Injection Molding Division
Molding Views

Summer 2024 | No. 123 www.injectionmoldingdivision.org Keep the connection! Join us on:

Chair's Message David Kusuma, Ph.D.

Dear Members of the Injection Molding Division (IMD),

It's an honor to have the opportunity to lead the SPE Injection-Molding Division during this new term, and I want to first express my gratitude to our prior Chairman, Jeremy Dworshak, and the entire IMD Board of Directors. Under Jeremy's leadership we have set a new direction to focus on creating new benefits and programs for our division members including closer collaboration with the SPE National organization.

In my first Chairman's letter, I want to highlight some of the plans for the new term, which I feel build nicely on the efforts of the recent past. I will name these the "four pillars" of focus for IMD in 2024 and 2025:

Collaborative Content Partnerships
With the excellent personal and professional networks provided through the SPE and many of our prominent members, we have the opportunity to create and strengthen partnerships with industry, educational institutions, intra-SPE divisions and sections, and external like-minded cross-disciplinary organizations. In this manner we will be able to obtain a higher quality of programming in a shorter period of time, than if we try to build content programs from scratch.

We are already in contact with several companies for industry visits, and with universities which are willing to host board meetings and open their facilities to the SPE community for specially arranged tours and lectures. Two events which I want to immediately highlight are the 25th International Polymer Colloquium hosted at the University of Madison-Wisconsin in March, and the Innovation and Emerging Plastic Technologies Conference hosted at Penn State Behrend in June. Both are being led by IMD board members, and are open to our SPE membership and the plastics community.

IN THIS ISSUE:

Additionally, we are reaching out to other SPE divisions and sections for potential joint events and forums, and we want to make collaborative inroads with aligned external organizations such as the Industrial Designers Society of America (IDSA) and the World Design Organization (WDO). Product developers require materials to make their innovations come to life so there is an opportunity for the IMD to expand our reach through those organizations.

Project Focused Committees

The long standing mission of the IMD has been to "promote the scientific and engineering knowledge of injection molding." There is work to be done to enable this objective, to build strategies which can be developed and implemented through the formation of targeted IMD committees.

Some of the most relevant committee projects would be to build and improve publications to expand member and public access to information, continue workshops (our first Workshop for the National Week of Injection Molding will take place on Sept 24-25, 2024), and improve communications outreach (including optimizing our website, newsletter, and social media).

Expertise with Higher Visibility

To build greater excitement and participation we also want to significantly increase our division's visibility, both to members within the SPE as well as externally. To this end, it will be important for us to focus on creating activity to happen where people already will be, instead of expecting them to travel to one of our stand-alone events.

One venue which is always well attended is the ANTEC, and we plan to work with the SPE National team to restart our IMD reception, which had been very well attended in the past. In addition, we are in discussion with the national office to launch an injection-molded plastics part competition, with the winning entries to be showcased at the 2025 ANTEC in Philadelphia. The competition will be judged by a panel of notable industry experts, with the results to be featured in a future Plastics Engineering issue, as well as other industry publications. There is also an idea about converting the showcase of winning parts into a traveling exhibition to facilitate further visibility for the winners, our division, and the SPE at large.

Future Proofing

The life blood of any organization is its members. I cannot emphasize enough that we must give full attention to continue building a foundation for the IMD that will continue to provide leadership into the future. This means increasing our division membership by inviting more professionals to join the SPE-IMD; also by inviting younger industry professionals to participate and join the leadership of our IMD board. This is an open invitation to anyone who would like to get involved; we welcome participation at every level of interest!

In mentoring younger industry professionals, I feel we should try to also improve our supporting activities to bring new sponsors and work to offer more scholarships and internships. And we should promote sustainability as it relates to our industry. We witness everyday how plastics has the power to transform communities and we should always keep in mind our need to highlight the benefits of plastics and responsible use in raising the quality of life around the world. To avoid misconceptions about our industry, we will need to strive to champion leadership as a key pathway towards a better future in everything we do.

David Kusuma, Ph.D.
Chair, SPE Injection Molding Divisio

SEPTEMBER 2024

POLYMERIC MATERIALS: COMMODITY PLASTICS, ENGINEERING RESINS AND SPECIALTY POLYMERS - UMASS LOWELL PLASTICS ENGINEERING SEMINARS

TUESDAY, SEPTEMBER 3, 2024 - FRIDAY, SEPTEMBER 6, 2024 - ALL DAY

UMASS LOWELL, 185 RIVERSIDE ST., LOWELL, MA

For more information: **https://gps.uml.edu/professional-training/plastics/seminars/polymer-materials-commodity-engineering-resins.cfm**

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN POLYMER INFORMATICS

SEPTEMBER 3, 2024

VIRTUAL

This workshop introduces participants to the emerging field of polymer informatics with a focus on machine learning techniques. Polymer informatics utilizes computational and data-driven approaches to understand and predict polymer properties and behaviors, which is essential for materials innovation. The course will cover foundational concepts in polymer science and machine learning, emphasizing the integration of these disciplines.

For more information: **https://www.4spe.org/i4a/pages/index.cfm?pageid=8862**

SPE WORKSHOP: INNOVATIVE COST MANAGEMENT APPROACHES TO ACHIEVE IMPROVED PROFITABILITY OF YOUR PLASTICS BUSINESS

TUESDAY, SEPTEMBER 10, 2024 - THURSDAY, SEPTEMBER 12, 2024

VIRTUAL

For more information: **https://www.4spe.org/i4a/pages/index.cfm?pageID=8750**

SPE COURSE - IMPORTANCE OF SUSTAINABLE PRACTICES IN PLASTICS TECHNOLOGY: CONSUMER PREFERENCE AND BRAND IMAGE SEPTEMBER 16, 2024

MONDAY, SEPTEMBER 16, 2024 11:00 AM (EDT) - 12:00 PM (EDT)

VIRTUAL

The course delves into the critical need for sustainable practices in plastics technology, highlighting the environmental challenges associated with conventional plastics. It discusses how plastics, despite their versatility and widespread use, are under scrutiny from an environmental standpoint. The session emphasizes the importance of integrating sustainable practices into plastics technology to address these challenges and advocate for a more environmentally and socially responsible approach.

For more information: **https://www.4spe.org/i4a/pages/index.cfm?pageID=8970**

SPE WEBINAR: POLYKETONE: UNDERSTANDING THE MATERIAL AND PROPERTIES

WEDNESDAY, SEPTEMBER 18, 2024 11:00 AM (EDT) - 12:00 PM (EDT)

VIRTUAL

Aliphatic polyketone, often referred to as just polyketone (POK), is a semi-crystalline plastic resin. Polyketone has a carbon backbone consisting of polar ketone groups. Commercial forms include the homopolymer made up of alternative segments of carbonyl structure and ethylene, and the copolymer which includes propylene segments.

For more information: **https://www.4spe.org/i4a/pages/index.cfm?pageID=8572**

Industry Events/Webinar Calendar Continued

SPE COLOR AND APPEARANCE CONFERENCE (CAD RETEC®)

MONDAY, SEPTEMBER 23, 2024 - WEDNESDAY, SEPTEMBER 25, 2024

TAMPA, FL

The 62nd Annual Society of Plastics Engineers Color and Appearance Division RETEC® will be held in Tampa, FL, during September 23-25, 2024. Come join us at the Tampa Marriott Water Street to celebrate Sailing Away with Color and engage in topics related to plastics coloration and appearance.

For more information: **https://specad.org/2024-cad-retectm-homepage/**

NATIONAL WEEK OF INJECTION MOLDING

TUESDAY, SEPTEMBER 24, 2024 - WEDNESDAY, SEPTEMBER 25, 2024

VIRTUAL

For more information: **https://www.4spe.org/i4a/pages/index.cfm?pageID=8893**

SPE TPO 2024 GLOBAL AUTOMOTIVE CONFERENCE

SUNDAY, SEPTEMBER 29, 2024 - WEDNESDAY, OCTOBER 2, 2024

TROY, MI

For more information: **https://auto-tpo.com/call-for-presentations/**

Call for Technical Papers & Article

We are currently seeking informative and educational articles on a variety of topics pertinent to the injection molding industry.

Do you have a paper or article you would like to publish in the next newsletter? Share your knowledge with the SPE Injection Molding Division members.

For more information on submissions visit:
www.injectionmoldingdivision.org or send your articles to:

publisherIMDNewsletter@gmail.com

spe

NATIONAL WEEK OF INJECTION MOLDING

September 24–25, 2024

spe
INJECTION
MOLDING

Join us! Sept 24-25, 2024

Join this online event with virtual breakout rooms for networking.

During the Week of Injection Molding, experts from the industry explored some of the most popular trends, techniques, and technologies that make Injection Molding one of the most versatile molding options available whether you're a student, molder, supplier, or OEM.

AGENDA:

Tuesday, September 24
- Platinum Sponsor Presentation
- Revolutionizing Injection Molding through Hybrid Manufacturing
- Introduction to Ultrasonic Plastic Welding
- Network Roundatable
- Speaker Presentations
- Panel Discussion

Wednesday, September 25
- Platinum Sponsor Presentation
- Bioplastics and Biocomposites in the Circular Economy
- Accounting for Viscosity Variation in Sustainable Resins with iMFLUX Technology
- Network Roundatable
- Sustainable Reinforcements in Polypropylene
- What's the matter with Plastics (the Industry)?
- Panel Discussion

Silver Sponsors: BRYAN HAUGER CONSULTING SLIDE

For more details visit www.4spe.org

SPEAKERS:

Brandon Birchmeier, President
Birchmeier Plastics Solutions

Conor Carlin, President
SPE-Inspiring Plastics Professionals

Leo Klinstein, VP of Engineering & R&D
Dukane IAS, LLC

Jason Locklin, Professor
University of Georgia

Charles Martin, President
Leistritz Extrusion

Lynzie Nebel, Upstream Quote Engineer
Cytiva

Srikanth Pilla, Professor
University of Delaware

James Preston, Vice President Strategic Growth
RheTech LLC

Mark Remmert, CEO
Green Dot Bioplastics LLC

Processing and Molding Polymers with 1.5-Nanometer Titanates and Zirconates in Pellet Form

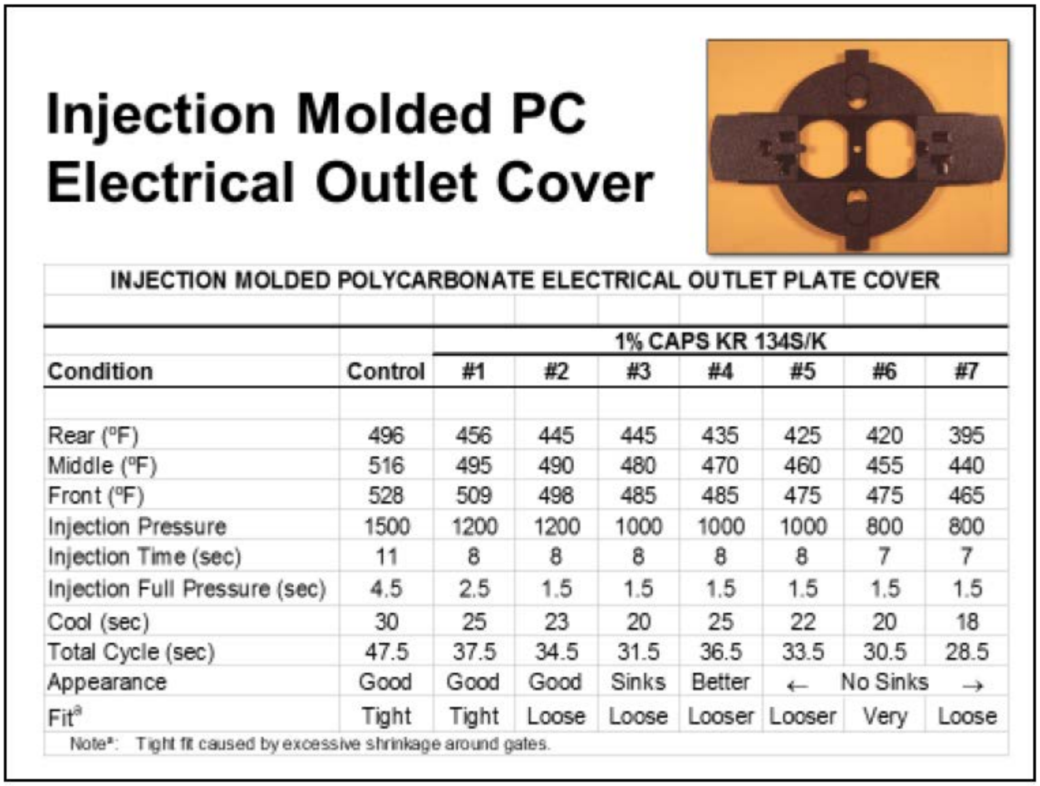
By Salvatore J. Monte Kenrich Petrochemicals, Inc. sjmonte@4kenrich.com

Added to the hopper just like a color concentrate, 2 to 3 parts of a phosphato titanate or zirconate in pellet masterbatch form per 1,000 parts of filled or unfilled compound provides a method (Function 1-Coupling) for in-situ interfacial nano-surface modification of most all inorganic and organic materials in a compound independent of the interface's hydroxyl content and absent the need for water to effect hydrolysis for coupling as with silanes while providing metallocene-like repolymerization catalysis (Function 2-Catalysis) and (Function 3) nano-intumescence for flame retardance resulting in: the use of larger amounts of regrind and recycle; copolymerization of blends of dissimilar addition and condensation polymers such as HDPE, PP and PET; prevention of delamination of PP/HDPE blends; faster production cycles at lower temperatures producing thermoplastic parts having less heat stress differentials, better finish, and increased stress-strain strength; and control of burn rate and burn rate exponent. Compounds having subject additives age better due to the removal of water at the polymer-reinforcement interface normally left when using a silane or no additives that cause loss of adhesion during water boil tests.

