Catalyst Portion

Ti/Al Additive



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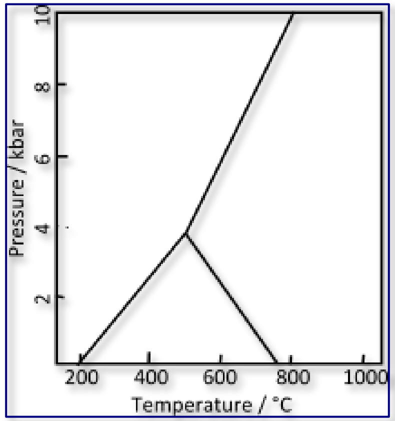

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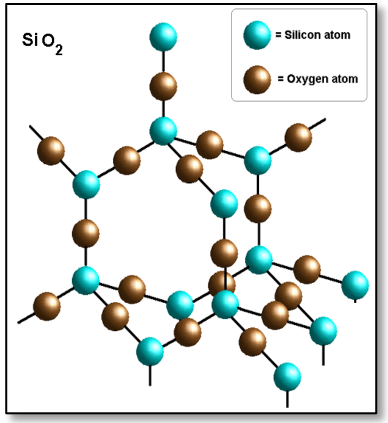

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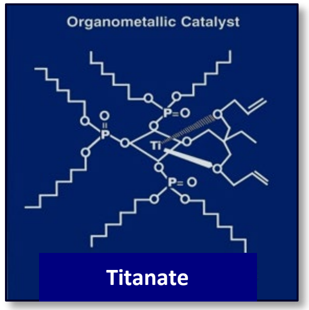
Ti/Al Additive

Advanced Solution Chemistry



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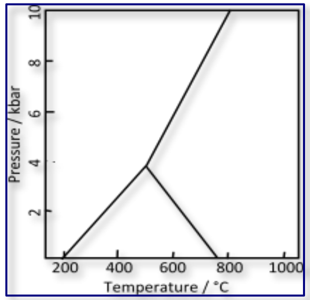

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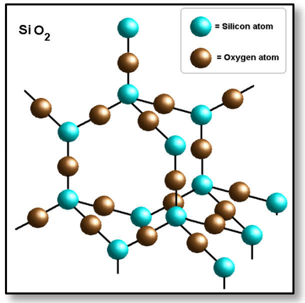

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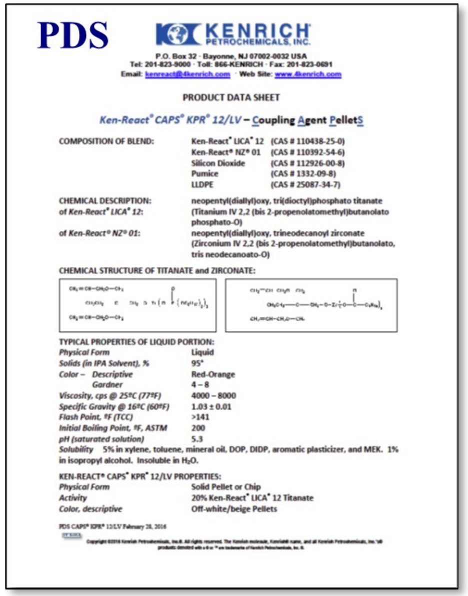
Ti/Al Additive

Monte uses Ti/Al in powder/pellet form to recycle PVC/Polymer compounds in the extruder melt.

Titanium/Aluminum Filler Coupling & Polymer Catalysis Additive for Mechanical Recycling of Polymers #1 to #7



PDS

KENRICH PETROCHEMICALS, INC.

P.O. Box 32 · Bayonne, NJ 07002-0032 USA
Tel: 201-823-9000 · Toll: 866-KENRICH · Fax: 201-823-0691
Email: kenreact@4kenrich.com · Web Site: www.4kenrich.com

PRODUCT DATA SHEET

Ken-React® CAPS® KPR® 12/LV – Coupling Agent PelletS

COMPOSITION OF BLEND:	Ken-React® LICA® 12	(CAS # 110438-25-0)
	Ken-React® NZ® 01	(CAS # 110392-54-6)
	Silicon Dioxide	(CAS # 112926-00-8)
	Pumice	(CAS # 1332-09-8)
	LLDPE	(CAS # 25087-34-7)

CHEMICAL DESCRIPTION:
of *Ken-React® LICA® 12*: neopentyl(diallyl)oxy, tri(dioctyl)phosphato titanate (Titanium IV 2,2 (bis 2-propenolatomethyl)butanolato phosphato-O)
of *Ken-React® NZ® 01*: neopentyl(diallyl)oxy, trineodecanoyl zirconate (Zirconium IV 2,2 (bis 2-propenolatomethyl)butanolato, tris neodecanoato-O)

CHEMICAL STRUCTURE OF TITANATE and ZIRCONATE:

TYPICAL PROPERTIES OF LIQUID PORTION:

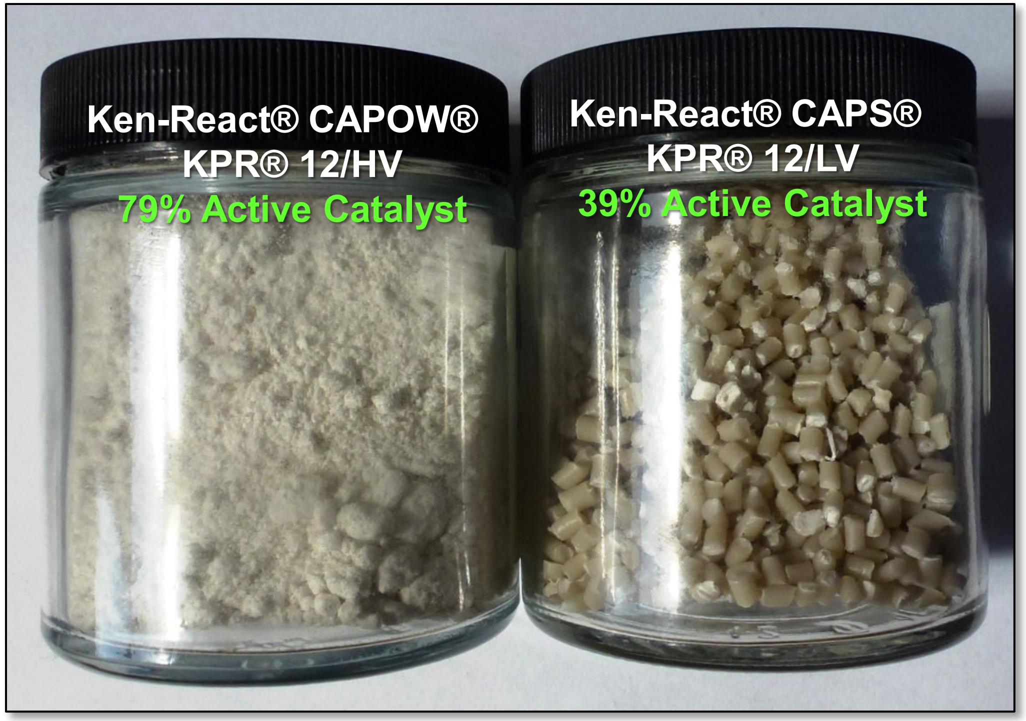
Physical Form	Liquid
Solids (in IPA Solvent), %	95*
Color – Descriptive	Red-Orange
Gardner	4 – 8
Viscosity, cps @ 25ºC (77ºF)	4000 – 8000
Specific Gravity @ 16ºC (60ºF)	1.03 ± 0.01
Flash Point, ºF (TCC)	>141
Initial Boiling Point, ºF, ASTM	200
pH (saturated solution)	5.3

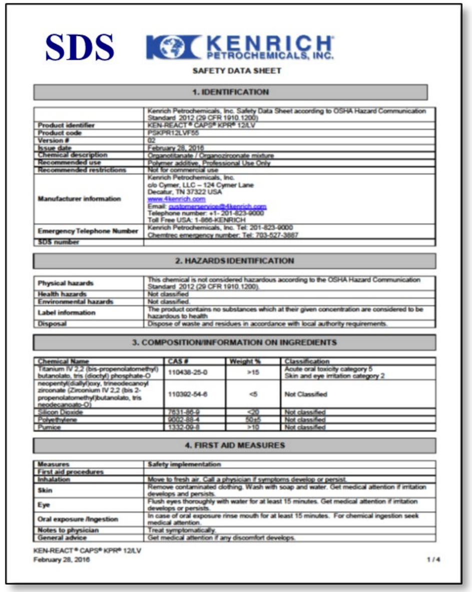
Solubility 5% in xylene, toluene, mineral oil, DOP, DIDP, aromatic plasticizer, and MEK. 1% in isopropyl alcohol. Insoluble in H_2O.

KEN-REACT® CAPS® KPR® 12/LV PROPERTIES:

Physical Form	Solid Pellet or Chip
Activity	20% Ken-React® LICA® 12 Titanate
Color, descriptive	Off-white/beige Pellets

PDS CAPS® KPR® 12/LV February 28, 2016





SDS

KENRICH PETROCHEMICALS, INC.

SAFETY DATA SHEET

1. IDENTIFICATION

	Kenrich Petrochemicals, Inc. Safety Data Sheet according to OSHA Hazard Communication Standard 2012 (29 CFR 1910.1200)
Product identifier	KEN-REACT® CAPS® KPR® 12/LV
Product code	PSKPR12LVF55
Version #	02
Issue date	February 28, 2016
Chemical description	Organotitanate / Organozirconate mixture
Recommended use	Polymer additive, Professional Use Only
Recommended restrictions	Not for commercial use
Manufacturer information	Kenrich Petrochemicals, Inc. c/o Cymer, LLC – 124 Cymer Lane Decatur, TN 37322 USA www.4kenrich.com Email: customerservice@4kenrich.com Telephone number: +1- 201-823-9000 Toll Free USA: 1-866-KENRICH
Emergency Telephone Number	Kenrich Petrochemicals, Inc. Tel: 201-823-9000 Chemtrec emergency number: Tel: 703-527-3887
SDS number	

2. HAZARDS IDENTIFICATION

Physical hazards	This chemical is not considered hazardous according to the OSHA Hazard Communication Standard 2012 (29 CFR 1910.1200).
Health hazards	Not classified
Environmental hazards	Not classified.
Label information	The product contains no substances which at their given concentration are considered to be hazardous to health
Disposal	Dispose of waste and residues in accordance with local authority requirements.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS #	Weight %	Classification
Titanium IV 2,2 (bis-propenolatomethyl) butanolato, tris (dioctyl) phosphate-O	110438-25-0	>15	Acute oral toxicity category 5 Skin and eye irritation category 2
neopentyl(diallyl)oxy, trineodecanoyl zirconate (Zirconium IV 2,2 (bis 2-propenolatomethyl)butanolato, tris neodecanoato-O)	110392-54-6	<5	Not Classified
Silicon Dioxide	7631-86-9	<20	Not classified
Polyethylene	9002-88-4	50±5	Not classified
Pumice	1332-09-8	>10	Not classified

4. FIRST AID MEASURES

Measures	Safety implementation
First aid procedures	
Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin	Remove contaminated clothing. Wash with soap and water. Get medical attention if irritation develops and persists.
Eye	Flush eyes thoroughly with water for at least 15 minutes. Get medical attention if irritation develops or persists.
Oral exposure /Ingestion	In case of oral exposure rinse mouth for at least 15 minutes. For chemical ingestion seek medical attention.
Notes to physician	Treat symptomatically.
General advice	Get medical attention if any discomfort develops.

KEN-REACT® CAPS® KPR® 12/LV
February 28, 2016 1/4

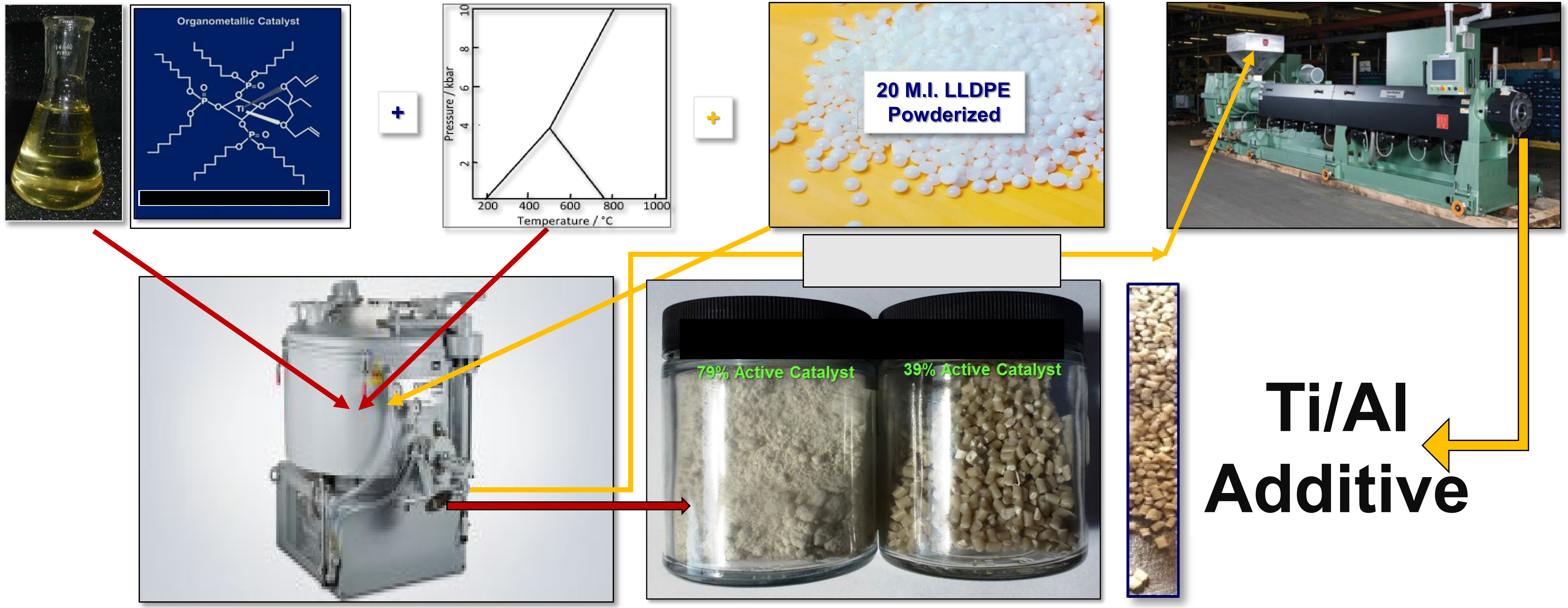
1961 to 2015
Products made in Bayonne, NJ

2015 to Now
Products made in Decatur & Dayton, TN

Cymer-Dayton Facility - 411 Manufactures Road, Dayton, TN

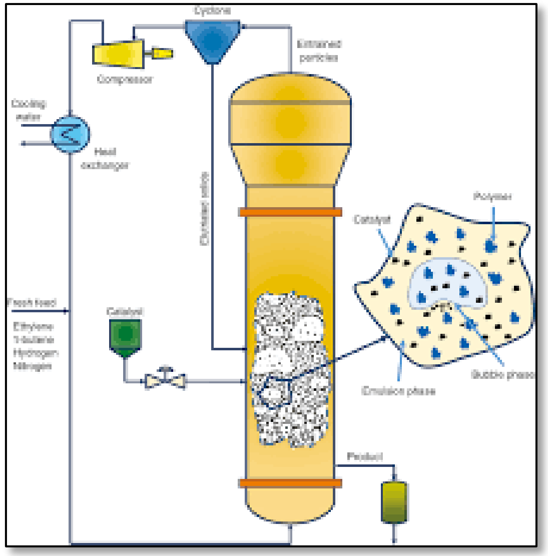
Cymer,LLC Decatur Facility – 124 Cymer Lane,Decatur, TN

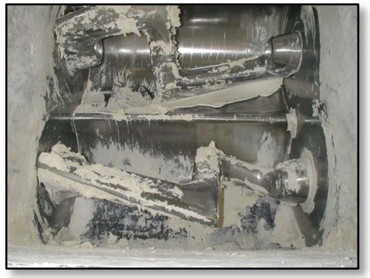
Pellet masterbatches of neoalkoxy titanate/mixed metal catalyst are added at the extruder hopper like a color concentrate – or Compounders use a powder masterbatch

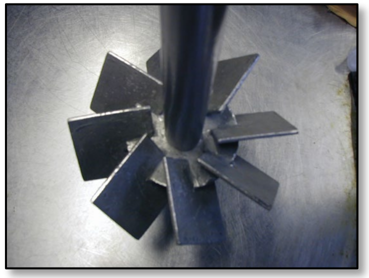


Reactor
Titanocene Polymerization – Ethylene Monomer

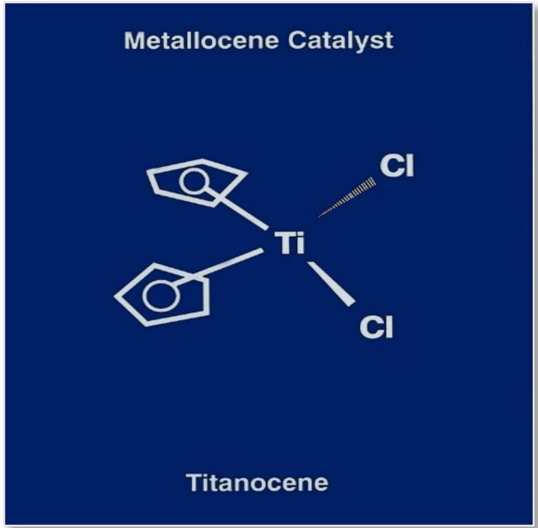
Extruder – 2-Arm – Planetary – Cowles
Titanate Repolymerization – Polymers #1 to #7

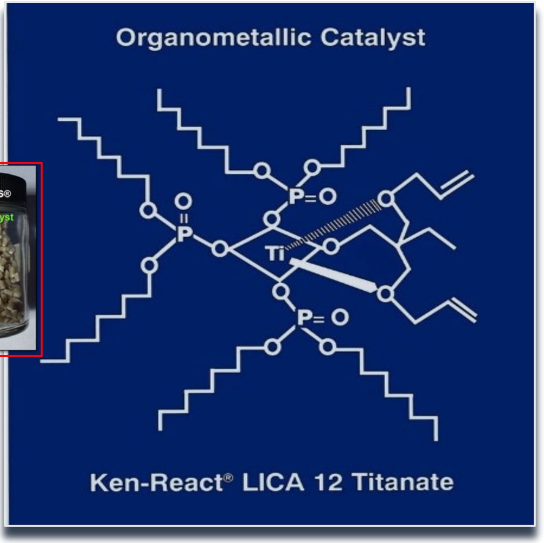






Titanocene:
Monomer to Polymer



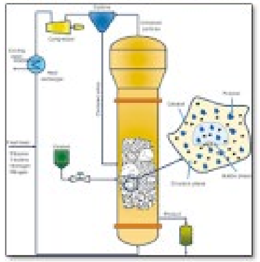


Titanate:
Recycle to Re-Polymer

50-Year Evolution of Subject Ti-Al Nano-Technology

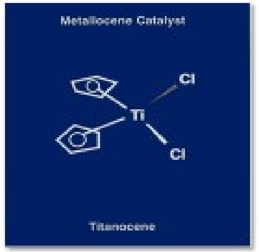
SIX FUNCTIONS

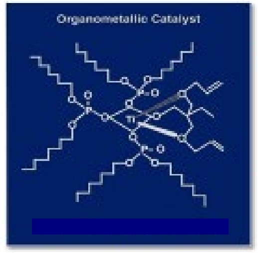
Reactor
Titanocene Polymerization – Ethylene Monomer



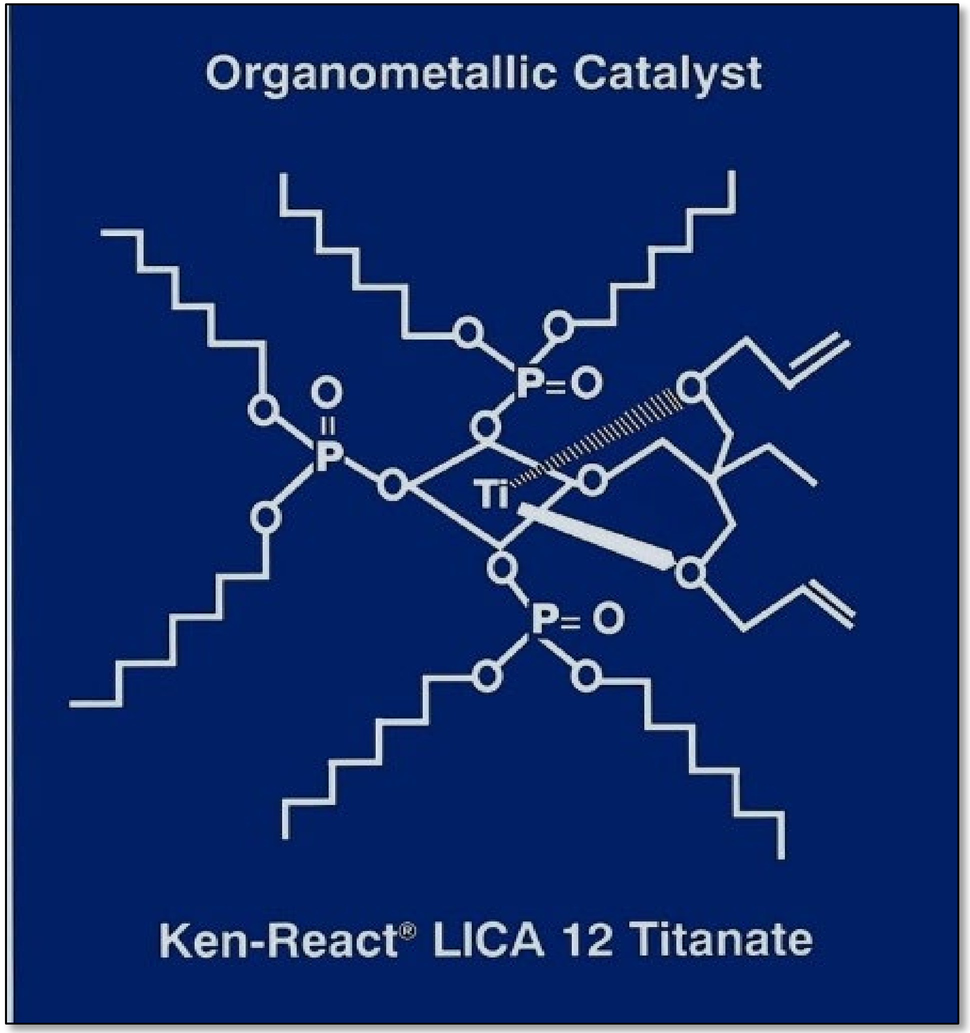
Extruder
Titanate Repolymerization – Ethylene Polymers

Monomer to Polymer





Recycle to Copolymer

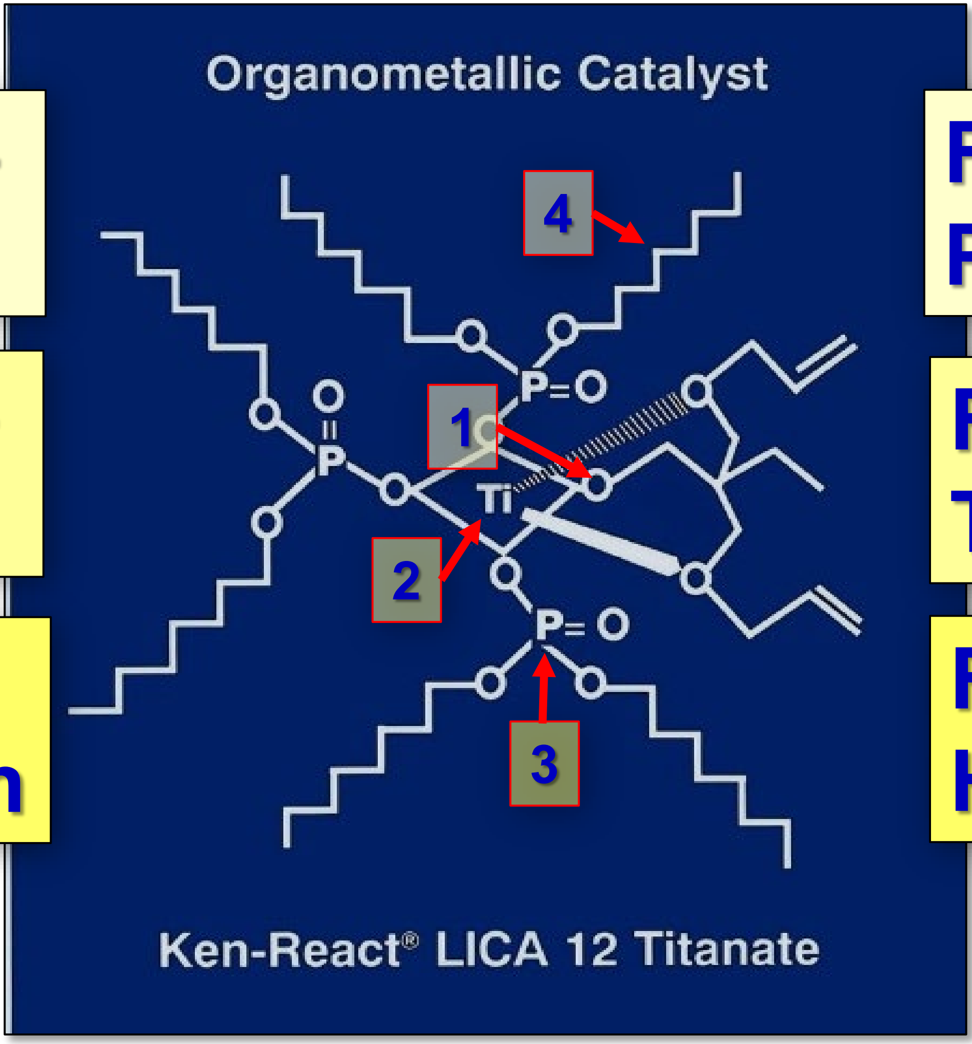


SIX FUNCTIONS

Function 1 – Coupling

Function 2 – Catalysis

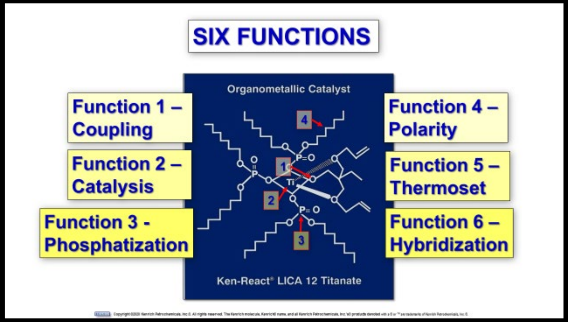
Function 3 - Phosphatization



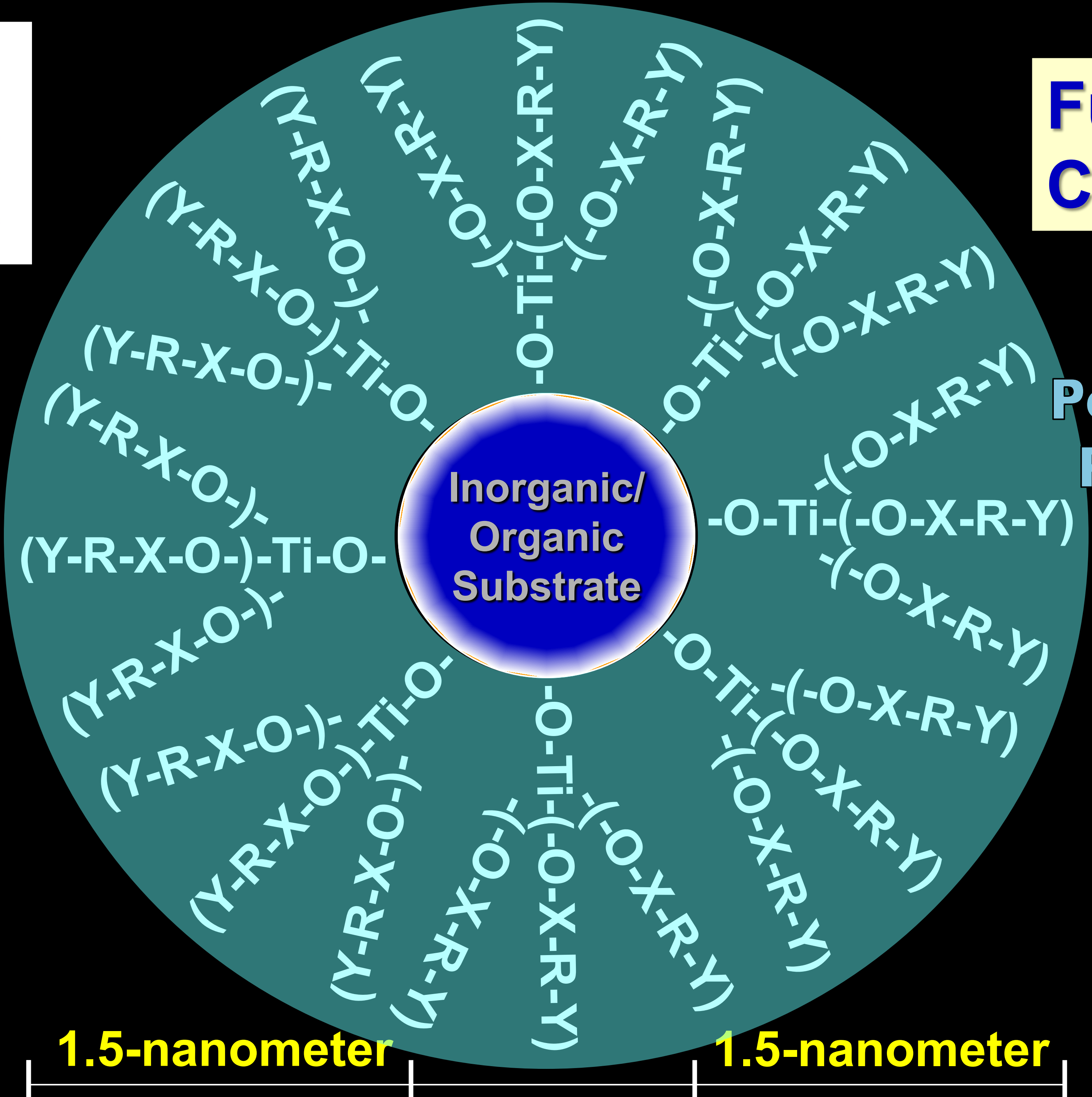
Function 4 – Polarity

Function 5 – Thermoset

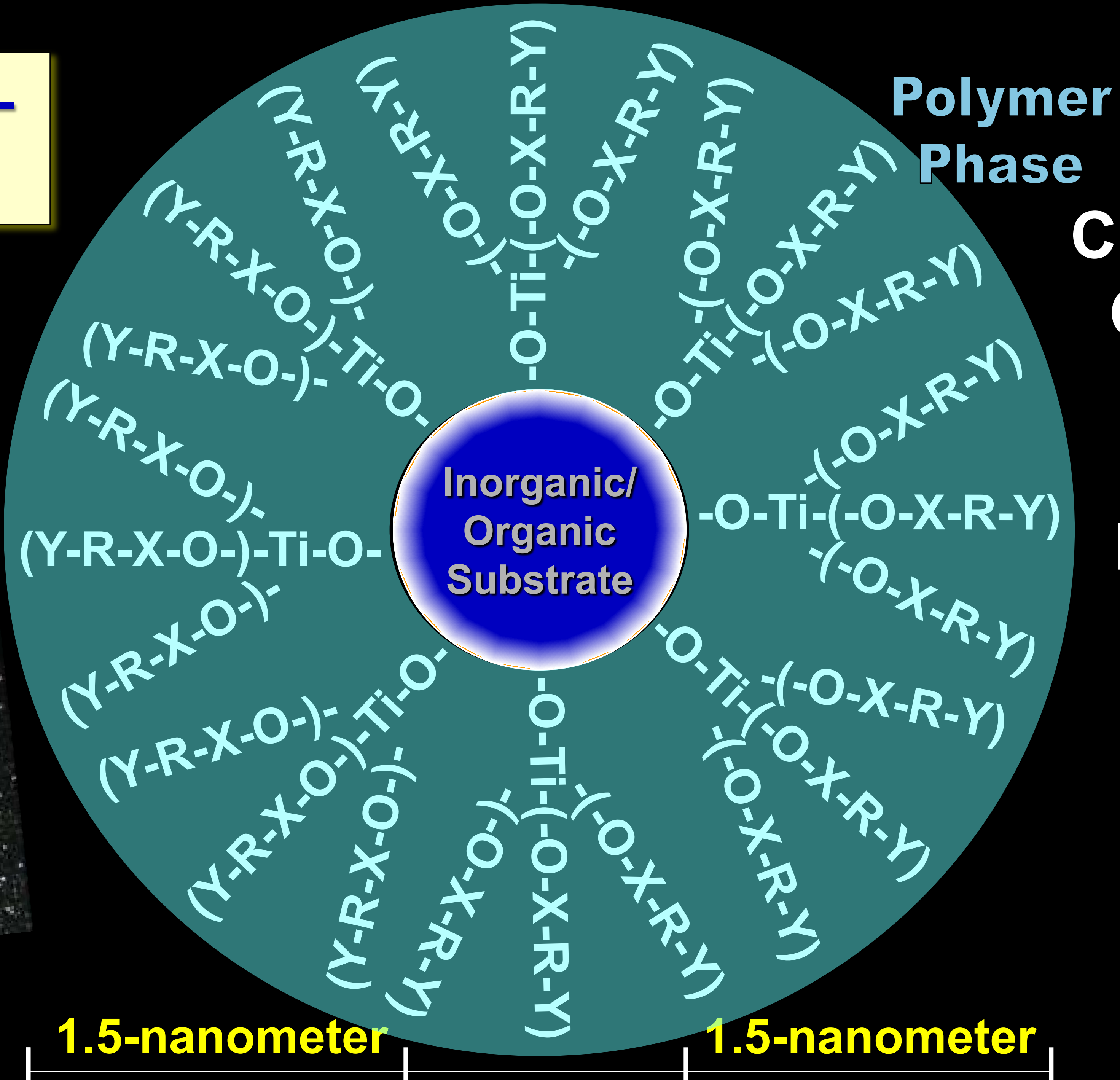
Function 6 – Hybridization



Function 1 – Coupling

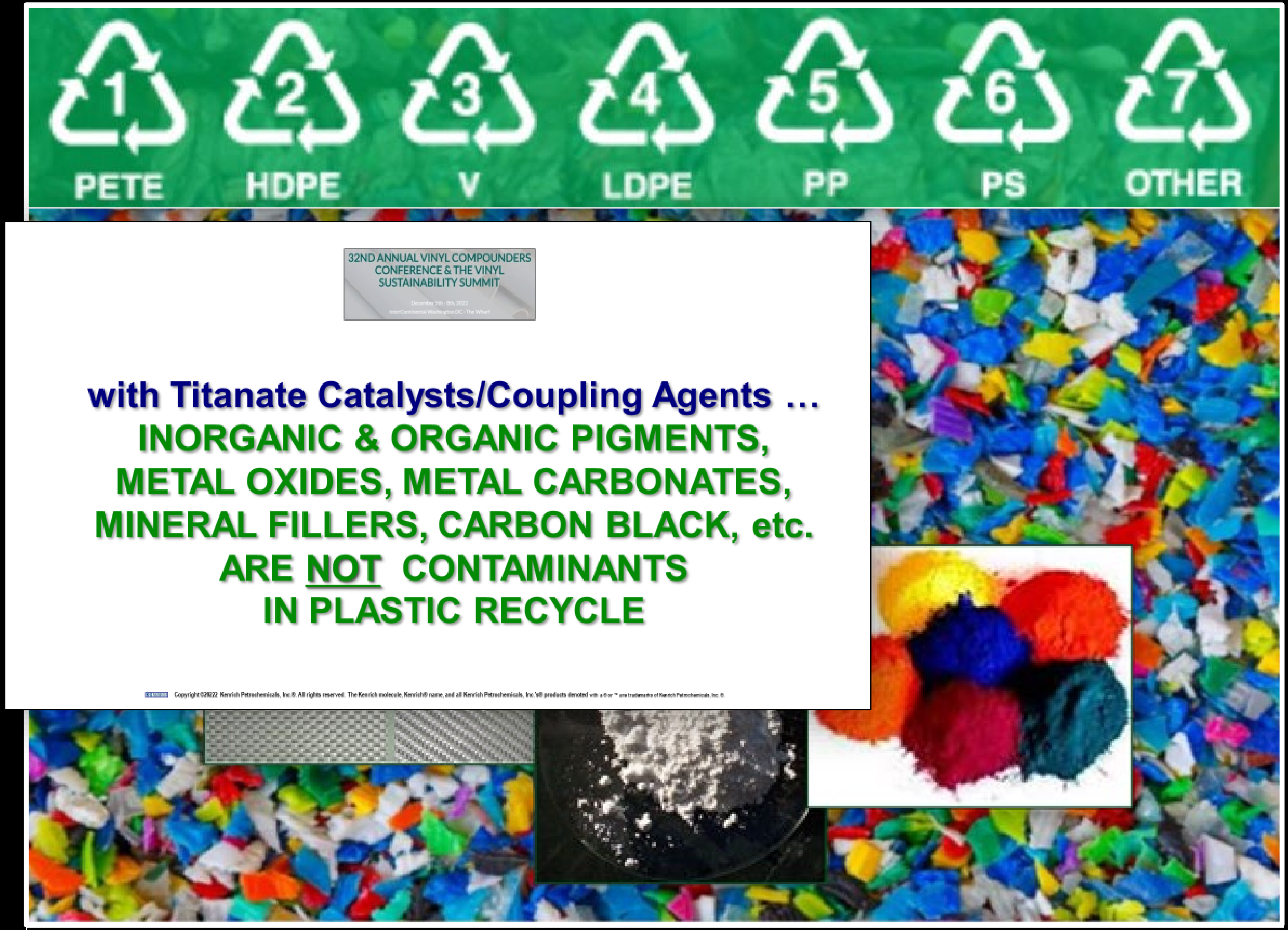


Function 1 – Coupling



Recycled Compounds Contain A Mixed Bag of Polymers & Inorganic and Organic Materials

Recycled Compounds Contain A Mixed Bag of Polymers & Inorganic and Organic Materials



Recycled Compounds Contain A Mixed Bag of Polymers & Inorganic and Organic Materials

Recycle Mix: Polymers #1 to #7 & Fillers, Fibers, Pigments, etc.

