July 20 from 2 pm – 4 pm ET:
**Mechanical Recycling**

Improvements in mechanical recycling continue to be made for the vinyl industry. Speakers will discuss additives to bolster recycled material performance and quality, and advanced sorting technology to remove contaminants and increase the yield of recycled material.

**Advanced Solutions in Vinyl Recycling with Titanate Catalysts/Coupling Agents, Salvatore Monte, Kenrich Petrochemicals**
Advanced Solutions in Vinyl Recycling with Titanate Catalysts/Coupling Agents

Salvatore J. Monte – Kenrich Petrochemicals, Inc.

July 20, 2021 – 2:00-4:00pm
Advanced Solutions in Vinyl Recycling with Titanate Catalysts/Coupling Agents

Hosted VINYLTEC 2010 as President the P-NJ Section

Voting Member & Recycle Sub-Committee

SPE Fellow & Honored Service Member

PPA Board of Governors – Newsletter Chair

450- ACS CAS Abstracted Works by S.J. Monte

32-US Patents Filed Worldwide

Classified TOP SECRET for DOD IMEM Program
Titanium/Aluminum coupling and catalysis applications are demonstrated in mechanical recycling.

Ziegler, Natta & Kaminisky used Titanium and Aluminum catalysts to produce Addition Polymers – Vinyl is an Addition polymer;

Titanate catalysts produce Condensation Polymers;

Heteroatom Titanates couple fillers and catalyze Polymers;

Mercuric Chloride and Palladium catalysts convert monomer to PVC polymer. Heteroatom Titanates REPOLYMERIZE PVC polymer.

Monte uses Ti/Al in powder/pellet form to recycle PVC/Polymer compounds in the extruder melt.
Titanium and Aluminum Additive 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.
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 TiCl₄ and Al(C₂H₅)₂Cl useful for the production of polyethylene.
- Natta used crystalline α-TiCl₃ in combination with Al(C₂H₅)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 metalloccenes with methylaluminoxane (MAO) –[O–Al(CH₃)]ₙ.

Titanium and Aluminum Additive Chemistry

The Nobel Prize in Chemistry 1963

Karl Ziegler
Prize share: 1/2

Giulio Natta
Prize share: 1/2

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• Monte uses Neoalkoxy Titanate in combination with Al$_2$SiO$_5$ 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.
Kaminisky Titanocene – Monte Titanate

New Titanium and Aluminum Additive Chemistry
Introducing Titanium & Aluminum Additive Chemistry

This is The Titanium Catalyst Portion

Organometallic Catalyst

Ken-React® LICA® 12 Titanate
Introducing Titanium & Aluminum Additive Chemistry

This is The Titanium Catalyst Portion

Organometallic Catalyst

Phase Diagram of $\text{Al}_2\text{SiO}_5$

+ 

This is The Mixed Metal Catalyst Portion

Ken-React® LICA 12 Titanate

Ken-React® CAPS® KPR® 12/LV

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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**

Ken-React® CAPOW® 
KPR® 12/HV 
79% Active Catalyst

Ken-React® CAPS® 
KPR® 12/LV 
39% Active Catalyst

---

PDS (Product Data Sheet) 
Ken-React® CAPOW® KPR® 12/HV (Coupling Agent/Polymer)

SDS (Safety Data Sheet) 
Ken-React® CAPS® KPR® 12/LV

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Pellet masterbatches of (CAPS® KPR®) neoalkoxy titanate/mixed metal catalyst are added at the extruder hopper like a color concentrate – or Compounders use a (CAPOW®) powder masterbatch.
Titanocene: Monomer to Polymer

Titanocene

Titanate: Recycle to Re-Polymer

Reactor
Titanocene Polymerization – Ethylene Monomer

Extruder
Titanate Repolymerization – PVC & Ethylene Polymers
Evolution of Subject 
Ti-Al Nano-Technology

SIX FUNCTIONS

Organometallic Catalyst

Ken-React® LICA 12 Titanate

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SIX FUNCTIONS

Function 1 – Coupling

Function 2 – Catalysis

Function 3 – Phosphatization

Function 4 – Polarity

Function 5 – Thermoset

Function 6 – Hybridization

Organometallic Catalyst

Ken-React® LICA 12 Titanate
Problem Solving Takeaways From This Presentation - Coupling

(1) **Couple in situ via proton coordination** to all fillers, pigments and organics – from CaCO₃ to Carbon to AZO:
Problem Solving Takeaways
From This Presentation - Coupling