Introduction

OK. So you are up-to-date on Industry 4.0 and have the latest and greatest processing equipment, controls, sensors and software such as iMFLUX®. And you know your compound materials behavior such as "crystallinity" based on your data and pay attention to machine conditions to optimize their performance. But, the specific behavior of materials alone and in combination will always remain a challenge as the Internet of Things – the basis of 4.0 – depends on data and the data depends on the accumulated experience inputted.

Marcel Beraud, Director – Global Services AMT – The Association of Manufacturing Technology makes several key points in his article, What Does it Take to Be 4.0 Ready?: "…As an avid floor manufacturing guy, to me it all starts with the basics. We need to have robustness in everything we do: our designs, our process instructions and controls, our material selection…" – see link: https://issuu.com/amtonline/docs/amtnews_july_final_web/11 . So, if your 40% fiberglass reinforced Polycarbonate part calls for an injection molding profile temperature setting input of 496-528°F while 1 to 2 parts per thousand parts of a titanate will allow a setting of 395-465°F, your 4.0 process with the higher temperature settings will have to overcome problems such as: shrinkage at the gate, sink marks, dimensional stability, uniform appearance and mechanical properties and not have the advantage of faster production cycle times. See IM PC Electrical Outlet Cover **Table 1** data next:



Injection Molded PC Electrical Outlet Cover

INJECTION MOLDED POLYCARBONATE ELECTRICAL OUTLET PLATE COVER

		1% CAPS KR 134S/K						
Condition	**Control**	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**
Rear (°F)	496	456	445	445	435	425	420	395
Middle (°F)	516	495	490	480	470	460	455	440
Front (°F)	528	509	498	485	485	475	475	465
Injection Pressure	1500	1200	1200	1000	1000	1000	800	800
Injection Time (sec)	11	8	8	8	8	8	7	7
Injection Full Pressure (sec)	4.5	2.5	1.5	1.5	1.5	1.5	1.5	1.5
Cool (sec)	30	25	23	20	25	22	20	18
Total Cycle (sec)	47.5	37.5	34.5	31.5	36.5	33.5	30.5	28.5
Appearance	Good	Good	Good	Sinks	Better	←	No Sinks	→
Fit[a]	Tight	Tight	Loose	Loose	Looser	Looser	Very	Loose

Note[a]: Tight fit caused by excessive shrinkage around gates.

Table 1

Temperature is just one of the inputs. In a SPE Webinar entitled Ductile to Brittle Transitions in Plastics - October 18, 2018 – see link: https://www.4spe.org/i4a/ams/meetings/?controller=meetings&action=loginOrGuest, Jeffrey A. Jansen, Senior Managing Engineer and a Partner at The Madison Group stated, "There are numerous factors that influence a ductile-to-brittle transition within plastic materials, such as:

- Temperature
- Stress Concentration
- Chemical Contact

- Molecular Weight
- Degradation
- Filler Content
- Contamination
- Poor Fusion
- Strain Rate
- Time Under Load
- Crystallinity
- Plasticizer Content

Within these variables such as Crystallinity listed above there are many subset phenomena that need to be understood and controlled.

According to Michael Sepe's sequential chronological posts in *Plastics Technology Magazine* on Materials Processing: "There are several process-related issues that influence crystallinity besides cooling rate" – see links for detailed discussion:

Published: 10/1/2018: *Materials: A Processor's Most Important Job, Part 9*

How to establish molding conditions that minimize internal stress in a part.

Published: 8/28/2018: *Materials: A Processor's Most Important Job, Part 8*

How processing adjustments can control molded-in stress.

Published: 8/1/2018: *Materials: A Processor's Most Important Job, Part 7*

There are several process-related issues that influence crystallinity besides cooling rate. Let's examine a few.

Published: 6/1/2018: *Materials: A Processor's Most Important Job, Part 6*

The importance of mold temperature to the development of the desired polymer crystalline structure becomes absolutely crucial in the case of high-performance materials.

Published: 4/27/2018: *Materials: A Processor's Most Important Job, Part 5*

Using a mold temperature above a polymer's Tg ensures a degree of crystallinity high enough to provide for dimensional stability, even if the part must be used at elevated temperatures. But POM is an exception. Why?

Published: 3/29/2018: *Materials: A Processor's Most Important Job, Part 4*

Engineering polymers require higher mold temperatures to achieve their ideal structure. The temptation to turn down the mold temps can hurt part performance.

Published: 3/1/2018: *Materials: A Processor's Most Important Job, Part 3*

Processors are often expected to compensate for ill-advised decisions made earlier in the product-development process. In the case of shrinkage, one of the most common 'fixes' is to simply reduce the mold temperature.

Published: 1/23/2018: *Materials: A Processor's Most Important Job, Part 2*

Process conditions help determine the difference between the maximum degree of crystallinity that can be achieved in a polymer and the degree that is present in a molded part.

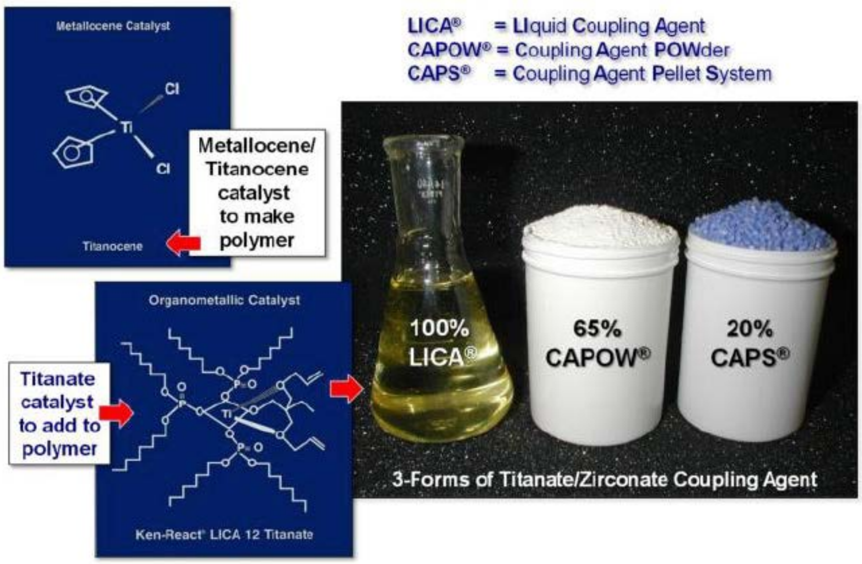
Published: 1/2/2018: *Materials: A Processor's Most Important Job, Part 1*

Many processors don't realize that preserving material characteristics is crucial to product success and failure. The focus here is on molecular weight.

Published: 12/1/2017: *Materials: Cycle Time—Science vs. Rules of Thumb, Part 6*

This installment—on elastomers—completes a series, whose theme is to bring more science to the discipline of molding. The overall message: Ask a lot of questions whenever someone posits this or that 'rule of thumb' about processing..."

Figure 1. Three Forms – Liquid, Powder & Pellet



So, what's left in a processor's arsenal to meet ever-increasing materials performance demands and resultant processing challenges intrinsic in the above variables in polymeric compositions?

How about ADDITIVES? Specifically, 1.5-nanometer Neoalkoxy Titanates and Zirconates in pellet form that provide a means to widen the window of material processing success via in situ organometallic Ti or Zr catalysis that improves flow and properties of unfilled and filled polymers. In effect, the materials in the polymer melt become the site of reactive titanium or zirconium interactions that provide for a more efficient use of raw materials.

This paper can be executive summarized (like the doctor who says, "Take two aspirins and call me in the morning"): "Tumble blend 1 part Ken-React® CAPS® L® 12/L (**see Figure 1**) additive with 100 parts of polymer compound material and then reduce processing temperature conditions by 10% for more for reactive compounding shear".

Discussion

There are over 450-ACS CAS Abstracts of "Works by S.J. Monte" starting with a December 1974 Modern Plastics magazine article entitled "New Coupling Agent for Filled Polyethylene" by S. J. Monte and P.F. Bruins, Professor of Chemical Engineering at Brooklyn Polytechnic Institute (now NYU Tandon School of Engineering) and my M.S. Polymeric Materials mentor in 1969. There are also several thousand ACS CAS Abstracted patents and technical papers issued to "others" based on my teachings.

In many of my past articles we taught the nano-technology of subject organometallics by discussing the chemistry of the SIX FUNCTIONS. I wrote a 340-page Ken-React® Reference Manual and distributed 80,000 copies over the period of 1985 to 1995 until the advent of the electronic era where people wanted CD's and now Memory Sticks. Provided next are some links that are instructive beyond the scope of this article:

- *Plastics Recycling World* – May/June 2018 HELPING PLASTICS COME TOGETHER - Catalysis Approach to Compatibilization: https://content.yudu.com/web/1rl19/0A42x3p/PRWMayJun18/html/index.html?page=52&origin=reader.
- *Rubber World Magazine* – February 2918 "Why Titanates and Zirconates May Be Better Adhesion Promoters Than Silanes for Silica & Carbon Reinforced Polymeric Compositions": http://digital.ipcprintservices.com/publication/?m=9911&l=1#{%22issue_id%22:476701,%22page%22:34}
- TITANIUM CATALYST PELLET ADDITIVE COPOLYMERIZES PCR (POST-CONSUMER RECYCLE) IN THE MELT: https://4kenrich.com/wp-content/uploads/2018/02/Ken-React-KPR-Global-Plastics-Summit-2015-Chicago-Multi-SlidesTitanate-Catalyst-for-PC.pdf .
- *Paint & Coatings Industry Magazine* – October 2017 – TITANATES & ZIRCONATES VS. SILANES: https://4kenrich.com/wp-content/uploads/2017/10/pci1017p48-Kenrich-FT-PCI-Oct-2017-Issue-PCI-Approved-for-Publication.pdf .
- TITANATES AND ZIRCONATES IN THERMOPLASTIC AND ELASTOMER COMPOUNDS: https://4kenrich.com/technical-information/titanates-and-zirconates-in-thermoplastic-and-elastomer-compounds/ .
- PIA White Paper: Compatibilizers: Creating New Opportunity for Mixed Plastics: https://www.plasticsindustry.org/sites/plastics.dev/files/Compatibilizers%20Whitepaper%20(Version%201.0)_0.pdf
- Dental Materials Journal 2017; 36(5): 539–552: Review of titanate coupling agents and their application for dental composite fabrication: https://4kenrich.com/wp-content/uploads/2018/09/Review-of-titanate-coupling-agents-and-their-application-for-dental-composite-fabrication-Dental-Materials-Journal-2017-365-539-552.pdf

The SIX FUNCTIONS of the physical organic chemistry of tetravalent organometallic Titanium and Zirconium may explain why they work – but, many polymer processors are not chemists and are more schooled in mechanical engineering, IT – or come from sales, marketing and business management. So, I decided to approach this paper from Jeffrey A. Jansen and Michael Sepe's processor viewpoints – and not the chemistry of the additive.