PE & PP are ADDITION POLYMERS

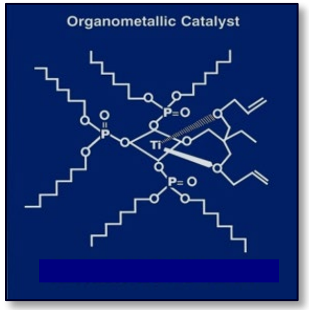
PET is a CONDENSATION POLYMER

Incompatibility PE & PP

Incompatibility PET & PE

THE FILLER INTERFACE – Function 1 COUPLING

Advanced Solution Chemistry



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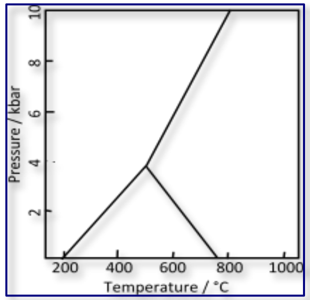

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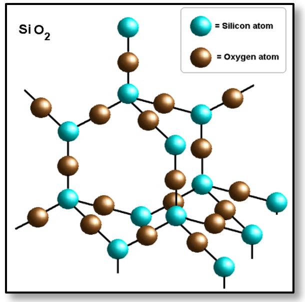

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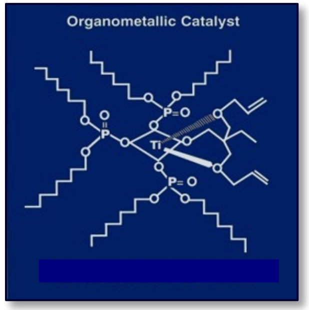
Ken-React®
CAPS®
KPR® 12/LV

THE POLYMER INTERFACE – Function 2 CATALYSIS

Advanced Solution Chemistry



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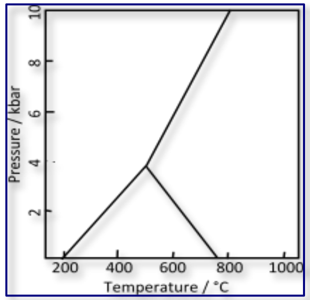

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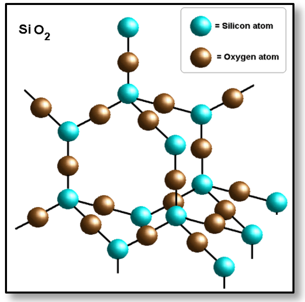

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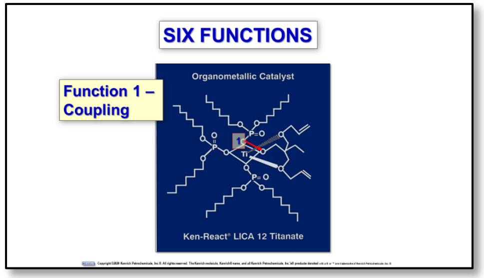
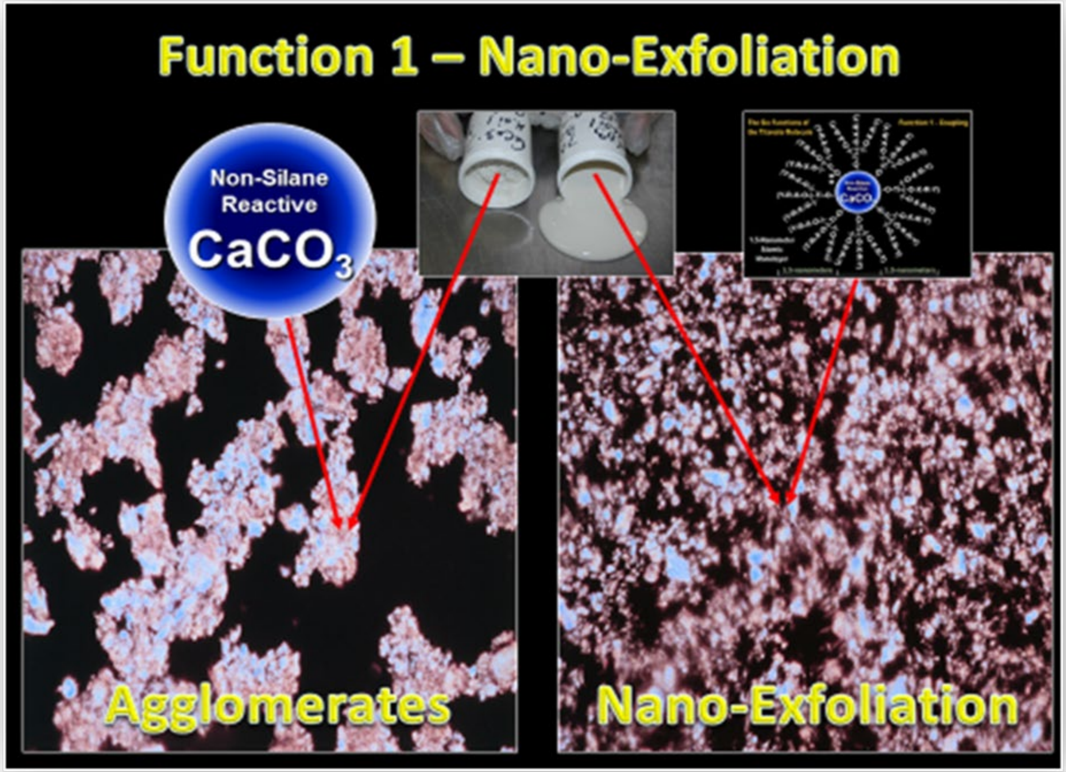
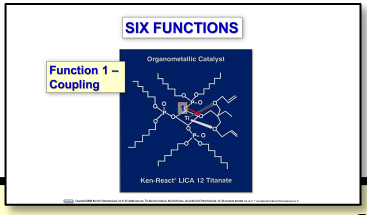
CAPS®
KPR® 12/LV



THE FILLER INTERFACE

(1) Couple *in situ* via proton coordination to all fillers, pigments and organics– from CaCO3 to Carbon to AZO:





Function 1 Coupling: NO HYDROLYSIS – NO WATER needed – COUPLES IN THE MELT: Enables the Extruder as a Polymerization Reactor for Organometallic Coupling & Catalyzing Recycled Polymers

Unlike Silanes – Titanates Couple to ALL Inorganics & Organics in Nano-Atomic Monolayers

Fillers & Organics are no longer contaminants to be sorted out before recycle.

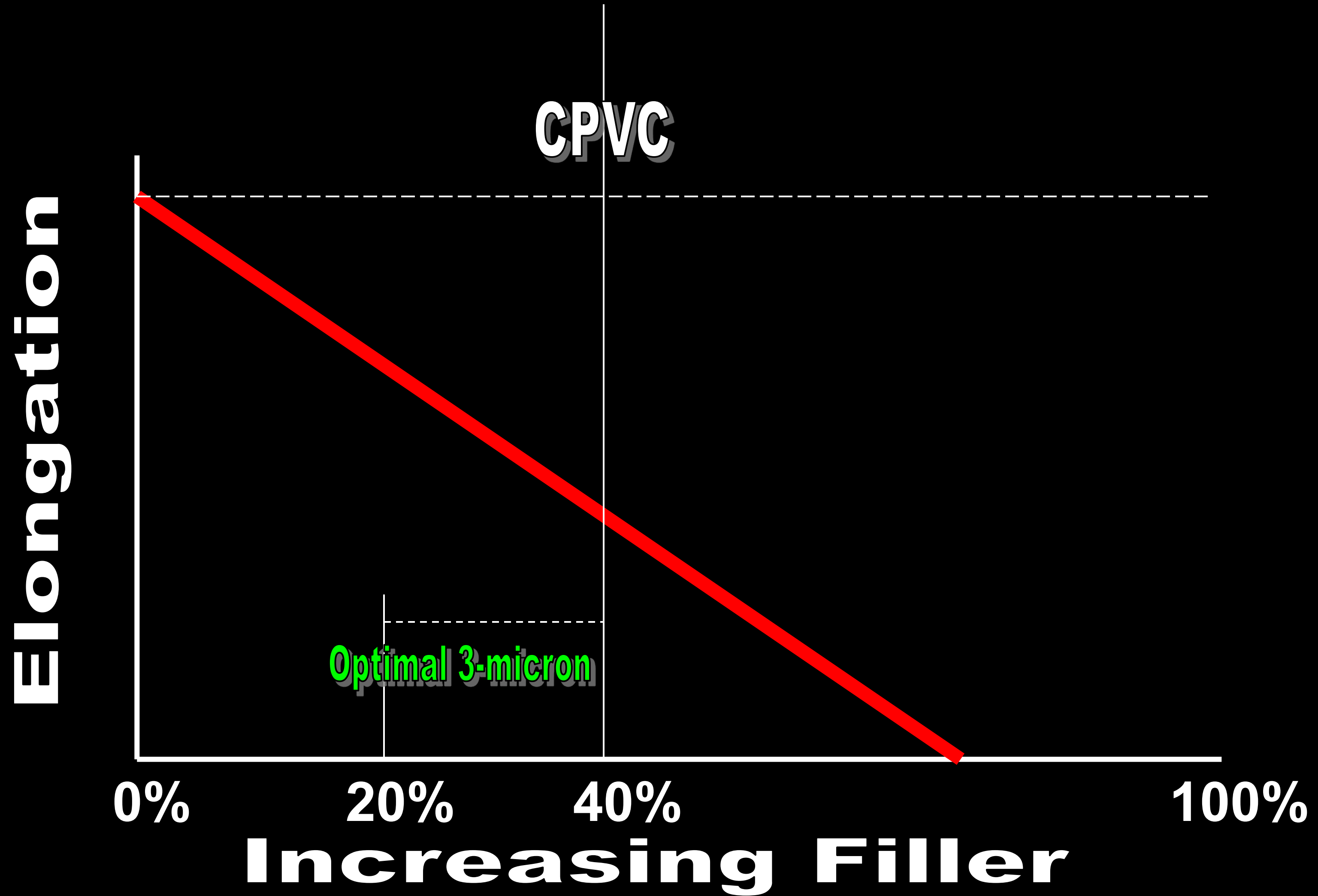
Sustainable

CaCO3 is added to the recycled PET fiber for carpet wearability/heft

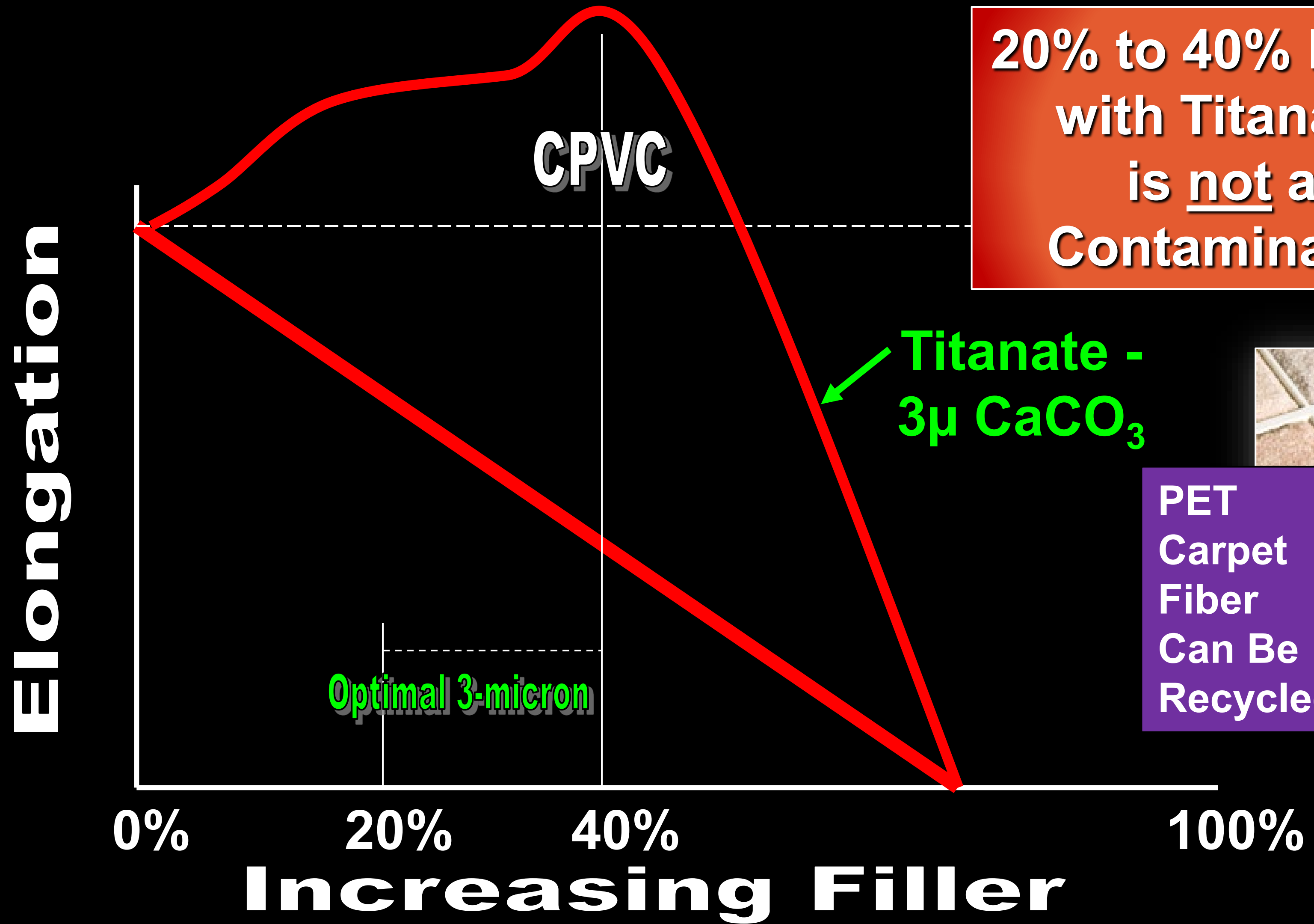
Only 2% of PET Carpet Fiber Is Recycled Due To CaCO3

Unsustainable

TITANATE Function 1 Coupling & Function 2 Catalysis
Elongation - Shift in Critical Pigment Volume Concentration Point



TITANATE Function 1 Coupling & Function 2 Catalysis
Elongation - Shift in Critical Pigment Volume Concentration Point

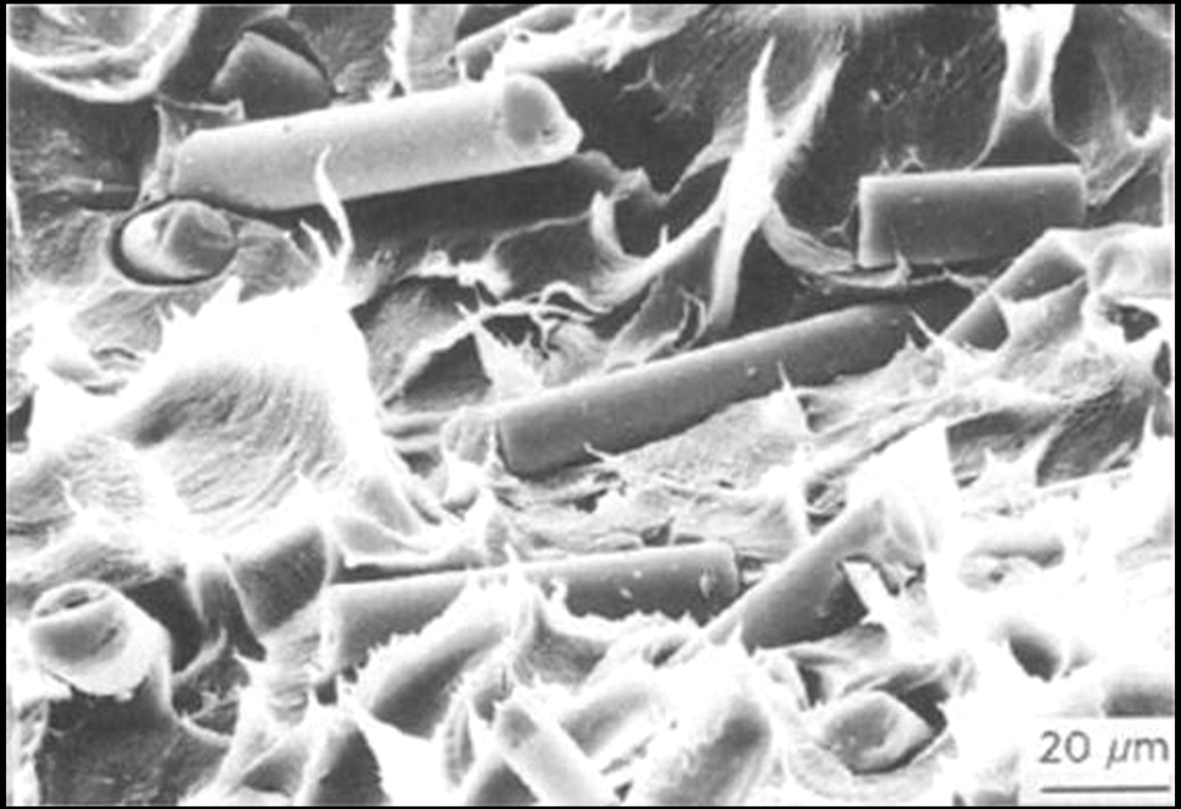


20% to 40% Filler with Titanate is <u>not</u> a Contaminant.

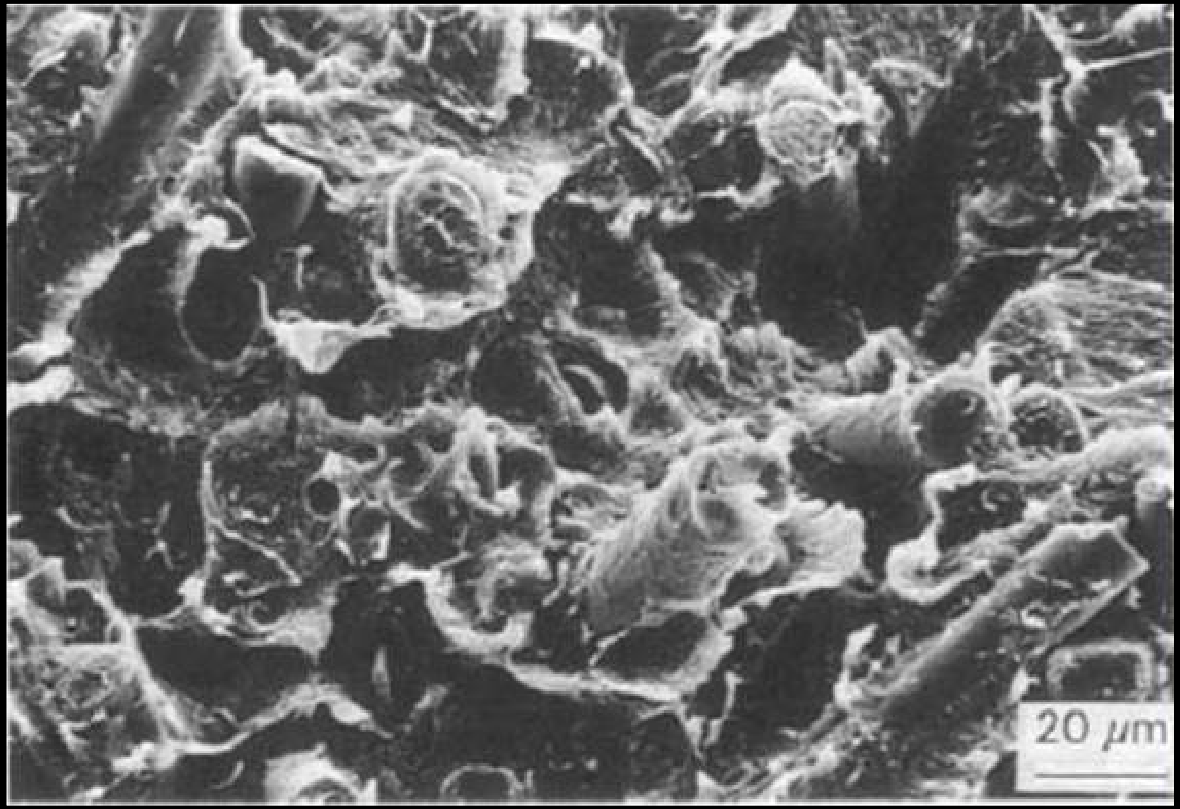
PET Carpet Fiber Can Be Recycled

Titanates and Zirconates – They Are Different Than Silanes

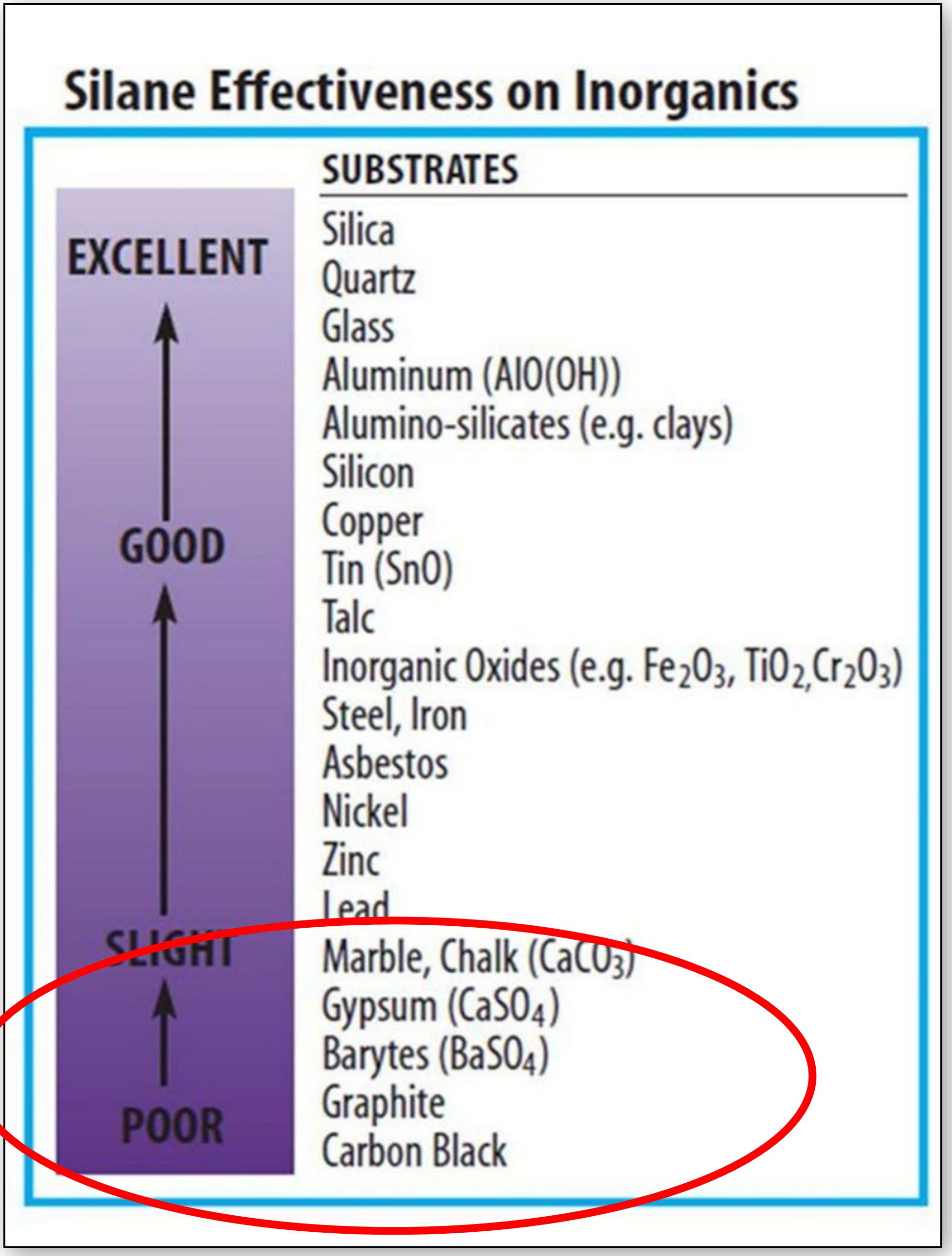
E-Glass Fiber/ETFE (Ethylene TetraFluoroEthylene)
ETFE (think Teflon®) is extremely non-polar



No Zirconate: Silane Sized E-Glass Fiber/ETFE (Ethylene TetraFluoroEthylene)



With Zirconate: Silane Sized E-Glass Fiber/ETFE (Ethylene TetraFluoroEthylene)


Silane Effectiveness on Inorganics
SUBSTRATES
EXCELLENT
GOOD
SLIGHT
POOR
Silica
Quartz
Glass
Aluminum (AlO(OH))
Alumino-silicates (e.g. clays)
Silicon
Copper
Tin (SnO)
Talc
Inorganic Oxides (e.g. Fe_2O_3, TiO_2, Cr_2O_3)
Steel, Iron
Asbestos
Nickel
Zinc
Lead
Marble, Chalk ($CaCO_3$)
Gypsum ($CaSO_4$)
Barytes ($BaSO_4$)
Graphite
Carbon Black


A Silane Recycle Mindset:
Most fillers are contaminants
Not True with Titanates:
Fillers such as BaSO4
are not contaminants

Silane Effectiveness on Inorganics

	SUBSTRATES
EXCELLENT	Silica
	Quartz
	Glass
	Aluminum (AlO(OH))
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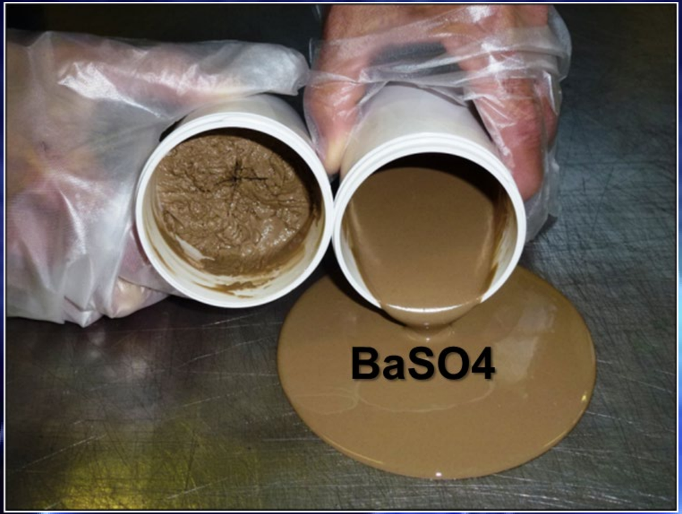
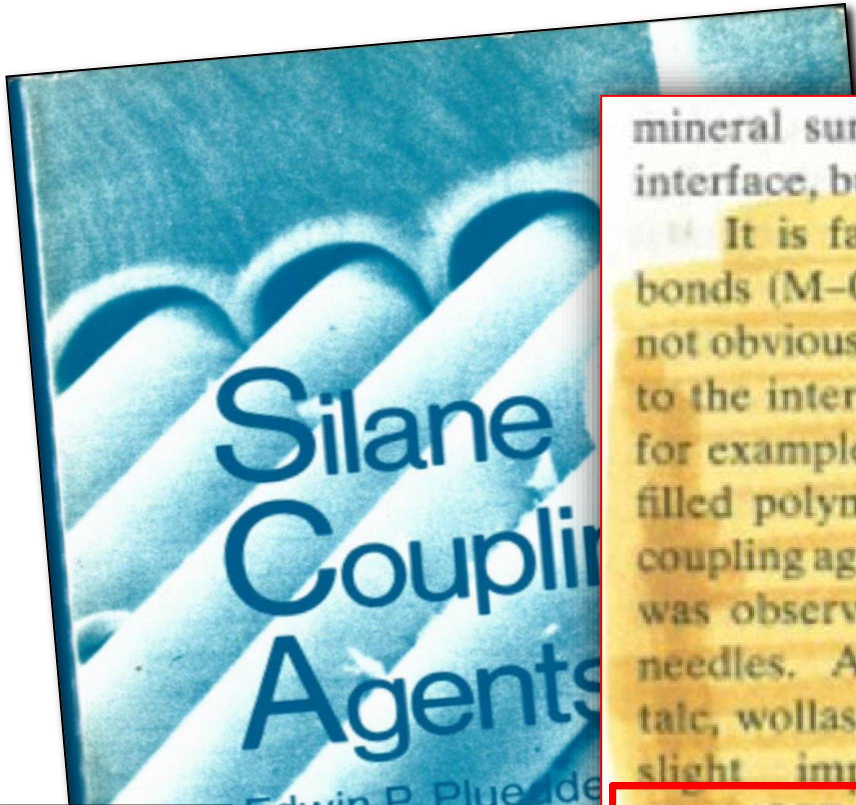
POOR	Graphite
	Carbon Black

A Silane Recycle Mindset: Most fillers are contaminants



Not True with Titanates: Fillers such as BaSO4 are not contaminants

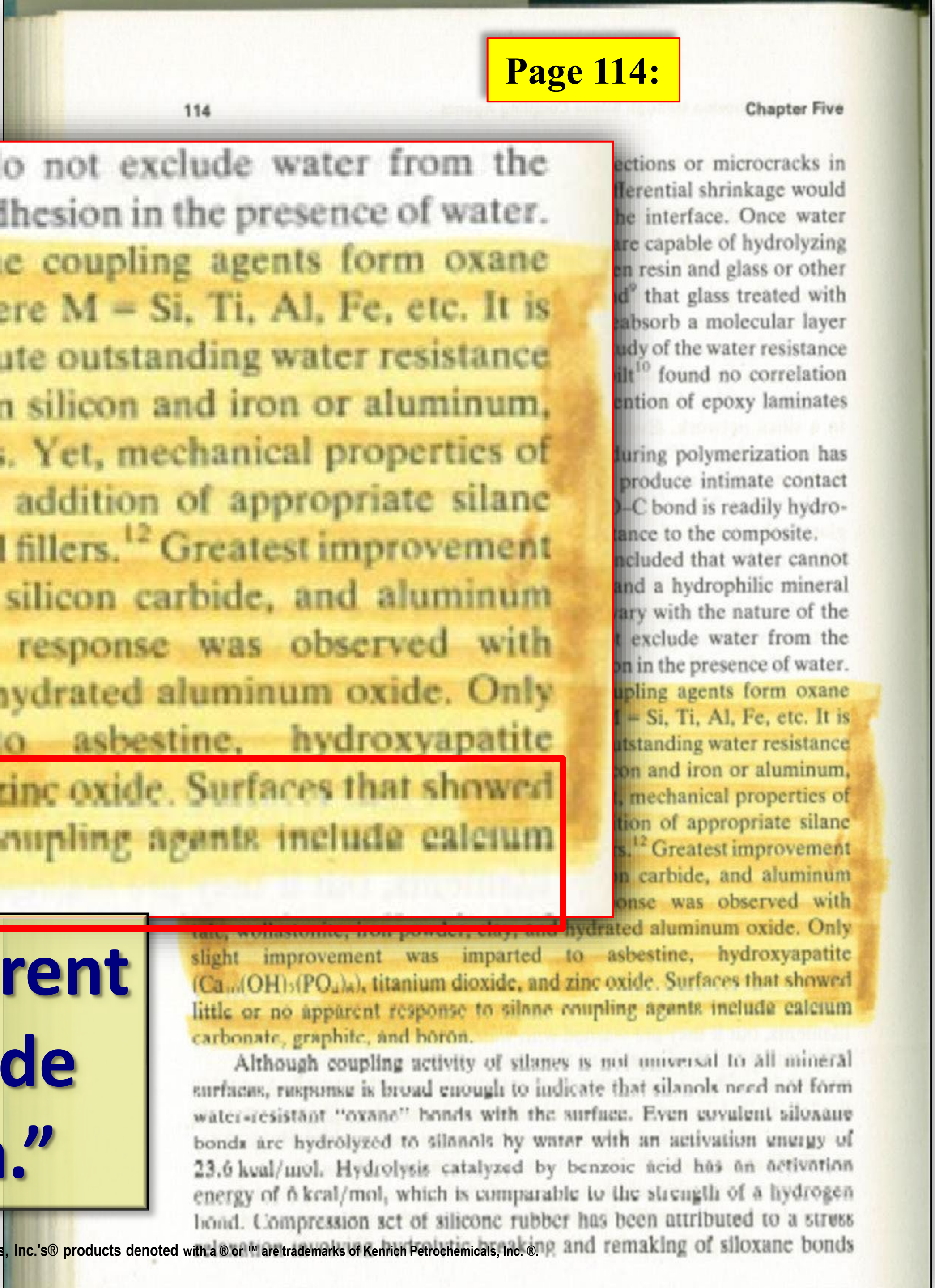


mineral surface. Silane coupling agents do not exclude water from the interface, but somehow function to retain adhesion in the presence of water.

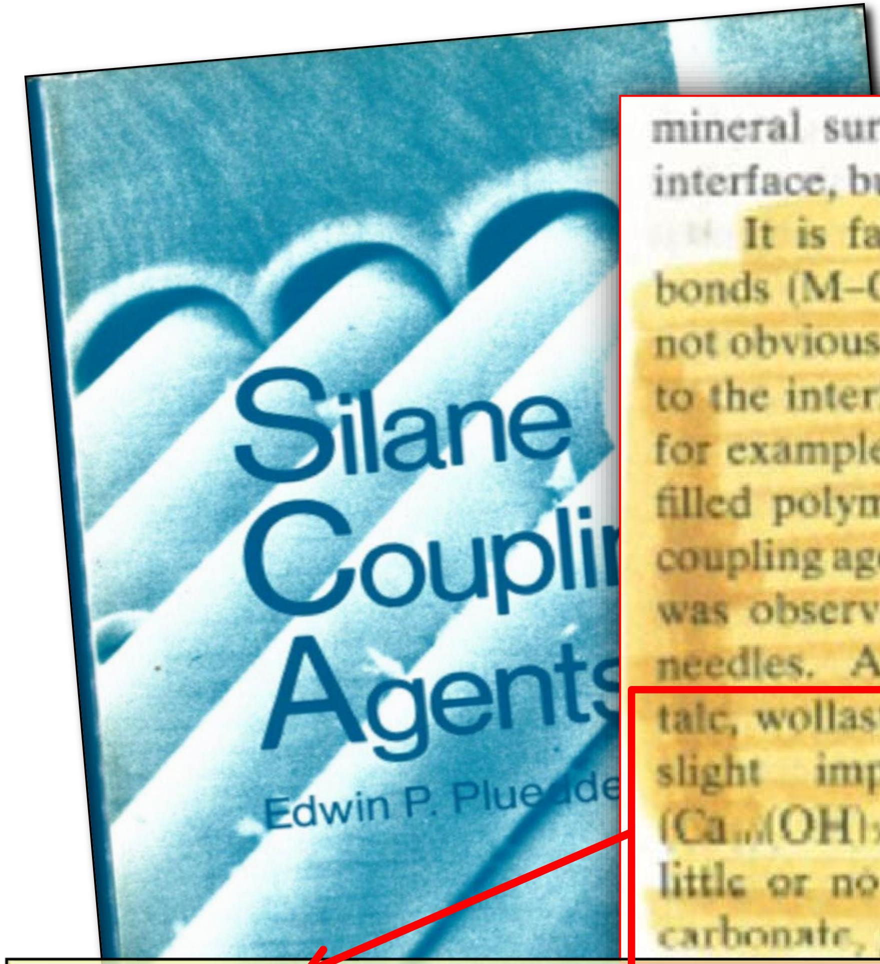
It is fairly well established that silane coupling agents form oxane bonds (M–O–Si) with mineral surfaces where M = Si, Ti, Al, Fe, etc. It is not obvious that such bonds should contribute outstanding water resistance to the interface since oxane bonds between silicon and iron or aluminum, for example, are not resistant to hydrolysis. Yet, mechanical properties of filled polymer castings were improved by addition of appropriate silane coupling agents with a wide range of mineral fillers.[12] Greatest improvement was observed with silica, alumina, glass, silicon carbide, and aluminum needles. A good but somewhat lesser response was observed with talc, wollastonite, iron powder, clay, and hydrated aluminum oxide. Only slight improvement was imparted to asbestine, hydroxyapatite $(Ca_{10}(OH)_2(PO_4)_6)$, titanium dioxide, and zinc oxide. Surfaces that showed little or no apparent response to silane coupling agents include calcium carbonate, graphite, and boron.

"… Surfaces that showed little or no apparent response to silane coupling agents include calcium carbonate, graphite, and boron."

Page 114:




One Nanometer = 10 Carbons = c – c – c – c – c – c – c – c – c – c
• 0.5% Titanate
• Disperse in M.O.
• Stir in CaCO3



Page 114:

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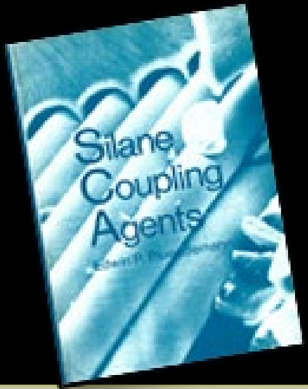
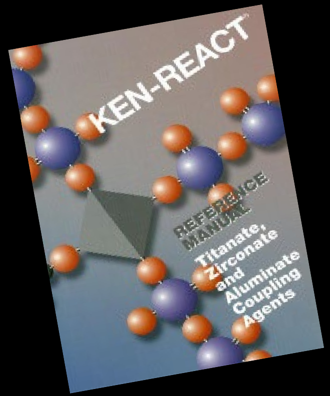
Although coupling activity of silanes is not universal to all mineral surfaces, response is broad enough to indicate that silanols need not form water-resistant "oxane" bonds with the surface. Even covalent siloxane bonds are hydrolyzed to silanols by water with an activation energy of 23.6 kcal/mol. Hydrolysis catalyzed by benzoic acid has an activation energy of 6 kcal/mol, which is comparable to the strength of a hydrogen bond. Compression set of silicone rubber has been attributed to a stress relaxation involving hydrolytic breaking and remaking of siloxane bonds

"… Only slight improvement was imparted to asbestine, hydroxyapatite [Ca5(PO4)3(OH)], titanium dioxide and zinc oxide."

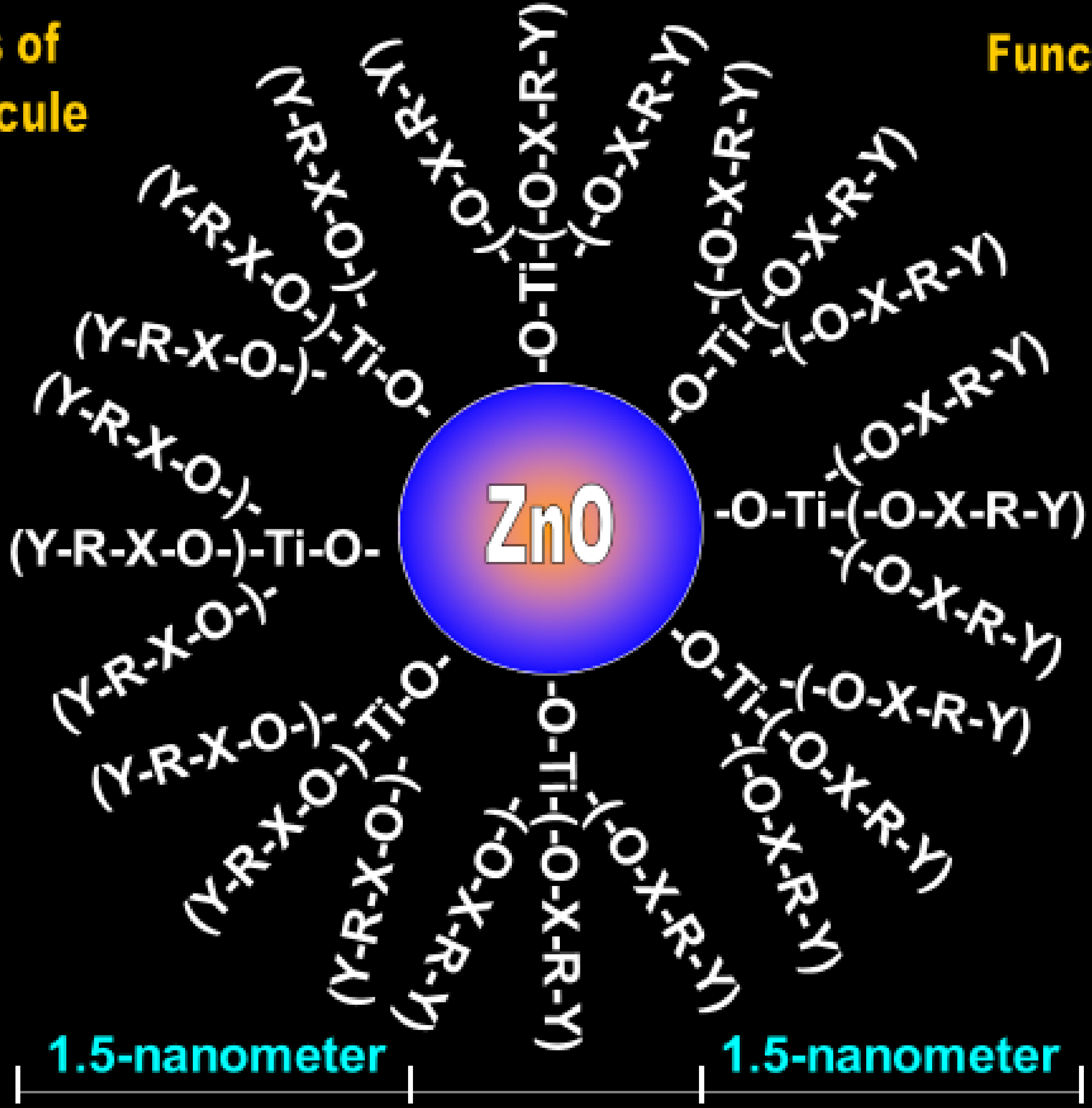


"Silanes"-Plueddemann:
"… Only slight improvement was imparted …
titanium dioxide and zinc oxide."