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

- No hydrolysis as with Silanes – No pretreatment.
- Functionalize – Increase electron and heat transfer.
- Nano-Titanium Phosphatize for Flame Retardance.
- Use polymer melt (or plasticizer) as coupling medium.
- Filler viscosity reduction – shift in pigment/binder CPVC.
Problem Solving Takeaways From This Presentation - Coupling

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Advanced Solutions in Vinyl Recycling with Titanate Catalysts/Coupling Agents

Salvatore J. Monte – Kenrich Petrochemicals, Inc.
July 20, 2021 – 2:00-4:00pm

PROBLEM SOLVING
RECYCLE IS A COMPLEX
MATERIALS CHALLENGE

Nano-Titanium Phosphatize for Flame Retardance.

PROBLEM SOLVING
INSSENSITIVE MUNITIONS IS A COMPLEX
MATERIALS CHALLENGE

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

Salvatore J. Monte
sjmonte@4kenrich.com • www.4kenrich.com

Insensitive Munitions & Energetic Materials (IMEM) Technology Symposium
April 7-8, 2021
Virtual Conference

NDIA
National Defense Industrial Association
Problem Solving Takeaways From This Presentation –

Coupling – Catalysis – Phosphatization

(1) **Couple in situ via proton coordination** to all fillers, pigments and organics – from CaCO3 to Carbon to AZO:
   - Nano-Titanium Phosphatize for Flame Retardance.

**IM Problem Solved:** Unsustainable unplanned detonation of rockets and explosives causing great loss of life and valuable equipment.

Advanced Solutions in Vinyl Recycling with Titanate Catalysts/Coupling Agents

Just as in RECYCLE, to solve the Unsustainable problem of unplanned detonation – I applied the lessons learned dealing with similar or same materials in PVC & polymer composites.

1980 – Monte theorizes:
1. We can make AZO nitramine blowing agent more explosive for PVC pool floats.
2. We can create nano-titanium intumescence on any interface for flame retardance.
3. We can improve the flow and strength of Injection Molded CAB screwdriver handles.

19-PERF LOVA Propellant
- 85% RDX Nitramine
- 15% CAB Plastic
- 0.5% LICA 12
PLASTICS EXPERIENCE IN VINYL & I.M. CAB Screwdriver Handles

- Nano-Titanium Phosphatize for Flame Retardance

RDX/CAB & Plastic Bound Explosives

AZO Foamed PVC
Nitramine Blowing Agents:
AZO, RDX, HMX
PLASTICS EXPERIENCE IN VINYL & I.M. CAB Screwdriver Handles

- Nano-Titanium Phosphatize for Flame Retardance

**RDX/CAB & Plastic Bound Explosives**

**AZO Foamed PVC**

**Nitramine Blowing Agents:**

AZO, RDX, HMX

Improve the Flow of Injection Molded Screw Driver Handles
PLASTICS EXPERIENCE IN VINYL & I.M. CAB Screwdriver Handles

- Nano-Titanium Phosphatize for Flame Retardance
Problem Solving Takeaways – Unplanned Detonation

First ADPA Presentation – June 1, 1982


First Picatinny Arsenal Presentation – January 10, 1983

ARRADCOM, Dover, NJ, Jan. 10, 1983
41. Fillers and Coupling Agent Symposium, ARCO, Newton Square, PA, March 16-17, 1983
42. Naval Weapons Center, Yorktown, VA, April 20, 1983

Distribution Statement A, Approved for public release. Distribution Unlimited
PLASTICS EXPERIENCE IN VINYL & I.M. CAB Screwdriver Handles

• Nano-Titanium Phosphatize for Flame Retardance

Monte et al.

US Patent 6,197,135 B1:
“ENHANCED ENERGETIC COMPOSITES”
Problem Solving Takeaways – Unplanned Detonation

- Nano-Titanium Phosphatize for Flame Retardance

RDX/CAB & Plastic Bound Explosives

Issued Mar 6, 2001

Filed Feb. 18, 1986

Held under DoD Secrecy Orders for 15-years-1-month
Nano-Titanium Phosphatize for Flame Retardance

INSENSITIVE EXPLOSIVE COMPOSITION

ENHANCED ENERGETIC COMPOSITES

RDX/CAB & Plastic Bound Explosives

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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-dinitropropyl 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...
This explosive is used in the Penetration Augmented Munition as well as having potential for use on the guns for the Bradley Fighting vehicle, in addition it has applications in the following programs which involve blasting munitions: Multi-purpose Individual Munition, Bunker defeat Munition, Explosive foxhole digger, Bridge Road Munition, and any mining or rock blasting application.