Let's take the aforementioned Jansen's *Ductile to Brittle Transitions in Plastics* factors starting with Temperature and comment on how titanate and zirconate additives will influence those factors in a positive way to give you – the polymer processor – a wider window of success for processors and then make our case with illustrations and data.

- **Temperature** – 2-parts additive per 1,000-parts polymer will allow the average process temperature to be lowered 10% and decrease cycle time by up to 40% and double extrusion rates. See **Table 2** for parts produced.

Plant Trial	Polymer	Molding Process	Part Produced	Coupling Agent	% Reduction	
					Temp.	Cycle Time
1*	HDPE (Phillips 5202)	Blow	Automotive	CAPS NZ 12/L	8.6	32.4
2	HDPE (Regrind 25053P)	Blow	Drum	NZ 12	9.2	18.9
3	HDPE (0.96M.I.)	Blow	Container	CAPS LZ 12/L	12.2	9.2
4	HDPE (Regrind 25053P)	Blow	Ski Board	CAPS L 12/E	16.1	18.4
6	HDPE (Undisclosed)	Inj.	Milk Crate	CAPS NZ 12/L	10.2	8.2
8	HDPE (Dow 08054)	Inj.	Drum.	LICA 12	6.6	15.8
10	HDPE (Dow 4052N)	Inj.	Drum Rim	CAPOW NZ 12/H	15.8	16.0
12	MDPE (100% Regrind)	Ext.	Profile	CAPS C.A./B.A.	12.3	14.1
13	LDPE (Undisclosed)	Inj.	Bumper	CAPS NZ 12/L	4.5	17.3
14*	PP	Inj.	Carry Box	CAPS L 12/E	8.3	8.7
15	PP	Inj.	Proprietary	LICA 12	12.0	28.5
16	PP (8310KO)	Inj.	Crock Pot	CAPS NZ 12/L	14.7	15.0
20*	HIPS	Inj.	Vac Nozzle	CAPS L 12/K	9.8	16.7
21	GPPS	Inj.	Closure	CAPS L 12/E	7.0	21.0
23*	ABS (BW KJC 34187)	Inj.	Computer	CAPS L09/K	11.9	22.1
24*	ABS (33838 Regrind)	Inj.	Carrier Box	CAPS L12/E	3.4	12.8
25	ABS (Undisclosed)	Inj.	Printer	CAPS L 09/K	7.9	16.4
27	ABS (Regrind)	Ext.	Frames	CAPS L 09/K	5.0	13.7
31	PBT	Inj.	Proprietary	CAPOW KZ TPP/H	3.4	31.2
32	PBT	Inj.	Proprietary	CAPOW L 2/H	1.1	30.5

Table 2

Figure 2 shows that the temperature/cycle time reduction effect on filled and unfilled PP is the result of filler coupling and polymer catalysis.

Figure 3 shows a doubling of unfilled Rigid PVC extrudate output at 85°F lower temperature with no sacrifice in appearance or dimensional stability.

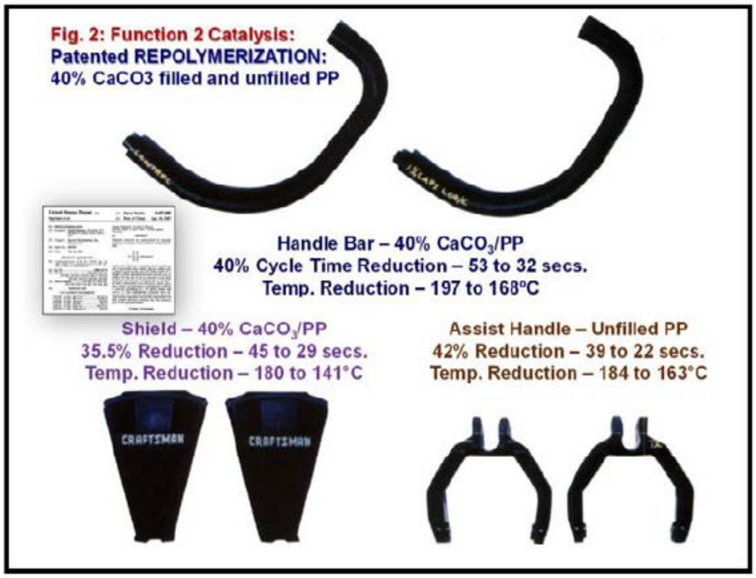


Fig. 2: Function 2 Catalysis:
Patented REPOLYMERIZATION:
40% CaCO3 filled and unfilled PP

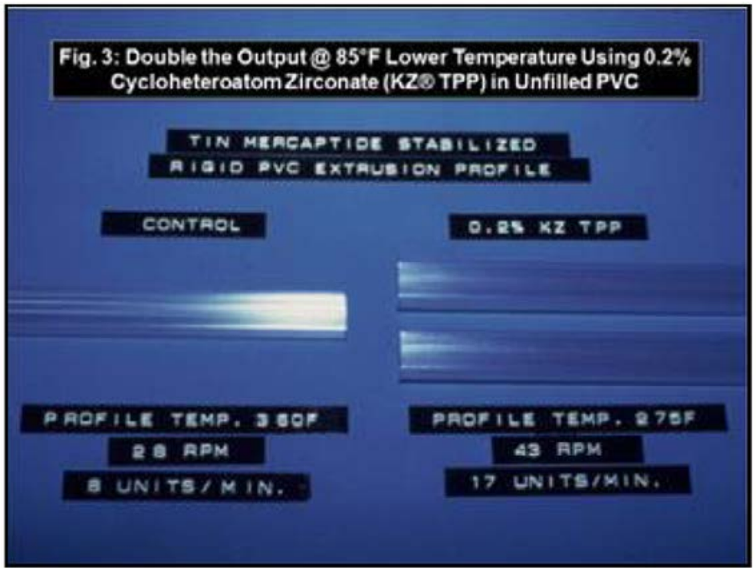
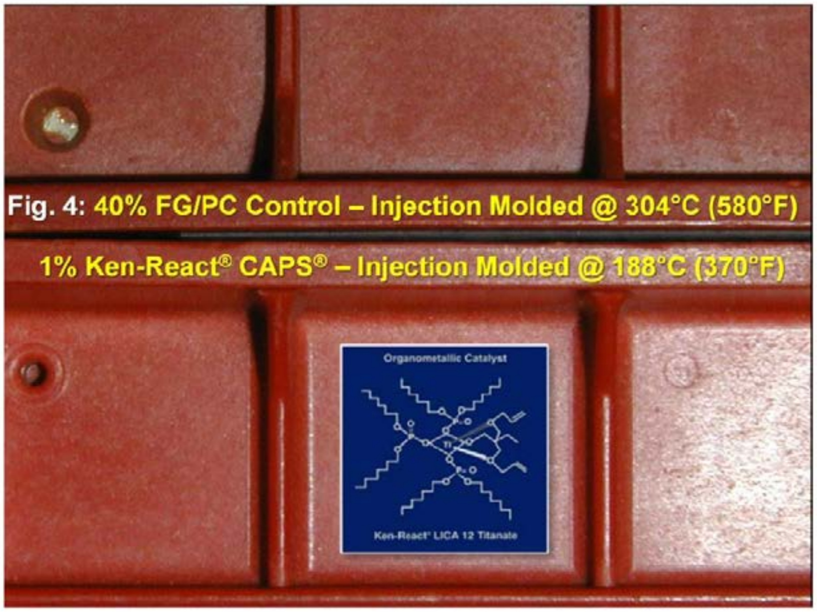
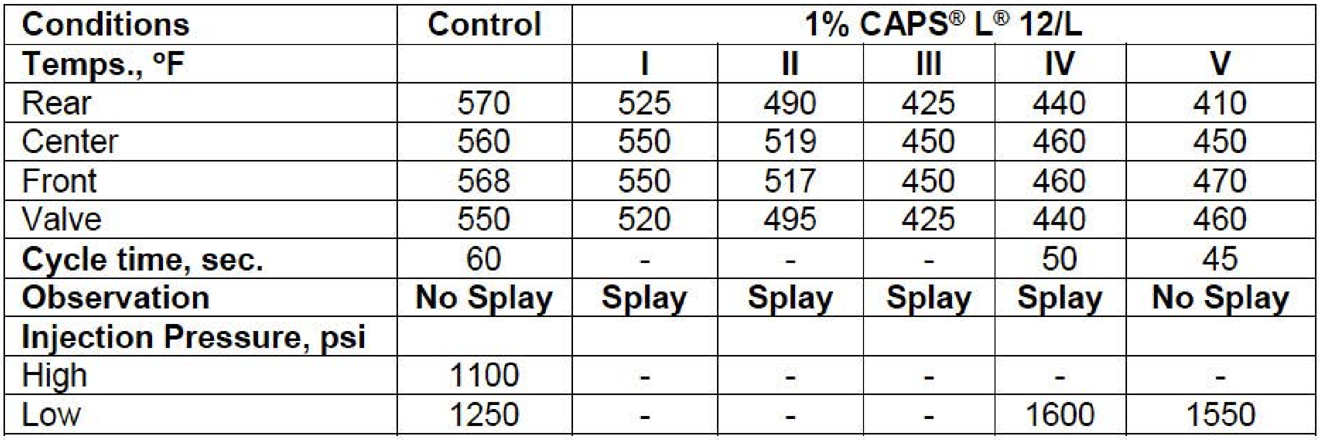


Fig. 3: Double the Output @ 85°F Lower Temperature Using 0.2% Cycloheteroatom Zirconate (KZ® TPP) in Unfilled PVC



- **Stress Concentration** – According to Sepe: "*Mechanical properties and dimensional stability of a part are greatly affected by the levels and uniformity of molded-in stresses. Mold-filling velocity and switchover point, as well as cooling rate and flow-channel dimensions are molders' tools for controlling stresses in molded parts.*" **Figure 4** shows the reduced stress and improved dimensional stability, better weld line formation, brighter color of a pre-compounded 40% fiberglass reinforced, red iron oxide pigmented PC injection molded part by the addition at the IM Press of 1% Ken-React® CAPS® L® 12/L by Stanley A. Watson of Diamond Machining Technology, Inc. enabling a temperature reduction of 210°F.

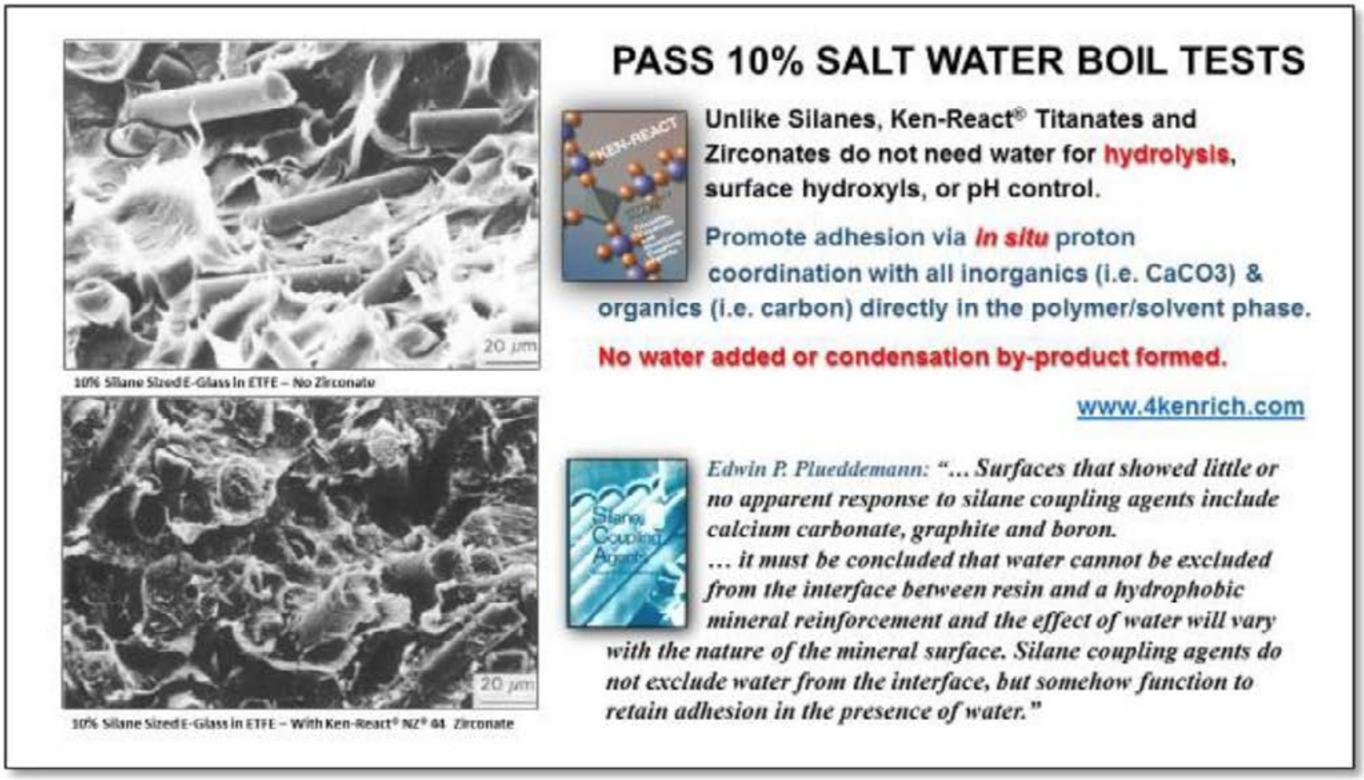
Table 2A shows a 25% cycle time reduction and 20% temperature reduction for an IM PC part.