The Six Functions of the Titanate Molecule

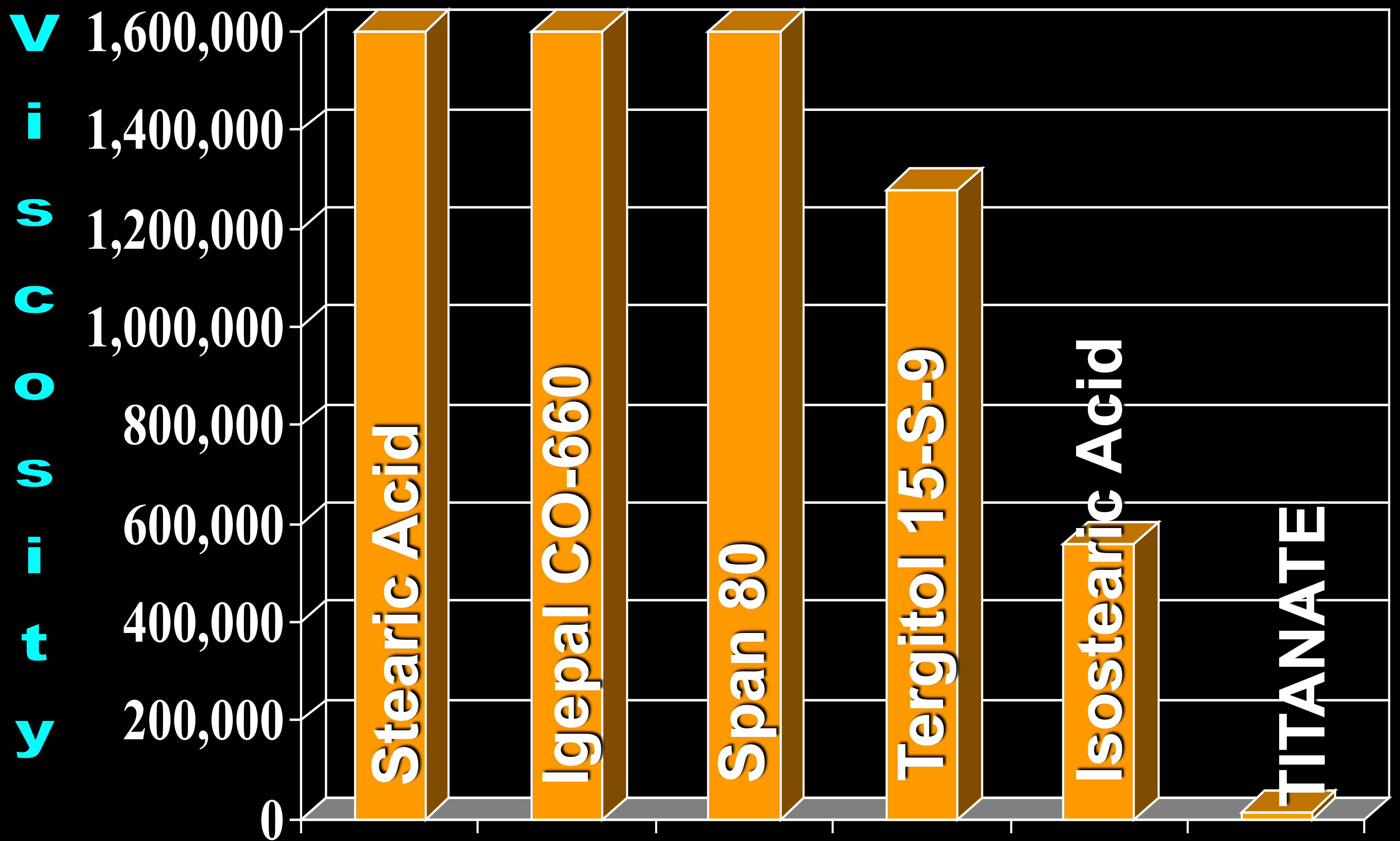
Function 1 - Coupling



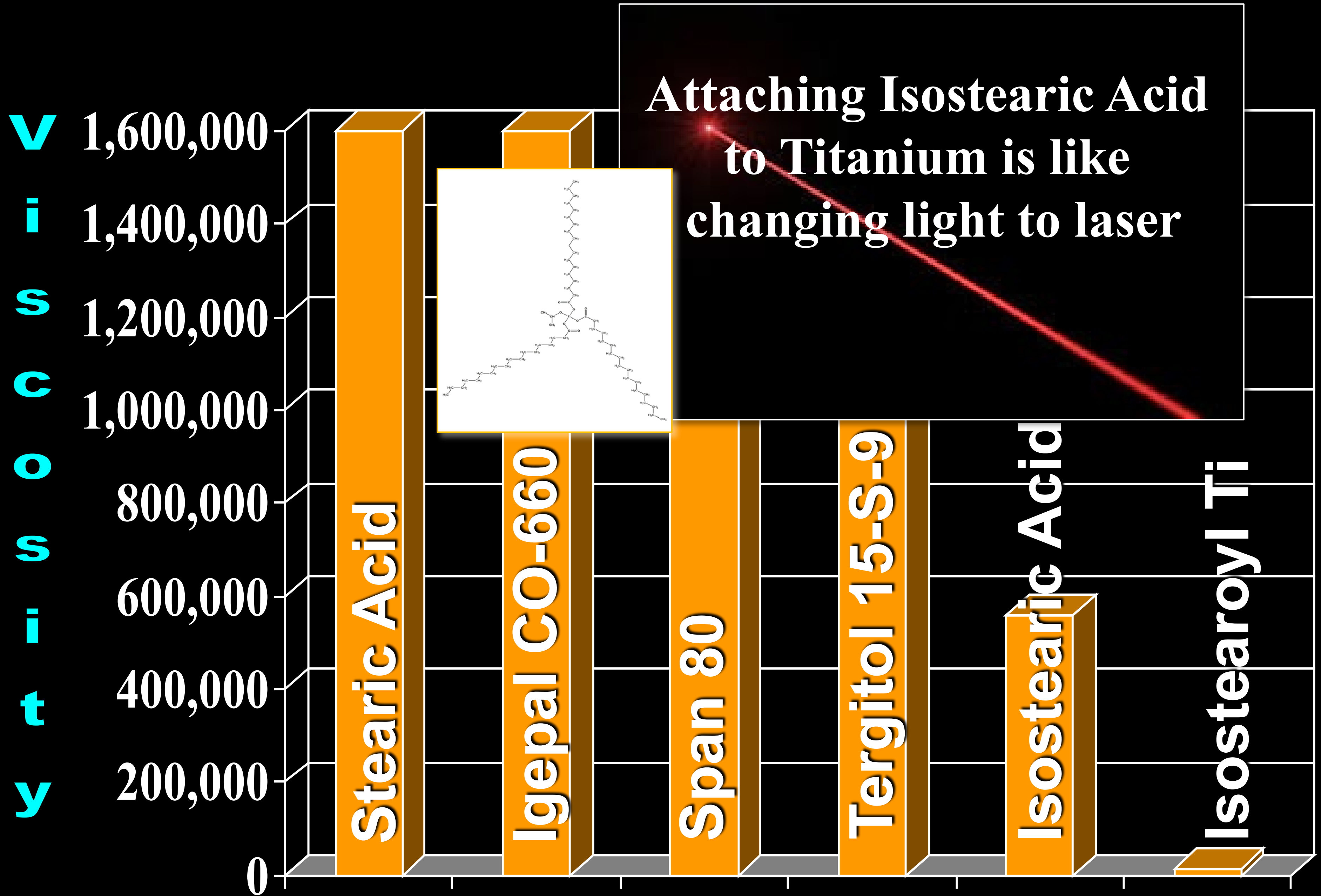
1.5-Nanometer Atomic Monolayer


CH3–CH–O–Ti–[O–C(=O)–C17H35]3 (with CH3 above the CH)
1,600,000 cps
12,800 cps
55% ZnO Dispersed In Mineral Oil
CONTROL
0.5 wt. % TITANATE

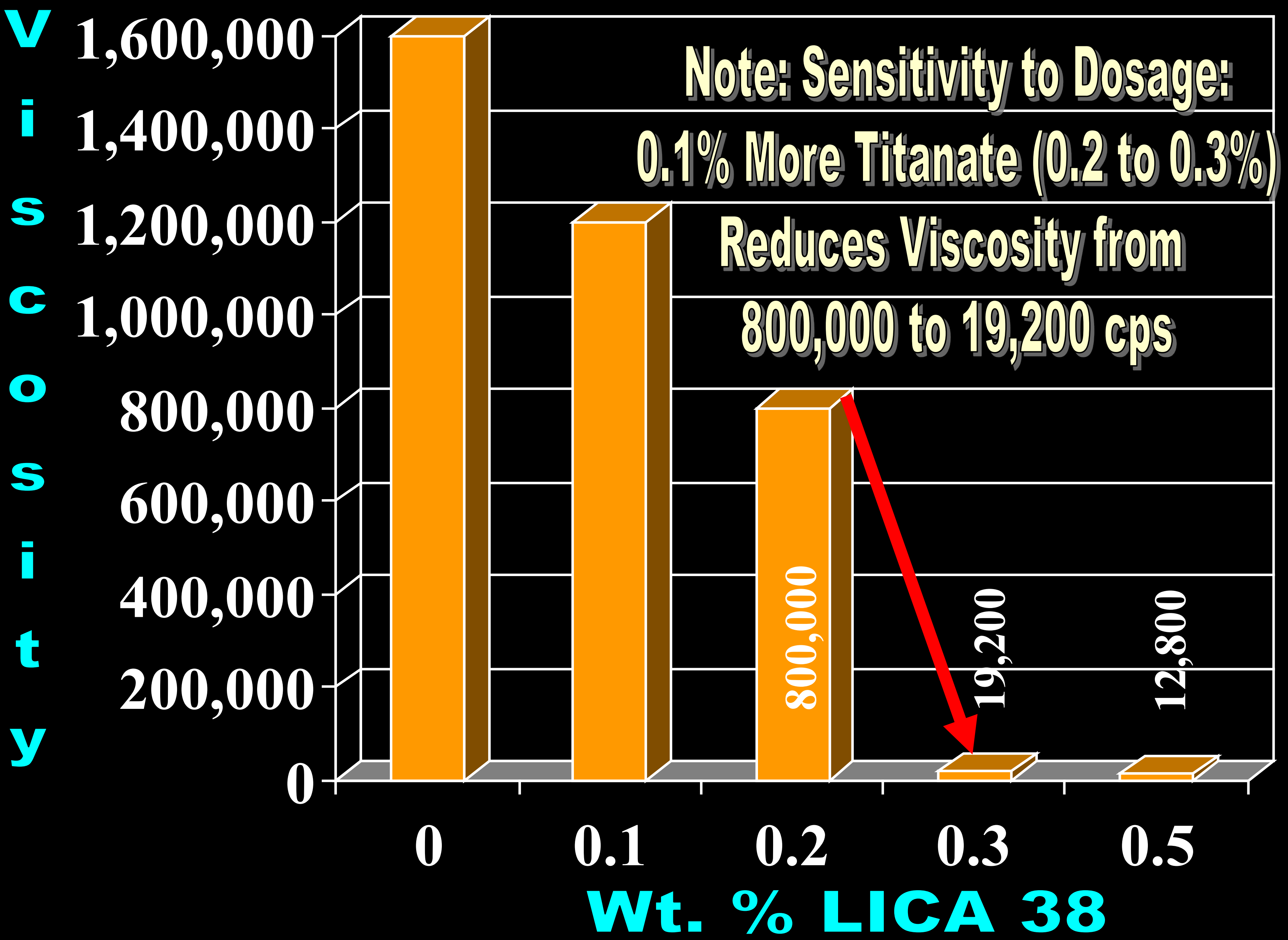
55% ZnO Dispersed In Mineral Oil



55% ZnO Dispersed In Mineral Oil



55% ZnO Dispersed In Mineral Oil



Dispersion of Metal Oxides and Conductive Particulate is important in applications such as digital copier toner, polymer magnets, smart coatings, etc.

Patented ZnO Apps

SCIENCE IP®

Order 2435843

Ti or Zr coupling agents
[20071228-20080930/ED]
|
Search Report

Prepared for
Salvatore J. Monte, President
of
Kenrich Petrochemicals, Inc.

September 30, 2008

CONFIDENTIAL

Science IP • 2540 Olentangy River Rd, Columbus, OH 43202 • ScienceIP@cas.org • 1-866-360-0814 • FAX 614-447-5443

ZnO filled chloroprene and natural rubber
Faculty of Sciences and Engineering Technology, Yemen

ZnO and Metal Hydroxides as Flame Retardants
School of Chem. & Environmental Sci., Hebei U., China

ZnO Sunscreen
Kosei Co., Ltd., Japan

Cosmetic Sunscreen ZnO
L'Oreal, France

TiO2 and Transparent ZnO
Kobo Products, Inc., USA

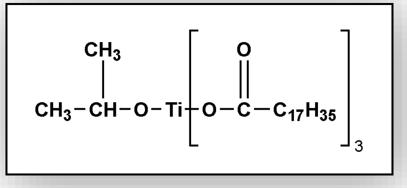
Aluminum or ZnO Heat Conductive Composites
Foxconn Technology Co., Ltd., Taiwan

Nano Functional ZnO, Tourmaline, Alumina, Zirconia, Magnesium Oxide, Titania, and Maifan

Stone Filled Polyamide, PET, Polyacrylonitrile, and PU
Diamond Polymer Science Co., Ltd., Taiwan

Titanate/Silane ZnO Treatment for Silicone
Kosei Co., Ltd., Japan

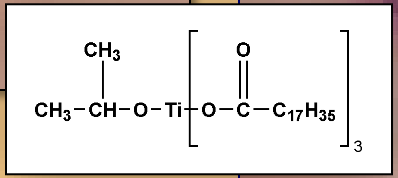
Sand-fixing agent w. hi-strength in petroleum recovery
Petrochina Co., Ltd., Peop. Rep. China



Isopropyl Titanium Triisostearate is the World Standard for Dispersion of TiO2 and ZnO in Facial Cosmetics and Sun Block Formulations

COATING LIPS AND EYES

Improving COLOR & APPEARANCE



FACIAL COSMETICS

L5 ANSWER 32 OF 84 CA

AN 176:403502 CA Full-text

TI Injection molding process for high-strength and large-size modified PVC interior trim parts

IN Xu, Fei
PA Yangzhou Jiakun New Energy Co., Ltd., Peop. Rep. China

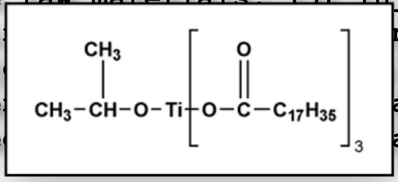
SO Faming Zhuanli Shenqing, 6pp.
LA Chinese
FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	CN 113512260	A	2021-10-19	CN 2021-10906120	20210809
PRAI	CN 2021-10906120		20210809		

PSPI

PATENT NO.	KIND	STATUS	STATUS DATE
CN 113512260	A	Alive	20211028

AB Title PVC interior trim part comprises 100 parts of PVC resin, 10-15 parts of lubricant (paraffin wax, calcium stearate and polyethylene wax), 1-5 parts of filler (calcium carbonate or carbon black), 1-4 parts of coupling agent (iso-Pr triisostearoyl titanate), 30-50 parts of modifier (polyethylene, powd. nitrile rubber and vinyl chloride-acrylonitrile copolymer compounded in the ratio 1:1:1.5) and 2-8 parts of plasticizer (DOS or DOTP). Prepn. method comprises steps: (1) weighing and adding the raw materials into mixer for high-speed mixing, then putting the mixed raw materials into double-screw extruder for extrusion, and cutting and granulating the extruded plastic strips; (2) drying: drying the extruded raw material particles at 85 +/-5° for at least 30 min, and stirring the raw materials continuously in the drying process to fully remove water vapor in the raw materials; (3) injection molding: putting the dried raw materials i[...]ne for heating and melting; (4) injection machine inj[...] into a mould, provided with a cooling device, and whe[...]and after a product is formed, the mold is opene[...]aken out.



IT 61417-49-0

RL: MOA (Modifier or additive use); USES (Uses)
(coupling agent; injection molding process of high-strength large-size modified PVC interior trim part)

FDA's Voluntary Cosmetic Registration Program (**VCRP**)

Safety Assessment of
Titanium Complexes as Used in Cosmetics

Status: Final Report
Release Date: June 5, 2019
Panel Date: April 8-9, 2019

The 2019 Cosmetic Ingredient Review Expert Panel members are: Chair, Wilma F. Bergfeld, M.D., F.A.C.P.; Donald V. Belsito, M.D.; Ronald A. Hill, Ph.D.; Curtis D. Klaassen, Ph.D.; Daniel C. Liebler, Ph.D.; James G. Marks, Jr., M.D.; Ronald C. Shank, Ph.D.; Thomas J. Slaga, Ph.D.; and Paul W. Snyder, D.V.M., Ph.D. The CIR Executive Director is Bart Heldreth, Ph.D. This report was prepared by Wilbur Johnson, Jr., M.S., Senior Scientific Analyst.

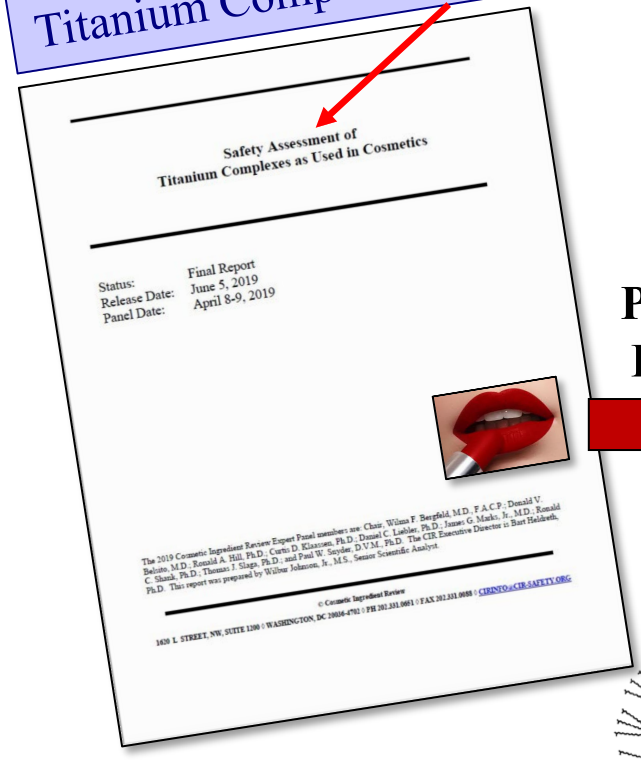
1620 L STREET, NW, SUITE 1200 ◊ WASHINGTON, DC 20036-4702 ◊ PH 202.331.0651 ◊ FAX 202.331.0088 ◊ CIRINFO@CIR-SAFETY.ORG

…According to 2019 VCRP data, Isopropyl Titanium Triisostearate is reported as being used in 513 cosmetic products (506 leave-on and 7 rinse-off products); half of the reported uses are in lipstick formulations (253).[8]

…use survey conducted by the Council in 2017 indicate that Isopropyl Titanium Triisostearate is used in leave-on products (eye shadows) and at concentrations up to 0.3% in rinse-off products (eye make-up removers).[9] …

Invention/Technology Evolution – 1973 to 2022

Safety Assessment of
Titanium Complexes as Used in Cosmetics


Safety Assessment of
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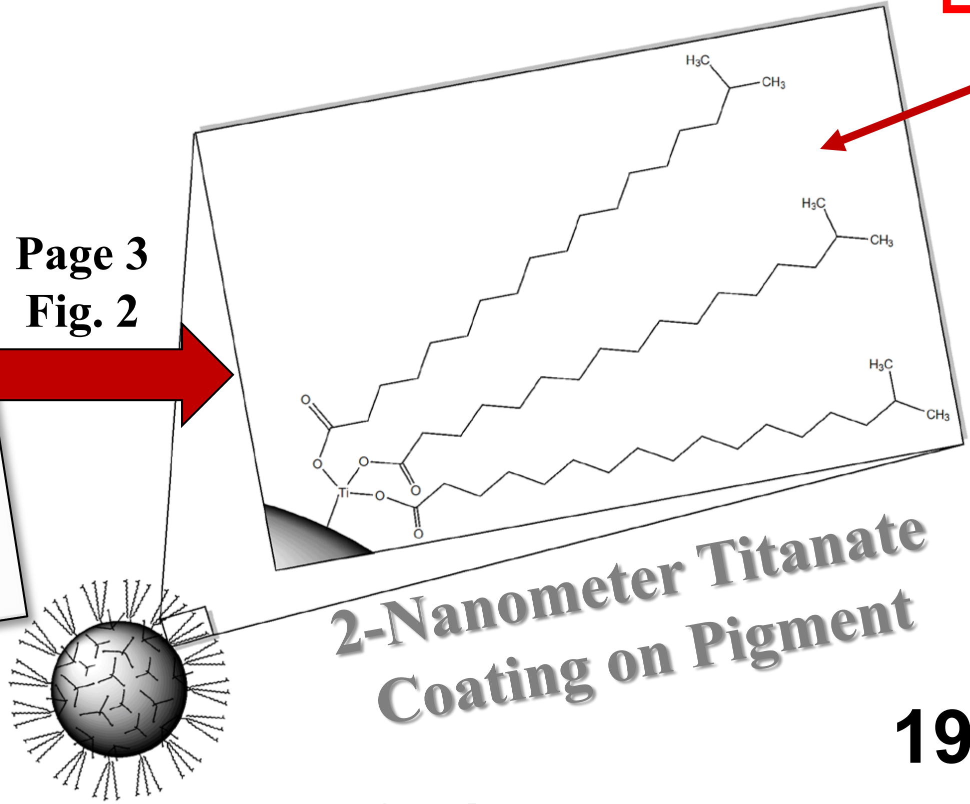
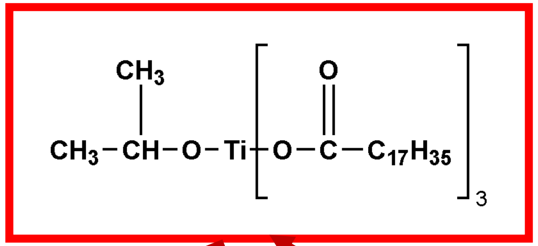
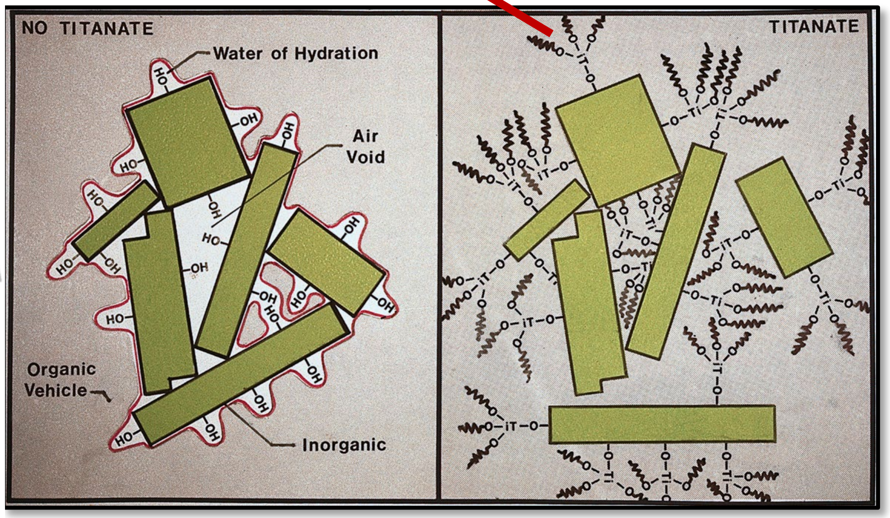
Status: Final Report
Release Date: June 5, 2019
Panel Date: April 8-9, 2019

Page 3
Fig. 2



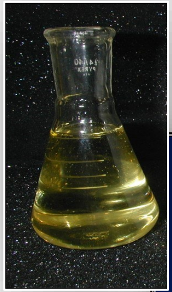
2-Nanometer Titanate
Coating on Pigment

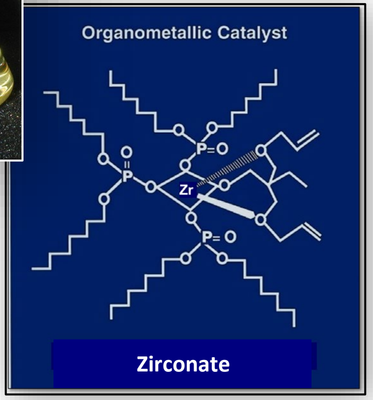




2019 Drawing – Fe2O3/Titanate

1973 Drawing by S. J. Monte
(46-years earlier)

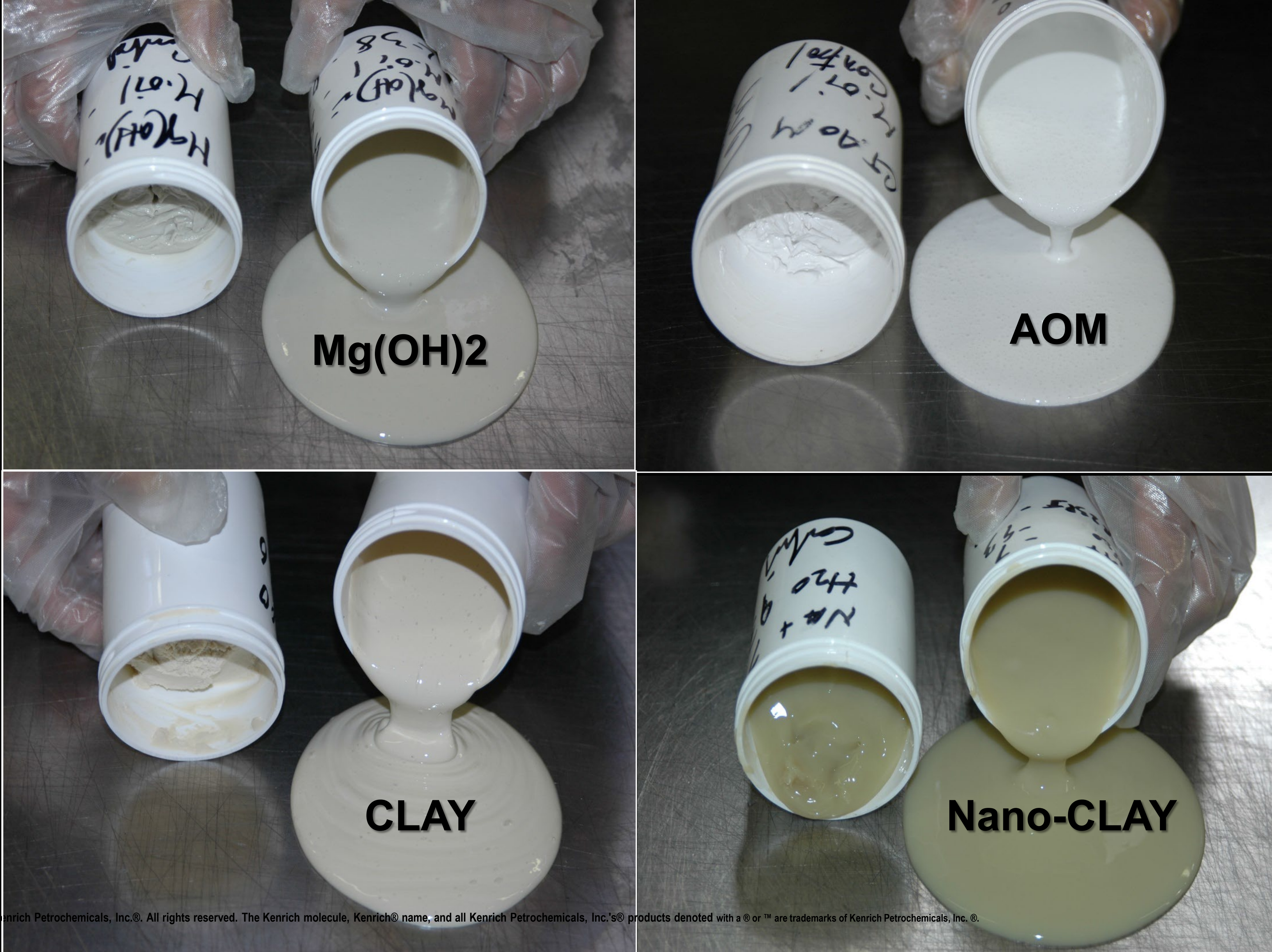




Disperse Organic and Inorganic Pigments

The LIquid Coupling Agent can be added to the liqui-color concentrate and then added at the hopper.

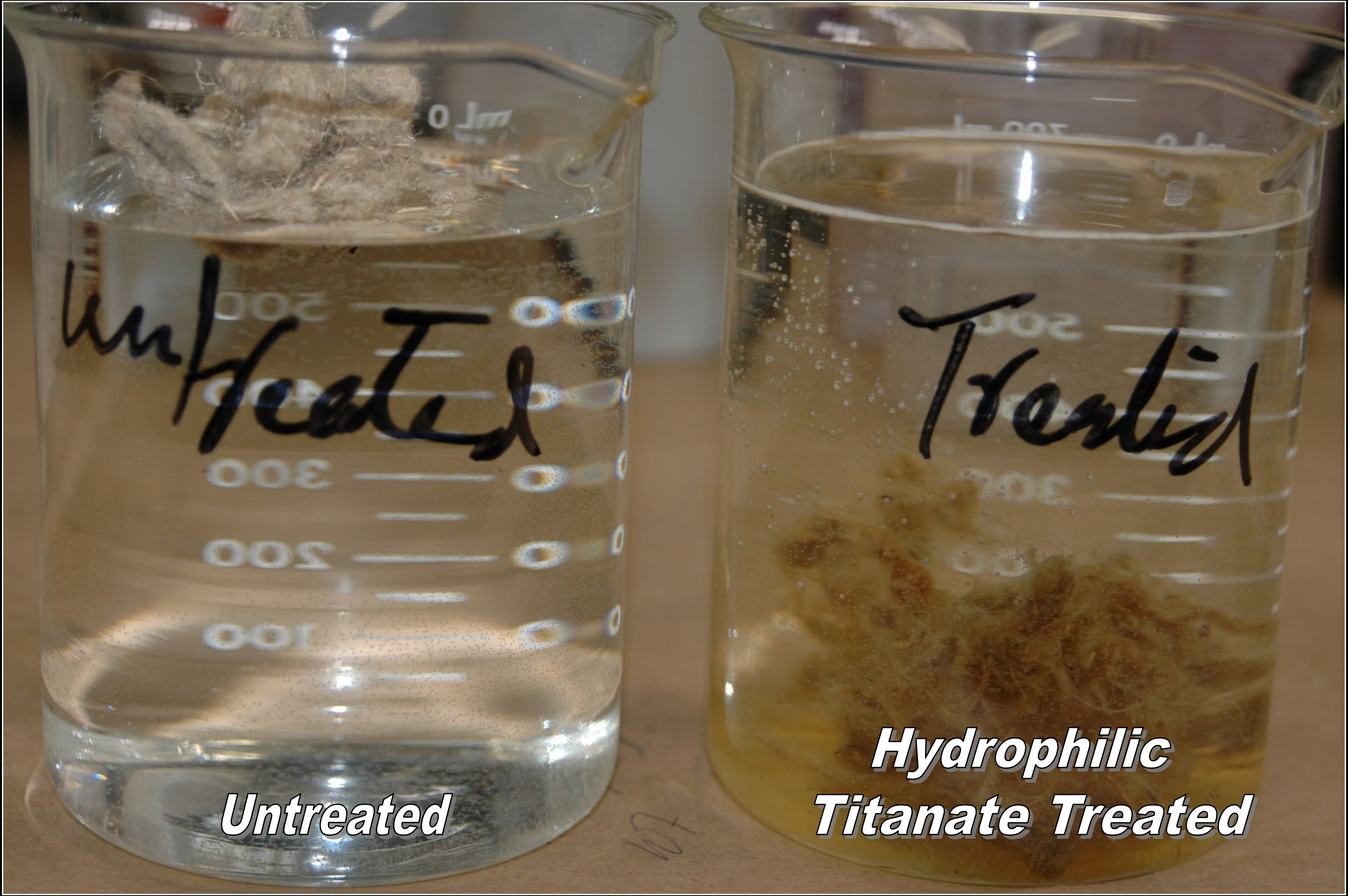
A low dosage of Titanate added in situ into mineral oil followed by filler addition reduces viscosity

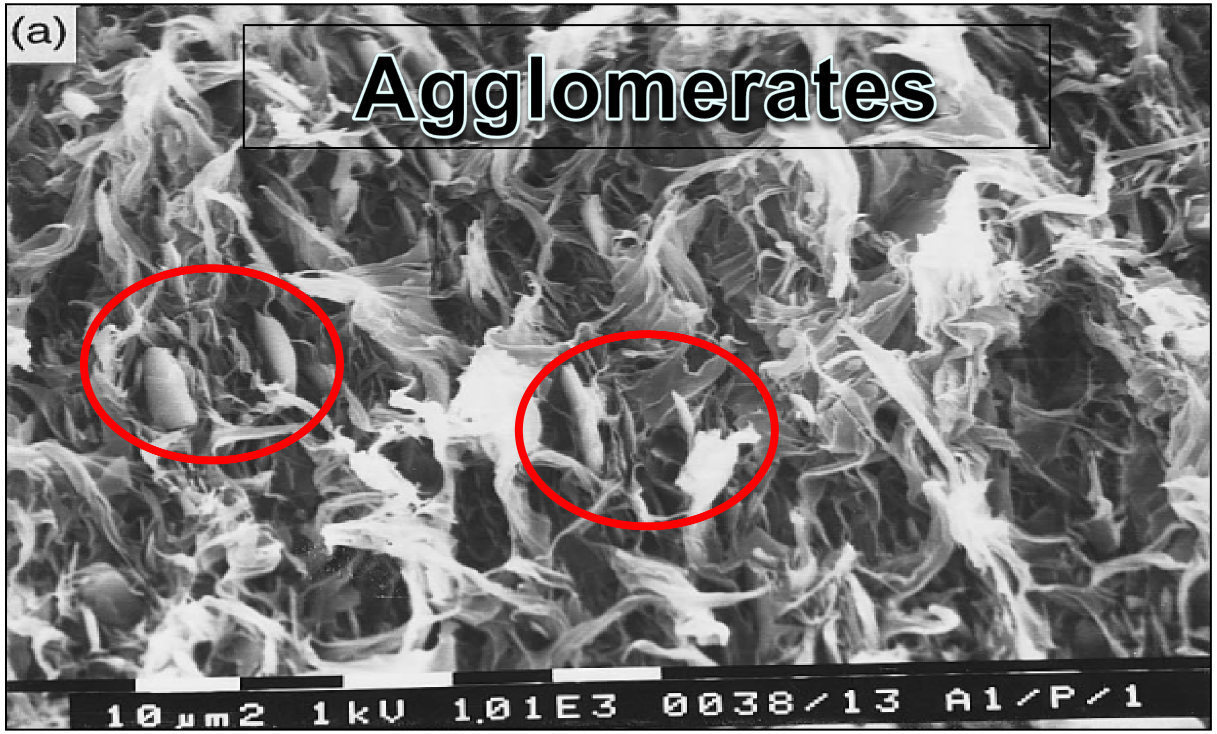


A low dosage of Titanate added in situ into mineral oil followed by filler addition reduces viscosity

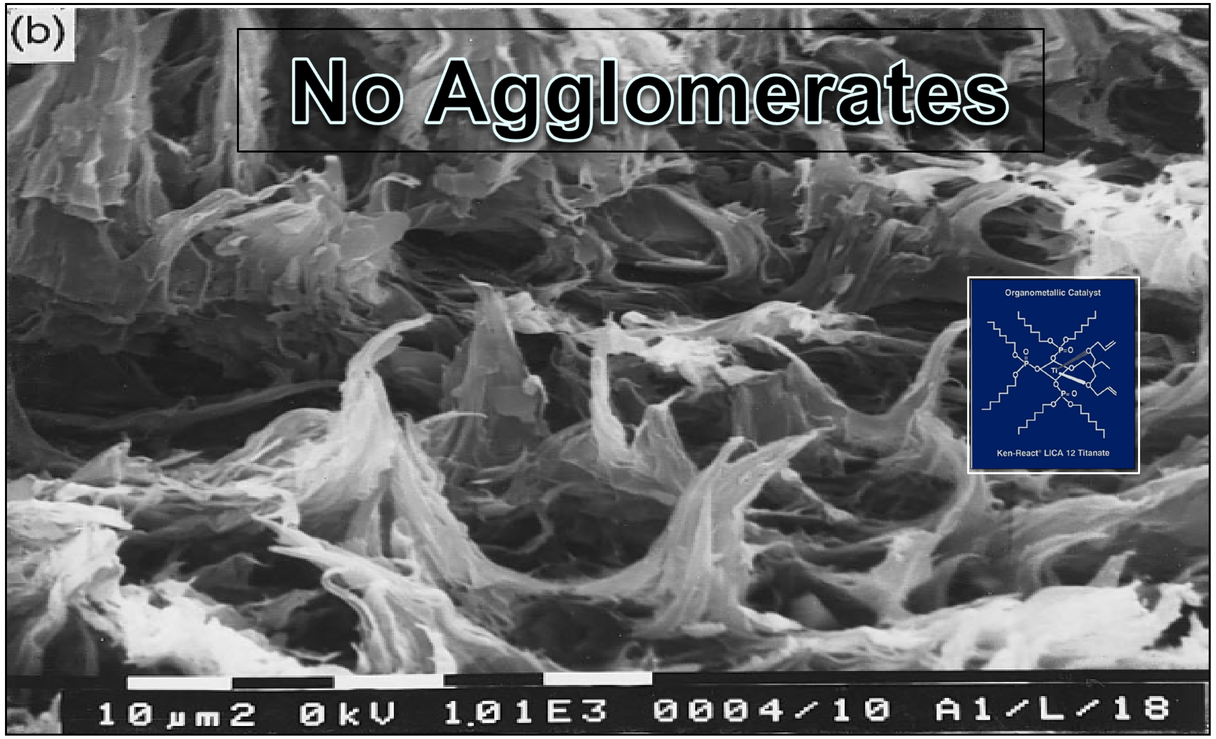
A low dosage of Titanate added in situ into mineral oil followed filler addition reduces viscosity

Reacts with Sustainable Organics such as Flax & Cellulose





30% Talc/PP – No Titanate



30% Talc/PP–0.5% Titanate

ELSEVIER

European Polymer Journal 36 (2000) 789–801

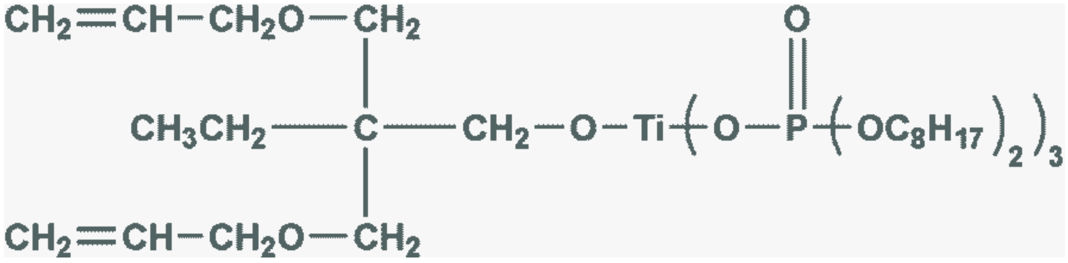
EUROPEAN POLYMER JOURNAL

Effects of titanate coupling agent on rheological behaviour, dispersion characteristics and mechanical properties of talc filled polypropylene

Chuah Ai Wah[a,*], Leong Yub Choong[b], Gan Seng Neon[b]

[a] *Petronas Research and Scientific Services Sdn. Bhd., Off Jalan Ayer Itam, Kawasan Institusi Bangi, 43000 Kajang, Selangor, Malaysia*