Note 2: Our composition is the only one that is not sensitive to impact sensitivity, or sympathetic detonation.
BACKGROUND

...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.

METHODOLOGY 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.
BACKGROUND

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

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.

Nano-Note: Δ 0.25 wt.% -- Optimal to Inert

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.
Nano-Titanium Phosphatize for Flame Retardance

Al/AP/HTPB PU Solid Rocket Fuel

United States Patent

<table>
<thead>
<tr>
<th>Patent Number: 5,753,853</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monte et al.</td>
</tr>
<tr>
<td>Date of Patent: May 19, 1998</td>
</tr>
</tbody>
</table>

SOLID PROPELLANT WITH TITANATE BONDING AGENT


Assignee: Kenrich Petrochemicals, Inc., Bayonne, N.J.

Notice: The term of this patent shall not extend beyond the expiration date of Pat. No. 5,753,853.

Filed Feb. 20, 1986

Held under DoD Secrecy Orders for 12-years-3-months

Issued May 19, 1998

Filed Feb. 20, 1986

Liquid elastomer-based propellant having incorporated organo-titanates having positive ballistic and physical effects on the propellants, serving to reduce burn rate exponents and overall burn rates, as well as increasing the tensile strength and elasticity of the propellant. Organophosphate and pyrophosphate esters are used as the preferred sources.
Problem Solving Takeaways
From This Presentation - Catalysis

(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.
• Repolymerization: Regenerate regrind to virgin properties.
Problem Solving Takeaways From This Presentation - Catalysis

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

- Lower process temperatures from 10 to 40%.
- Repolymerization: Regenerate regrind to virgin properties.
Problem Solving Takeaways From This Presentation - Catalysis

(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.
Transparent Recycled PVC Extrusion

360°F 275°F

2x OUTPUT @ 85°F (47°C) LOWER TEMPERATURE

PROFILE TEMP. 360°F
28 RPM
8 UNITS/MIN.

PROFILE TEMP. 275°F
43 RPM
17 UNITS/MIN.
The window of PVC RECYCLE processing temperatures is made wider.
One of 32-US Patents: “REPOLYMERIZATION” Mechanical Properties of 11 – Unfilled Plastics 6-Ti/Zr @ 4 dosages
**Titanium Catalysis**

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

---

**UNFILLED PP**

Effect of Neoalkoxy Tinate CAPOW L 12/H on the Properties of Injection Molded Unfilled PP

<table>
<thead>
<tr>
<th>Coupling Agent Additive</th>
<th>Weight % of Resin</th>
<th>Tensile Yield K psi</th>
<th>% Elong. @ Break</th>
<th>Flexural Modulus psi x 10³</th>
<th>Notched Izod @ R.T. ft.lb./in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.00</td>
<td>4.9</td>
<td>120</td>
<td>21</td>
<td>0.7</td>
</tr>
<tr>
<td>L 12/H</td>
<td>0.10</td>
<td>5.4</td>
<td>127</td>
<td>24</td>
<td>0.9</td>
</tr>
<tr>
<td>L 12/H</td>
<td>0.30</td>
<td>5.7</td>
<td>142</td>
<td>26</td>
<td>1.1</td>
</tr>
<tr>
<td>L 12/H</td>
<td>0.50</td>
<td>5.6</td>
<td>148</td>
<td>22</td>
<td>1.4</td>
</tr>
<tr>
<td>L 12/H</td>
<td>0.75</td>
<td>5.2</td>
<td>139</td>
<td>21</td>
<td>1.1</td>
</tr>
</tbody>
</table>

---

**The Extruder acts as a Polymerization Reactor for Organometallic Catalysis**

---

**Unfilled Plastics Data**

- ABS
- Acetal
- Acrylic
- CAB
- Nylon6
- PC
- PP
- HDPE
- PBT
- PPO
- PS
Titanium, Zirconium & Aluminum Polymer Catalysis – without or with filler allows: Polymer Mechanical Properties Are Increased.