Conditions	**Control**	**1% CAPS® L® 12/L**				
Temps., °F		**I**	**II**	**III**	**IV**	**V**
Rear	570	525	490	425	440	410
Center	560	550	519	450	460	450
Front	568	550	517	450	460	470
Valve	550	520	495	425	440	460
Cycle time, sec.	60	-	-	-	50	45
Observation	**No Splay**	**Splay**	**Splay**	**Splay**	**Splay**	**No Splay**
Injection Pressure, psi						
High	1100	-	-	-	-	-
Low	1250	-	-	-	1600	1550

Table 2A

Chemical Contact – The most chemical resistant plastics are PTFE, ETFE, PPS, etc. – see: https://www.curbell-plastics.com/Research-Solutions/Chemical-Resistance-of-Plastics. Water is a polymer's Achilles heel. When a filler or reinforcement or pigment is added to the plastic, water on the filler is also introduced via: water bearing-agglomerates; or water at the nano-filler/polymer interface; or water of hydrolysis is left on the fiberglass during silane sizing – see Edwin P. Plueddemann quote from his book "Silane Coupling Agents" in **Figure 5**:



PASS 10% SALT WATER BOIL TESTS

Unlike Silanes, Ken-React® Titanates and Zirconates do not need water for hydrolysis, surface hydroxyls, or pH control.

Promote adhesion via *in situ* proton coordination with all inorganics (i.e. CaCO3) & organics (i.e. carbon) directly in the polymer/solvent phase.

No water added or condensation by-product formed.

www.4kenrich.com

Edwin P. Plueddemann: "… Surfaces that showed little or no apparent response to silane coupling agents include calcium carbonate, graphite and boron. … it must be concluded that water cannot be excluded from the interface between resin and a hydrophobic mineral reinforcement and the effect of water will vary with the nature of the mineral surface. Silane coupling agents do not exclude water from the interface, but somehow function to retain adhesion in the presence of water."

Figure 5

Figure 6 shows the added resistance to chemical contact by a titanate in a 49% FG/Vinyl Ester part having 2-month exposure to 5% caustic (NaOH):

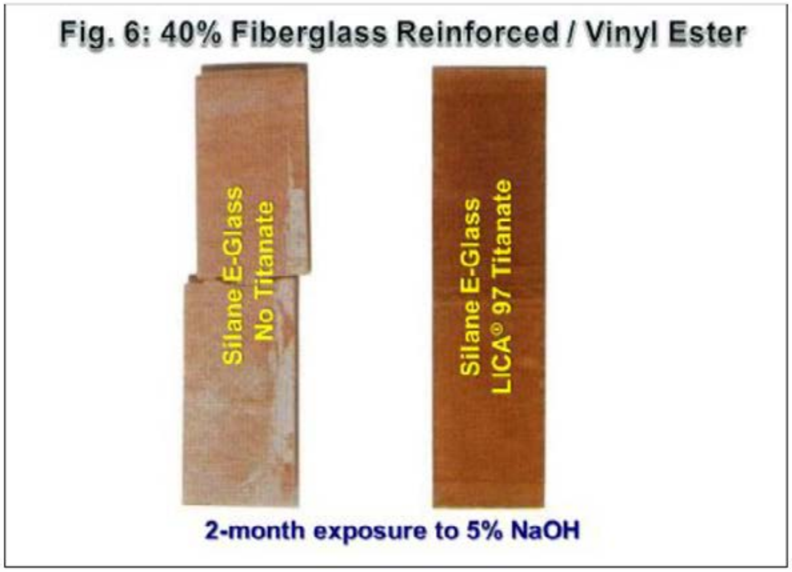


Fig. 6: 40% Fiberglass Reinforced / Vinyl Ester

2-month exposure to 5% NaOH

- **Molecular Weight** – Generally, the strength of a polymer increases with its molecular weight at the expense of processability as measured by its melt flow index (MFI). In addition, melt processing of a polymer causes chain scissoring resulting in lesser mechanical properties of regrind or recycle. Subject heteroatom titanates/zirconates improve the processability of the polymer allowing the use of HMW polymer while maintaining or building MW in situ via Ti or Zr catalysis in the polymer melt. For example, Brabender readings using 0.16 phr of a 20% active zirconate pellet masterbatch (CAPS® NZ® 12/L) in unfilled PP show at 180ºC a lower torque and higher mechanicals using a stronger (HMW) MFI 30 PP than a control using a weaker (LMW) MFI 120 PP – see **Table 3** provided by a Swiss film processor:

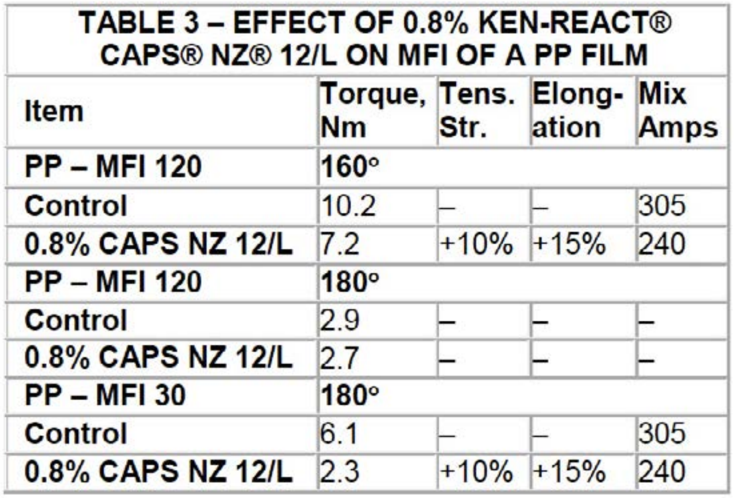


TABLE 3 – EFFECT OF 0.8% KEN-REACT® CAPS® NZ® 12/L ON MFI OF A PP FILM

Item	Torque, Nm	Tens. Str.	Elong-ation	Mix Amps
PP – MFI 120	160°			
Control	10.2	–	–	305
0.8% CAPS NZ 12/L	7.2	+10%	+15%	240
PP – MFI 120	180°			
Control	2.9	–	–	–
0.8% CAPS NZ 12/L	2.7	–	–	–
PP – MFI 30	180°			
Control	6.1	–	–	305
0.8% CAPS NZ 12/L	2.3	+10%	+15%	240

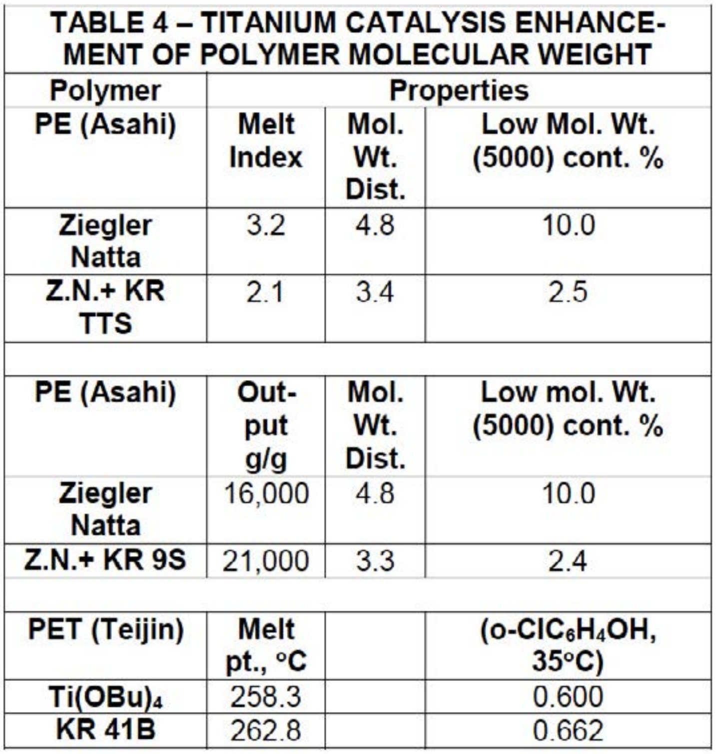


TABLE 4 – TITANIUM CATALYSIS ENHANCEMENT OF POLYMER MOLECULAR WEIGHT

Polymer	Properties		
PE (Asahi)	Melt Index	Mol. Wt. Dist.	Low Mol. Wt. (5000) cont. %
Ziegler Natta	3.2	4.8	10.0
Z.N.+ KR TTS	2.1	3.4	2.5
PE (Asahi)	Out-put g/g	Mol. Wt. Dist.	Low mol. Wt. (5000) cont. %
Ziegler Natta	16,000	4.8	10.0
Z.N.+ KR 9S	21,000	3.3	2.4
PET (Teijin)	Melt pt., °C		(o-ClC_6H_4OH, 35°C)
$Ti(OBu)_4$	258.3		0.600
KR 41B	262.8		0.662

Table 4 summarizes some of the early catalyst work done in Japan with monoalkoxy and coordinate titanates (invented by the author) on Z.N. catalyzed PE Addition Polymers and a PET Condensation polymer.

U.S. Patent 5,237,042 issued to the Korea Institute of Science and Technology (KIST) entitled, "*Process for the Preparation of Polybutylene Terephthalate Based Polyme*r" disclosed the use of a complex catalyst consisting of antimony and titanium (KR® 41B) compounds to produce a PBT polymer "*having excellent color, a small amount of side-product and a high degree of polymerization within a short time*". The KIST study sponsored by 7 S. Korean PET fiber producers cost $3MM and spanned five years, confirmed KR® 41B (tetraisopropyl di(dioctyl) phosphito coordinate titanate) to be the most efficient polymerization catalyst for PET.

Figure 7 illustrates two catalysis/mol. wt. points:

1. LDPE/PP – 50/50 blends of Addition polymers LDPE and PP are normally a compatibility issue prone to delamination during molding.

2. The Neoalkoxy phosphato titanate (LICA® 12) is a living catalyst constantly annealing molecular chains to maintain MFI integrity through several thermal cycles. (next page)

Figure 8 shows the copolymerization effect of proprietary Ken-React® CAPS® KPR® 12/LV technology on a blend of dissimilar post-consumer (PE/PP/PET) recycle consisting of: LLDPE from a fractional melt film; PP Copolymer from mixed 20-35 MFI injection molded caps; PET from thermo-formed clamshell food packaging.

Figure 9 provides some of the history of the evolution of Z-N, Metallocene, and subject titanate catalysts, which are unique because of their ability to copolymerize Addition (PE, PP) / Condensation (PET, PA) Polymers. Note: MAH compatibilizers depolymerize Condensation polymers. **Figure 10** shows the compatibilization effect on a LDPE/PP regrind blend and illustrates a titanocene designed for polymerization and a titanate (LICA® 12) for repolymerization catalysis.