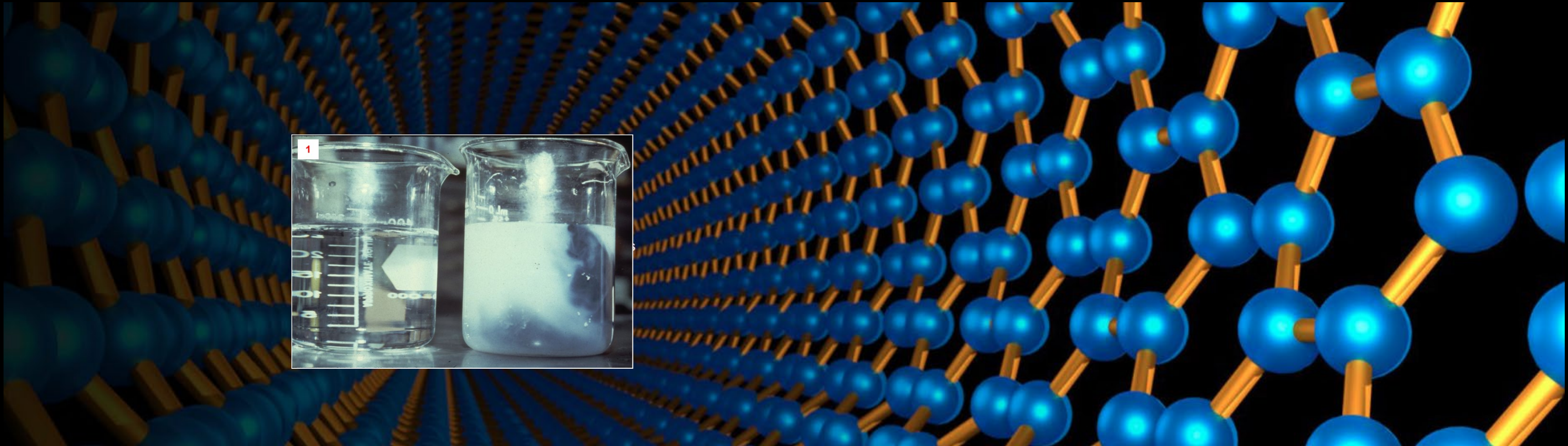
[b] *Department of Chemical Engineering, University of Malaya, 50603, Kuala Lumpur, Selangor, Malaysia*



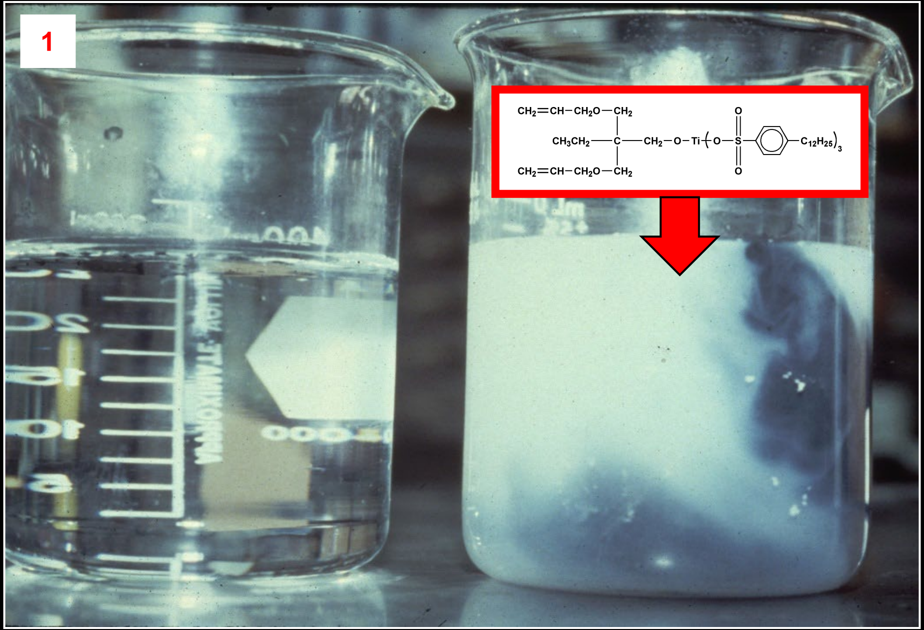
Neoalkoxy Phosphato Titanate

Different Than Silanes

Silanes do not Nano-Phosphatize or Couple to Carbon



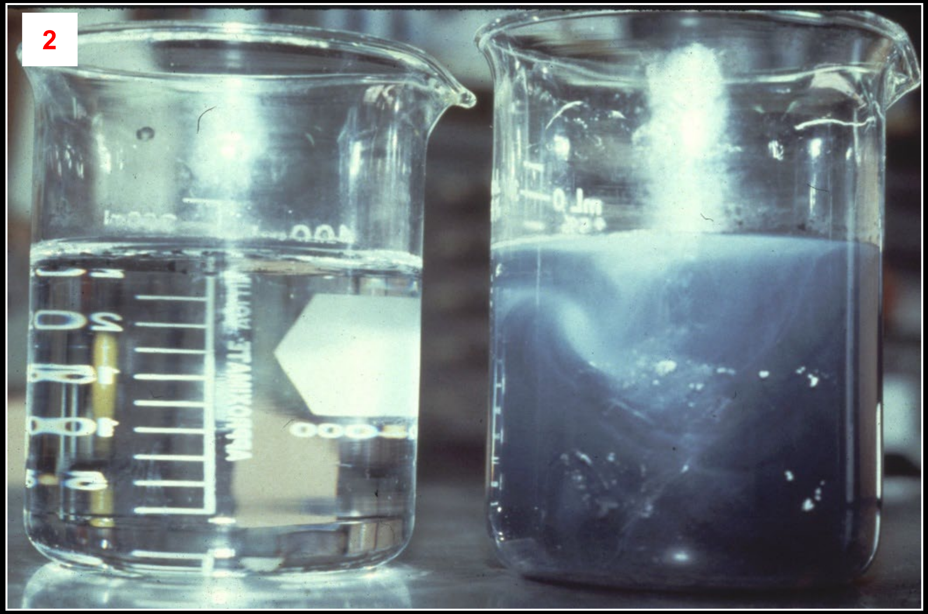
Titanate Coupling to XC-72 Conductive Carbon Black in Water

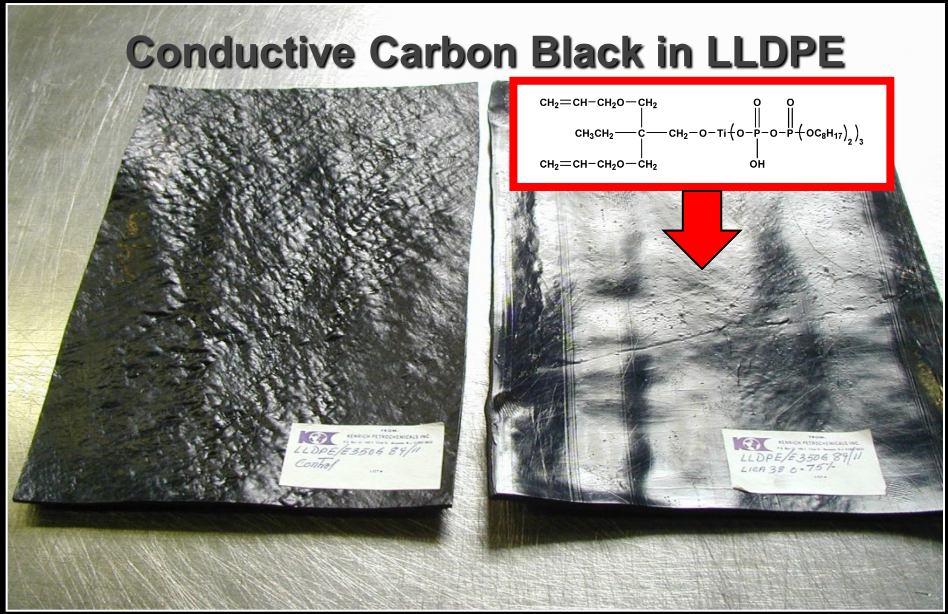


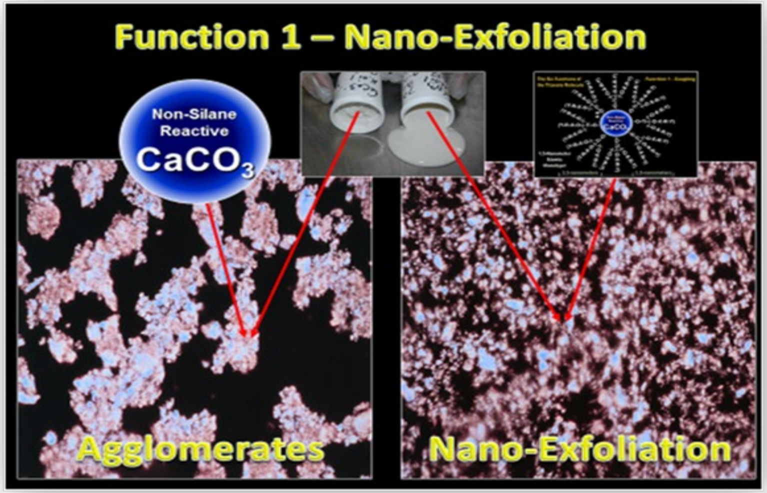
No Titanate Titanate

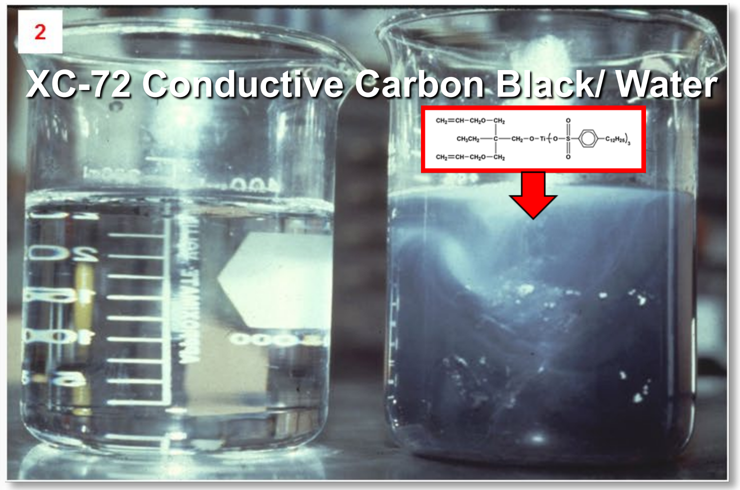
No Titanate Titanate

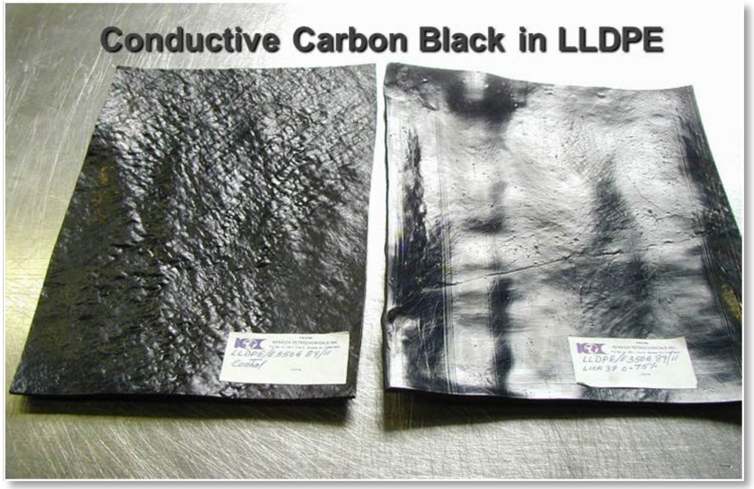
No Mechanical Stirring



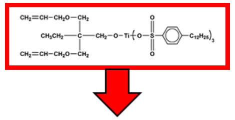








RESISTIVITY OF 3.75% XC-72R CONDUCTIVE BLACK IN STYRENE-BUTADIENE BLOCK COPOLYMER/PS 10mm THICK TEST SLAB



Wt.% LICA 09 Carbon Black	Resistivity Surface, Ω/sq.	Volume, Ω·cm
Control	> 10^{16}	7.8×10^{14}
0.67	1.7×10^{12}	3.0×10^{12}
1.00	2.1×10^{8}	4.3×10^{7}
2.00	5.7×10^{7}	3.7×10^{7}

My 32nd Patent Issued Mar. 5. 2020

US 20200071230A1

(19) United States
(12) Patent Application Publication
Monte

(10) Pub. No.: US 2020/0071230 A1
(43) Pub. Date: Mar. 5, 2020

(54) CONSTRUCTION MATERIALS, COMPOSITIONS AND METHODS OF MAKING SAME

(71) Applicant: S&E INNOVAT TECHNOLOGI (US)

(72) Inventor: Salvatore J. Mo

(73) Assignee: S&E INNOVAT TECHNOLOGI (US)

Publication Classification

(51) Int. Cl.
C04B 20/10 (2006.01)

Returned From Darmstadt Mar. 5. 2020

Praxisforum Kunststoffrezyklate

Salvatore J. Monte – Kenrich Petrochemicals, Inc.

HANSER

3-4 March 2020 in Darmstadt

Forum Plastic Recyclates 2020
Quality Increase of Material & Processing


US 20200071230A1

(19) United States
(12) Patent Application Publication
Monte

(10) Pub. No.: US 2020/0071230 A1
(43) Pub. Date: Mar. 5, 2020

(54) CONSTRUCTION MATERIALS, COMPOSITIONS AND METHODS OF MAKING SAME

(71) Applicant: S&E TEC (US)

(72) Inventor: Salva

(73) Assignee: S&E TEC (US)

(21) Appl. No.: 1

Publication Classification

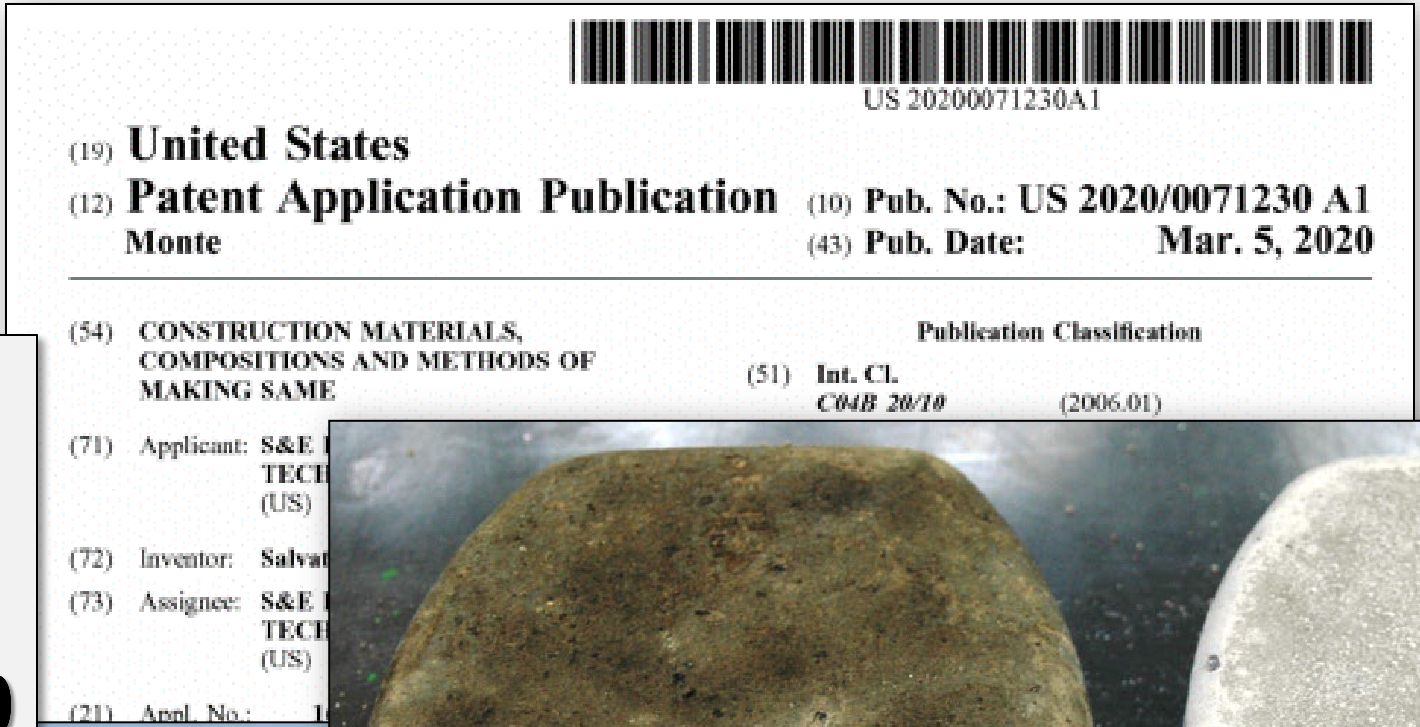
(51) Int. Cl.
C04B 28/10 (2006.01)

My 32nd Patent Issued Mar. 5. 2020

Returned From Darmstadt Mar. 5. 2020

Compatibilize Oil Soaked Seawater Sand with OPC

Returned From Darmstadt Mar. 5. 2020


US 20200071230A1

(19) United States
(12) Patent Application Publication
Monte

(10) Pub. No.: US 2020/0071230 A1
(43) Pub. Date: Mar. 5, 2020

(54) CONSTRUCTION MATERIALS, COMPOSITIONS AND METHODS OF MAKING SAME

(71) Applicant: S&E
TECH
(US)

(72) Inventor: Salvat

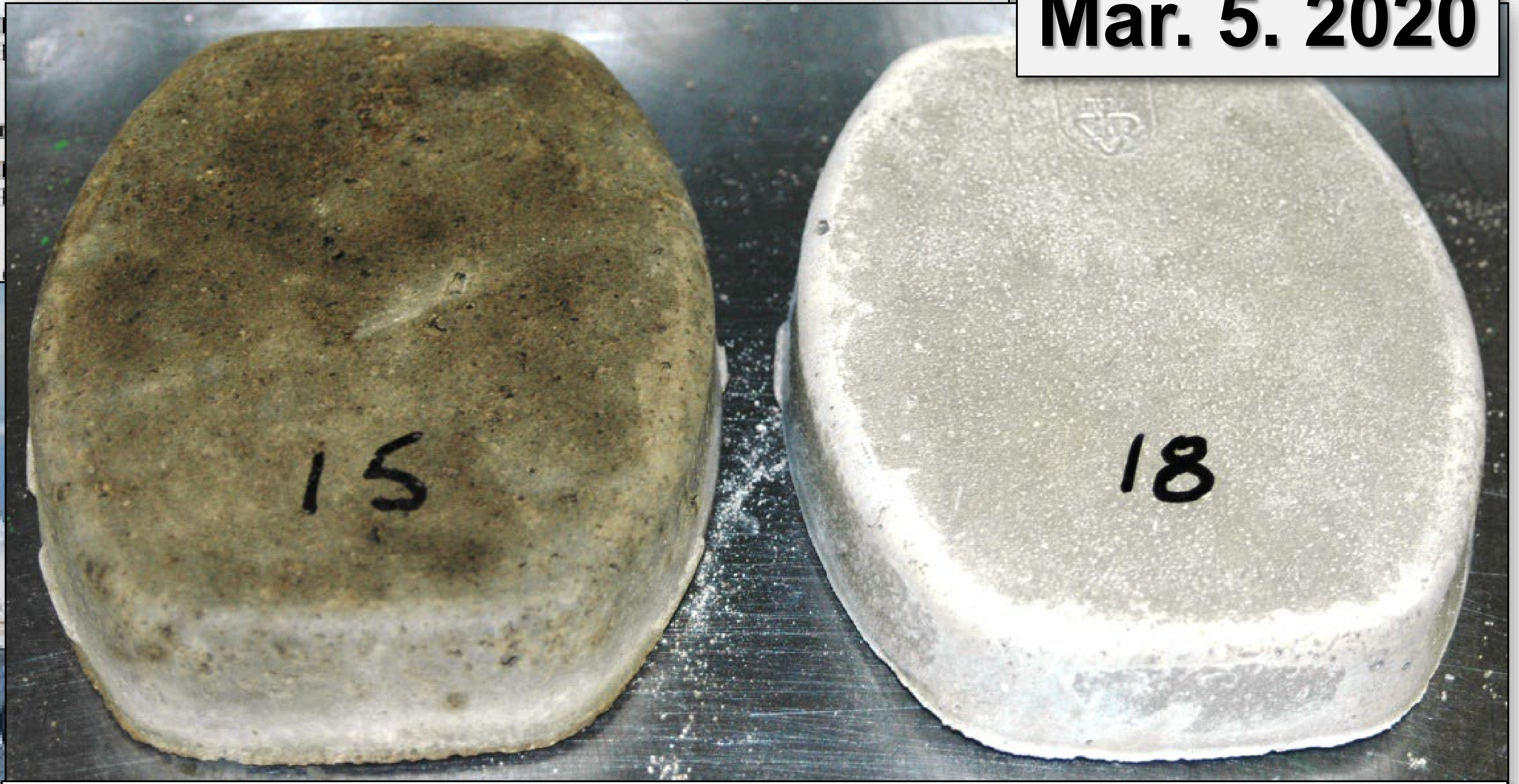
(73) Assignee: S&E
TECH
(US)

(21) Appl. No.:

Publication Classification

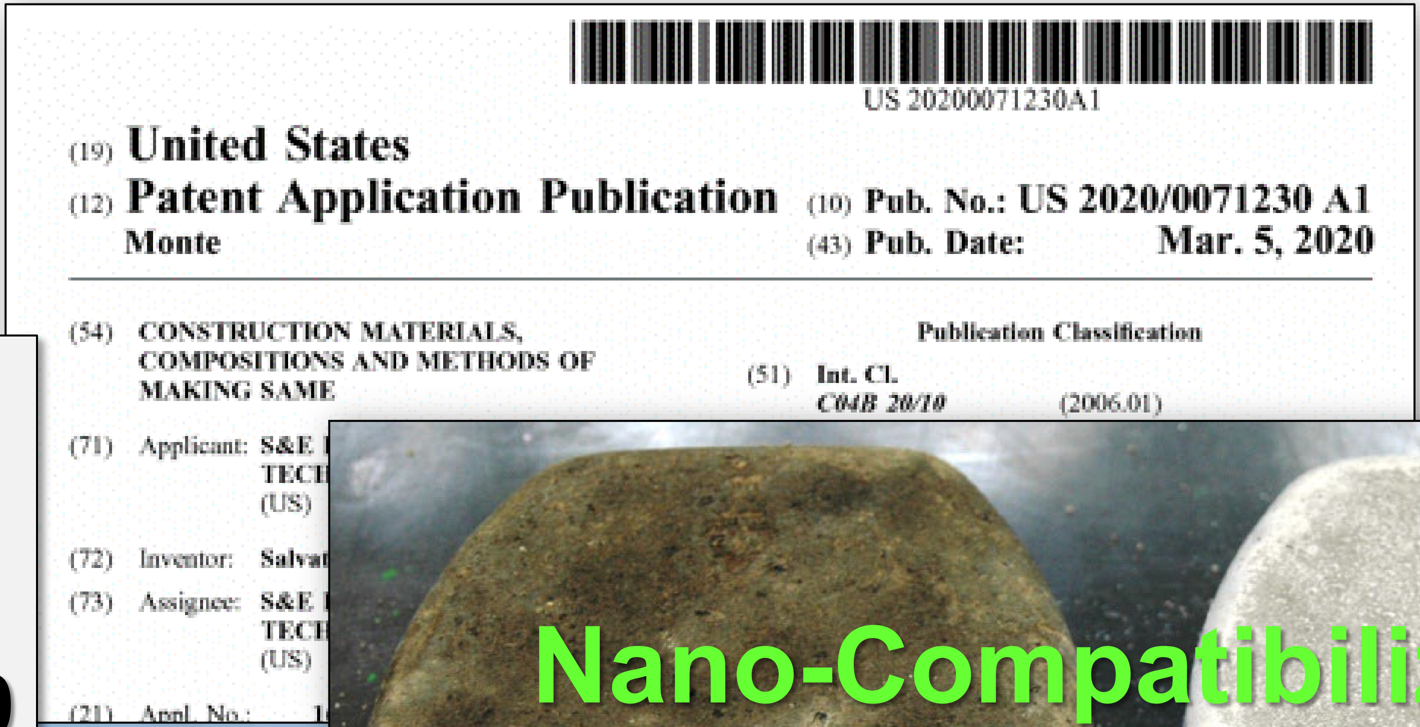
(51) Int. Cl.
C04B 28/10 (2006.01)

My 32nd Patent Issued Mar. 5. 2020



Compatibilize Oil Soaked Seawater Sand with OPC

Returned From Darmstadt Mar. 5. 2020


US 20200071230A1

(19) United States
(12) Patent Application Publication
Monte

(10) Pub. No.: US 2020/0071230 A1
(43) Pub. Date: Mar. 5, 2020

(54) CONSTRUCTION MATERIALS, COMPOSITIONS AND METHODS OF MAKING SAME

Publication Classification

(51) Int. Cl.
C04B 20/10 (2006.01)

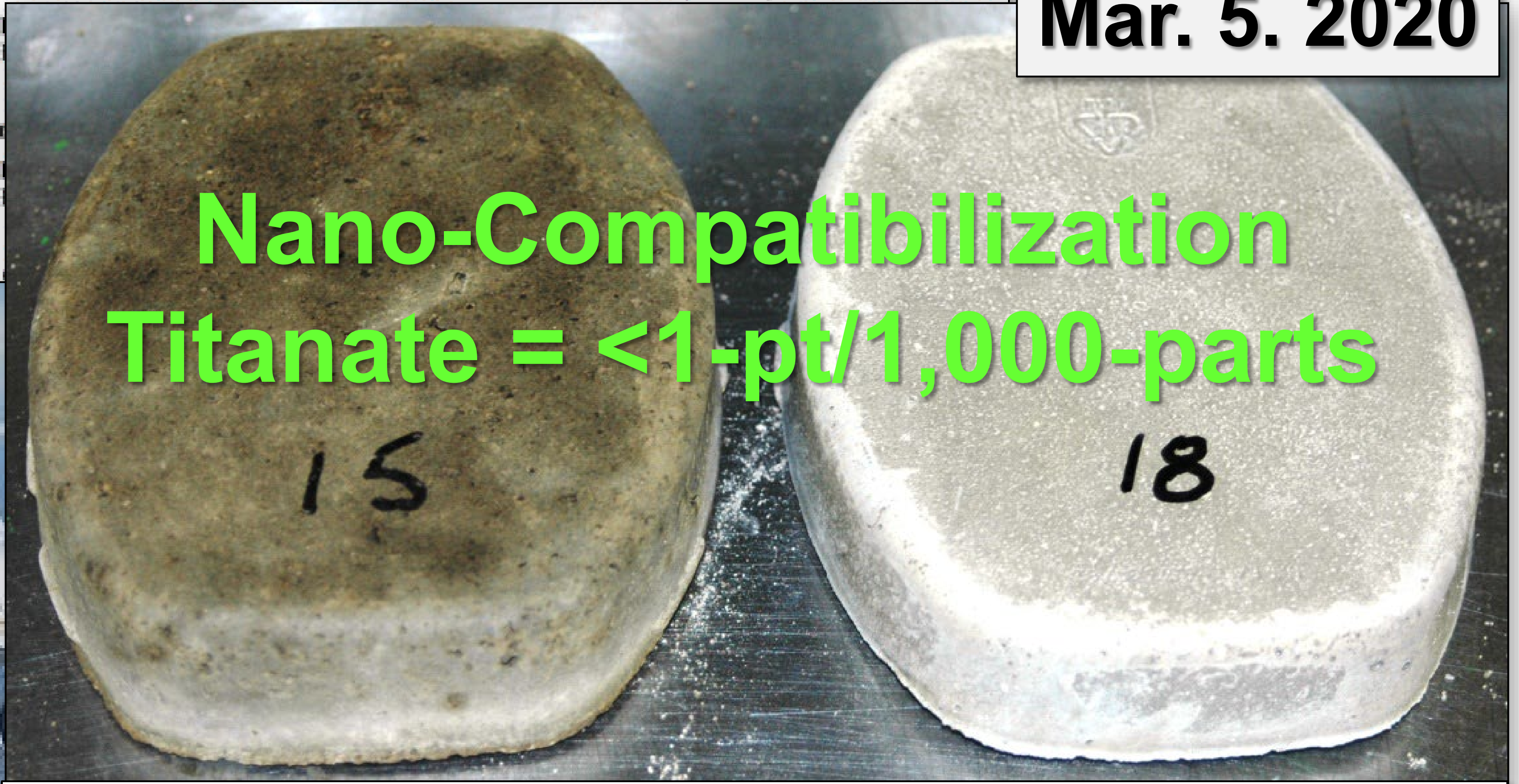
(71) Applicant: S&E I… TECH… (US)

(72) Inventor: Salva…

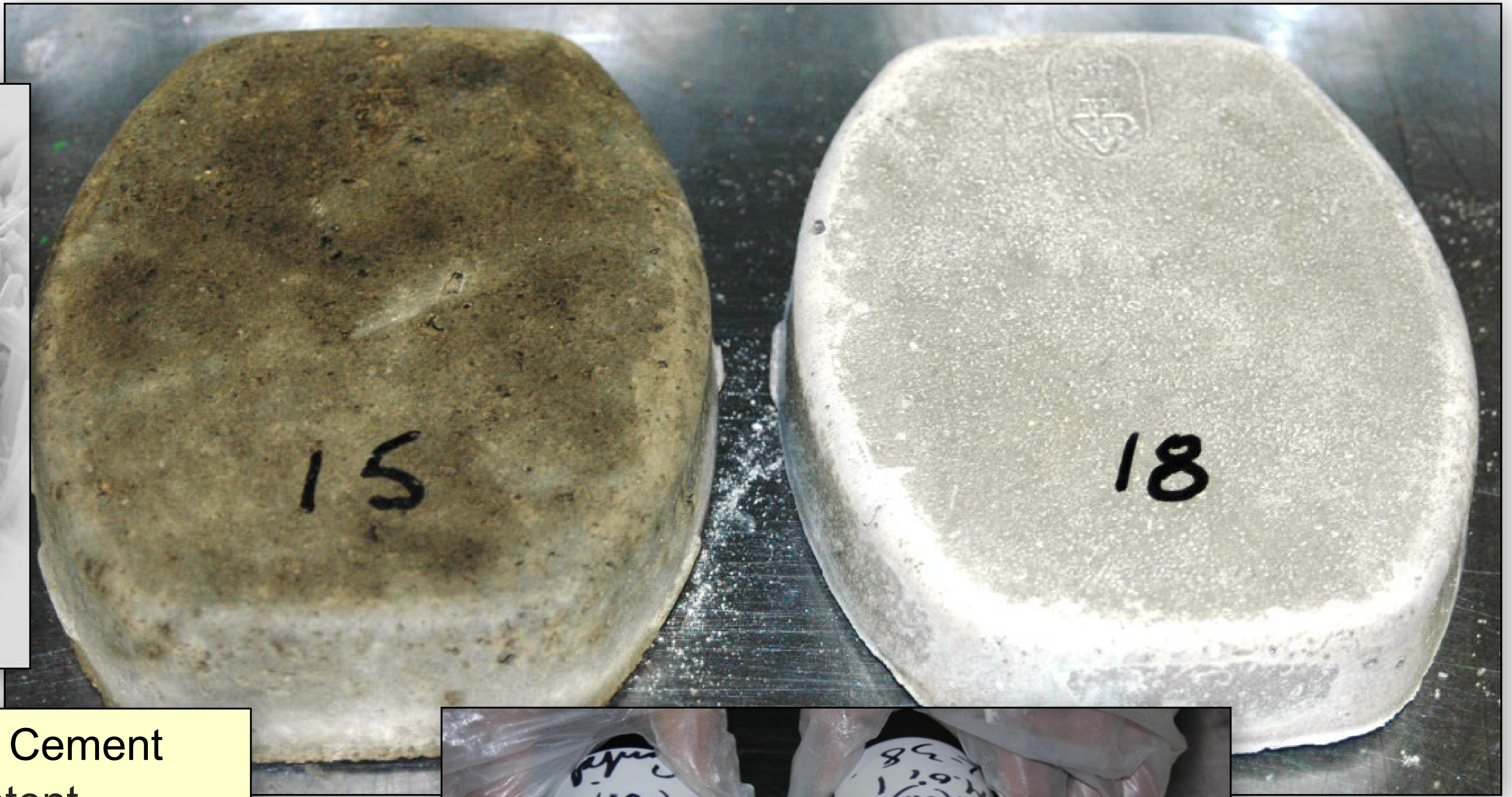
(73) Assignee: S&E I… TECH… (US)

(21) Appl. No.: 1…

My 32nd Patent Issued Mar. 5. 2020

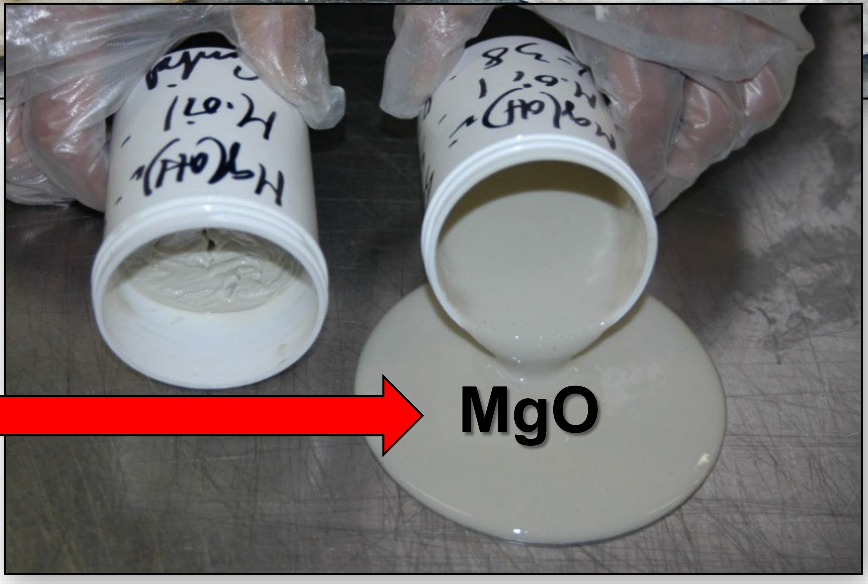


Compatibilize Oil Soaked Seawater Sand with OPC

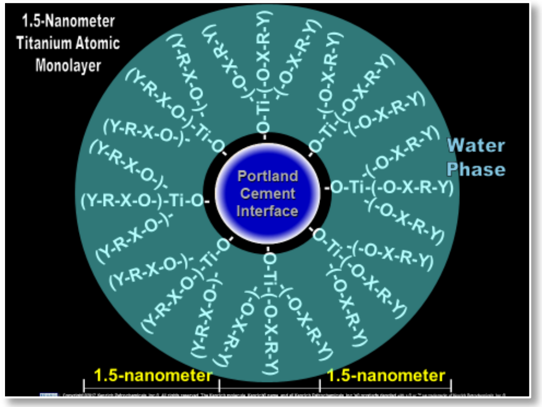


~ Oxide Composition Ordinary Portland Cement

Oxide	Per cent content
CaO (non-silane reactive)	60.0–67.0
SiO_2	17.0–25.0
Al_2O_3 (aluminum oxide in cement)	3.0–8.0
Fe_2O_3	0.5–6.0
MgO	0.1–4.0
Alkalies (K_2O, Na_2O)	0.4–1.3
SO_3 (non-silane reactive)	1.3–3.0



A New 1.5-Nanometer Titanium Treated Portland Cement (ASTM C150 – Type I) reduces the cement water ratio by 31% to equivalent slump (flow).



Portland Cement

Oxide	% content
CaO	60.0–67.0
SiO_2	17.0–25.0
Al_2O_3	3.0–8.0
Fe_2O_3	0.5–6.0
MgO	0.1–4.0
Alkalies (K_2O, Na_2O)	0.4–1.3
SO_3	1.3–3.0

The effects of nano-titanium organo-functionality on the Portland Cement interface provides a technology for new & novel concrete structures.

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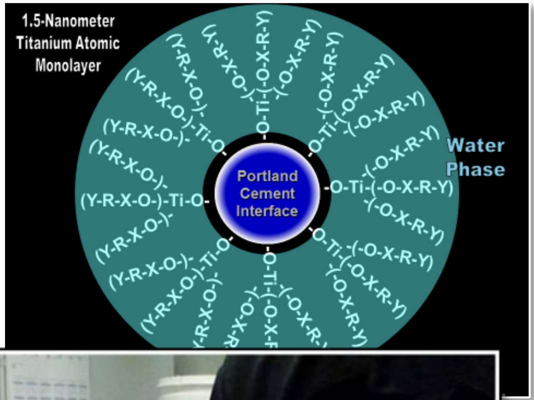

Portland Cement	
Oxide	**% content**
CaO	60.0–67.0
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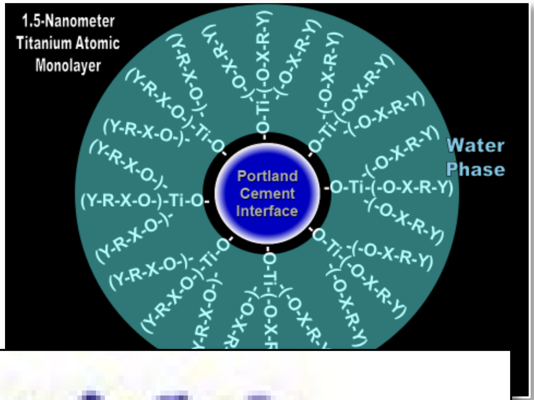

Compound	Ultramarine Blue	Meta Kaolin	Portland Cement
SiO2	39.180	51.150	17.0 – 25.0
Al2O3	25.330	42.110	3.0 – 8.0
Fe2O3	1.489	1.180	0.5 – 6.0
CaO	0.390	0.030	60.0 – 67.0
MgO	0.314	0.590	0.1 – 4.0
SO3	5.724	0.070	1.3 – 3.0
Na2O	18.735	0.220	0.4 – 1.3
K2O	0.815	0.480	

Portland Cement

Oxide	% content
CaO	60.0–67.0
SiO_2	17.0–25.0
Al_2O_3	3.0–8.0
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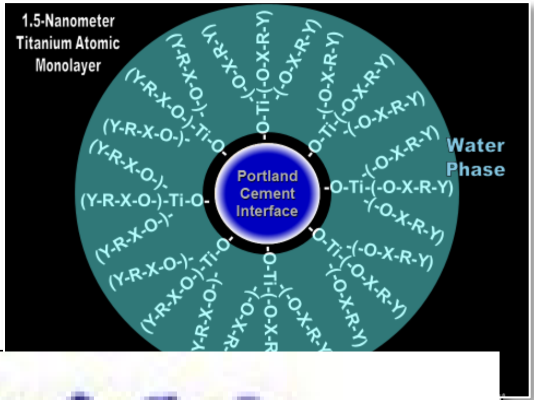
SO_3	1.3–3.0

The effects of nano-titanium organo-functionality on the Ultramarine Blue Pigment or Kaolin interface provides a technology for new & novel coatings.

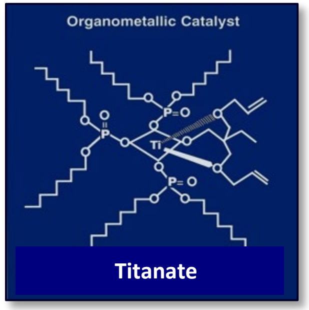


EVALUATION OF 0.35% LICA 38ENP TITANATE BY WEIGHT OF ULTRAMARINE BLUE PIGMENT (Grade 5008 - 2.14µm) IN TOLUENE AND MINERAL OIL					
50% UB 5008 In Toluene			50% UB 5008 In Mineral Oil		
	0.35% EPP Titanate			0.35% EPP Titanate	
Control	In Situ	Pre-treat	Control	In Situ	Pre-treat
80,000	25	45	150,400	16,000	1,700

The effects of nano-titanium organo-functionality on the Ultramarine Blue Pigment or Kaolin interface provides a technology for new & novel coatings.