Provides Nano-Titanium Technology for VINYL RECYCLING of Polymers #1 to #7
Titanium/Aluminum Filler Coupling Agent & Polymer Catalyst Additive for Mechanical Recycling of Polymers #1 to #7

Developed from a Half-Century of Nano-TITANATE Experience

1974 Modern Plastics Article

New coupling agent for filled polyethylene

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My Mission Statement for the last 46-years is “...To teach the more efficient use of raw materials through the use of titanates and zirconates.”
SPE VINYLTEC 2004
Technical Paper
The Application of Titanates in PVC

FINER FOAM CELL STRUCTURE
Titanate Increases Strength of AZO Foamed PVC Plastisol

Trade Shows, TableTops & Conference Papers

Developed from a Half-Century of Nano-TITANATE Experience
PVC Chapter – Reference Manual Addendum – Pages Add-57 to Add-63
Printed in 1993
Is China Cleaning Our R&D Clocks in PVC Compatibilization and Nanotechnology While We Combat Prop 65 and Regs

Monday – July 10, 2017 – 3:15pm-4:00pm

Salvatore J. Monte

www.4kenrich.com sjmonte@4kenrich.com
Abstracts Based on Subject Titanates & Zirconates

Up to 2013 – China = 25% of Abstracts
2013--2016 – China = 72% of Abstracts
2015--2020 – China = 85% of Abstracts
Abstracts Based on Subject Titanates & Zirconates In PVC/Polymer Blends – Regenerated PVC

- Developed from a Half-Century of Nano-TITANATE Experience

**Prop 65/Asbestos Lawyer**

**Abstracts Based on Subject Titanates & Zirconates**

**In PVC/Polymer Blends – Regenerated PVC**

This invention relates to a process of regenerating polyvinyl chloride plastic material. The plastic comprises:

- **Regenerated PVC 100-120**: modified nano Ca carbonate 25-35, Ca-In stabilizers 1-2, stearic acid 1-2, dicarboxy ester
- **Titanates 0-5**
- **Zirconates 0.5-2.5**
- **Acrylate impact modifier 2-4**
- **IE 2-4**
- **Alz high-gloss primer 2-3**
- **IE wax 1-2-0.5**
- **Paraffin wax 0-2-0.5**
- **Carboxylate impact modifier 2-4**

This invention involves use of nano Ca carbonate, which is dispersed in the plastic matrix to create a more uniform dispersion. The resulting plastic blend is then extruded into pellets, which can then be used in a variety of applications. The invention is particularly useful for applications requiring improved mechanical properties, such as increased flexibility and impact resistance. The use of nano Ca carbonate allows for improved dispersion and a reduction in the amount of plasticizer required, which can lead to improved cost-effectiveness and environmental benefits.
New colored plastic steel profile manufactured from regenerated polyvinyl chloride


The plastic comprises regenerated
- PVC 100-120,
- titanate modified nano Ca carbonate 25-30,
- Ca-Zn stabilizer 1-2,
- stearic acid 1-2,
- dioctyl ester 0.5-1,
- plasticizer (epoxyfatty acid Me ester) 0.5-1,
- chlorinated PE 2-4,
- ABS high-glue powder 2-5,
- PE wax 0.1-0.5,
- paraffin wax 0.5-0.7,
- acrylate impact modifier ACR 2-5,
- MBS 2-5,
- iron oxide red 2-5,
- carbon black 0.01-0.04,
- pigment 0.1-0.2 part.

KENRICH: Three graduates from the University of KENTucky who were going to get RICH with a aromatic resin product called Kenflex – 1945.
Invention/Technology Evolution – 1973 to 2021

A DuPont Wire & Cable Symposium on Hypalon and Neoprene

Excerpts on The Use of Kenflex A in Hypalon and Neoprene

September 1959

Pre-1961 Maspeth, Queens

Aromatic Resins
1961 to 2015
Products made in Bayonne, NJ

2015 to Now
Products made in Decatur & Dayton, TN

Made in USA

Certified ISO 9001
Invention/Technology Evolution – 1973 to 2020

Aromatic Resins

HYPALON®
Processed with the aid of
KENFLEX® A
KENFLEX® N
KENMIX® Litharge
KENLASTIC® Litharge

NEOPRENE
Processed with the aid of
KENFLEX® A
KENFLEX® N
KENMIX® Red Lead
KENLASTIC® Red Lead
KEN - MAG®

NITRILE RUBBER
Processed with the aid of
KENFLEX® Resins
KENFLEX® Dispersion
KENMIX® Dispersions