In melt processing of the titanate catalysts it is important to maintain reactive compounding shear as the titanate will reduce compound viscosity. The subsequent loss of shear at the interface must be regained by controlling temperature, pressure and rpms to optimize the nano-reactions that cause total titanium organometallic filler coupling and polymer catalysis. Figure 11 (next page) is the general processing principle of

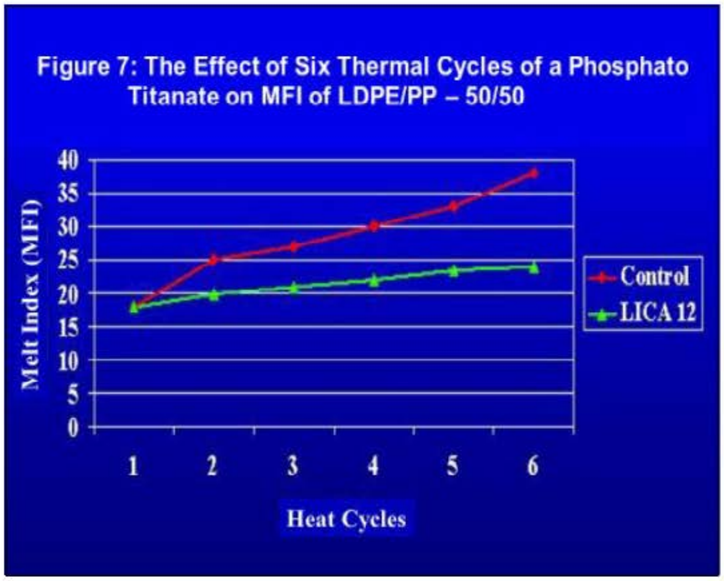


Figure 7: The Effect of Six Thermal Cycles of a Phosphato Titanate on MFI of LDPE/PP – 50/50

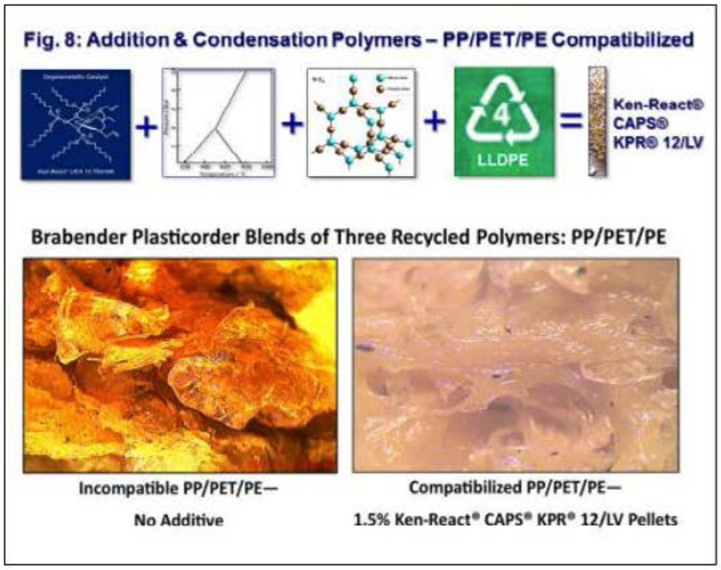


Fig. 8: Addition & Condensation Polymers – PP/PET/PE Compatibilized

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


Fig. 9: Recycled Plastics to Reach Sustainability Goals Need Compatibilizers

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 $Al(C_2H_5)_2Cl$ gave comparable activities 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). The MAO serves two roles: (i) alkylation of the metallocene halide and (ii) abstraction of an anionic ligand (chloride or methyl) to give an electrophilic catalyst with a labile coordination site.
- 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 sorting.

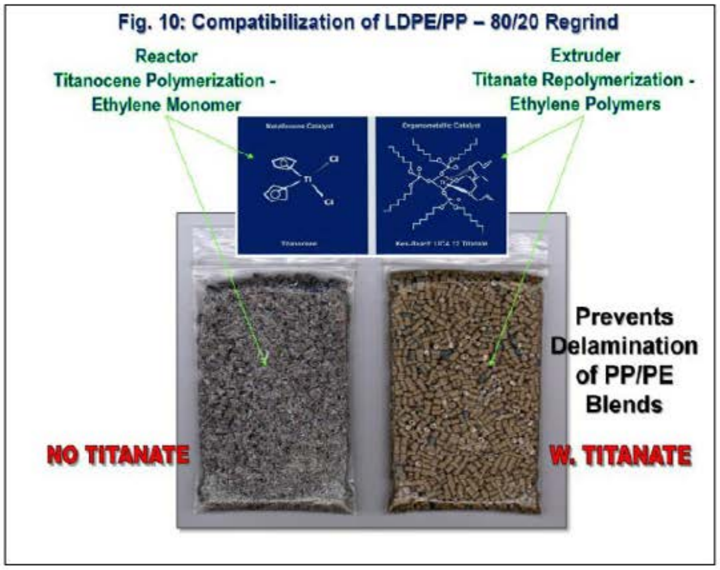


Fig. 10: Compatibilization of LDPE/PP – 80/20 Regrind

maintaining the interfacial Work Energy (defined as the Area under the plot of Torque vs. Time) and **Figure 12** shows the positive effect of lowering temperatures for reactive compounding shear and subsequent compatibilization of the materials in **Figure 8**.

The use of heteroatom titanates and zirconates in polymer melt processing changes significantly the data reference points for Industry 4.0.

- **Degradation** – Degradation of a thermoplastic polymer composition can occur within the polymer itself or at the interface where the polymer and fillers, pigments, or fibers such as fiberglass, graphite, aramids and cellulosics come together. The degree of dispersion of the filler in the polymer is a major degradation factor. Dispersion being defined as the complete deagglomeration of the filler particulates with its entrained air and moisture being displaced by the titanate/polymer phase to create a void-free and moisture-free composition. Thermosets may also experience breakdown of x-links.

Another source of degradation is water left on the surface of fiberglass after the silane hydrolysis adhesion mechanism (**see Figure 5**). The article entitled, "Review of titanate coupling agents and their application for dental composite fabrication" (see link in the introduction) states in its abstract: "Silane is a dominant coupler that is widely used in dentistry to promote adhesion among the components of dental composites. Silica-based fillers can be easily silanized because of their similarly ordered structure. However, silane is hydrolytically degraded in the aqueous oral environment and inefficiently bonds to non-silica fillers. Thus, the development of hydrolytically stable dental composites is an important objective in the research on dental materials. Titanate coupling agents (TCAs) exhibit satisfactory interfacial bonding, enhanced homogeneous filler dispersion, and improved mechanical properties of the composites. Titanates also provide superior hydrolytic stability in wet environments, which should be considered in fabricating dental composites. The addition of a small amount of titanates can improve the resistance of the composites to moisture.

Another example prevention of polymer degradation is shown in **Figure 13** wherein the titanate catalytic effect doubles the elongation of the silicone rubber jewelry mold compound and allows hot metal castings to increase from 11 to 250 cycles @ 460°C before degradation failure.

- **Filler Content** – Many of the negative factors of filler effects on polymer processing and mechanical properties are obviated when subject additives are used. There is a fundamental shift in the Critical Pigment Volume Concentration (CPVC) point of the filler/polymer ratio.

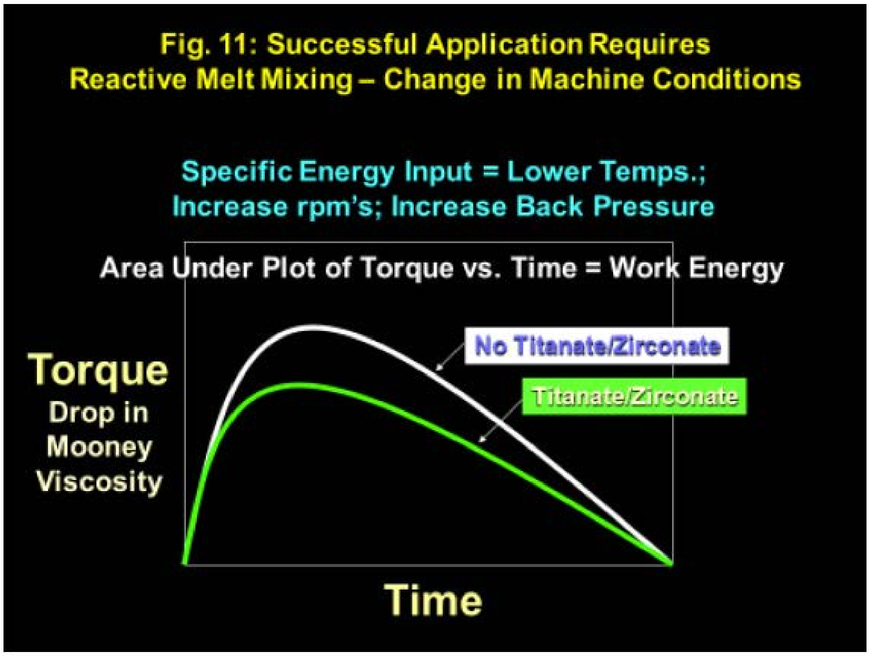


Fig. 11: Successful Application Requires Reactive Melt Mixing – Change in Machine Conditions

Specific Energy Input = Lower Temps.; Increase rpm's; Increase Back Pressure

Area Under Plot of Torque vs. Time = Work Energy

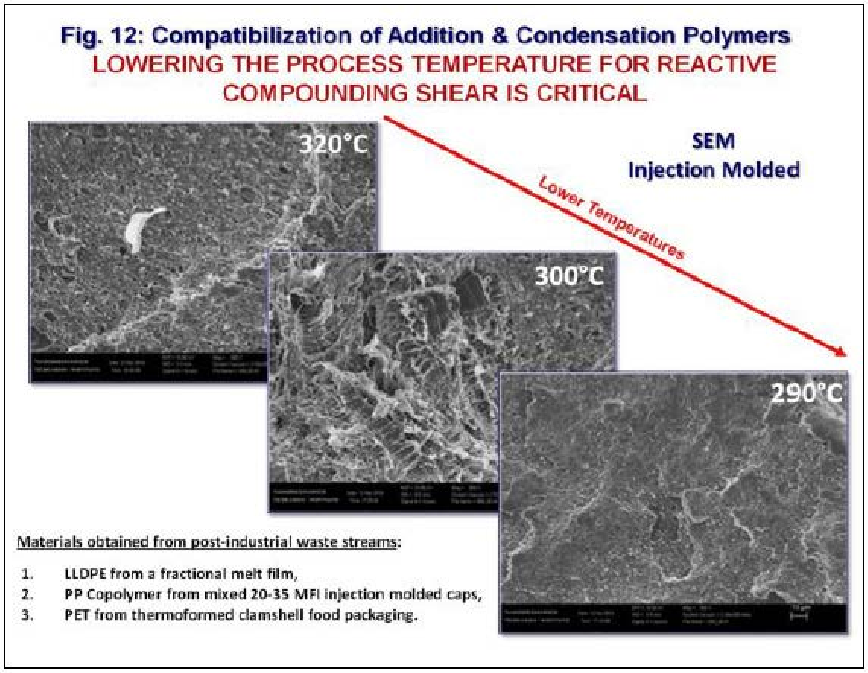


Fig. 12: Compatibilization of Addition & Condensation Polymers

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.

For example, the addition of CaCO3 filler will result in a loss in Elongation in direct proportion to the amount of filler added. Polymer Toughness is defined as the Area under the Plot of Stress vs. Strain. Strain is defined as the Elongation per Unit Length. **Figure 14** shows that a titanate treated CaCO3 will exhibit Elongations higher than unfilled polymer when loaded below the CPVC of the filled polymer composition.

Figure 15 shows that the titanate deagglom-erated filler – now devoid of mechanical property decreasing air and water voids – becomes a catalyst support bed for Titanium or Zirconium "Repolymerization" of the polymer phase producing unfilled to filled compositions that flow more readily and have greater flexibility.

The proton coordination coupling mechanism of titanates allows for reaction with any inorganic or organic substrate (**see Figure 16**) and does not have silane hydrolysis-hydroxyl requirements.