THE POLYMER INTERFACE – Function 2 CATALYSIS

Advanced Solution Chemistry



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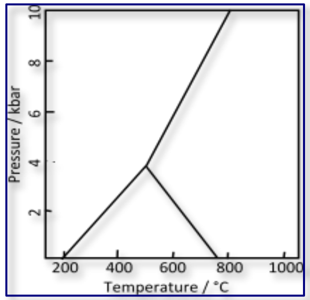

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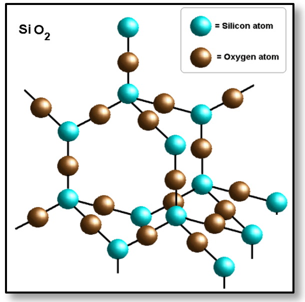

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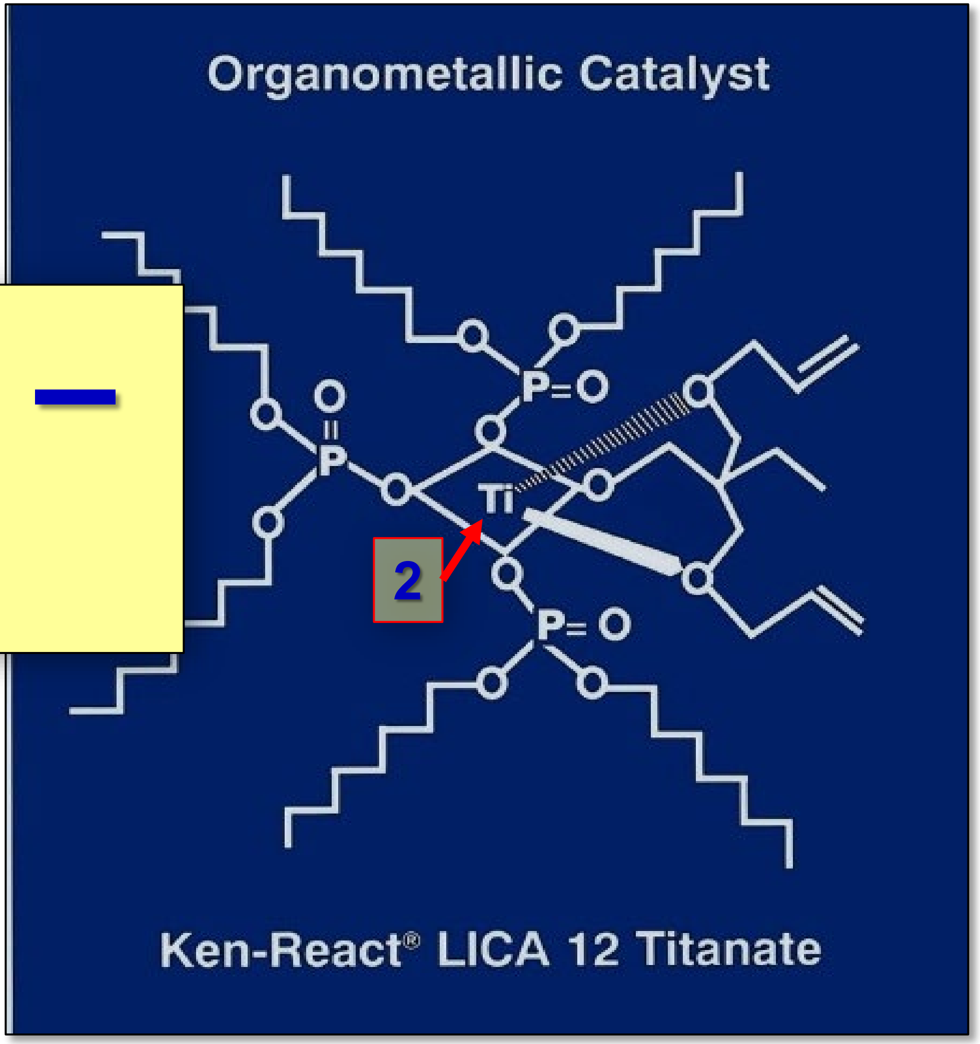
=

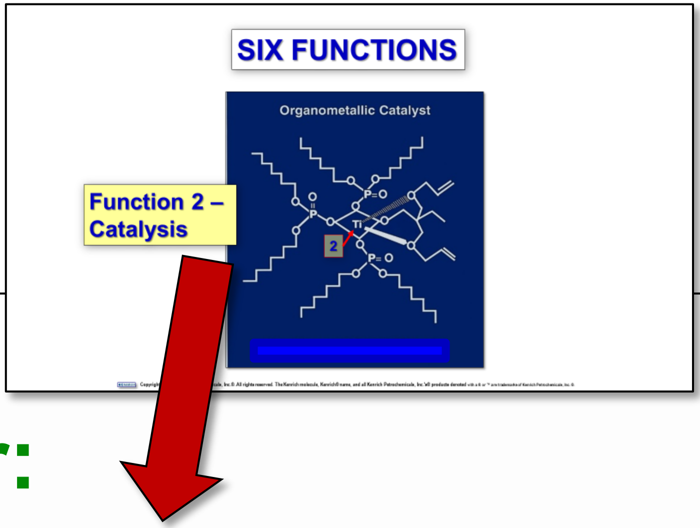
Ken-React®
CAPS®
KPR® 12/LV

SIX FUNCTIONS

Function 2 – Catalysis



Advanced Solutions in Mechanical Recycling with 1.5-Nanometer Titanate Catalysts/Coupling Agents



(2) Titanium, Zirconium & Aluminum Polymer Catalysis –without or with filler:

Polymer Mechanical Properties Are Increased.

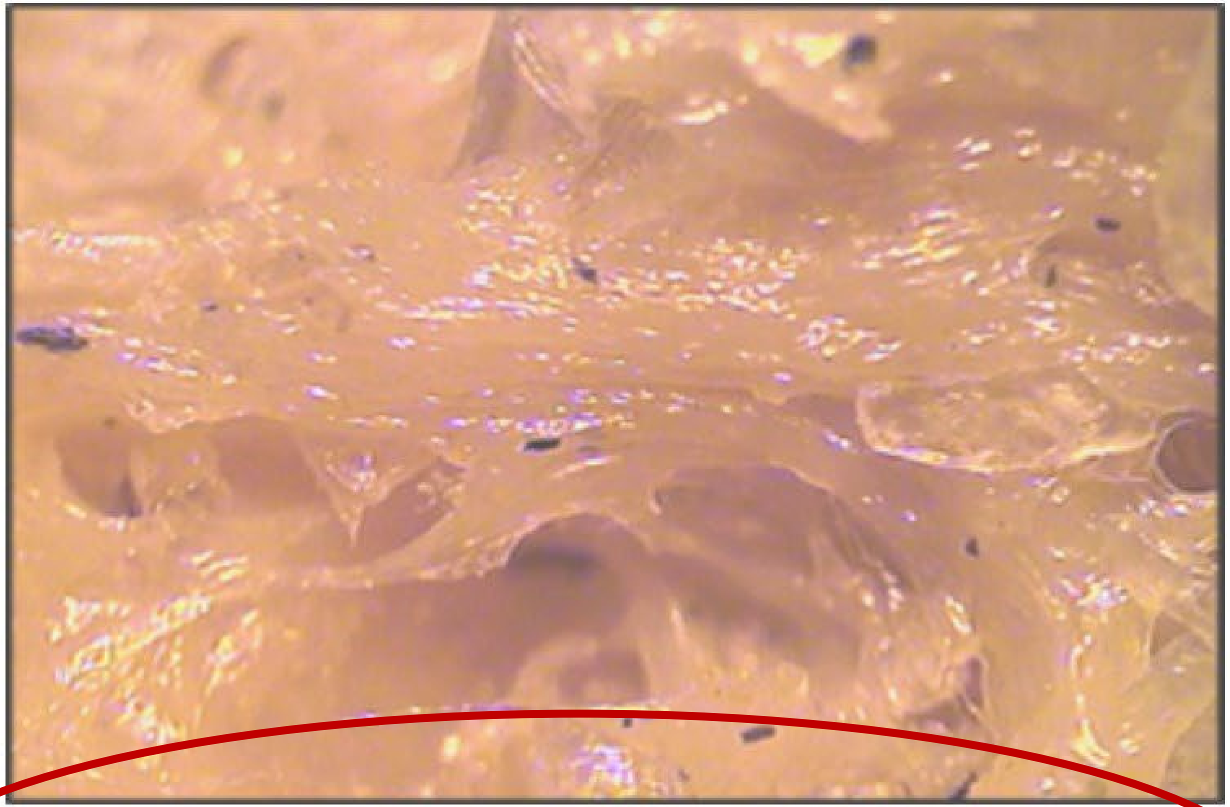
Provides Nano-Titanium Technology for RECYCLING of Polymers #1 to #7

Function 2 Titanium Catalysis for Compatibilization of Addition & Condensation Polymers

Brabender Plasticorder Blends of Three Recycled Polymers: PP/PET/PE

Incompatible PP/PET/PE—

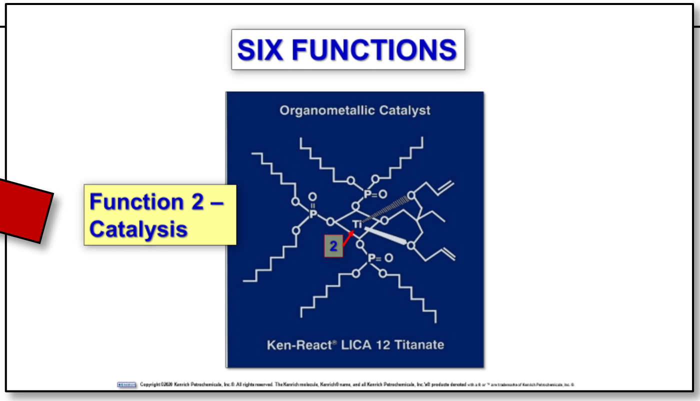
No Additive



Compatibilized PP/PET/PE—

1.5% Ken-React® CAPS® KPR® 12/LV Pellets

(2) Titanium, Zirconium & Aluminum Polymer Catalysis
–without or with filler allows:



- Significant increase in unfilled polymer flow @ 0.2% additive.
- Lower polymer process temperatures from 10 to 40%.
- In situ copolymerization of dissimilar polymers #1 to #7.
- Reduce PVC plasticizer up to 18% to equal elongation.
- Reduced monomer in UV+EB coatings.
- **Repolymerization:** Regenerate regrind to virgin properties.

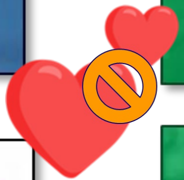

SUSTAINABILITY
Technology Challenge
Recycle Mix: Polymers #1 to #7 &
1 PETE
2 HDPE
3 V
4 LDPE
5 PP
6 PS
7 OTHER
Incompatibility PE & PP
Incompatibility PET & PE
4 LDPE
1 PETE
How to
Compatibilize?

Recycle Mix: Polymers #1 to #7 & Fillers, Fibers, Pigments, etc.

PE & PP are ADDITION POLYMERS

PET is a CONDENSATION POLYMER

Incompatibility PE & PP



Incompatibility PET & PE

RECYCLE Technology Challenge: Incompatibility of Fillers & Polymers

PE & PP are ADDITION POLYMERS

PET is a CONDENSATION POLYMER

Incompatibility PE & PP

Trouble Shooting for Injection Molding Process

- Black Spots, Brown streaks.
- Blisters (Air Entrapment).
- Brittleness.
- Bubbles.
- Burn Marks, Dieseling.
- Cracking, Crazing.
- Delamination.
- Discoloration.
- Excessive Flash.
- Flow, Halo, Blush Marks.
- Gate Stringing, Drooling.
- Gels.
- Jetting.
- Material Leakage.
- Oversized Part.
- Part Sticking.
- Short Shot (Incomplete Filled Parts).
- Sink Marks.
- Splay Marks, Silver Streaks.
- Sprue Sticking.
- Surface Finish (Low Gloss).
- Surface Finish (Scars, Wrinkles).
- Undersized Part.
- Valve Pin Does Not Close.
- Voids.
- Warping, Part Distortion.
- Weld Lines.

Injection Molding Delamination
5% PP (Tupperware) in 95% HDPE (Milk Jug) = part reject

RECYCLE Technology Challenge: Incompatibility of Fillers & Polymers

PE & PP are ADDITION POLYMERS

PET is a CONDENSATION POLYMER

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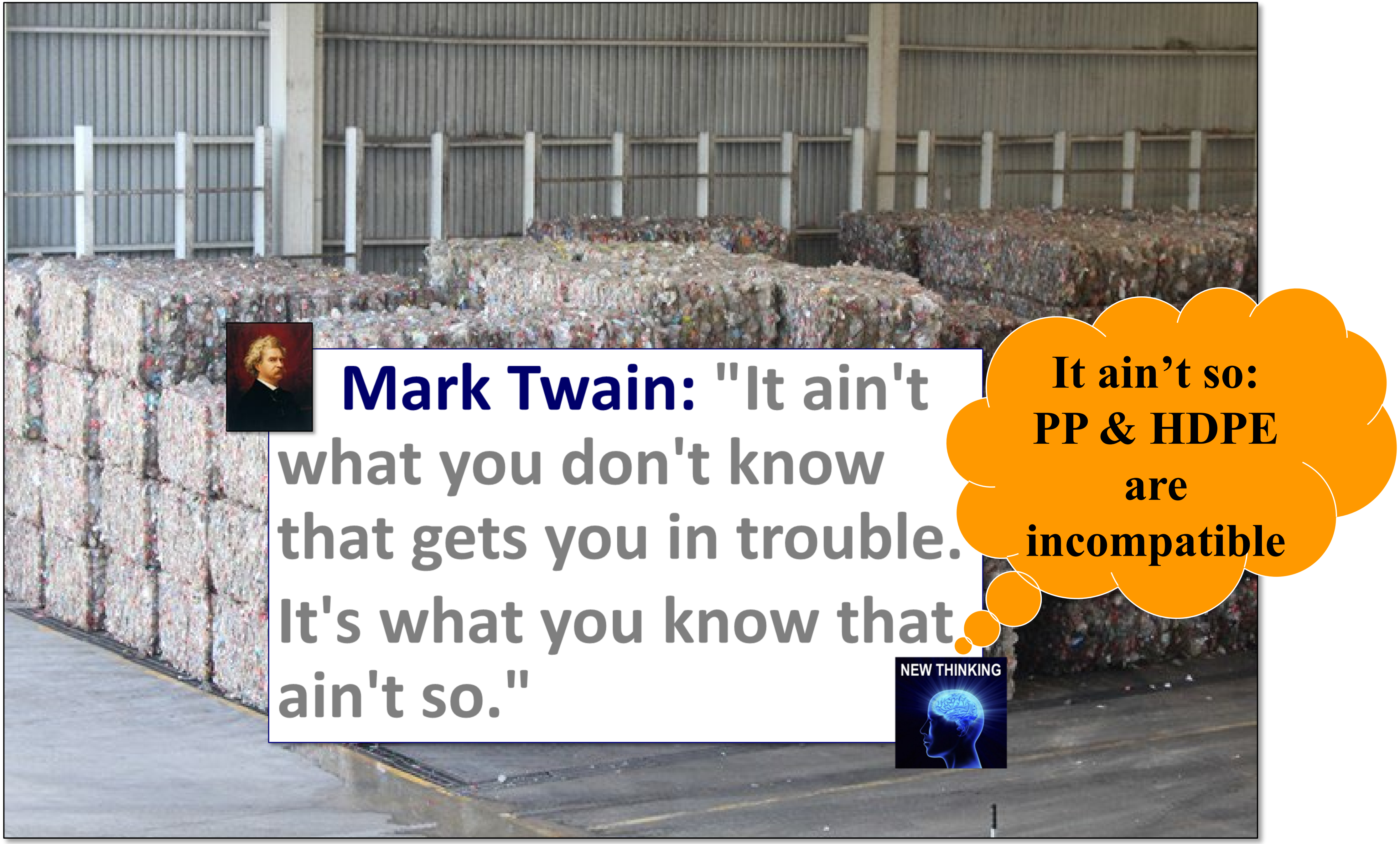
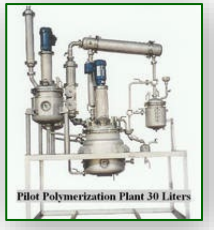
Injection Molding Delamination
5% PP (Tupperware) in 95% HDPE (Milk Jug) = part reject

PP & HDPE are incompatible

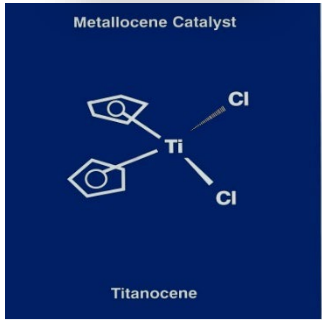

Mark Twain: "It ain't what you don't know that gets you in trouble. It's what you know that ain't so."
It ain't so: PP & HDPE are incompatible
NEW THINKING

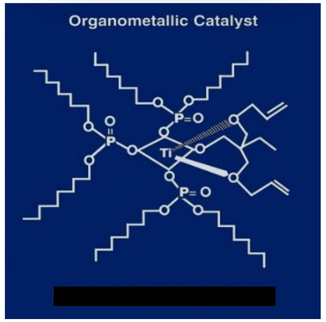
Reactor
Titanocene Polymerization - Ethylene Monomer



Extruder
Titanate Copolymerization - Ethylene Polymers

Injection Molding Delamination
5% PP (Tupperware) in 95% HDPE (Milk Jug) = part reject

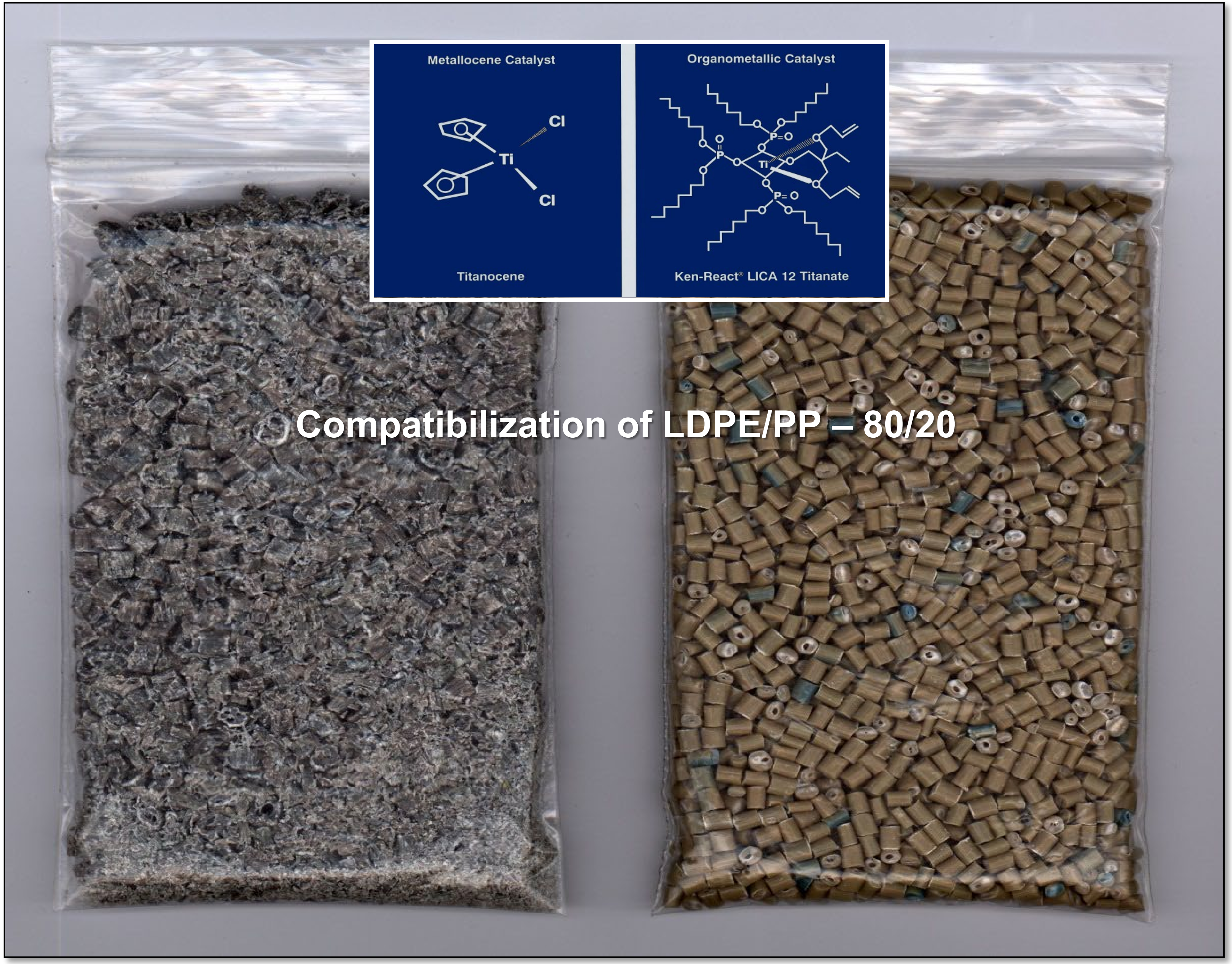




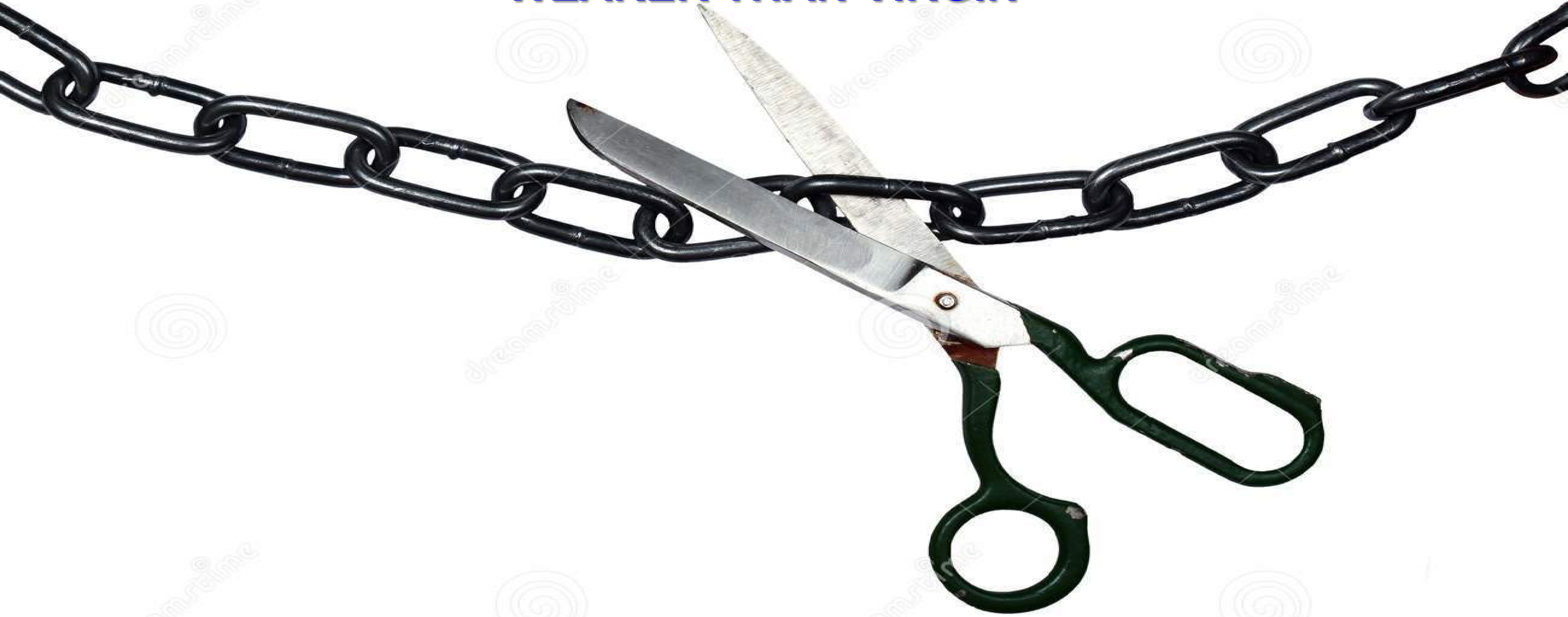
Compatibilization of LDPE/PP – 80/20 Regrind Using 0.2% Titanate Catalyst

PP & HDPE are Compatible

PE & PP are COMPATIBLE



CHAIN SCISSORING DURING MELT PROCESSING IS WHAT MAKES RECYCLE & REGRIND WEAKER THAN VIRGIN



REPOLYMERIZATION of LDPE/PP – 50/50 Regrind

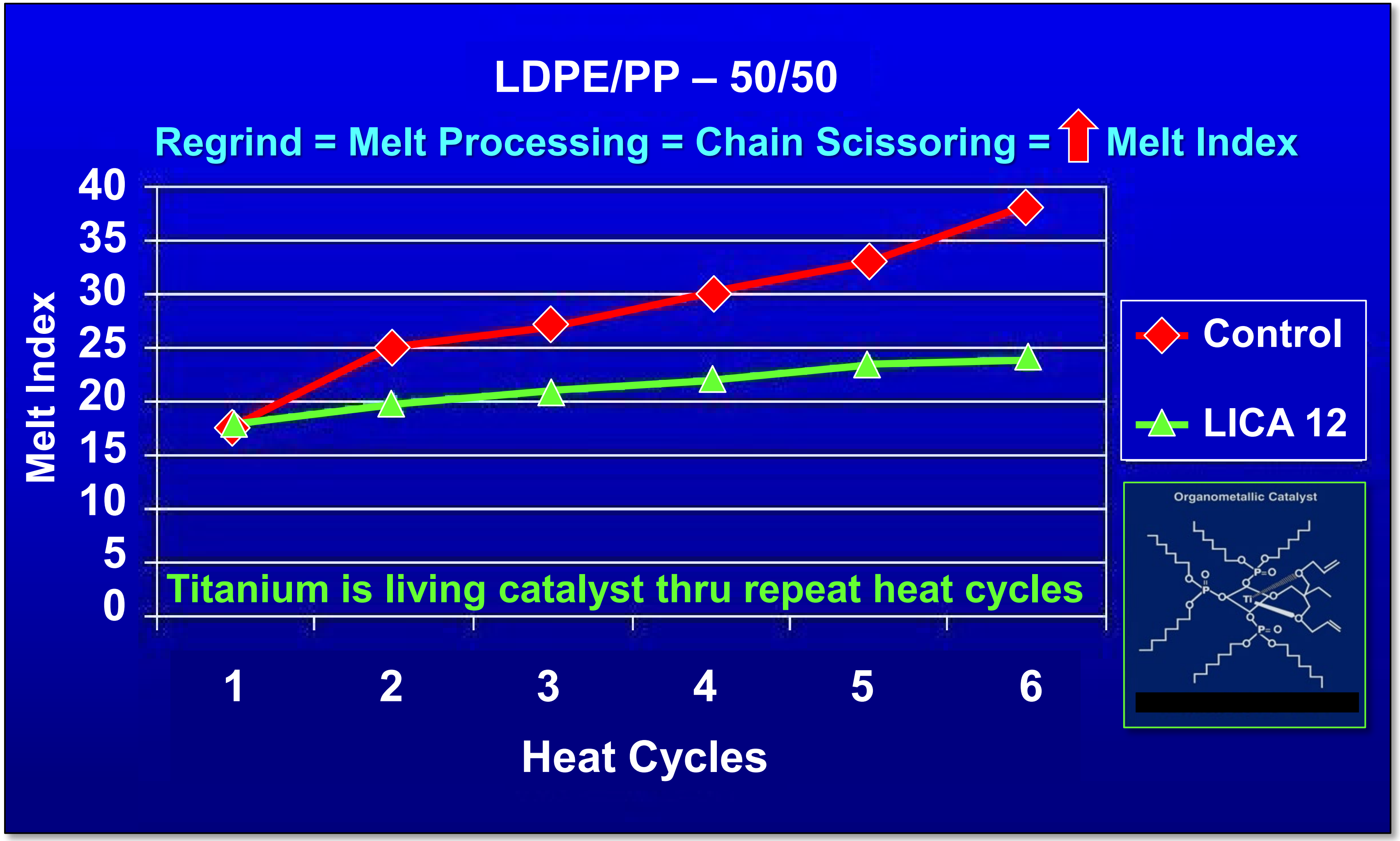
Using 1% Titanate Catalyst Pellet = 2 parts per thousand Titanate

Chain Scissoring Effect - 6 Heat Cycles on LDPE/PP – 50/50 Regrind

Without and With Titanium Catalysis

REPOLYMERIZATION of LDPE/PP – 50/50 Regrind

Using 1% Titanate Catalyst Pellet = 2 parts per thousand Titanate

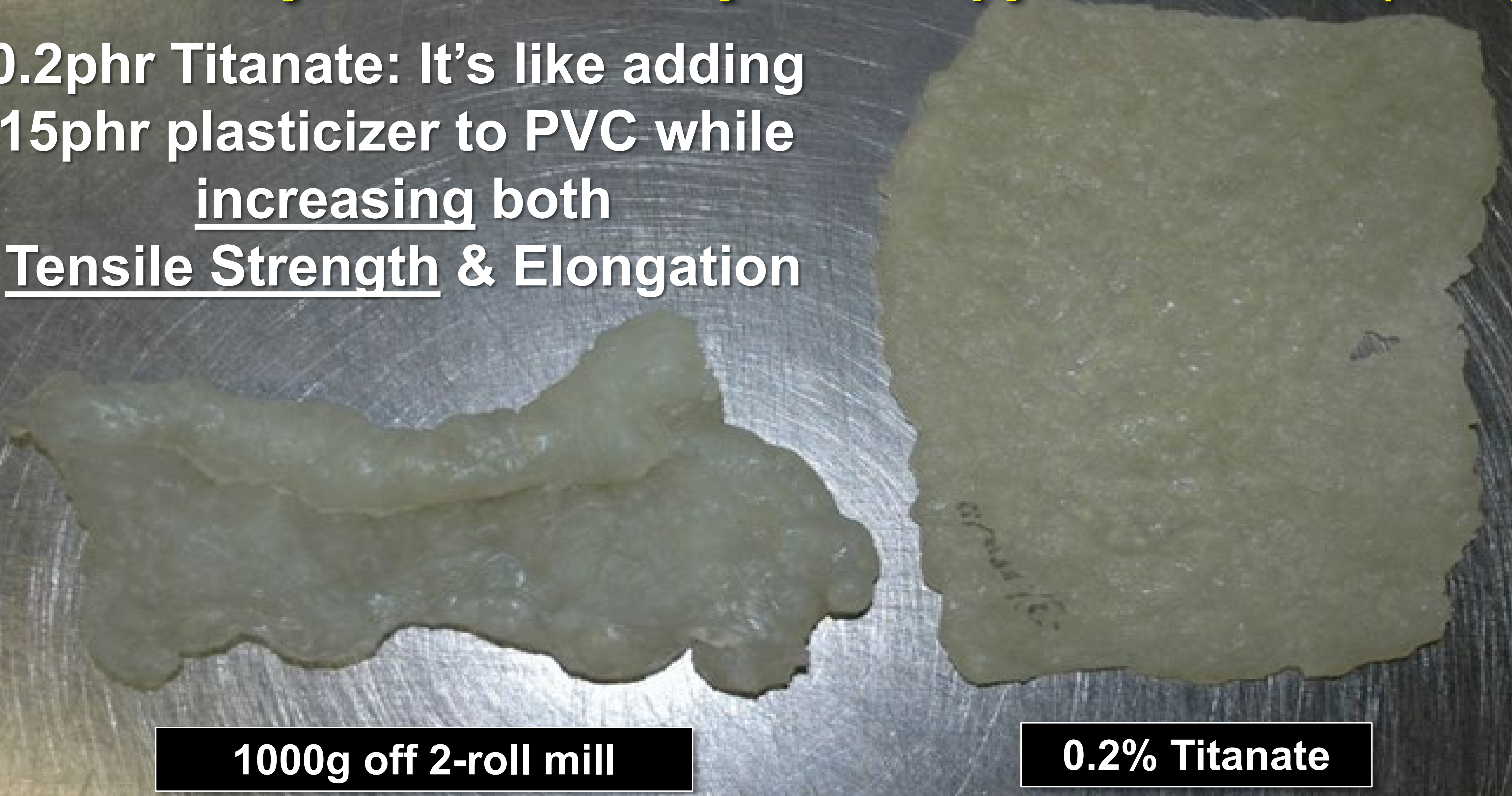


Mark Twain: "It ain't what you don't know that gets you in trouble. It's what you know that ain't so."

You can't plasticize without losing tensile

Titanate Catalysis Unfilled Ethylene Propylene Rubber (EPR)

0.2phr Titanate: It's like adding 15phr plasticizer to PVC while <u>increasing</u> both <u>Tensile Strength</u> & Elongation



It's like adding
15phr plasticizer while
increasing both
Tensile Strength & Elongation

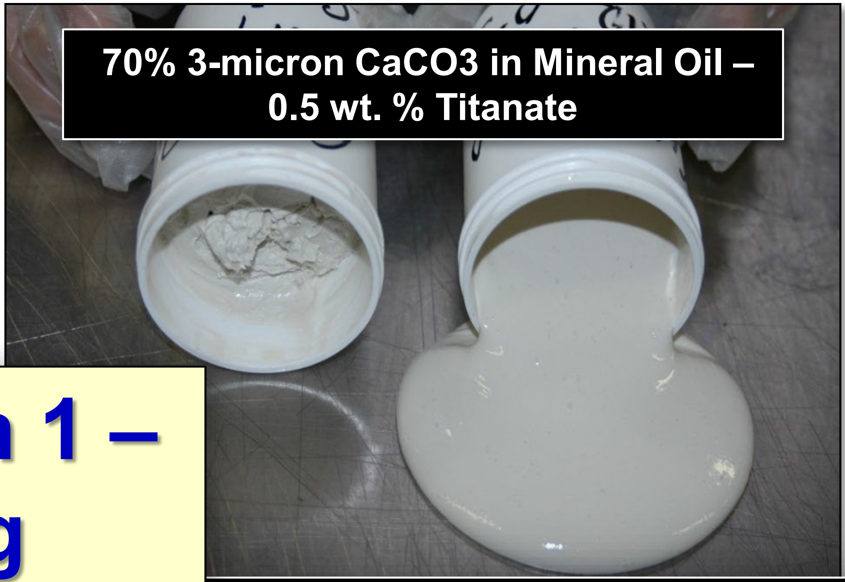
Titanium Catalysis Is How You Increase the COR of a Golf Ball

1000g off 2-roll mill

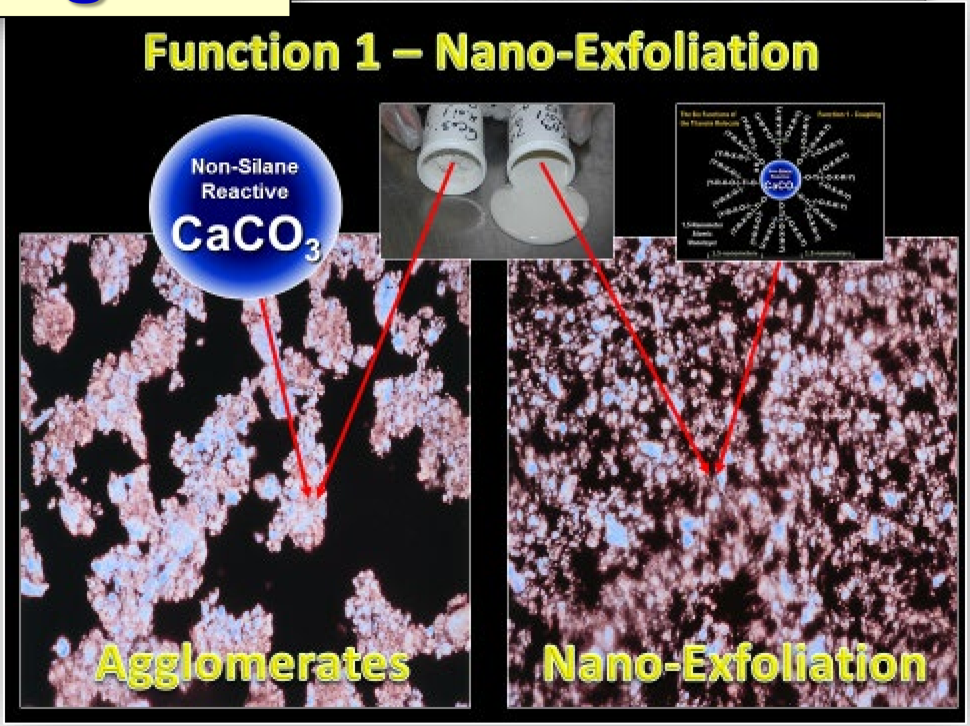
0.2% Titanate

70% 3-micron $CaCO_3$ Filled PP Homo-Polymer - No White Stress Cracking

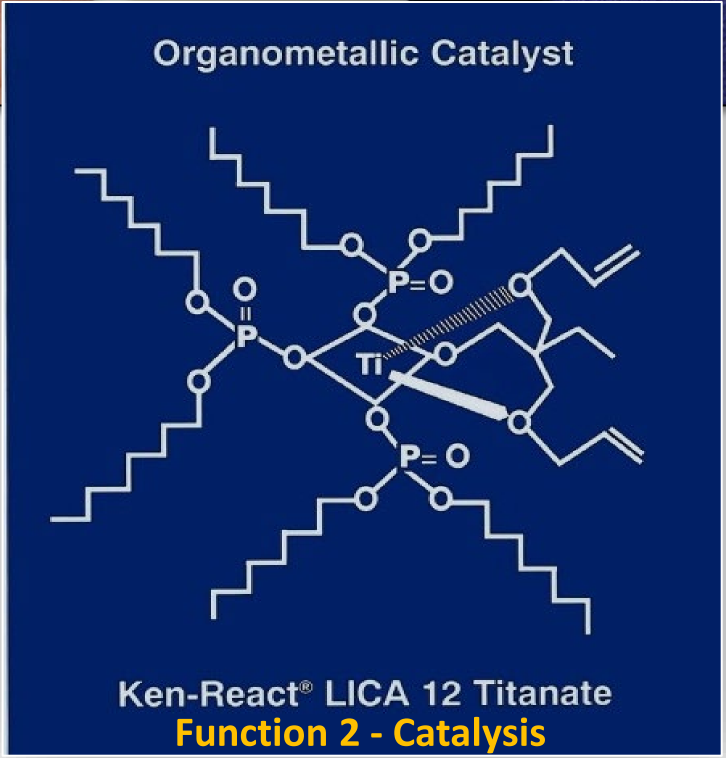
Filler Coupling and Polymer Catalysis = Compatibility



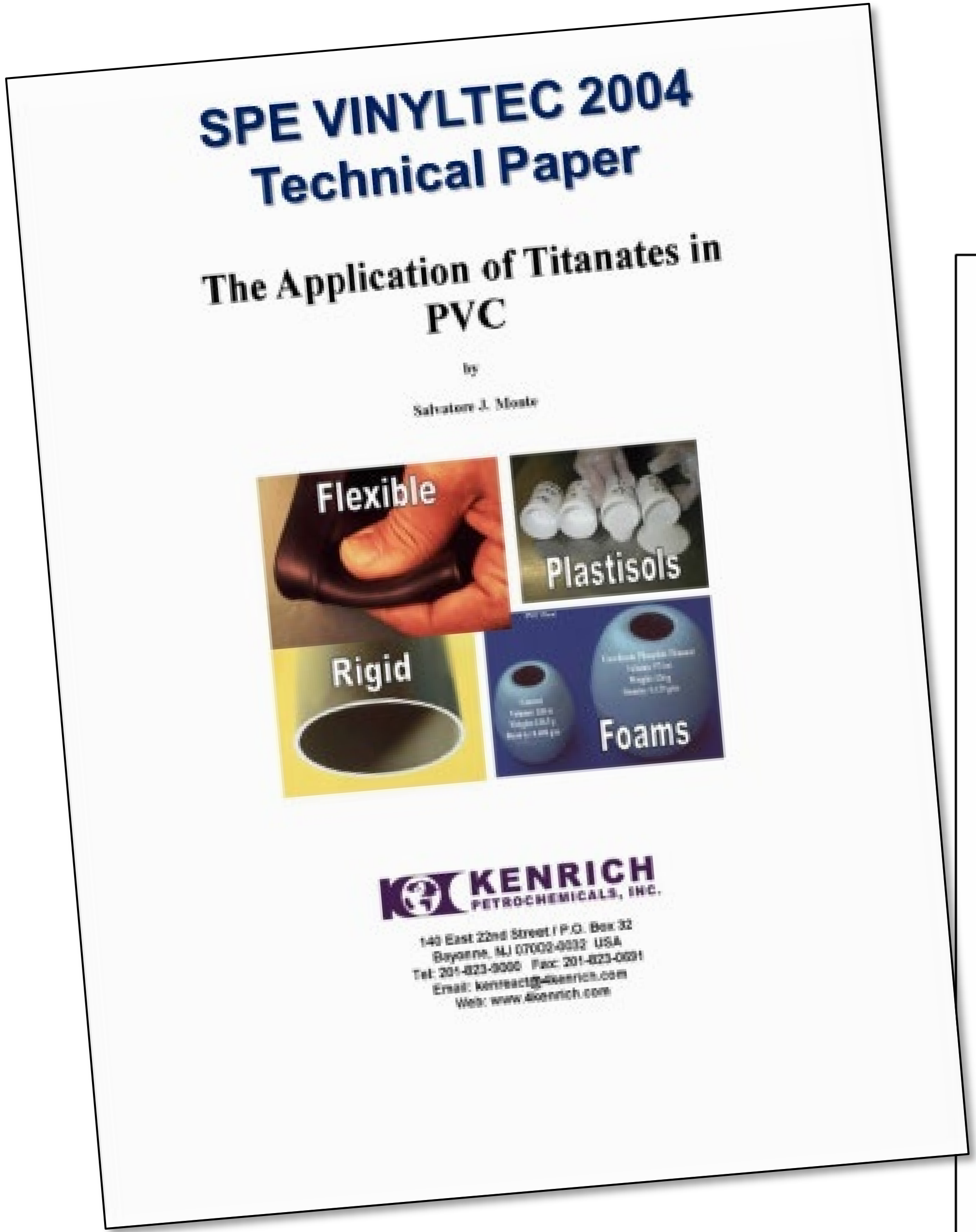
Function 1 – Coupling



Function 2 - Catalysis



Function 2 - Catalysis



SPE VINYLTEC 2004
Technical Paper

The Application of Titanates in PVC

by

Salvatore J. Monte

KENRICH PETROCHEMICALS, INC.