BUTYL RUBBER
Processed with the aid of
KENFLEX® A
Invention/Technology Evolution – 1973 to 2020

Aromatic Resins

Dispersions for Rubber
Invention/Technology Evolution – 1973 to 2020

Aromatic
Resins

Dispersions
for Rubber
85% ZnO in Napthenic Oil/Wax
Invention:
Transesterify 3-moles Isostearic Acid with 1-mole TIPT
Invention: Transesterify 3-moles Isostearic Acid with 1-mole TIPT
Function 1 – Coupling

Recycled PVC compounds contain a mixed bag of inorganic & organic additives.
The Six Functions of the Titanate Molecule

Function 1 - Coupling

1.5-Nanometer Atomic Monolayer

1.5-nanometer 1.5-nanometer
55% ZnO Dispersed In Mineral Oil

1,600,000 cps

CONTROL

12,800 cps

0.5 wt. % TITANATE
55% ZnO Dispersed In Mineral Oil

- Stearic Acid
- Igepal CO-660
- Span 80
- Tergitol 15-S-9
- Isostearic Acid

Viscosity

55% ZnO Dispersed In Mineral Oil

Stearic Acid
Igepal CO-660
Span 80
Tergitol 15-S-9
Isostearic Acid

VISCOITY

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55% ZnO Dispersed In Mineral Oil

Attaching Isostearic Acid to Titanium is like changing light to laser.
55% ZnO Dispersed In Mineral Oil

Note: Sensitivity to Dosage: 0.1% More Titanate (0.2 to 0.3%) Reduces Viscosity from 800,000 to 19,200 cps
Patented ZnO Apps

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

2020: EU REACH Registered in 680 Cosmetic Formulations
Advanced Solutions in Vinyl Recycling with Titanate Catalysts/Coupling Agents

Improving COLOR & APPEARANCE

FACIAL COSMETICS
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 2020

Safety Assessment of Titanium Complexes as Used in Cosmetics

2-Nanometer Titanate Coating on Pigment

2019 Drawing – Fe₂O₃/Titanate  1973 Drawing by S. J. Monte
Function 1 – Coupling

Recycled PVC Compounds Contain A Mixed Bag of Inorganic & Organic Additives
The Liquid Coupling Agent can be added to the liqui-color concentrate and then added at the hopper.
“Silanes”-Plueddemann: “... Only slight improvement was imparted ... titanium dioxide and zinc oxide.”
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
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

<table>
<thead>
<tr>
<th>Wt.% LICA 09 Carbon Black</th>
<th>Resistivity Surface, Ω/sq.</th>
<th>Resistivity Volume, Ω·cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>&gt; 10^{16}</td>
<td>7.8 \times 10^{14}</td>
</tr>
<tr>
<td>0.67</td>
<td>1.7 \times 10^{12}</td>
<td>3.0 \times 10^{12}</td>
</tr>
<tr>
<td>1.00</td>
<td>2.1 \times 10^{8}</td>
<td>4.3 \times 10^{7}</td>
</tr>
<tr>
<td>2.00</td>
<td>5.7 \times 10^{7}</td>
<td>3.7 \times 10^{7}</td>
</tr>
</tbody>
</table>

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The Next Frontier in Polymer Composite Innovation
The Next Frontier in Polymer Composite Innovation

391 Abstracts based on Ti/Zr

80%

March 2019

- Graphene – 109x
- Graphite – 177x
- CNTs – 105x
Returned From Darmstadt Mar. 5. 2020

Salvatore J. Monte – Kenrich Petrochemicals, Inc.

Forum Plastic Recyclates 2020
Quality Increase of Material & Processing

3-4 March 2020 in Darmstadt

My 32nd Patent Issued Mar. 5. 2020
Compatibilize Oil Soaked Seawater Sand with OPC

United States Patent Application Publication

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CONSTRUCTION MATERIALS, COMPOSITIONS AND METHODS OF MAKING SAME

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TECH (US)
Patent Classification
Int. Cl.
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Compatibilize Oil Soaked Seawater Sand with OPC

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Compatibilize Oil Soaked Seawater Sand with OPC

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Nano-Compatibilization Titanate = <1-pt/1,000-parts

Compatibilize Oil Soaked Seawater Sand with OPC

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My 32nd Patent Issued Mar. 5. 2020
Advanced Solutions in Vinyl Recycling with Titanate Catalysts/Coupling Agents

You can’t just mix everything together
Addition Polymers Are Different

PVC is #3
What! You can’t just mix everything together?