- **Contamination** – Besides the intrinsic incompatibility of many polymers, filler contamination without a coupling agent can diminish properties such as impact strength – **see Figure 14**.
- **Poor Fusion** – Fusion of plastics depends on many factors related to polymer flow and surface compatibility. **Figure 17** shows the improved flow and part definition of a Cellulose Acetate compound:
- **Strain Rate - Time Under Load** – These properties are a function of elongation and tensile strength and are measured in many different ways such as the COR (Coefficient Of Restitution). The COR is related to the square root of the Yield Strength divided by the Elastic Modulus – **see Figure 18**.
- **Crystallinity** – U.S. Patent 5,340,861 entitled "*Polyphenylene Sulfide Composition with improved Crystallizing Characteristic*" was issued to the Industrial Technology Research Institute, Hsinchu, Taiwan. Typically, the isothermal crystallization time at 250°C was reported substantially decreased from 175.2 to 105.8 seconds and the crystallization temperature was increased by 8.0°C using LICA® 09.

Excerpts from "*Detailed Description of the Preferred Embodiments*" of the patent are provided here:

Fig. 13: Increased Heat Aging of a Silicone Rubber Jewelry Mold from 11 to 250 Cycles Before Failure @ 460C.

15 Minute Cure @ 149°C – Silicone Rubber – Original Properties		
Tensile Strength, psi	718	500
Elongation, %	178	350
Tear Die B	65	40
Shore A Hardness	73	65
Number of Parts Produced By Mold Before Failure@ 460°C	Control 11	KR® TTS 250

Fig. 14: Filler With Titanate Exhibits Increased Elongation below the CPVC (Critical Pigment Volume Concentration) Point of the Filler/Polymer

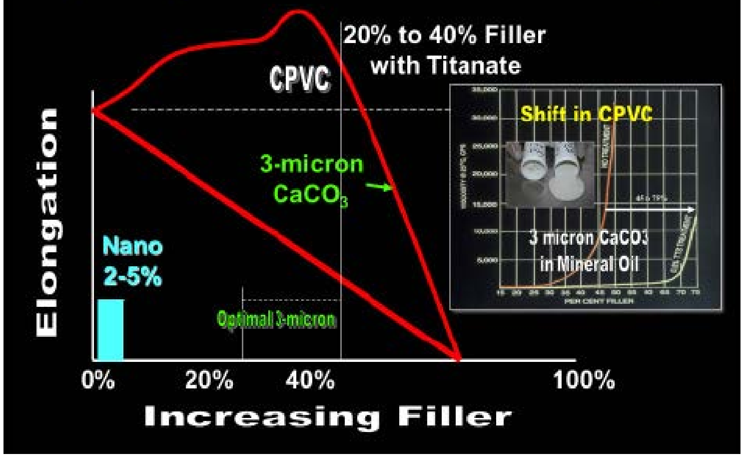
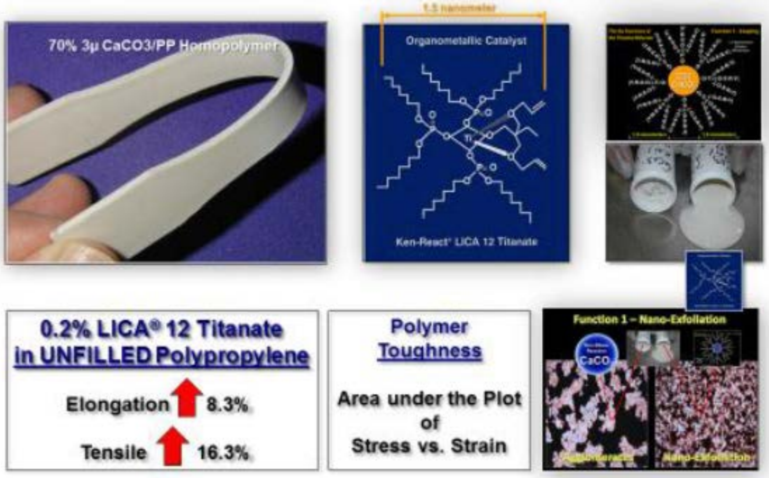


Fig. 15: Titanate Catalysis increases Polymer Toughness because both Tensile and Elongation increase



0.2% LICA® 12 Titanate in UNFILLED Polypropylene

Elongation ↑ 8.3%

Tensile ↑ 16.3%

Polymer Toughness

Area under the Plot of Stress vs. Strain

Example 1

A modified polyphenylene sulfide resin containing 3 wt. % titanium organometallic compound and 97 wt. % of molten polyphenylene sulfide resin was prepared. The titanium organometallic compound, which is designated as Organometallic Compound (1), has the following structure:

R’-O-Ti-(Q-R”)3

Wherein:

R’ is an alkyl group having three carbons,

Q is a SO3 group.

R” is represented by the following formula:

Wherein R is an alkyl group, Cn ,H2n’+1,n’=12’.

The molten polyphenylene sulfide resin had a viscosity of 1,800 poise (measured at a temperature of 310°C, and a shear rate of 100 sec-1). The modified polyphenylene sulfide was compounded with a Werner & Pfleider twin-screw extruder (Model ZSK-30). The temperature of the screw die was maintained at 315o C. After the modified polyphenylene sulfide composition was evenly compounded, it was palletized, dried, cooled, and monitored with a Perkin-Elmer differential scanning calorimeter (Model DSC-7) to study the crystallization rate by measuring the isothermal crystallization time and crystallization temperature.

Isothermal crystallization time is defined as the time required for the polyphenylene sulfide sample to crystallize at a given temperature, after the sample was quickly cooled to that given temperature. During the differential scanning calorimetry study, the polyphenylene sulfide sample was heated to a temperature of 310°C, remained there for 3 minutes. Then the sample was quickly cooled at a rate of 200°C/min to a pre-determined temperature of 250°C and maintained at 250°C for 10 minutes. The isothermal crys-

Fig. 16: Titanate reacts with all pigments, carbon, organics, cellulosics & minerals

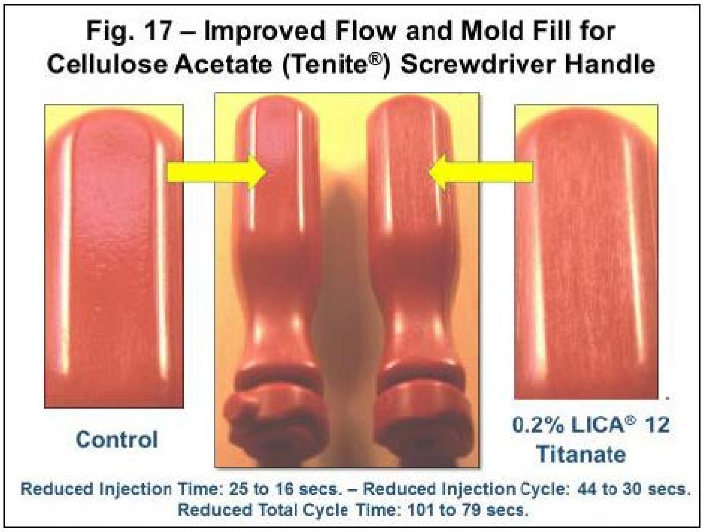


Fig. 17 – Improved Flow and Mold Fill for Cellulose Acetate (Tenite®) Screwdriver Handle

Reduced Injection Time: 25 to 16 secs. – Reduced Injection Cycle: 44 to 30 secs. Reduced Total Cycle Time: 101 to 79 secs.

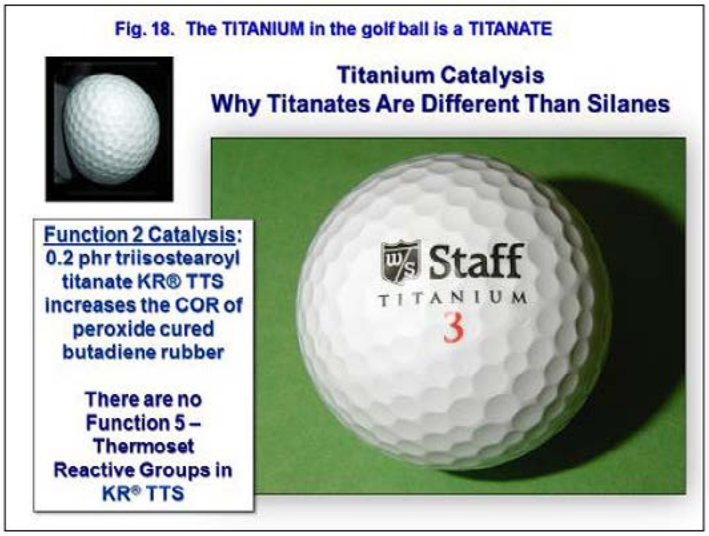


Fig. 18. The TITANIUM in the golf ball is a TITANATE

Titanium Catalysis
Why Titanates Are Different Than Silanes

Function 2 Catalysis: 0.2 phr triisostearoyl titanate KR® TTS increases the COR of peroxide cured butadiene rubber

There are no Function 5 – Thermoset Reactive Groups in KR® TTS

tallization time was determined from the differential scanning calorimetry curve. A lower value of isothermal crystallization time indicates a more rapid crystallizing rate. Crystallization temperature is defined as the temperature at which an exothermic peak was observed in the differential scanning calorimetry study under an isothermal cooling condition. The temperature of the polyphenylene sulfide sample was first raised to 310°C, and remained there for 3 minutes. The sample was cooled at a rate of 10oC/min to 50oC, and monitored with a differential scanning calorimeter. A higher value of crystallization temperature indicates a more rapid crystallizing rate, which is a desirable characteristic in the fabrication of the polyphenylene sulfide resin.

Item	*Example 1*	*Comparative Example 1*
Wt % of PPS Resin	*97.0*	*100.0*
Wt % of Organometallic Compound	*3.0*	*0.0*
Crystallization Temp. (°C)	*246.81*	*238.72*
Crystallization Time (sec.)	*105.8*	*175.2*

Table 1

Results of the isothermal crystallization time and the crystallization temperature are summarized in **Table 1**.

Comparative Example 1

A polyphenylene sulfide sample was prepared and tested using the same procedure as described in Example 1, except that the test sample did not contain the titanium organometallic compound. Results of the isothermal crystallization time and the crystallization temperature for this comparative sample are also summarized in **Table 1**.

From **Table 1**, it is evident that the addition of the titanium organometallic compound significantly improves both the isothermal crystallization time and the crystallization temperature of the polyphenylene sulfide resin. The isothermal crystallization time (at 250°C.) was substantially decreased from 175.2 seconds to 105.8 seconds and the crystallization temperature was increased by 8.09°C, with the addition of titanium organometallic compound.

Our experience has shown levels of titanate at less than 0.1% and typically in the range of 0.2 to 0.4% by weight of polymer produce good results.

For example, An extruded part using 0.5% Ken-React® CAPOW® NZ® 97/H (65% active aromatic amino zirconate on silica powder) Henschel mixed with PPS powder and next extruded is shown in **Figure 19** exhibited increased flow; eliminated necking; doubled Elongation; eliminated embrittlement and cracking; and produced a smooth finished part.

Fig. 19 - 40% Fiberglass Reinforced / PPS

- **Plasticizer Content** – The plasticizer effect of subject titanates and zirconates are largely misunderstood because of prior art thinking as to how process aids, wetting agents, surfactants and plasticizers work in polymers. In its simplest terms, a plasticizer works by being polymer compatible to increase flow and elongation while decreasing tensile strength. In contradistinction, subject titanates are thermally stable catalysts that change the morphology of the polymer to obtain the effect of a plasticizer. At 0.3 phr dosage levels – not only flow and elongation are improved – but also tensile strength – thus allowing significant reductions in plasticizer content or the use of higher molecular weight polymers for added strength.

For example, **Figure 20** shows the denerving of unfilled EPR (Vistalon® 404) rubber with just 0.3 phr of a monoalkoxy phosphato titanate in powder form called Ken-React® CAPOW® KR® 12/H.