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Bayonne, NJ 07002-0032 USA
Tel: 201-823-9000 Fax: 201-823-0691
Email: kenreact@4kenrich.com
Web: www.4kenrich.com

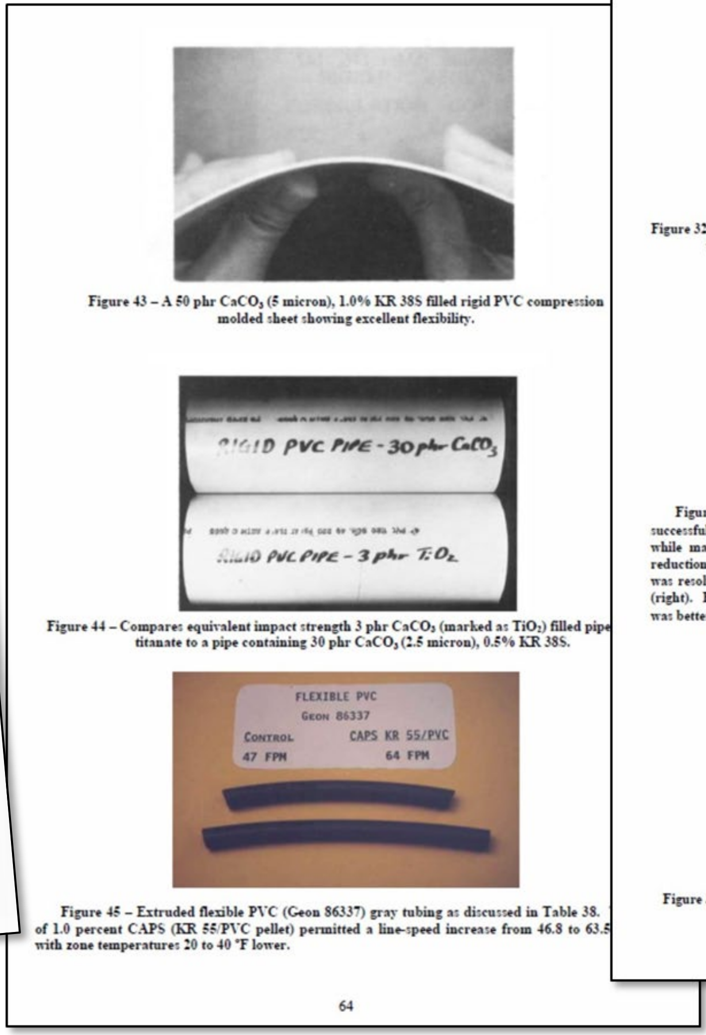

Figure 43 – A 50 phr $CaCO_3$ (5 micron), 1.0% KR 38S filled rigid PVC compression molded sheet showing excellent flexibility.

Figure 44 – Compares equivalent impact strength 3 phr $CaCO_3$ (marked as TiO_2) filled pipe titanate to a pipe containing 30 phr $CaCO_3$ (2.5 micron), 0.5% KR 38S.

Figure 45 – Extruded flexible PVC (Geon 86337) gray tubing as discussed in Table 38. of 1.0 percent CAPS (KR 55/PVC pellet) permitted a line-speed increase from 46.8 to 63.5 with zone temperatures 20 to 40 °F lower.

64

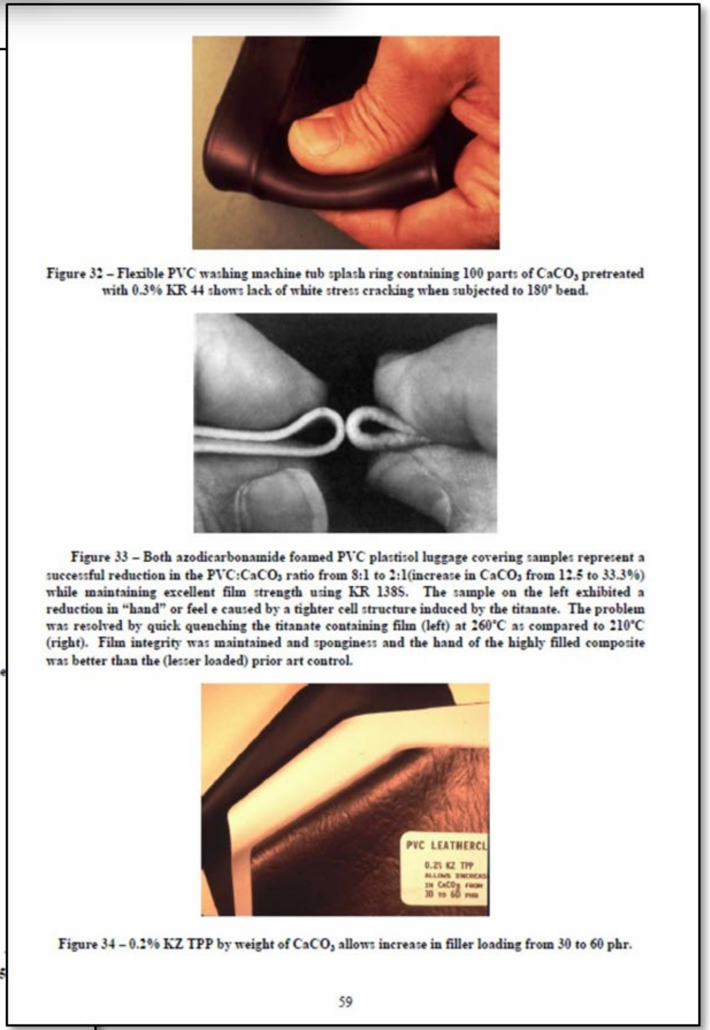

Figure 32 – Flexible PVC washing machine tub splash ring containing 100 parts of $CaCO_3$ pretreated with 0.3% KR 44 shows lack of white stress cracking when subjected to 180° bend.

Figure 33 – Both azodicarbonamide foamed PVC plastisol luggage covering samples represent a successful reduction in the PVC:$CaCO_3$ ratio from 8:1 to 2:1(increase in $CaCO_3$ from 12.5 to 33.3%) while maintaining excellent film strength using KR 138S. The sample on the left exhibited a reduction in "hand" or feel e caused by a tighter cell structure induced by the titanate. The problem was resolved by quick quenching the titanate containing film (left) at 260°C as compared to 210°C (right). Film integrity was maintained and sponginess and the hand of the highly filled composite was better than the (lesser loaded) prior art control.

Figure 34 – 0.2% KZ TPP by weight of $CaCO_3$ allows increase in filler loading from 30 to 60 phr.

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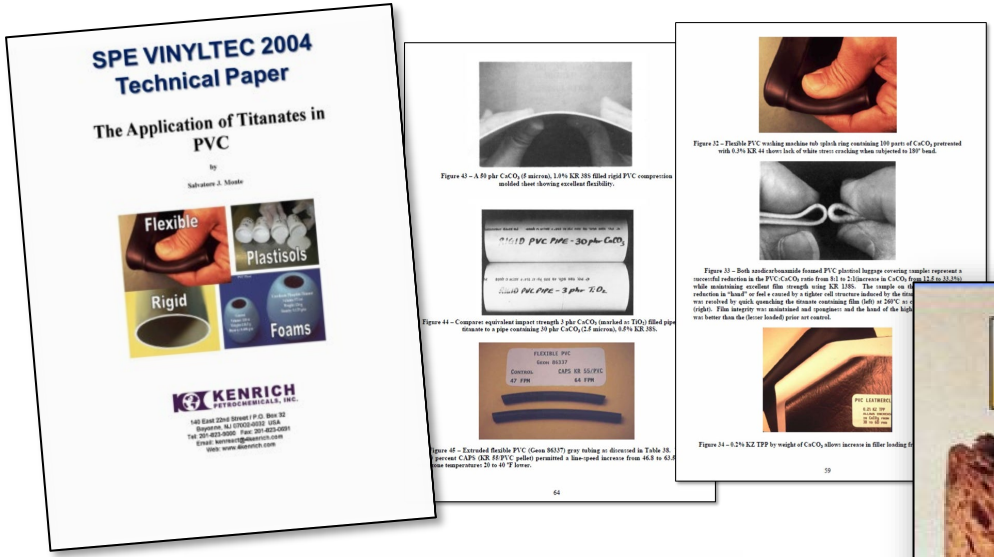
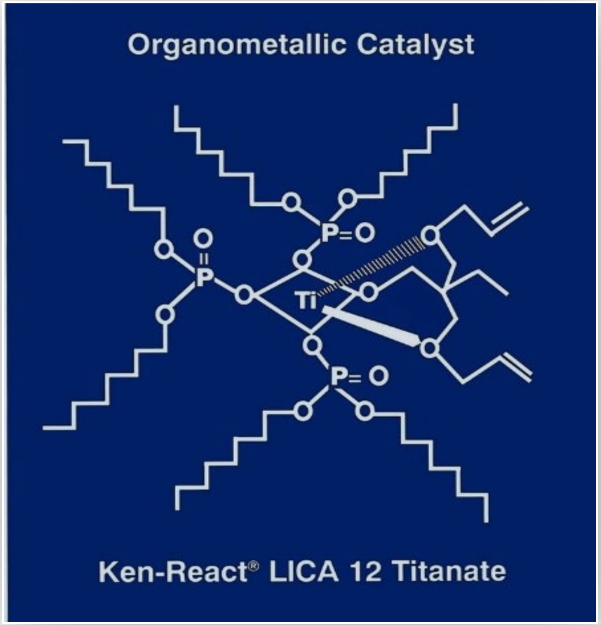
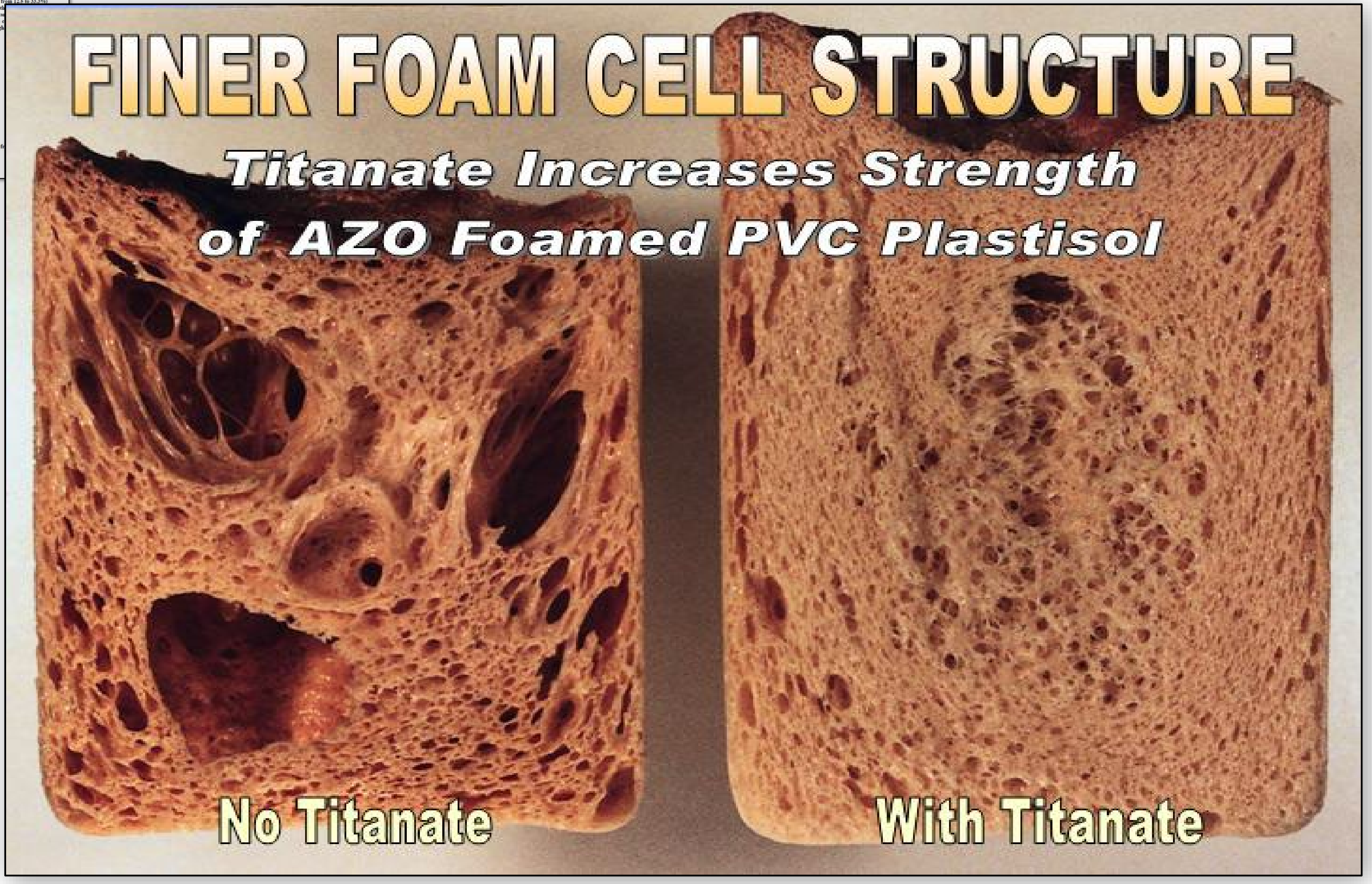
Function 2 - Catalysis





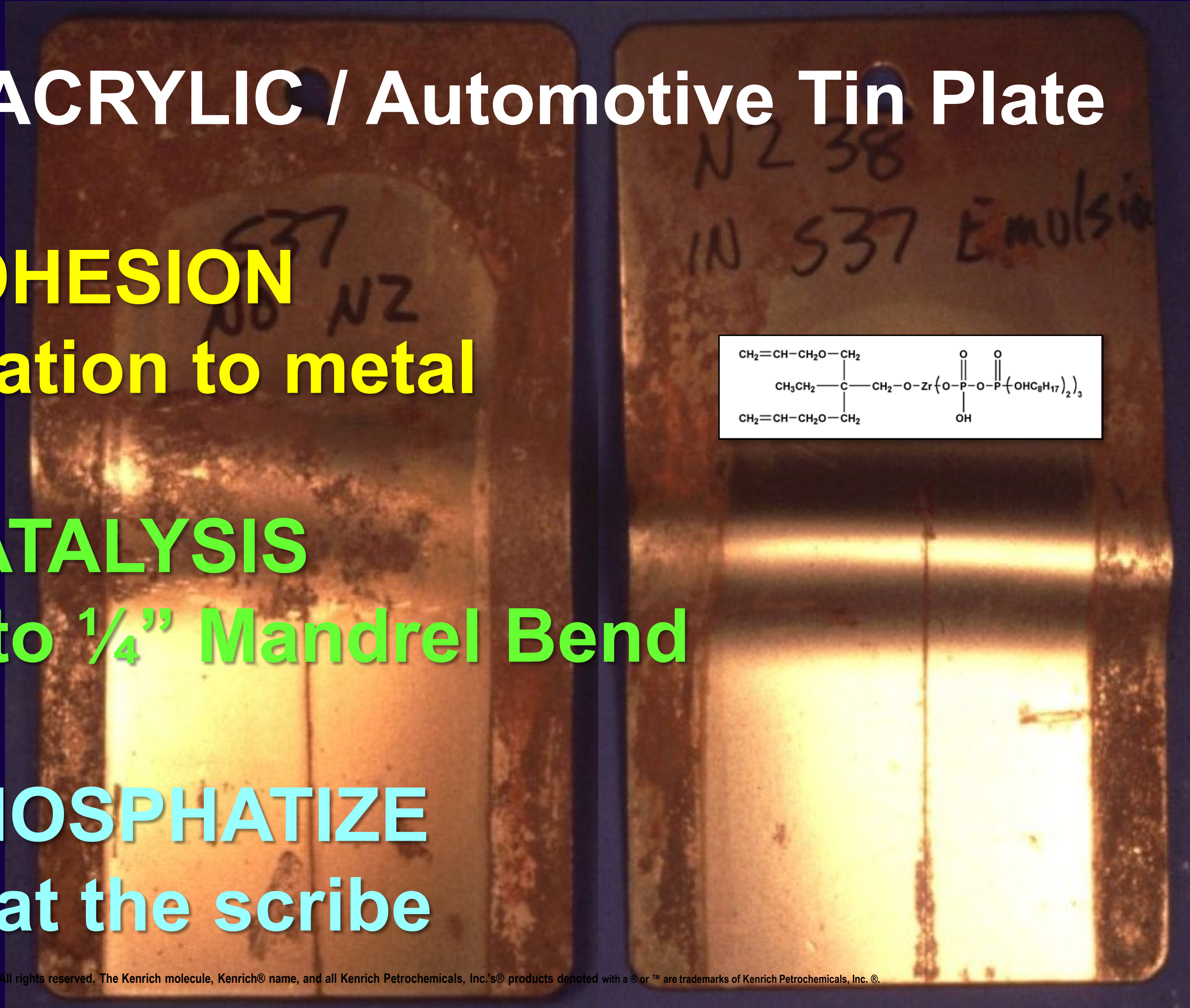


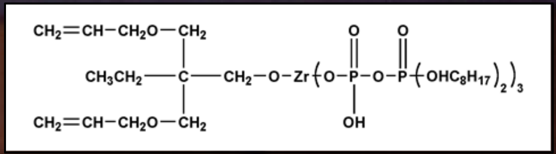
UNFILLED WB ACRYLIC / Automotive Tin Plate

Function 1 – ADHESION
Proton Coordination to metal

Function 2 – CATALYSIS
Flexibilize – 1” to ¼” Mandrel Bend

Function 3 – PHOSPHATIZE
Anti-Corrosion at the scribe





UNFILLED WB ACRYLIC Automotive Tin Plate

Function 1 – ADHESION

Function 2 – CATALYSIS

Function 3 – PHOSPHATIZE for nano-Ti-Phosphorus Intumescence – Flame Retardance

- **Nano-Titanium Phosphatize for Flame Retardance.**

July 19, 20, 26, & 27 | 2pm - 4pm ET | Virtual

2021 Vinyl Recycling Summit

Hosted by

VINYL SUSTAINABILITY COUNCIL

Advanced Solutions in Vinyl Recycling with Titanate Catalysts/Coupling Agents

Salvatore J. Monte – Kenrich Petrochemicals, Inc.

July 20, 2021 – 2:00-4:00pm

KENRICH PETROCHEMICALS, INC.

PROBLEM SOLVING RECYCLE IS A COMPLEX MATERIALS CHALLENGE

Insensitive Munitions & Energetic Materials (IMEM) Technology Symposium

April 7-8, 2021

Virtual Conference

NDIA National Defense Industrial Association

Advanced Insensitive Munitions & Energetic Materials Concepts Using 1.5-Nanometer Titanates & Zirconates

Salvatore J. Monte

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KENRICH PETROCHEMICALS, INC.

Distribution Statement A, Approved for public release. Distribution Unlimited

PROBLEM SOLVING INSENSITIVE MUNITIONS IS A COMPLEX MATERIALS CHALLENGE

Solved The 2-Decade Problem of Unplanned Detonation

Nano-Titanium Phosphatize for Flame Retardance

Classified TOP SECRET for DOD IM Program

RDX/CAB & Plastic Bound Explosives

US006197135B1

(12) **United States Patent**
Monte et al.

(10) **Patent No.:** US 6,197,135 B1
(45) **Date of Patent:** *Mar. 6, 2001

(54) ENHANCED ENERGETIC COMPOSITES

(75) Inventors: **Salvatore J. Monte**, Staten Island, NY (US); **Gerald Sugerman**, Allendale, NJ (US)

(73) Assignee: **Kenrich Petrochemicals, Inc.**, Hudson, NJ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: 06/841,471

(22) Filed: Feb. 18, 1986

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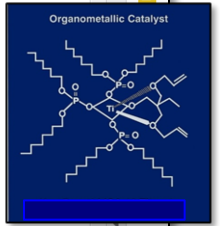
4,051,207	*	9/1977	Brachert et al.	149/100
4,139,404	*	2/1979	Goddard et al.	149/19.2
4,260,437	*	4/1981	Nakagawa et al.	149/19.9
4,352,700	*	10/1982	Hoffman	149/19.2
4,354,884	*	10/1982	Williams	149/10
4,597,924	*	7/1986	Allen et al.	149/19.91
4,713,127	*	12/1987	Muller et al.	149/98
4,985,094	*	1/1991	Nahlovsky et al.	149/19.9

* cited by examiner

Primary Examiner—Edward A. Miller
(74) *Attorney, Agent, or Firm*—Darby & Darby

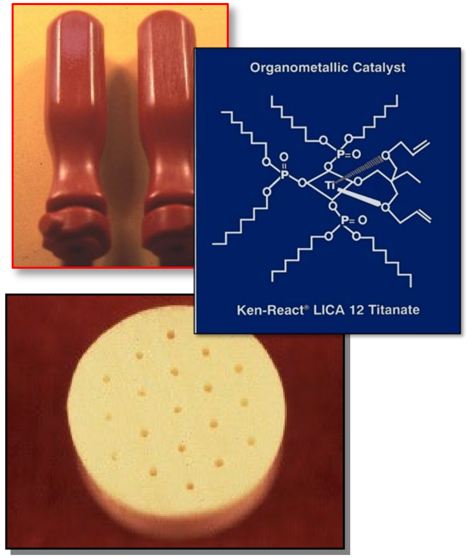
The instant invention relates to the use of certain selected neoalkoxy organo-titanates and organo-zirconates in energetic compositions to improve their processability, physical



Issued Mar 6, 2001

Held under DoD Secrecy Orders for 15-years-1-month

Filed Feb. 18, 1986



0.5% LICA-12 Titanate on Vulnerability of 85% HMX / Al Filled CAB Explosive

US Army Patent – "Insensitive Explosive Composition"

US005472531A

United States Patent [19]
Turci et al.

[11] **Patent Number: 5,472,531**
[45] **Date of Patent: Dec. 5, 1995**

[54] **INSENSITIVE EXPLOSIVE COMPOSITION**

[75] Inventors: **Joseph Turci**, Long Valley, N.J.; **Mark Mezger**, Mt. Bethel, Pa.; **Bernard Strauss**, Rockaway; **Thelma Manning**, Montville, both of N.J.

[73] Assignee: **The United States of America as represented by the Secretary of the Army**, Washington, D.C.

[21] Appl. No.: **385,843**

[22] Filed: **Feb. 1, 1995**

Related U.S. Application Data

[63] Continuation of Ser. No. 983,954, Dec. 1, 1992, abandoned.

[51] **Int. Cl.**[6] **C06B 25/34**
[52] **U.S. Cl.** **149/92**; 149/88; 149/109.6
[58] **Field of Search** 149/92, 88, 109.6

[56] References Cited

4,853,051 8/1989 Bennett et al. 149/19.4
5,240,523 8/1993 Willer 149/19.4

Primary Examiner—Donald P. Walsh
Assistant Examiner—Anthony R. Chi
Attorney, Agent, or Firm—Anthony T. Lane; Edward Goldberg; John E. Callaghan

[57] **ABSTRACT**

The explosive blasting composition in this invention contains 1 to 40 percent Aluminum powder, 40 to 80 percent Cyclotetramethylene Tetranitramine, 4 to 15 percent Cellulose Acetate Butyrate, 5 to 20 percent of 1:1 mixture of bis 2,2-dinitropropyl acetate and bis 2,2-dinitropropyl formal, and, and 0.25 to 0.75 percent Tri (dioctyl Phosphato) Titanate.

The method of making the above composition consists of combining Cyclotetramethylene Tetranitramine, Cellulose Acetate Buterate, 1:1 bis 2,2-dinitropropyl acetate and bis 2,2-dinitropropropyl formal, and tri (dioctyl phosphato) titanate, mixed at an elevated temperature for a period of time. Prior to blowdown, the Aluminum powder is added, to

Control	Sensitive
0.25% LICA 12	Brittle Extrudate
0.50% LICA 12	Patentable Insensitive
0.75% LICA 12	" Too Inert"

Function 1 – Dosage; Function 2 - Catalysis
Function 3 – Nano- Ti-Phosphatization

US005472531A

United States Patent [19]

Turci et al.

[11] **Patent Number: 5,472,531**

[45] **Date of Patent: Dec. 5, 1995**

Distribution Statement A, Approved for public release. Distribution Unlimited

[54] **INSENSITIVE EXPLOSIVE COMPOSITION**

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[73] Assignee: **The United States of America as represented by the Secretary of the Army**, Washington, D.C.

[21]
[22]
[63]
[51]
[52]
[58]

- **Aluminum Powder**
- **(HMX)**
- **Cellulose Acetate Butyrate**
- **Bis 2,2-dinitropropyl acetate**
- **Bis 2,2-dinitropropyl formal**
- **Tri(dioctyl Phosphato) Titanate @ 0.25 to 0.75 percent**

[56] References Cited

4,853,051 8/1989 Bennett et al. 149/19.4
5,240,523 8/1993 Willer 149/19.4

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Assistant Examiner—Anthony R. Chi
Attorney, Agent, or Firm—Anthony T. Lane; Edward Goldberg; John E. Callaghan

Issued Dec. 5, 1995

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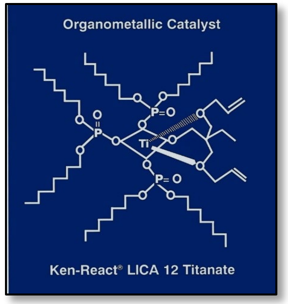
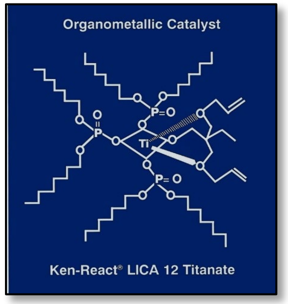
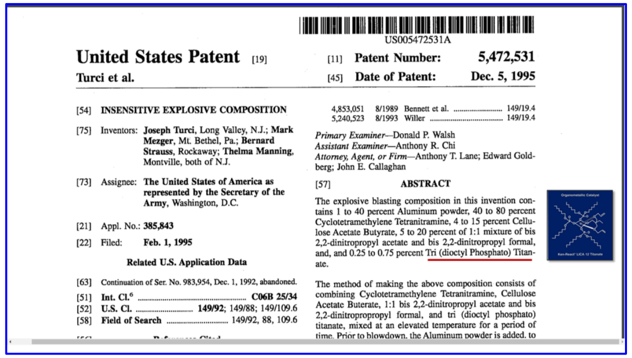




BACKGROUND



US005472531A

United States Patent [19] — Turci et al.

[11] **Patent Number:** 5,472,531
[45] **Date of Patent:** Dec. 5, 1995

[54] **INSENSITIVE EXPLOSIVE COMPOSITION**

[75] Inventors: **Joseph Turci**, Long Valley, N.J.; **Mark Mezger**, Mt. Bethel, Pa.; **Bernard Strauss**, Rockaway; **Thelma Manning**, Montville, both of N.J.

[73] Assignee: **The United States of America as represented by the Secretary of the Army**, Washington, D.C.

[21] Appl. No.: **385,843**

[22] Filed: **Feb. 1, 1995**

Related U.S. Application Data

[63] Continuation of Ser. No. 983,954, Dec. 1, 1992, abandoned.

[51] **Int. Cl.**[6] **C06B 25/34**
[52] **U.S. Cl.** **149/92**; 149/88; 149/109.6
[58] **Field of Search** 149/92, 88, 109.6

4,853,051 8/1989 Bennett et al. 149/19.4
5,240,523 8/1993 Willer 149/19.4

Primary Examiner—Donald P. Walsh
Assistant Examiner—Anthony R. Chi
Attorney, Agent, or Firm—Anthony T. Lane; Edward Goldberg; John E. Callaghan

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...Safety is the uppermost in the minds of the military when fielding such compositions.

...We have found that our composition (based on 0.5% LICA 12) *is the only composition at present, that can meet safety requirements. Various tests have shown that our composition performs as well or even better than any experimental blasting composition known to date. In fact our tests have shown that it performs ten percent better than the compositions of the art.*

METHOD OF MAKING PREFERRED EMBODIMENT OF THE INVENTION

Nano-Titanium Phosphatize for Flame Retardance

Column 2, Line 18. *Optionally LICA-12 may be used but not below 0.25% because it does not have the structural integrity to be able to cut. However, again, above 0.75% the composition is too inert.*

Titanium Catalysis

REPOLYMERIZATION

2021 Vinyl Recycling Summit

Hosted VINYLTEC 2010 as Preside

PLASTICS Voting Member & Recycle Su

SPE Fellow & Honored Service Me

PPA Board of Governors – N

450- ACS CAS Abstracted Wo

32-US Patents Filed Worldwide

Classified TOP SECRET for DOD IM

PLASTICS Hall of Fame 2021

Salvatore J. Monte, President

KENRICH PETROCHEMICALS, INC.

One of 32-US Patents: "REPOLYMERIZATION" Mechanical Properties of 11 – Unfilled Plastics

***

6-Ti/Zr @ 4 dosages

United States Patent [19]

[11] Patent Number: **4,657,988**

[45] Date of Patent: **Apr. 14, 1987**

[54] REPOLYMERIZATION

[75] Inventors: Gerald Sugerman, Allendale, N.J.; Salvatore J. Monte, Staten Island, N.Y.

[73] Assignee: Kenrich Petrochemicals, Inc., Bayonne, N.J.

[21] Appl. No.: 834,794

[22] Filed: Feb. 28, 1986

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 725,437, Apr. 22, 1985, which is a continuation-in-part of Ser. No. 609,727, May 14, 1984, abandoned.

[51] Int. Cl.[4] C08G 63/76

[52] U.S. Cl. 525/437; 525/390; 525/444; 525/453; 525/534; 528/17; 528/56; 528/207; 528/279; 528/286; 528/288

[58] Field of Search 525/390, 437, 444, 453, 525/534; 528/17, 56, 207, 279, 286, 288

[56] References Cited

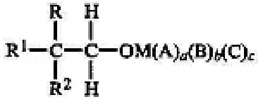
U.S. PATENT DOCUMENTS

4,036,796	7/1977	Sugiyama et al.	525/437 X
4,115,371	9/1978	Bier et al.	528/286 X
4,148,989	4/1979	Tews et al.	525/437
4,452,970	6/1984	Brunelle	528/279
4,454,312	6/1984	Kuze et al.	528/279 X
4,482,700	11/1984	Kühnrich et al.	528/279

Primary Examiner—Lucille M. Phynes
Attorney, Agent, or Firm—Bert J. Lewen; Henry Sternberg

[57] ABSTRACT

Polymeric materials are repolymerized by intensely admixing the polymer with an additive having the formula:

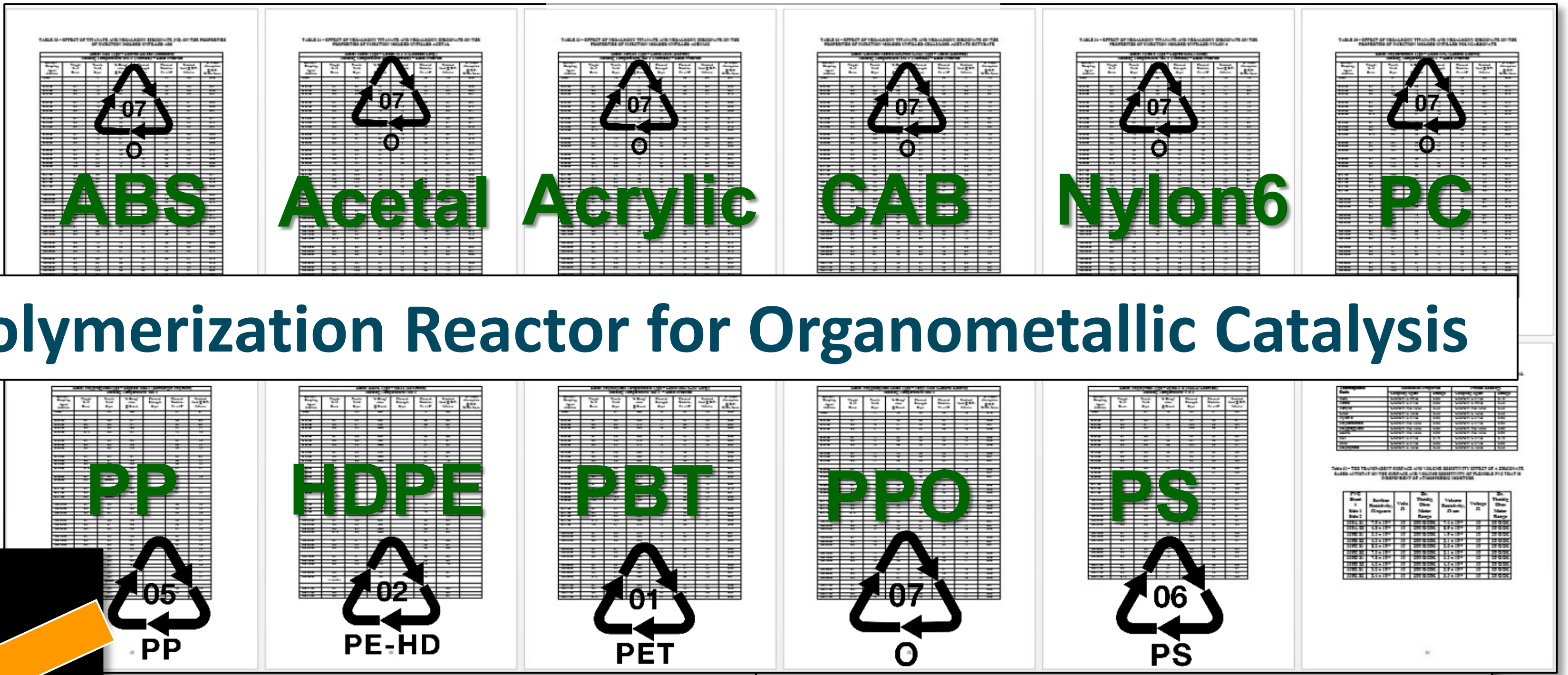


wherein M is titanium or zirconium, R, R^1 and R^2 are each a monovalent alkyl, alkenyl, alkynyl, aralkyl, aryl or alkaryl group having up to 20 carbon atoms or a halogen or ether substituted derivative thereof, and, in addition, R^2 may also be an oxy derivative or an ether substituted oxy derivative of said groups; A, B, and C are each a monovalent aroxy, thioaroxy, diester phosphate, diester pyrophosphate, oxyalkylamino, sulfonyl or carboxyl containing up to 30 carbon atoms; and $a+b+c=3$. The repolymerized polymers have improved physical properties and higher heat distortion temperatures, experience less thermal degradation and show greater solvolysis resistance than the polymers prior to the repolymerization.

5 Claims, No Drawings

REPOLYMERIZATION
11 – Unfilled Plastics
***
6-Ti/Zr @ 4 dosages

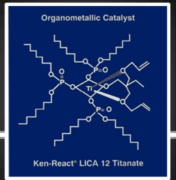
Unfilled Plastics Data



The Extruder acts as a Polymerization Reactor for Organometallic Catalysis

05
PP

UNFILLED PP



EFFECT OF NEOALKOXY TITANATE CAPOW L 12/H ON THE PROPERTIES OF INJECTION MOLDED UNFILLED PP

Coupling Agent Additive	Weight % of Resin	Tensile Yield K psi	% Elong. @ Break	Flexural Modulus psi x 10^4	Notched Izod @ R.T. ft.lb./in.
Control	0.00	4.9	120	21	0.7
L 12/H	0.10	5.4	127	24	0.9
L 12/H	0.30	5.7	142	26	1.1
L 12/H	0.50	5.6	148	22	1.4
L 12/H	0.75	5.2	139	21	1.1

Titanium Catalysis

Catalytic dosages:
2 to 3 pts titanate / 1,000 pts polymer

United States Patent [19] [11] Patent Number: 4,657,988

[54] REPOLYMERIZATION

Salvatore J. Monte, Staten Island, N.Y.

[73] Assignee: Kenrich Petrochemicals, Inc., Bayonne, N.J.