Plastics #1 to #7 are incompatible with each other.
Advanced Solutions in Vinyl Recycling with Titanate Catalysts/Coupling Agents

Plastics #1 to #7 are incompatible with each other
Add to the 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
Add to the mix: Polymers #1 to #7 & Fillers, Fibers, Pigments, etc.

Functions 1 & 2 – Coupling & Catalysis

Elongation

Increasing Filler

0% 20% 40% 100%

Nano 2-5%

Optimal 3-micron

CPVC

20% to 40% Filler with Titanate

3-micron CaCO₃
PE & PP are ADDITION POLYMERS
PET is a CONDENSATION POLYMERS

Incompatibility PE & PP

Incompatibility PET & PE
PE & PP are ADDITION POLYMERS
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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
Sustainability Goals such as a Circular Economy using Curbside Recycle in new plastic parts is technically not possible with current industry practices:
Sustainability Goals such as a Circular Economy using Curbside Recycle in new plastic parts is technically not possible with current industry practices:

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

Injection Molding Delamination
5% PP (Tupperware) in 95% HDPE (Milk Jug) = part reject
Compatibilization of LDPE/PP – 80/20
Chain Scissoring Effect - 6 Heat Cycles on LDPE/PP – 50/50 Regrind
REPOLYMERIZATION of LDPE/PP – 50/50 Regrind
Using 1% Titanate Catalyst Pellet = 2 parts per thousand Titanate
New thinking in Compatibilization & Polymer Regeneration via Ti / Zr Coupling & Catalysis to reduce the need & cost to sort materials so as to broaden Recycling Compounding Capability...

PVC, PC & PA6 & other Engineering Plastics can be processed at much lower temperatures.
Maleated polymer compatibilizers work on Addition Polymers but depolymerize Condensation Polymers.

Maleated polymers couple polymers but not fillers.

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

40% FG/PC Control – Injection Molded @ 304°C (580°F)
1% Ken-React® CAPS® – Injection Molded @ 188°C (370°F)
Titanate Catalysis Unfilled EPR

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

1000g off 2-roll mill 0.2% Titanate
UNFILLED WB ACRYLIC Automotive Tin Plate

Function 1 – ADHESION

Function 2 – CATALYSIS

Function 3 - PHOSPHATIZE
Compatibilizing Recycled PET/PC – 80/20 Blend Using 0.3% CAPOW® Titanate Catalyst – 100°C lower Temp.

Copolymerization of Two Dissimilar Condensation Polymers

Extruded@ 180°C using 0.3% CAPOW® L®12/H Titanate Catalyst vs. 280°C without the Additive
Regrind: Compatibilizing HDPE / Nylon Film
Using 0.2% Titanate Catalyst

HDPE – Addition Polymer + NYLON – Condensation Polymer +
KEY SEARCH WORD: “BLEND”
44 References to “PVC”
2x OUTPUT @ 85°F (47°C) LOWER TEMPERATURE

PROFILE TEMP. 360°F
28 RPM
8 UNITS/MIN.

PROFILE TEMP. 275°F
43 RPM
17 UNITS/MIN.
71-ABSTRACTS on POLYBLENDs – sjmonte@4kenrich.com

SciCENIE IP
The CAS Search Service

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

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2x OUTPUT @ 85°F (47°C) LOWER TEMPERATURE
PROFILE TEMP. 360°F
28 RPM
8 UNITS/MIN.

PROFILE TEMP. 275°F
43 RPM
17 UNITS/MIN.
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.

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);
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.

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);
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.
PVC can be: Polymerized, Co-Polymerized, Re-Polymerized or De-Polymerized
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PVC can be: **Polymerized, Co-Polymerized, Re-Polymerized or De-Polymerized**
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

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

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.

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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

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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,
2. PP Copolymer from mixed 20-35 MFI injection molded caps,
3. PET from thermoformed clamshell food packaging.
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
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

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

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.
Lowering the process temperature for reactive compounding shear is critical.

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.
We have shown In Situ Macromolecule Titanate/Al (KPR®) Coupling & Catalysis is a significant strategic approach to reach VINYL RECYCLING sustainability goals.
Advanced Solutions in Vinyl Recycling with Titanate Catalyst/Coupling Agents

Salvatore J. Monte – Kenrich Petrochemicals, Inc.

July 20, 2021 – 2:00-4:00pm
The End

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