Evidence of Ken-React® LICA® 12 (Neoalkoxy trioctylphosphato titanate) catalytic effects on the morphological behavior of FR PBT was observed by Ping Yuan Liu in EP 547809; lines 29 to 51: "The Neoalkoxy titanate compounds are described in the chapter entitled "Neoalkoxy Titanates" in Bulletin No. KR 1084L-4, "Titanate, Zirconate and Aluminate Coupling Agents" Revised 1987, published by (Kenrich Petrochemicals, Inc.) are the neopentyl (diallyl) oxy titanates. Most preferred is neopentyl (dially) oxy,tri (dioctyl) phosphate titanate which is manufactured by Kenrich Petrochemicals, Inc. under the trade name LICA 12. The neoalkoxy titanate processing aid is preferably compounded in a carrier to aid in its distribution throughout the polymer system of the present invention. A compatible carrier can be employed for this purpose, although the preferred carriers are ethylene vinyl acetate or ethylene ethyl acetate. The preferred ratio of the neoalkoxy titanate to the carrier is from 10 to 30 parts of neoalkoxy titanate for 100 parts of neoalkoxy titanate and carrier, with a preferred range of from about 15 to 25 parts neoalkoxy titanate for 100 parts of neoalkoxy titanate and carrier. Any amount of neoalkoxy titanate that will serve to improve the physical properties of the final composition is suitable for use herein. However, the preferred range of the neoalkoxy titanate utilized in the present invention will be from 0.02 weight percent to 1.5 weight percent of the total composition, and preferably from 0.1 weight percent to 1.0 weight percent, and most preferably from 0.2 weight percent to 0.8 percent of the total composition. It has been discovered, surprisingly, that a weight parts above four weight percent of the neoalkoxy titanate, the melt viscosity of the composition is equivalent to what to what it was at when no neoalkoxy titanate was utilized therein. It has also been surprisingly discovered that when the melt viscosity of the resulting composition was decreased through the use of the neoalkoxy titanate the strand integrity, contrary to general experience, is increased to improve the processability of the final composition. This is very surprising because strand integrity, which is directed to the

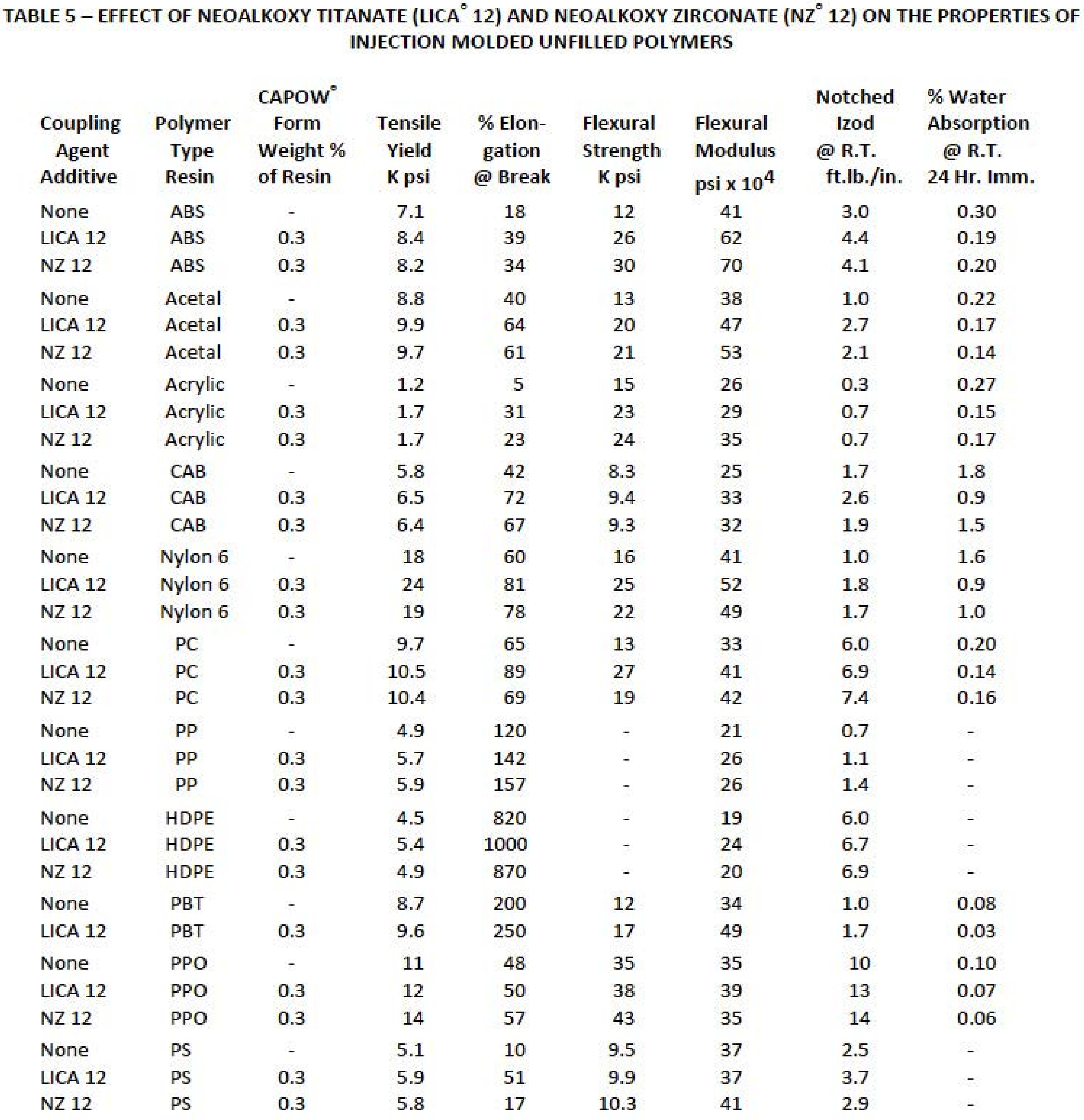


TABLE 5 – EFFECT OF NEOALKOXY TITANATE (LICA® 12) AND NEOALKOXY ZIRCONATE (NZ® 12) ON THE PROPERTIES OF INJECTION MOLDED UNFILLED POLYMERS

Coupling Agent Additive	Polymer Type Resin	CAPOW® Form Weight % of Resin	Tensile Yield K psi	% Elongation @ Break	Flexural Strength K psi	Flexural Modulus psi x 10^4	Notched Izod @ R.T. ft.lb./in.	% Water Absorption @ R.T. 24 Hr. Imm.
None	ABS	-	7.1	18	12	41	3.0	0.30
LICA 12	ABS	0.3	8.4	39	26	62	4.4	0.19
NZ 12	ABS	0.3	8.2	34	30	70	4.1	0.20
None	Acetal	-	8.8	40	13	38	1.0	0.22
LICA 12	Acetal	0.3	9.9	64	20	47	2.7	0.17
NZ 12	Acetal	0.3	9.7	61	21	53	2.1	0.14
None	Acrylic	-	1.2	5	15	26	0.3	0.27
LICA 12	Acrylic	0.3	1.7	31	23	29	0.7	0.15
NZ 12	Acrylic	0.3	1.7	23	24	35	0.7	0.17
None	CAB	-	5.8	42	8.3	25	1.7	1.8
LICA 12	CAB	0.3	6.5	72	9.4	33	2.6	0.9
NZ 12	CAB	0.3	6.4	67	9.3	32	1.9	1.5
None	Nylon 6	-	18	60	16	41	1.0	1.6
LICA 12	Nylon 6	0.3	24	81	25	52	1.8	0.9
NZ 12	Nylon 6	0.3	19	78	22	49	1.7	1.0
None	PC	-	9.7	65	13	33	6.0	0.20
LICA 12	PC	0.3	10.5	89	27	41	6.9	0.14
NZ 12	PC	0.3	10.4	69	19	42	7.4	0.16
None	PP	-	4.9	120	-	21	0.7	-
LICA 12	PP	0.3	5.7	142	-	26	1.1	-
NZ 12	PP	0.3	5.9	157	-	26	1.4	-
None	HDPE	-	4.5	820	-	19	6.0	-
LICA 12	HDPE	0.3	5.4	1000	-	24	6.7	-
NZ 12	HDPE	0.3	4.9	870	-	20	6.9	-
None	PBT	-	8.7	200	12	34	1.0	0.08
LICA 12	PBT	0.3	9.6	250	17	49	1.7	0.03
None	PPO	-	11	48	35	35	10	0.10
LICA 12	PPO	0.3	12	50	38	39	13	0.07
NZ 12	PPO	0.3	14	57	43	35	14	0.06
None	PS	-	5.1	10	9.5	37	2.5	-
LICA 12	PS	0.3	5.9	51	9.9	37	3.7	-
NZ 12	PS	0.3	5.8	17	10.3	41	2.9	-

integrity of the strand of the entire composition, is a function of melt strength. It is known that melt strength is a component of melt viscosity, therefore, typically it would be expected that when melt viscosity is decreased the melt strength will also be decreased. In the present invention, the opposite occurs, in that a decrease in melt viscosity does not bring about a corresponding decrease in strand integrity. This combination of properties is unexpected".

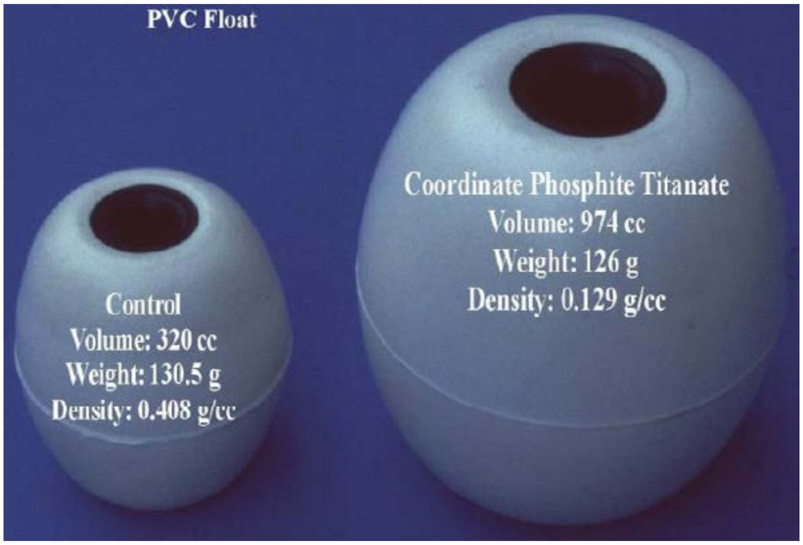


Figure 21

Table 5 summarizes the effect of 0.3% of the 65% active powder form of the neoalkoxy tridioctyl phosphato titanate and zirconate on eleven unfilled thermoplastics showing consistently a significant increase in elongation and an increase in tensile strength.

Typically, plasticizer content can be reduced up to 18% in a compound without sacrificing elongation or flexibility.

Examples: In flexible PVC compound, 3-micron CaCO3 amount can be increased from 45 to 65 phr for Wire and Cable Sheathing applications or from 80 to 150 phr for PVC Window Sills while providing processing and mechanical properties equivalent to conventional plasticizer art.

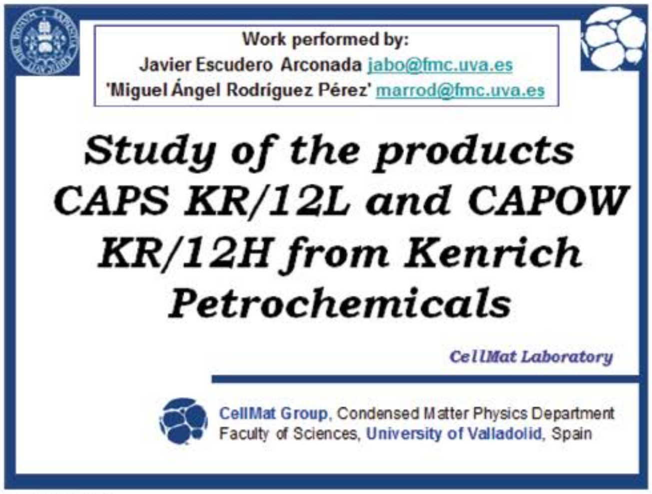
- Foamed Parts – Chemical blowing agents such as Azodicarbonamide are used to offset the increase in compound weight caused by addition of mineral fillers. Since subject organometallics proton coordinate with organics they can be used not only to disperse the AZO but also increase the foamability of the polymer due to the catalytic effect of increasing elongation and tensile, thus reducing open cell formation– **see Figure 21**.

Figure 21 – Exothermic AZO foamed PVC float-130.5g weight (left) with no titanate and a similar PVC float-126.0g (right) using KR® 55 to create finer cell structure and triple the volume by virtue of AZO dispersion and polymer catalysis.

Using Optical Expandometry Javier Escudero Arconada jabo@fmc.uva.es and Professor Miguel Ángel Rodríguez Pérez marrod@fmc.uva.es reported data on AZO foamed PP in their work entitled, "Study of the products CAPS® KR®12/L and CAPOW® KR®12/H from Kenrich Petrochemicals", as shown in **Figures 22 to 27**

Conclusion

Many of the sustainability challenges facing the molding and processing of polymer compositions of dissimilar organic and inorganic materials can be facilitated using subject 1.5-nanometer heteroatom organometallic titanates and zirconates to make their use more efficient and move the bar on Industry 4.0 parameters.