[21] Appl. No.: 834,794

[22] Filed: Feb. 28, 1986

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[51] Int. Cl.⁴ C08G 63/76

[52] U.S. Cl. 525/437; 525/390; 525/444; 525/453; 525/534; 528/17; 528/56; 528/207; 528/279; 528/286; 528/288

[58] Field of Search 525/390, 437, 444, 453, 525/534; 528/17, 56, 207, 279, 286, 288

[56] References Cited

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4,036,796	7/1977	Sugiyama et al.	525/437 X
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4,148,989	4/1979	Tews et al.	525/437
4,452,970	6/1984	Brunelle	528/279
4,454,312	6/1984	Kuze et al.	528/279 X
4,482,700	11/1984	Kühnrich et al.	528/279

Primary Examiner—Lucille M. Phynes

Sternberg

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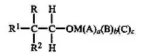
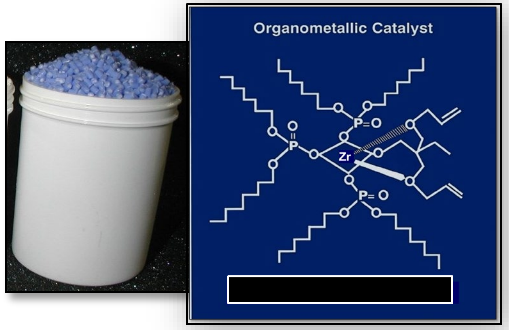
Polymeric materials are repolymerized by intensely admixing the polymer with an additive having the formula:

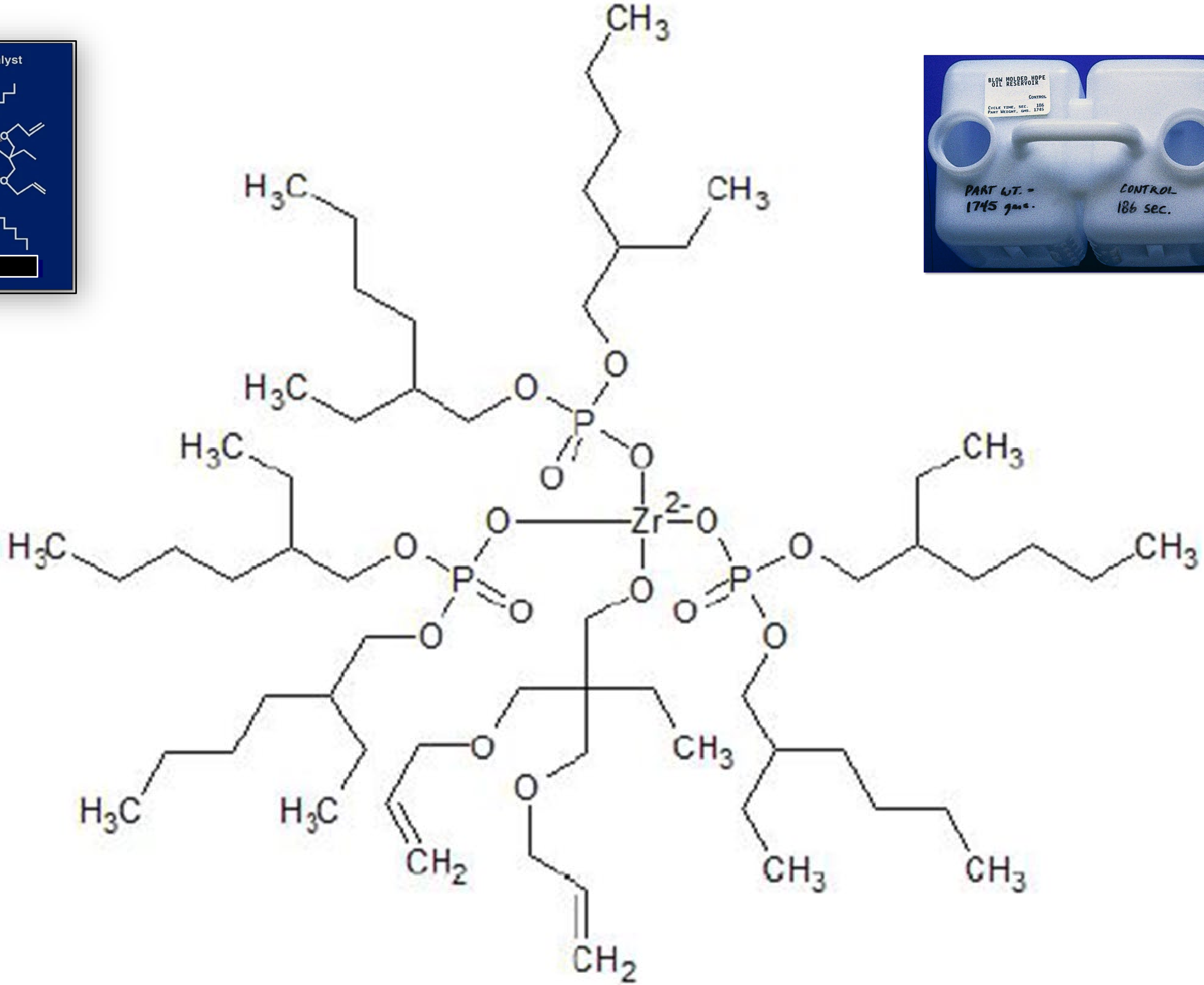


wherein M is titanium or zirconium, R, R^1 and R^2 are each a monovalent alkyl, alkenyl, alkynyl, aralkyl, aryl or alkaryl group having up to 20 carbon atoms or a halogen or ether substituted derivative thereof, and, in addition, R^2 may also be an oxy derivative or an ether substituted oxy derivative of said groups; A, B, and C are each a monovalent aroxy, thioaroxy, diester phosphate, diester pyrophosphate, oxyalkylamino, sulfonyl or carboxyl containing up to 30 carbon atoms; and $a+b+c=3$. The repolymerized polymers have improved physical properties and higher heat distortion temperatures, experience less thermal degradation and show greater solvolysis resistance than the polymers prior to the repolymerization.

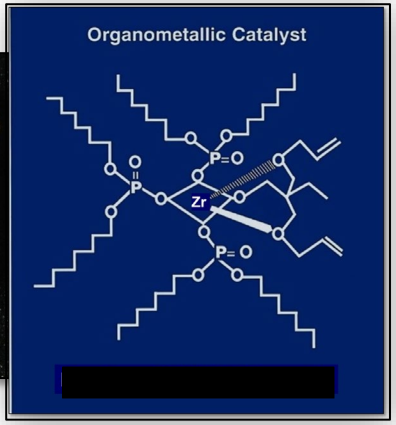
5 Claims, No Drawings

HDPE Regrind Using 0.2% Zirconate Catalyst as Pellet Masterbatch





HDPE Regrind Using 0.2% Zirconate Catalyst as Pellet Masterbatch



[redacted]

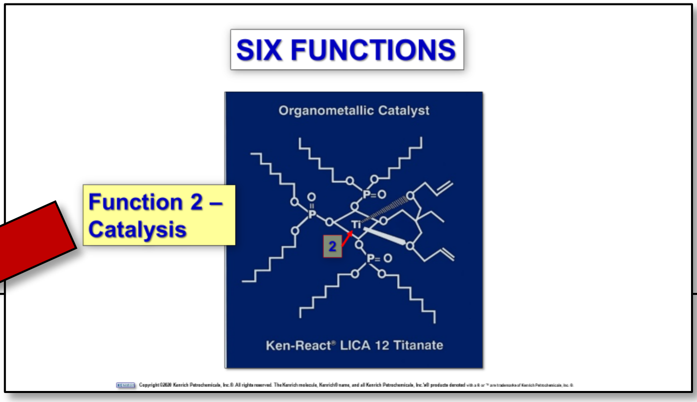
- Used 100% Regrind.
- Reduced Part Wt. from 1745g to 1500g to equivalent drop weight impact strength.
- Reduced Cycle Time 156 to 116 seconds.

New thinking in Compatibilization & Polymer Regeneration via Ti / Zr Coupling & Catalysis to reduce the need & cost to sort materials so as to broaden Mechanical Recycling Compounding Capability

***

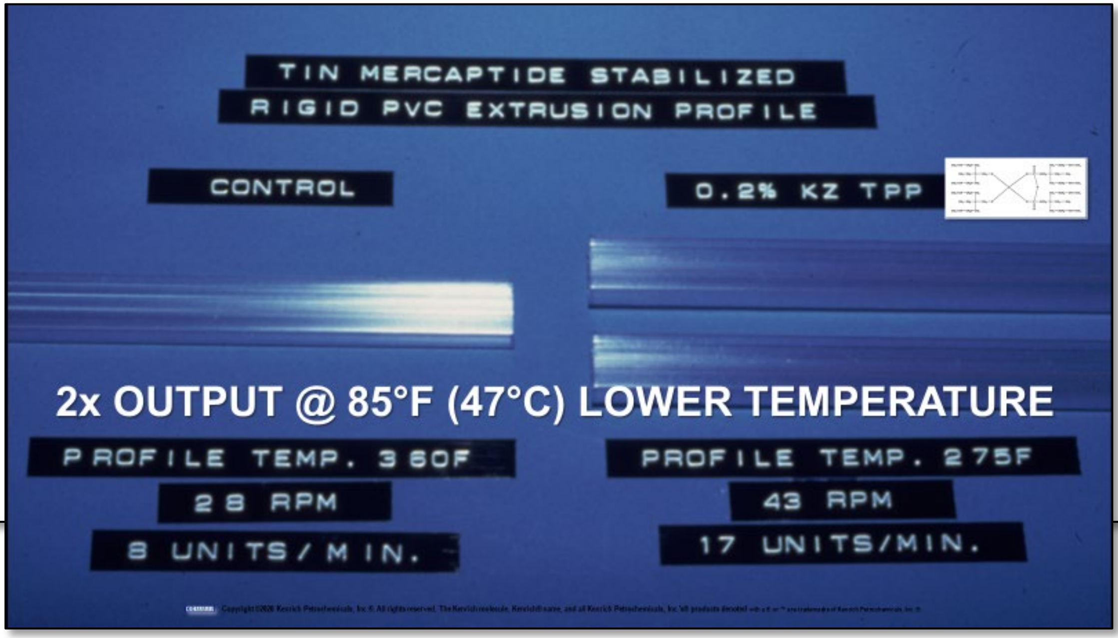
PVC, PC & PA6 & other Engineering Plastics can be processed at much lower temperatures.

Advanced Solutions in Mechanical Recycling with 1.5-Nanometer Titanate Catalysts/Coupling Agents

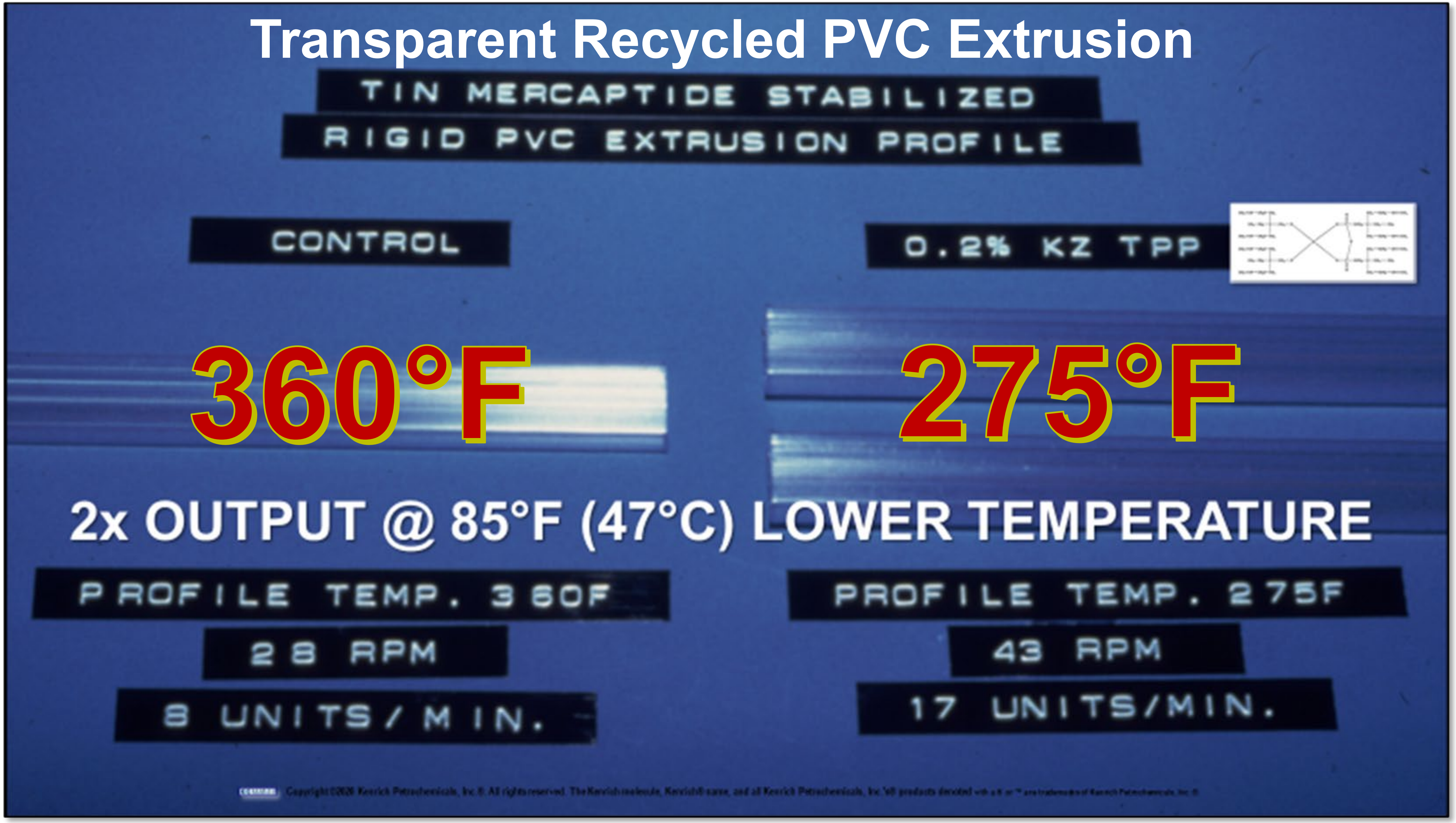


(2) Titanium, Zirconium & Aluminum Polymer Catalysis – without or with filler allows:

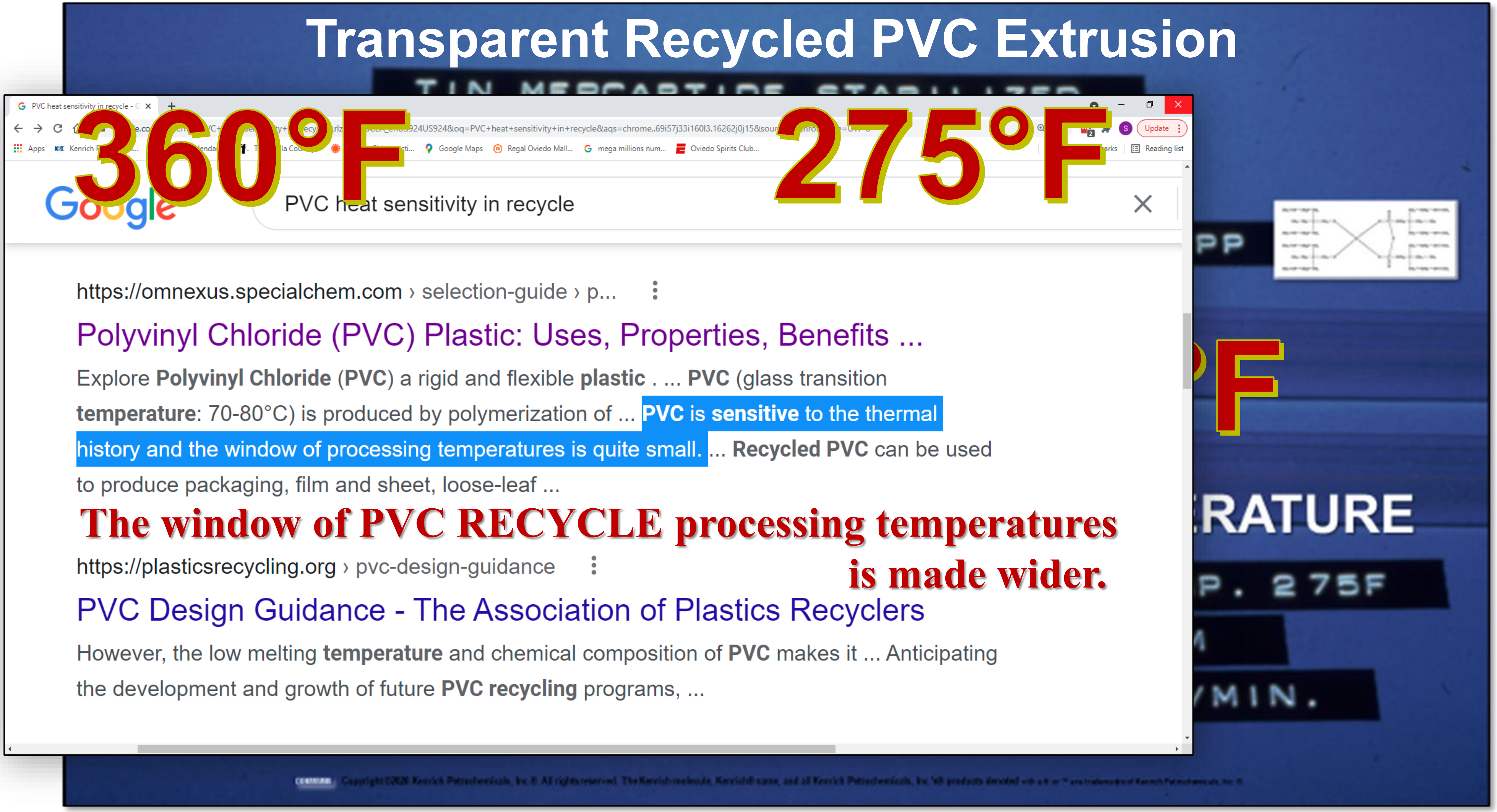
0.2% Zirconate in recycled unfilled / transparent rigid PVC to extrude twice as fast as the control @ 24% lower temp.



Advanced Solutions in Mechanical Recycling with 1.5-Nanometer Titanate Catalysts/Coupling Agents



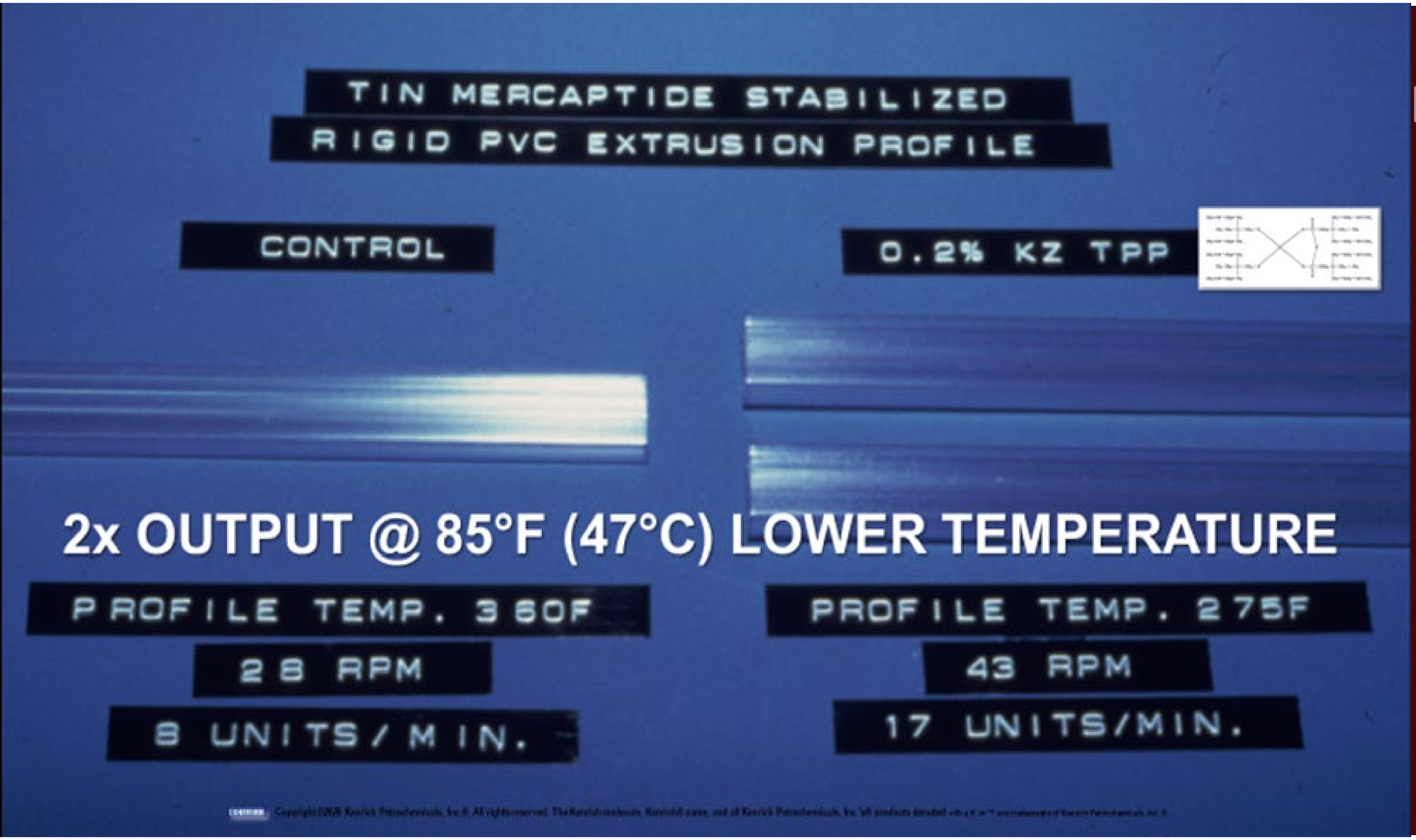
Advanced Solutions in Mechanical Recycling with 1.5-Nanometer Titanate Catalysts/Coupling Agents

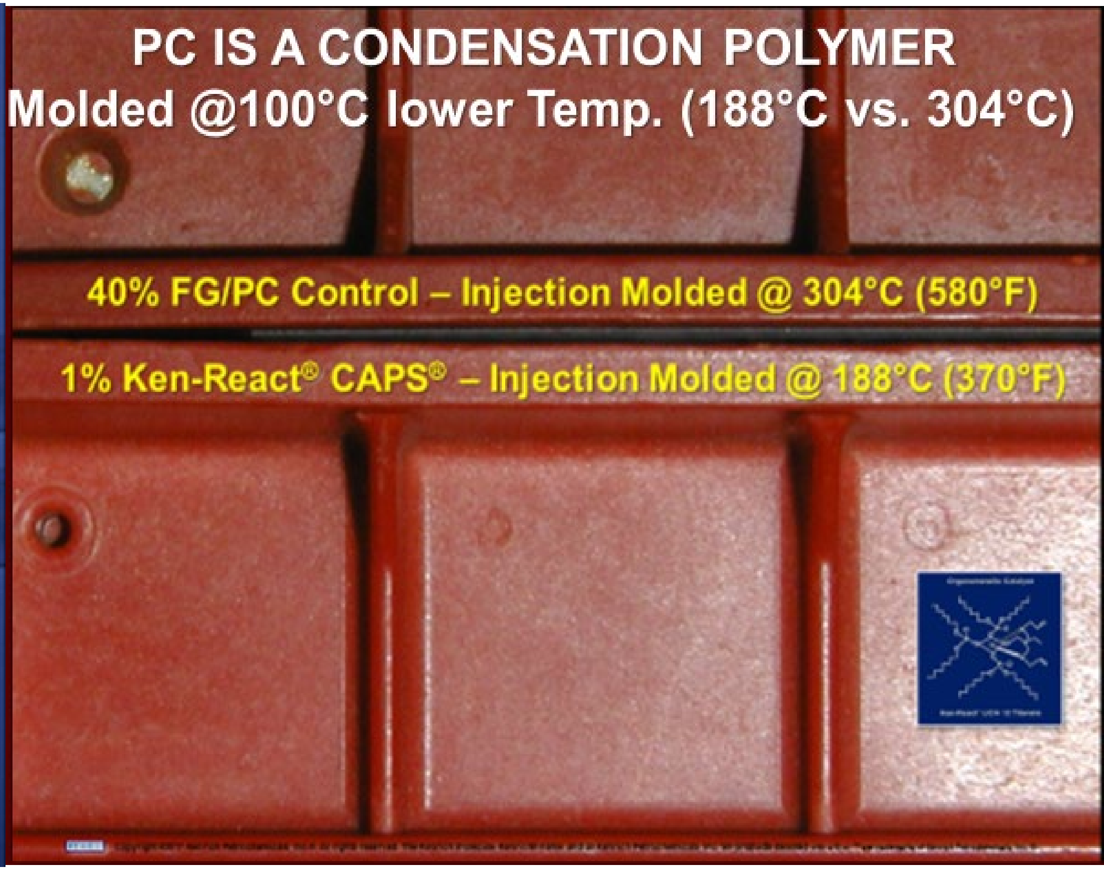


PC IS A CONDENSATION POLYMER
Molded @100°C lower Temp. (188°C vs. 304°C)

- **Maleated polymer compatibilizers work on Addition Polymers but depolymerize Condensation Polymers.**
- **Maleated polymers couple polymers but not fillers.**

71-ABSTRACTS on POLYBLENDS – sjmonte@4kenrich.com





71-ABSTRACTS on POLYBLENDS – sjmonte@4kenrich.com

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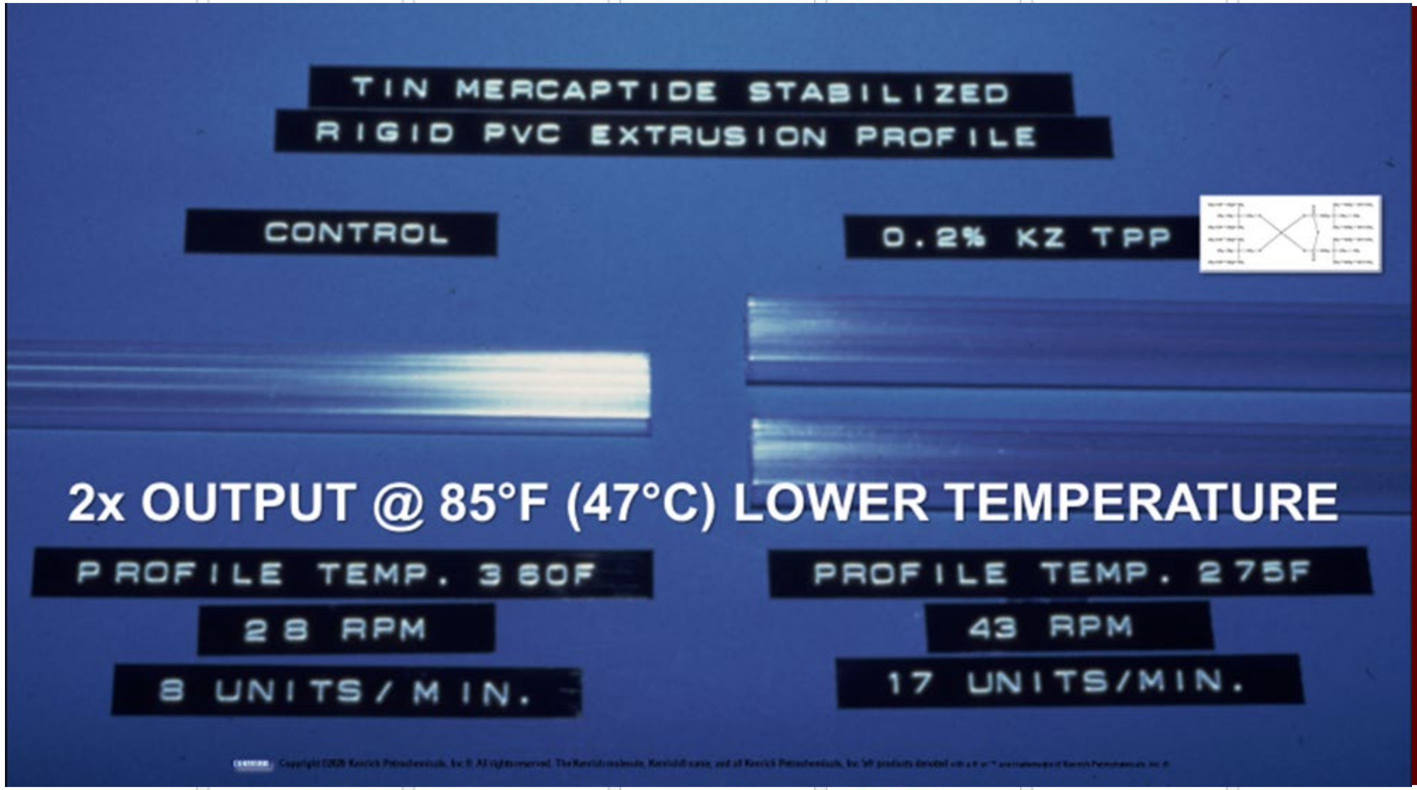
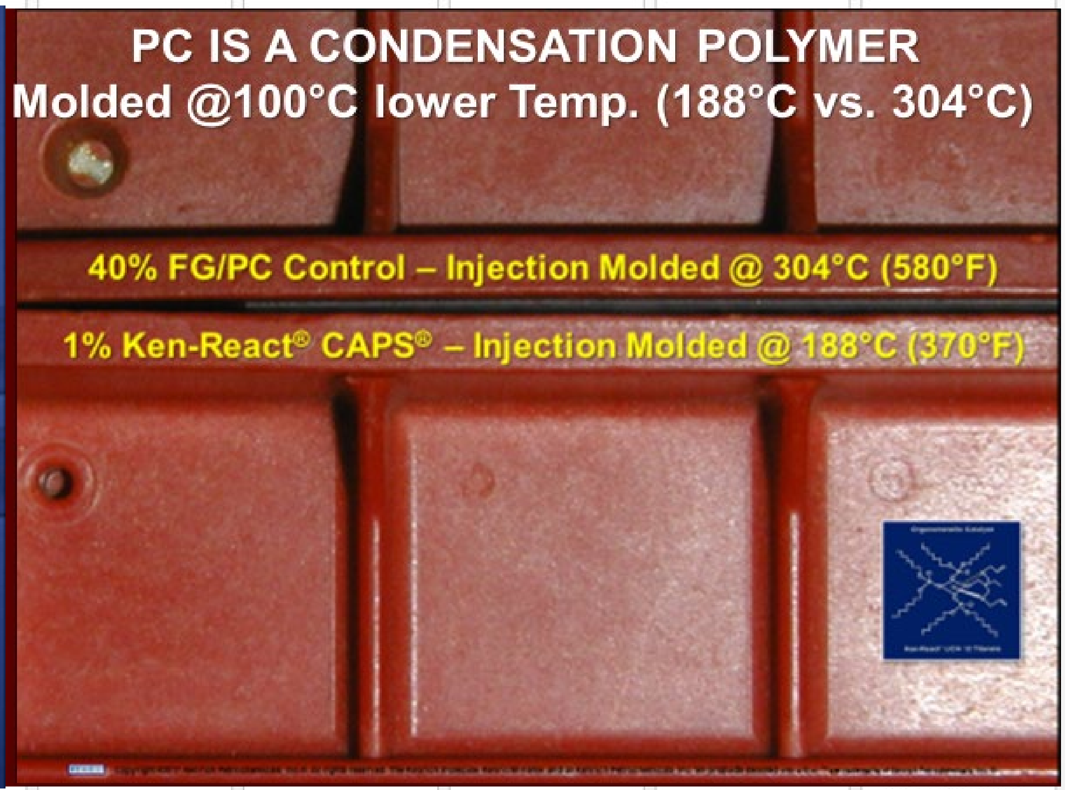
The CAS Search Service





71-ABSTRACTS on POLYBLENDS – sjmonte@4kenrich.com

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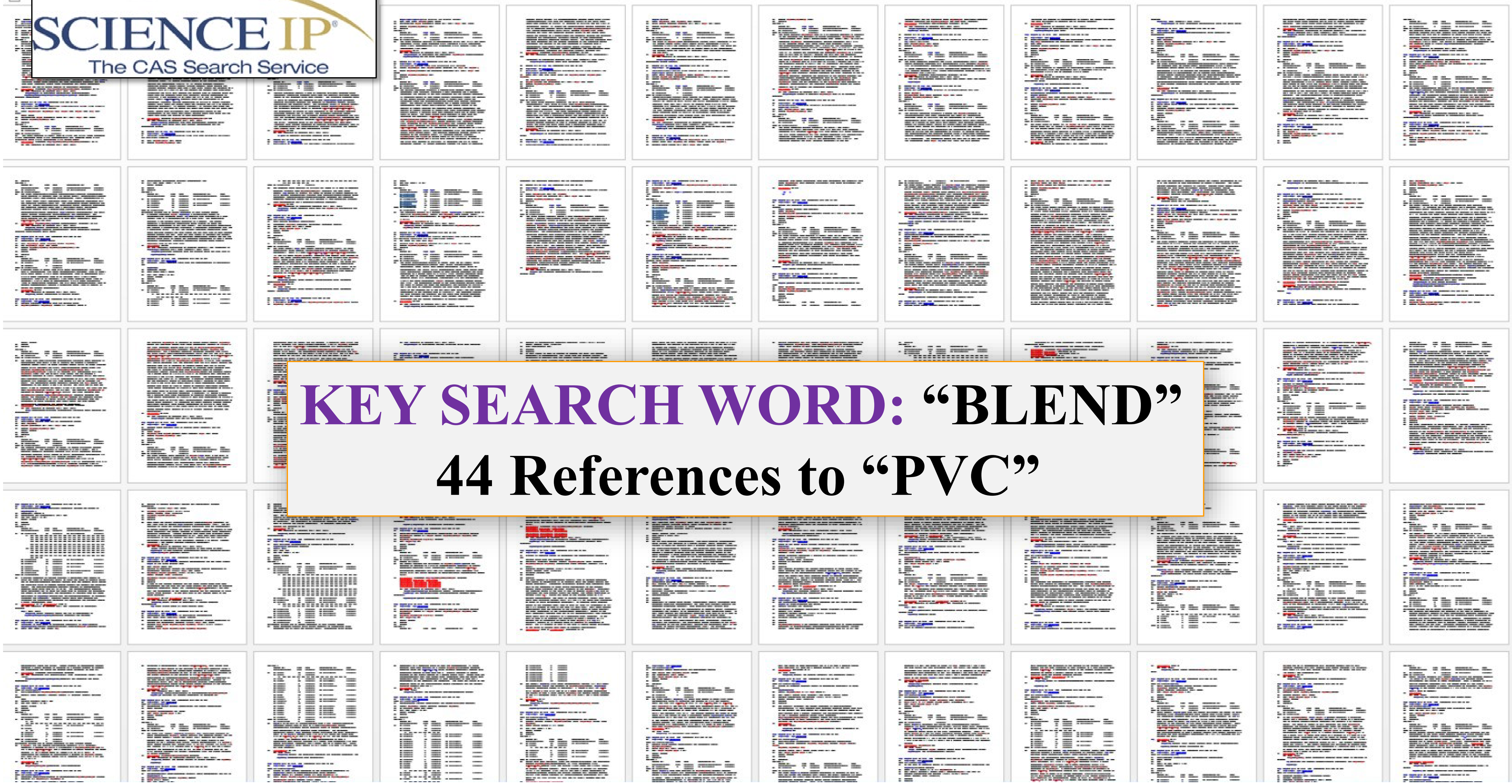
The CAS Search Service



L5 ANSWER 155 OF 439 CA COPYRIGHT 2016 ACS on STN

AN 163:386816 CA Full-text <<LOGINID::20160920>>

SCIENCE IP The CAS Search Service

PVC 45-55, polycarbonate 20-25

TI Polyvinyl chloride-polycarbonate alloy with good weathering resistance and antistatic property

PA Yin, Peihua, Peop. Rep. China

SO Faming Zhuanli Shenqing, 4pp.

LA Chinese

FAN.CNT 1

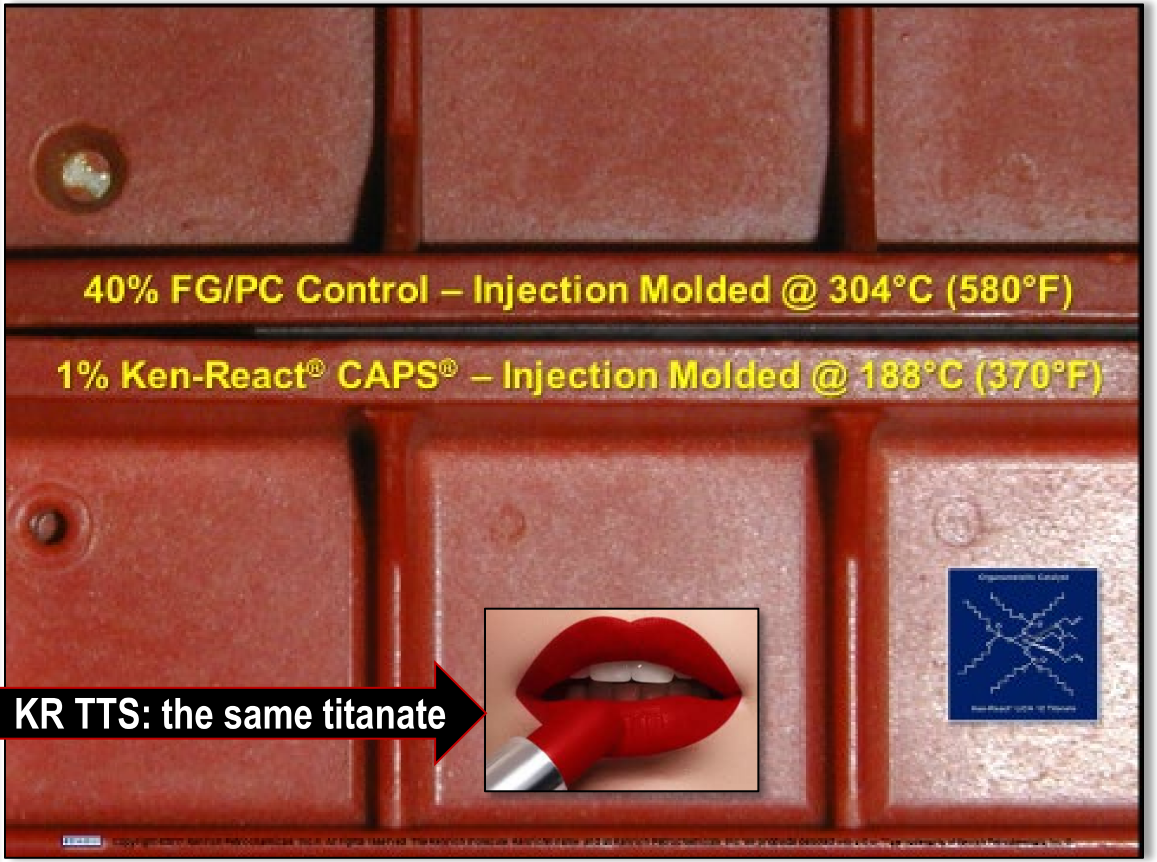
	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	CN 104861378	A	20150826	CN 2014-10847633	20141229
PRAI	CN 2014-10847633		20141229		

AB The present invention provides polyvinyl chloride (PVC)-polycarbonate alloy with good weathering resistance and antistatic property, comprising the following components by mass percentages: PVC 45-55, polycarbonate 20-25, SMA 2-4, ACR 3-6, attapulgite 2-8, melamine cyanurate 4-7, dioctyl phthalate 3-6, antistatic agent 1-3, UV absorber 1-2, calcium-zinc composite stabilizer 0.1-1, pentaerythritol stearate 0.5-1, and antioxidant 1010 0.1-0.5. The described PVC has average d.p. of 800-1,200, and weight average mol. weight of 50,000-120,000.

IT 61417-49-0, KR TTS

RL: MOA (Modifier or additive use); USES (Uses)
(polyvinyl chloride-polycarbonate alloy with good weathering resistance and antistatic property)

PVC temperatures range from:
500°F (260°C) to 212°F (100°C);
PC temperatures reduced from:
580°F (304°C) to 370°F (188°C);



KR TTS: the same titanate

L5 ANSWER 155 OF 439 CA COPYRIGHT 2016 ACS on STN
AN 163:386816 CA Full-text <<LOGINID::20160920>>

TI Polyvinyl chloride-polycarbonate alloy with good weathering resistance and antistatic property

PA Yin Peihua Peop Rep China

PVC 45-55, polycarbonate 20-25

PVC temperatures range from:
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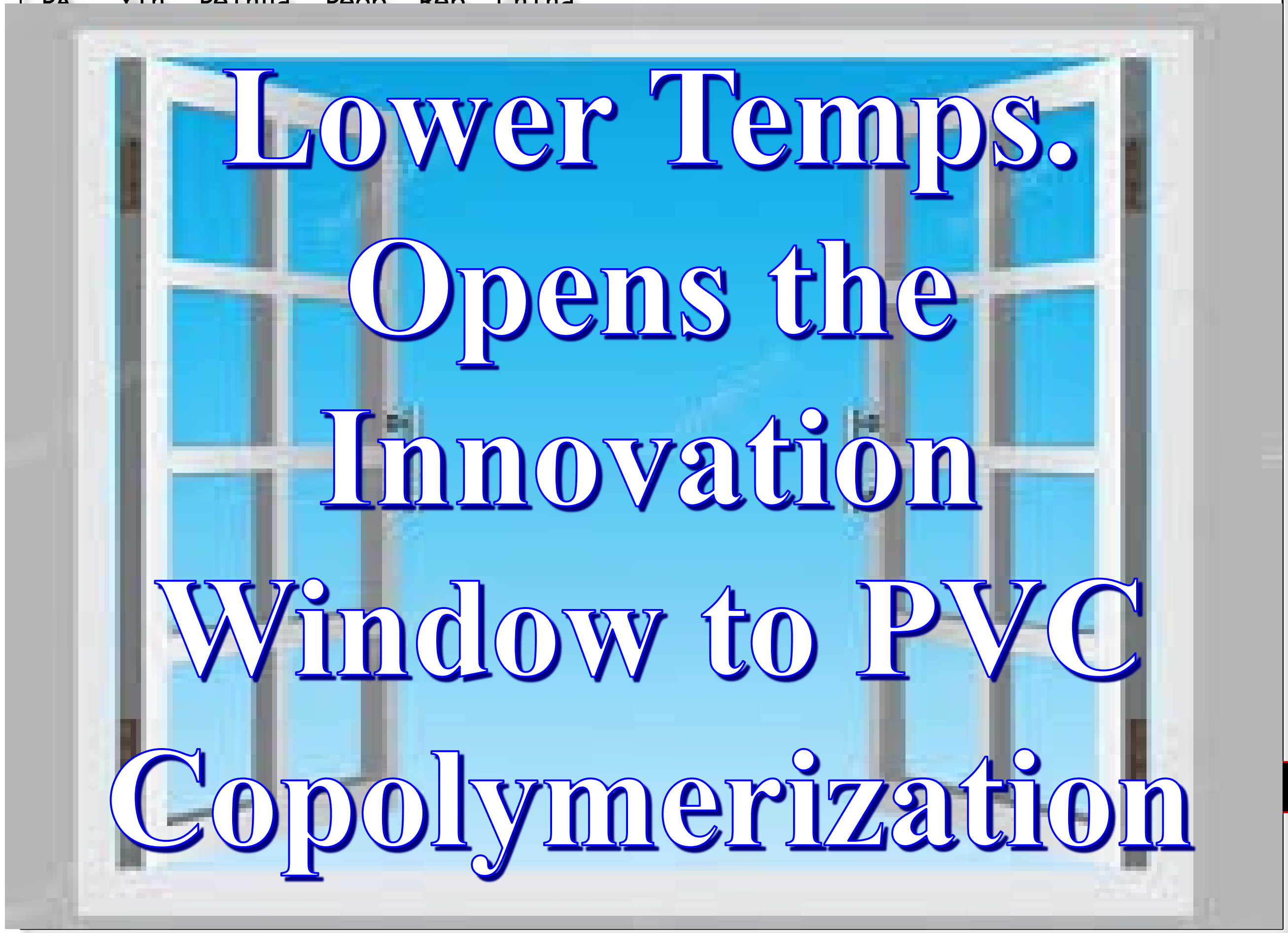
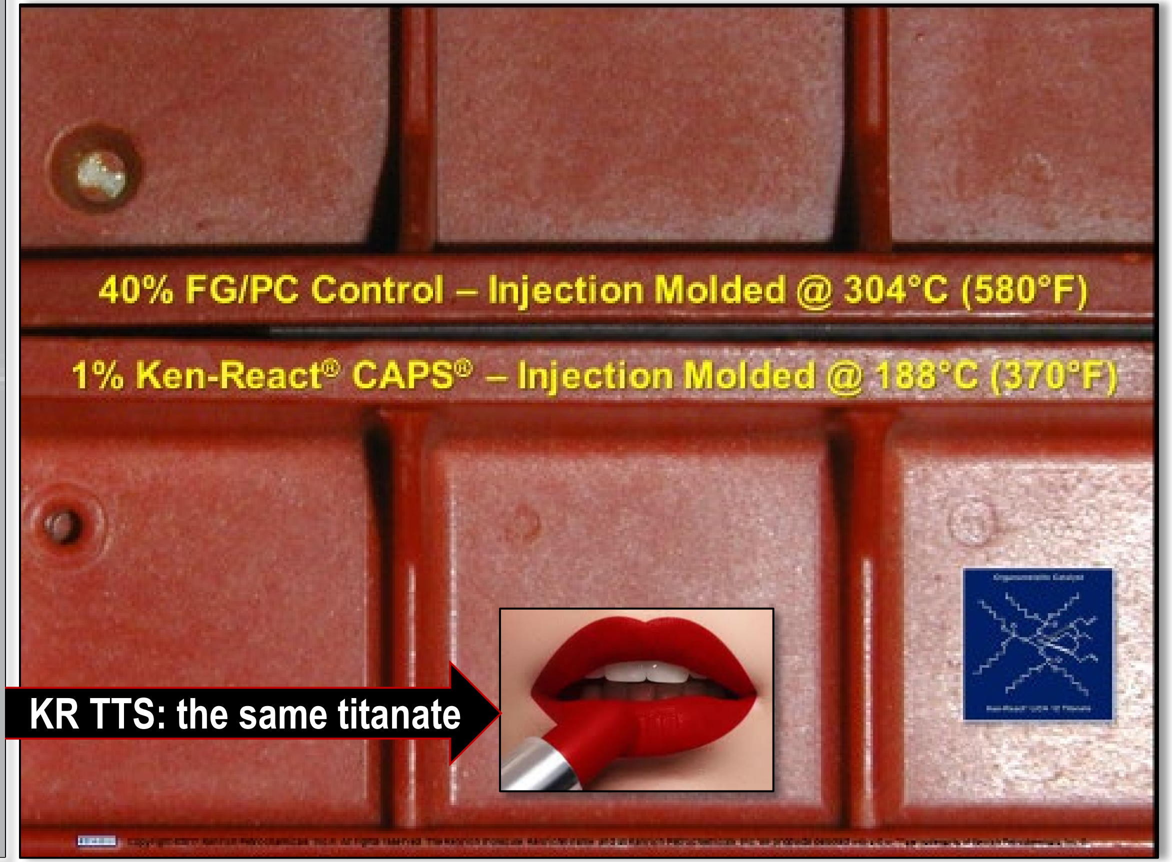




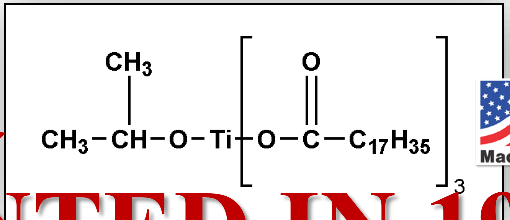
SCIENCE IP
The CAS Search Service

L5 ANSWER 152 OF 439 CA COPYRIGHT 2016 ACS on STN
AN 163:386826 CA Full-text <<LOGINID::20160920>>

TI Flame-retardant anti-aging polyvinyl chloride-polyethylene blended composite plastic

PA Yin, Peihua, Peop. Rep. China
SO Faming Zhuanli Shenqing, 5pp.
LA Chinese
FAN.CNT 1

INVENTED IN 2014



Made in USA

INVENTED IN 1973

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	CN 104861353	A	20150826	CN 2014-10838685	20141230
PRAI	CN 2014-10838685		20141230		

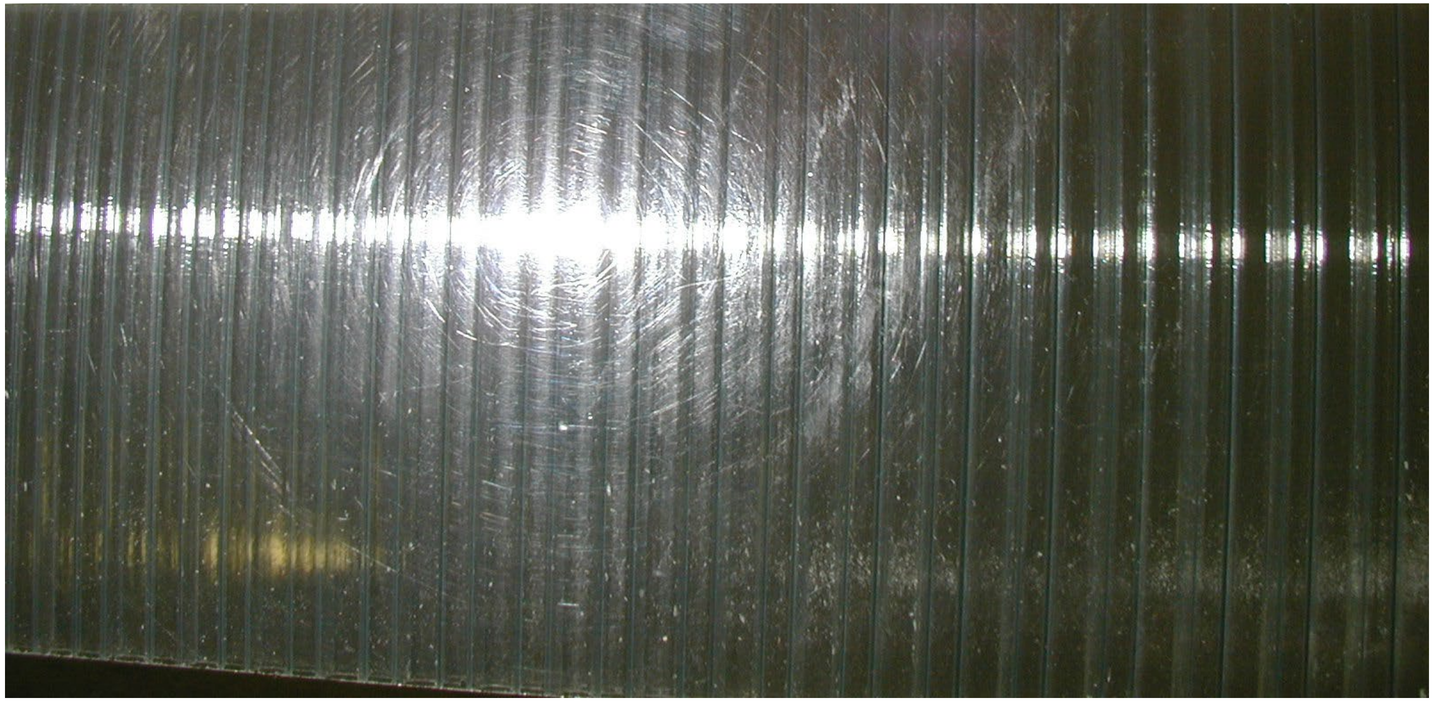
AB The title composite plastic comprises (by mass%): PVC 35-50, polyethylene 20-25, GMA-St-AN 2-4, SEBS 4-6, ACR 2-4, nano aluminum hydroxide 3-8, melamine cyanurate 4-7, zinc borate 1-4, light stabilizer 622 1-2, light stabilizer 944 1-2, dioctyl phthalate 5-8, calcium-zinc composite stabilizer 0.5-1.5, calcium stearate 0.5-1, iso-Pr triisostearoyl titanate 0.1-0.5, and antioxidant 1010 0.1-0.5. **The invention combines the resp. original advantages of PVC and polyethylene, and has excellent flame retardancy, anti-aging property, thermal stability and processability, and good mech. strength.**

IT 61417-49-0, Iso-propyl triisostearoyl titanate, KR TTS
RL: MOA (Modifier or additive use); USES (Uses)
(flame-retardant anti-aging polyvinyl chloride-polyethylene blended composite plastic)

Compatibilizing Recycled PET/PC – 80/20 Blend Using 0.3% CAPOW® Titanate Catalyst – 100°C lower Temp.

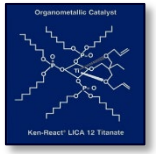
Copolymerization of Two Dissimilar Condensation Polymers

Extruded@ 180ºC using 0.3% [redacted] Titanate Catalyst vs. 280ºC without the Additive

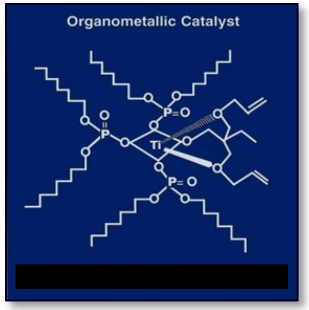


Regrind: Compatibilizing HDPE / Nylon Film
Using 0.2% Titanate Catalyst

HDPE – Addition Polymer + NYLON – Condensation Polymer +



Compatibilization of Addition & Condensation Polymers



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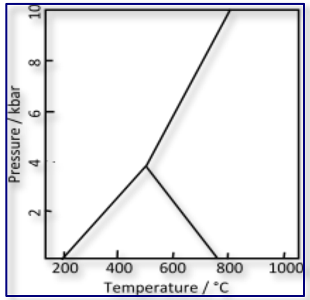

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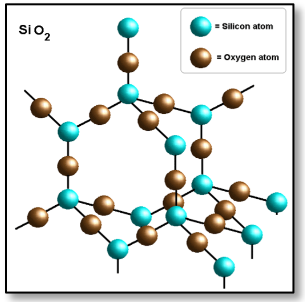

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Ti/Al Catalyst Additive

Incompatibility PP & PET & PE



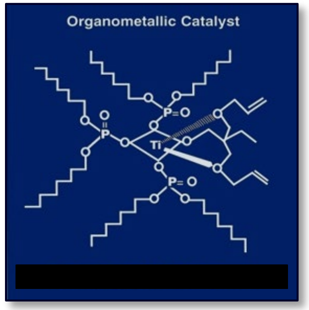


There are THREE Types of Compatibilizers:

1. **Bi-Polar Thermoplastics:** Links two dissimilar polymers. Works for PIR.
2. **Maleated PP /Polymers:**
   - Couples Addition polymers.
   - Does not couple fillers.
   - Often, depolymerizes Condensation polymers.
3. **Ti/Zr Coupling/Catalyst:** Synergistic with 1. & 2.

Catalyzes all polymers/Couples all inorganic & organic fillers, pigments, additives, etc.

Compatibilization of Addition & Condensation Polymers



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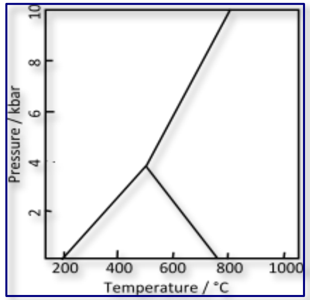

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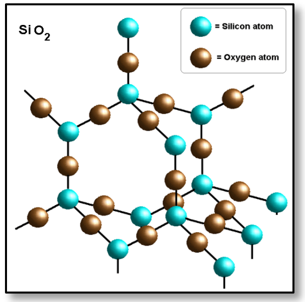

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Ti/Al Catalyst Additive

Incompatibility PP & PET & PE





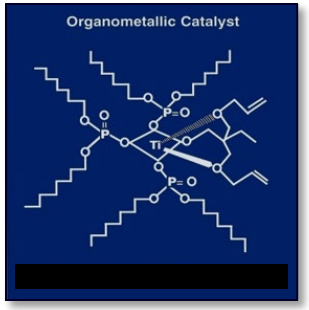



The effect of 1.5% Ken-React® CAPS® KPR® 12/LV on Brabender melt compounded PP/PET/PE Recycle Plastics @ 9% lower temperatures. Larger batches later extruded.

Materials obtained from post-industrial waste streams:

1. LLDPE is an Addition polymer.
2. PP is an Addition polymer.
3. PET is a Condensation polymer.

Compatibilization of Addition & Condensation Polymers



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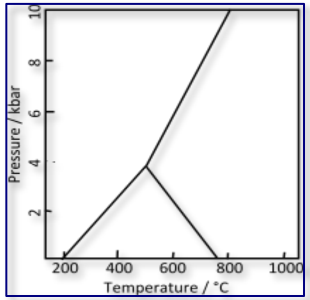

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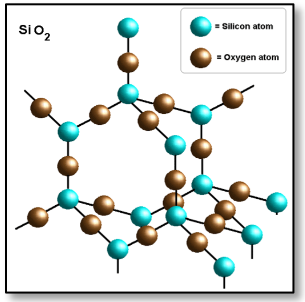

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Ti/Al Catalyst Additive

Incompatibility PP & PET & PE

The effect of 1.5% Ken-React® CAPS® KPR® 12/LV on Brabender melt compounded PP/PET/PE Recycle Plastics @ 9% lower temperatures. Larger batches later extruded.

Materials obtained from post-industrial waste streams:

1. **LLDPE from a fractional melt film,**
2. **PP Copolymer from mixed 20-35 MFI injection molded caps,**
3. **PET from thermoformed clamshell food packaging.**

Compatibilization of Addition & Condensation Polymers

Material ground into 1/4 – 1/2” flakes and melt compounded into pellets for IM using a 30:1 L/D - 20 mm single screw extruder.

Incompatibility PP & PET & PE

Polymer Specialties International Ltd.

175 Deerfield Road,
Newmarket, Ontario, L3Y 2L8
Cell: (905) 717-3723
E-mail: bryon.wolff@psi-cda.com

University of Waterloo Chemical Engineering Department.

The effect of 1.5% Ken-React® CAPS® KPR® 12/LV on Brabender melt compounded PP/PET/PE Recycle Plastics @ 9% lower temperatures. Larger batches later extruded.

Materials obtained from post-industrial waste streams:

1. **LLDPE from a fractional melt film,**
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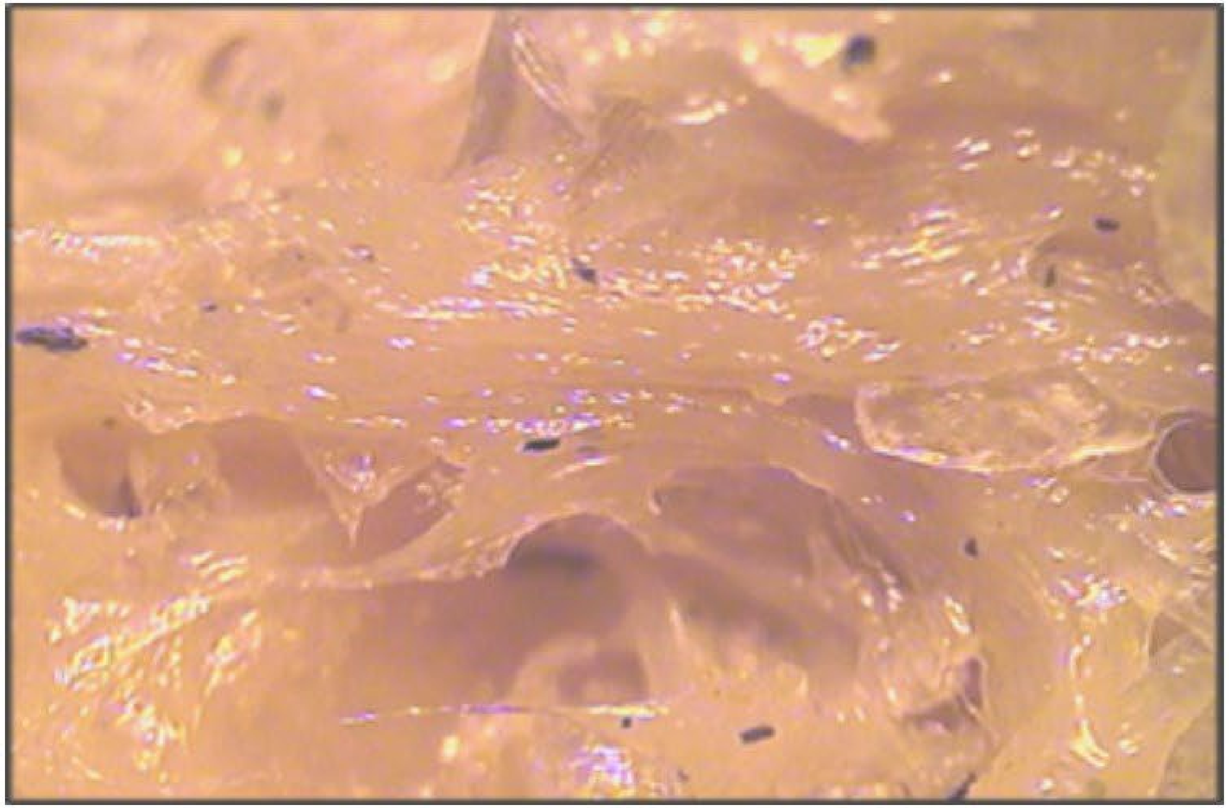
Compatibilization of Addition & Condensation Polymers

Brabender Plasticorder Blends of Three Recycled Polymers: PP/PET/PE



Incompatible PP/PET/PE—

No Additive

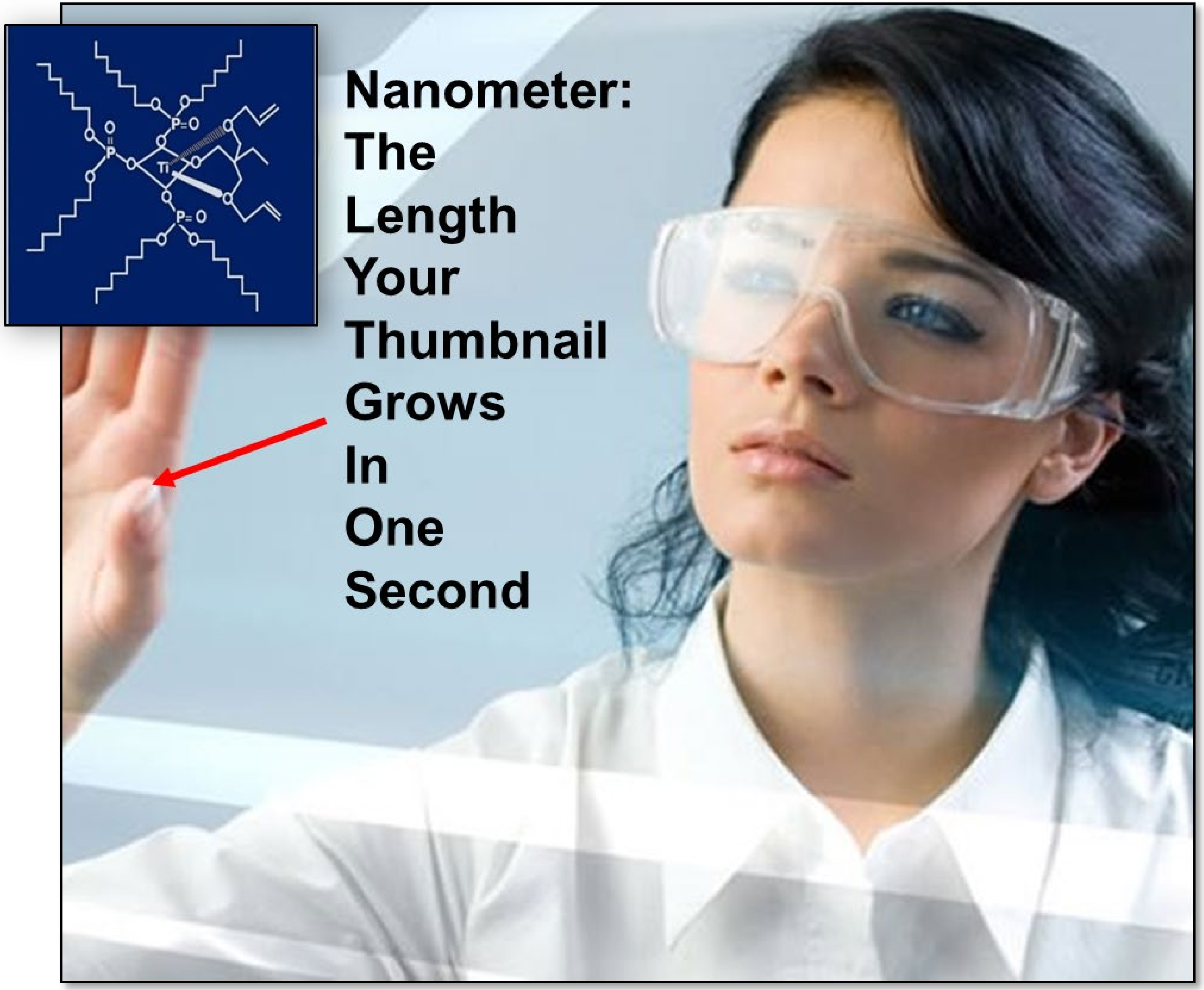
Compatibilized PP/PET/PE—

1.5% Ti/Al Catalyst Additive Pellets

One Nanometer = 10 Carbons = c – c – c – c – c – c – c – c – c – c

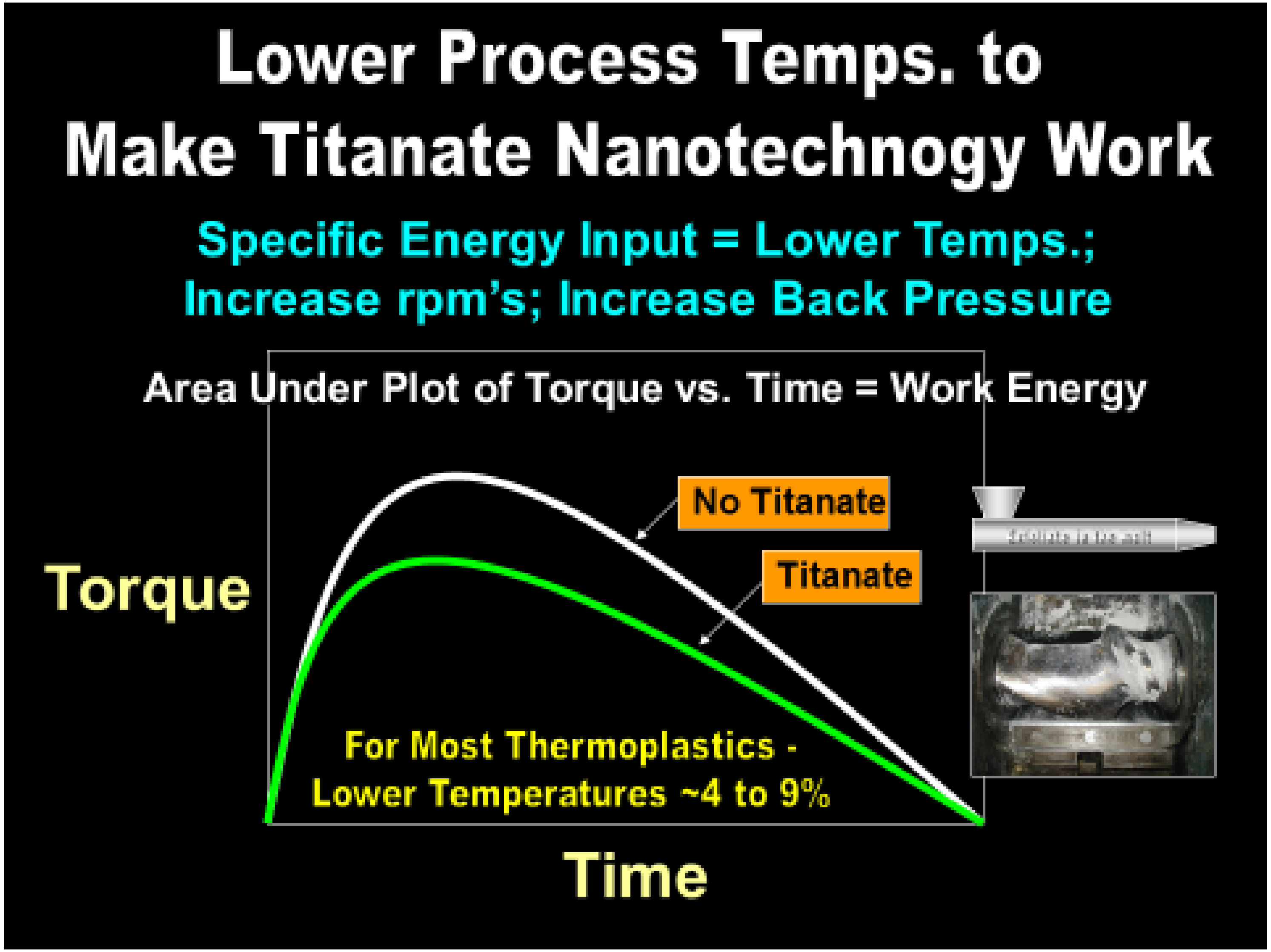
Compatibilization of Addition/Condensation Polymers & Fillers – Lower Temps.

The PHYSICS of MIXING is critical to proper use of KPR® Titanium and Aluminum Additive Chemistry



Compatibilization of Addition/Condensation Polymers – Lower Temps.

The PHYSICS of MIXING is critical to proper use of KPR® Titanium and Aluminum Additive Chemistry



Compatibilization of Addition & Condensation Polymers

LOWERING THE PROCESS TEMPERATURE FOR REACTIVE COMPOUNDING SHEAR IS CRITICAL

From: Bryon Wolff [mailto:bryon.wolff@psi-cda.com]
To: Salvatore J. Monte sjmonte@4kenrich.com
Subject: Re: 2015 Global Plastics Summit

University of Waterloo
Chemical Engineering Dept.

Good afternoon Sal
Below I've written a response to each of your questions. Should you require additional information etc. please don't hesitate to come back to me.
Best Regards

Bryon Wolff
Chief Technology Officer

Polymer Specialties International Ltd.
175 Deerfield Road,
Newmarket, Ontario, L3Y 2L8
Cell: (905) 717-3723
E-mail: bryon.wolff@psi-cda.com

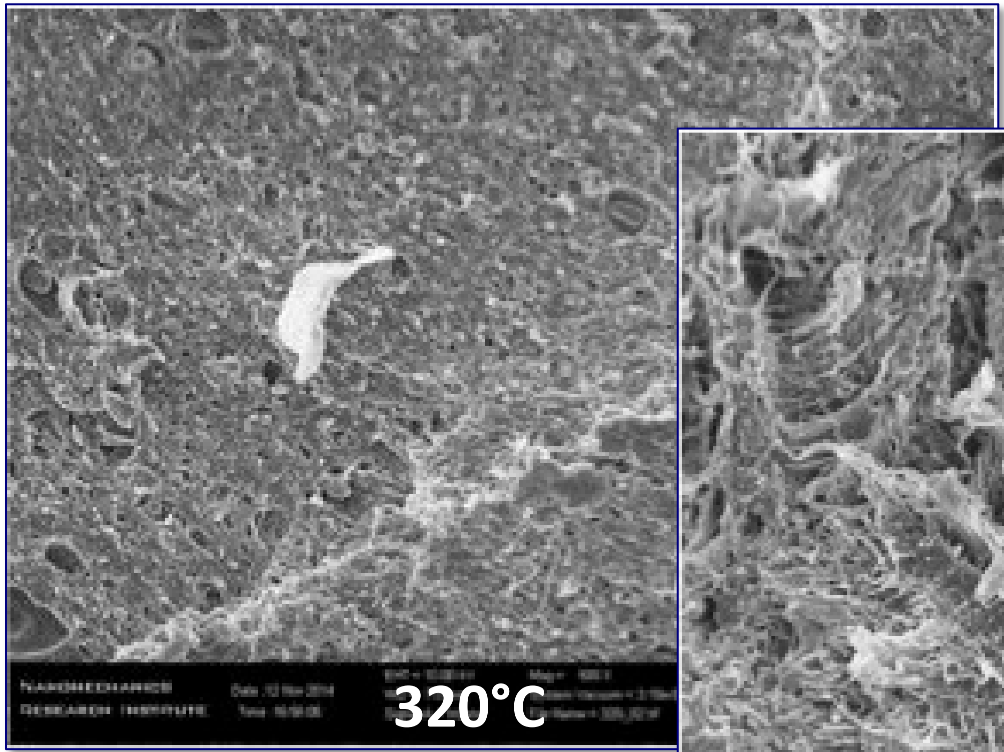
In your opinion, does the 10% drop in temperature from 320°F to 290°F indicate clearly the importance of reactive compounding shear?

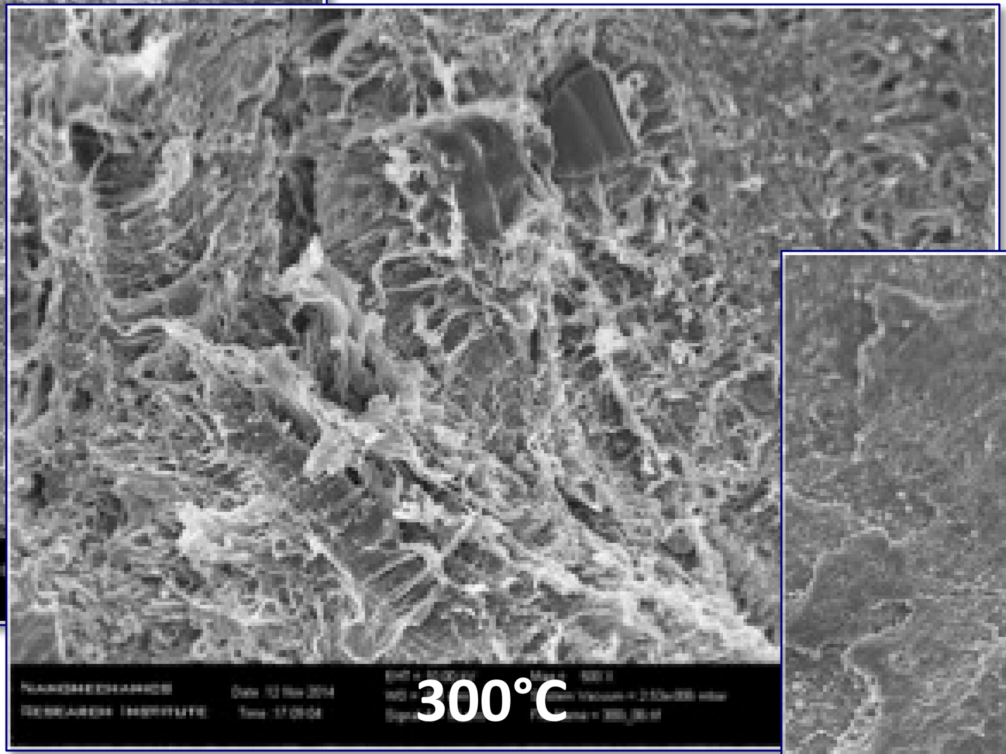
The surface of the extrudate exiting the die became significantly smoother. Upon further analysis with SEM and Izod, it was clear that the increasing the shear dramatically improved the dispersion and physical properties of the compound.

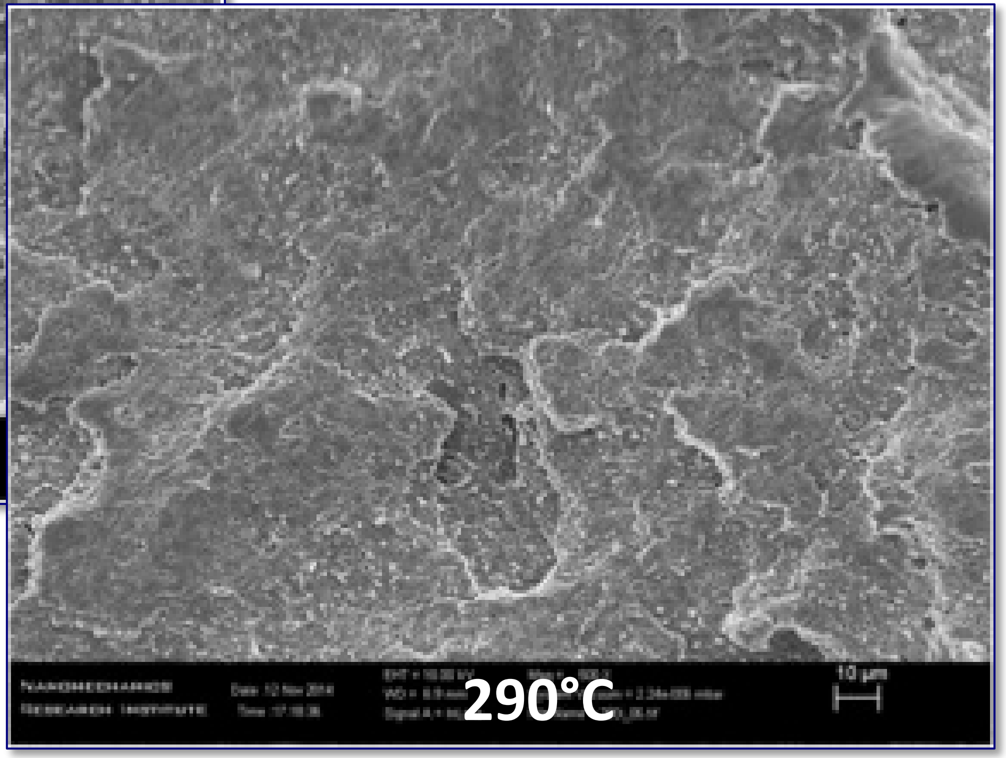
SEM
Injection Molded

Compatibilization of Addition & Condensation Polymers

LOWERING THE PROCESS TEMPERATURE FOR REACTIVE COMPOUNDING SHEAR IS CRITICAL







<u>Materials obtained from post-industrial waste streams</u>:

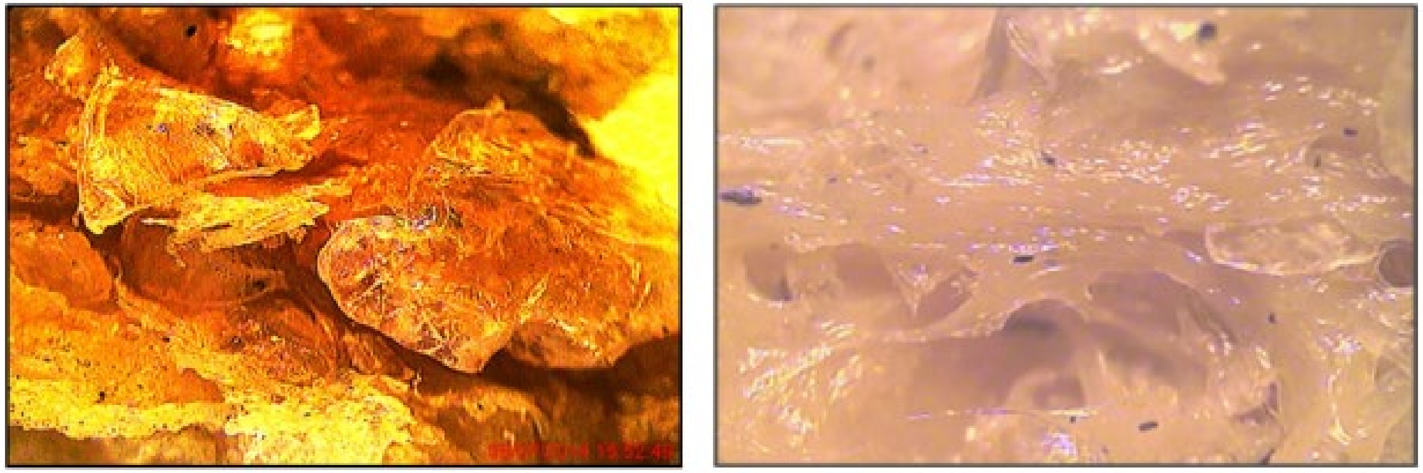
1. LLDPE from a fractional melt film,
2. PP Copolymer from mixed 20-35 MFI injection molded caps,
3. PET from thermoformed clamshell food packaging.

CONCLUSION

We have shown In Situ Macromolecule Titanate/Al Coupling & Catalysis is a significant strategic approach to reach Advanced Mechanical Recycling sustainability goals.

Compatibilization of Addition & Condensation Polymers

Brabender Plasticorder Blends of Three Recycled Polymers: PP/PET/PE



Incompatible PP/PET/PE—

No Additive

Compatibilized PP/PET/PE—

1.5% Ti/Al Catalyst Additive Pellets

The Extruder as a Reactor for Advanced Mechanical Recycling Using 1.5-Nanometer Titanates and Zirconates

Salvatore J. Monte
President | Kenrich Petrochemicals, Inc.

201-823-9000 | sjmonte@4kenrich.com | www.4kenrich.com

The Extruder as a Reactor for Advanced Mechanical Recycling Using 1.5-Nanometer Titanates and Zirconates

https://4kenrich.com/technical-information/

201-823-9000|sjmonte@4kenrich.com | www.4kenrich.com

Extrusion 2022

PT A Plastics Technology Event

December 6-8, 2022

Omni Charlotte Hotel harlotte, North C olin

The Extruder as a Rea to for A va ce Mechanical Rec g ing 1.5 Na eter ar t s Z co a e

Thank You

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https://4kenrich.com/technical-information/

The End

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