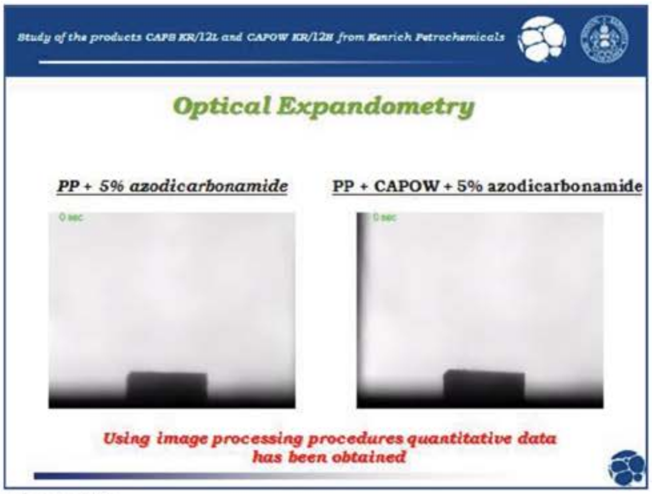
Work performed by:
Javier Escudero Arconada jabo@fmc.uva.es
'Miguel Ángel Rodríguez Pérez' marrod@fmc.uva.es

Study of the products CAPS KR/12L and CAPOW KR/12H from Kenrich Petrochemicals

CellMat Laboratory

CellMat Group, Condensed Matter Physics Department
Faculty of Sciences, University of Valladolid, Spain

Figure 24



Study of the products CAPS KR/12L and CAPOW KR/12H from Kenrich Petrochemicals

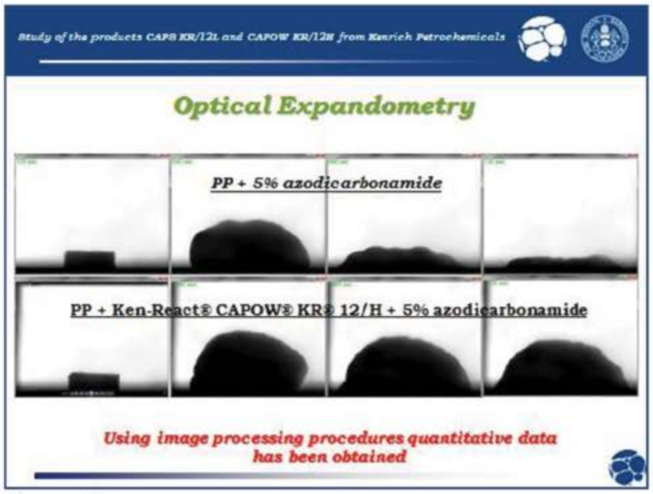
Optical Expandometry

PP + 5% azodicarbonamide

PP + CAPOW + 5% azodicarbonamide

Using image processing procedures quantitative data has been obtained

Figure 25



Study of the products CAPS KR/12L and CAPOW KR/12H from Kenrich Petrochemicals

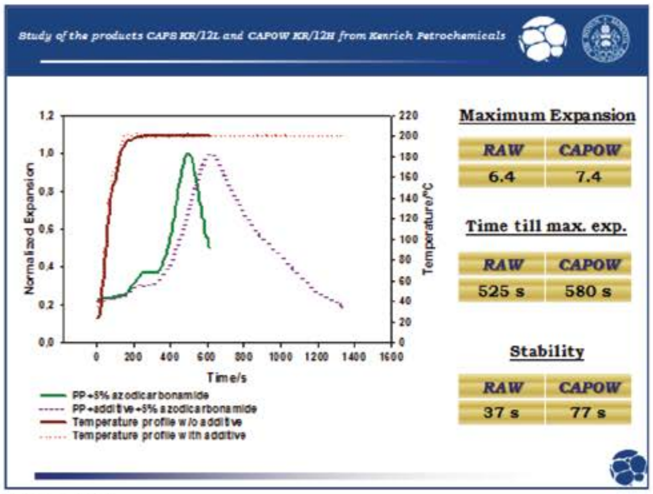
Optical Expandometry

PP + 5% azodicarbonamide

PP + Ken-React® CAPOW® KR® 12/H + 5% azodicarbonamide

Using image processing procedures quantitative data has been obtained

Figure 26



Study of the products CAPS KR/12L and CAPOW KR/12H from Kenrich Petrochemicals

Maximum Expansion

RAW	CAPOW
6.4	7.4

Time till max. exp.

RAW	CAPOW
525 s	580 s

Stability

RAW	CAPOW
37 s	77 s

Figure 27

Study of the products CAPS KR/12L and CAPOW KR/12H from Kenrich Petrochemicals

Mechanical Properties for PP

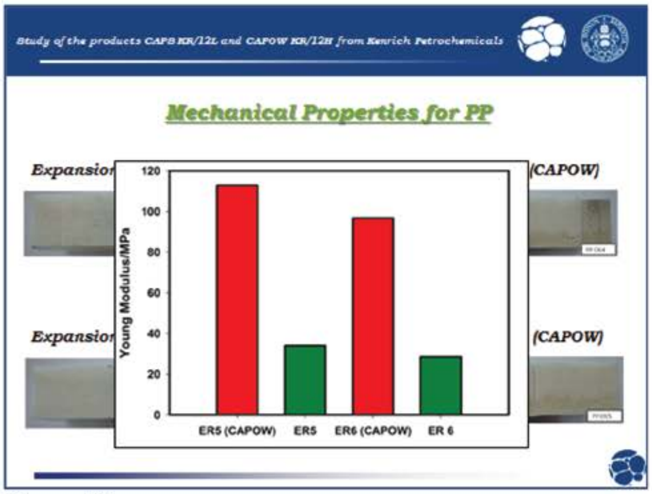
Expansion Ratio 5 (No CAPOW)

Expansion Ratio 5 (CAPOW)

Expansion Ratio 6 (No CAPOW)

Expansion Ratio 6 (CAPOW)

Figure 28



Study of the products CAPS KR/12L and CAPOW KR/12H from Kenrich Petrochemicals

Mechanical Properties for PP

Figure 29

National Week of Injection Molding
SPONSORSHIP OPPORTUNITIES

During the Week of Injection Molding, experts from the industry explore some of the most popular trends, techniques, and technologies that make Injection Molding one of the most versatile molding options available whether you're a student, molder, supplier, or OEM.

PLATINUM – Speaker Spot

GOLD – Host a Breakout Room

SILVER – Targeted Exposure

BRONZE – Support Your Industry

Why Sponsor this Online Event?

Brand Visibility: Showcase your brand in front of a relevant and engaged audience, including molders, suppliers, and original equipment manufacturers (OEMs).

Networking Opportunities: This event brings together experts and professionals from various facets of the injection molding industry.

Demonstrate Expertise: Enhance your reputation as thought leaders in the injection molding industry.

Targeted Marketing: Feature products and services that are directly relevant to the interests and needs of attendees.

Support for the Industry: Contribute to the advancement and education of the injection molding community. Enhance your image as a committed player in the industry's growth and development.

Recruitment Platform: An opportunity for sponsors to meet potential employees who are skilled and passionate about injection molding.

Customer Engagement: Engage directly with current and potential customers.

Community Contribution: Support the industry's community by helping to make such educational and networking events possible.

Contact: Sriraj S. Patel; spatel@polymer-ss.com; +1 315.529.7789
www.4spe.org

IMD Board of Directors Meeting
June 6th, 2024 – Virtual

Meeting minutes taken and submitted by Davide Masato (2023-2024 SPE IMD Secretary).

Welcome & Opening Remarks Jeremy Dworshak

Roll Call: Participants 18 out of 22 active board members on roster: quorum achieved.

Meeting begins with intro and overview from Jeremy. Agenda matches the discussion from the strategy meeting. This is good and thank you everyone. Discussion transition to the next Chair, David Kusuma.

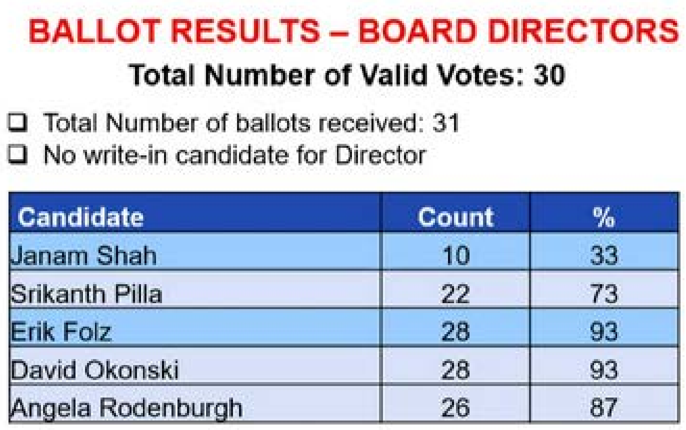
Approval of previous Meeting Minutes (Davide Masato)

Motion: pproval of previous meeting (20240322, Virtual). Motion (Davide Masato). Seconded by Edwin Tam. No discussion. All in favor.

Reports Discussion

Ballot results (Hoa Pham)

Action:
- Send contact information of interested voters to David K, Angela, Erik.
- Need volunteers for the future. Email Hoa interest for nominations.



BALLOT RESULTS – BOARD DIRECTORS

Total Number of Valid Votes: 30

☐ Total Number of ballots received: 31
☐ No write-in candidate for Director

Candidate	Count	%
Janam Shah	10	33
Srikanth Pilla	22	73
Erik Folz	28	93
David Okonski	28	93
Angela Rodenburgh	26	87

SUMMARY OF BALLOT 2024

BoD Officers 2024 – 2025 *(ends on June 30, 2025)*

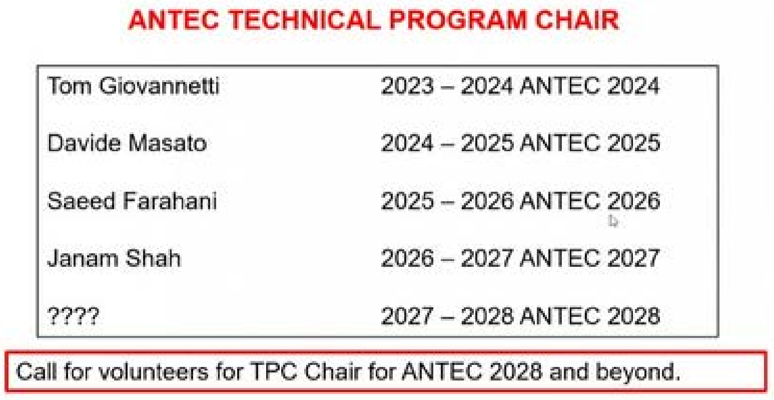
☐ Chair	David Kusuma	☐ Treasurer	Raymond McKee
☐ Chair Elect	Tom Giovannetti	☐ Technical Director	Chad Ulven
☐ Past Chair	Jeremy Dworshak	☐ Secretary	Saeed Farahani

Re-Elected/Elected BoD Directors *(term ends on June 30, 2027)*

Candidates
☐ Erik Foltz
☐ Janam Shah
☐ Srikanth Pilla
☐ Angela Rodenburgh
☐ David Okonski

No Longer on BOD
☐ Alex Beaumont
☐ Larry Geist

NOTE: Councilor July 1, 2023 – June 30, 2026: Edwin Tam



ANTEC TECHNICAL PROGRAM CHAIR

Tom Giovannetti	2023 – 2024 ANTEC 2024
Davide Masato	2024 – 2025 ANTEC 2025
Saeed Farahani	2025 – 2026 ANTEC 2026
Janam Shah	2026 – 2027 ANTEC 2027
????	2027 – 2028 ANTEC 2028

Call for volunteers for TPC Chair for ANTEC 2028 and beyond.

CHAIR PROGRESSION

Term	Secretary	TPC	Chair-Elect	Chair
2023 - 2024	Davide Masato	Tom Giovannetti	David Kusuma	Jeremy Dworshak
2024 - 2025	Saeed Farahani	Davide Masato	Tom Giovannetti	David Kusuma
2025 - 2026	Janam Shah	Saeed Farahani	Davide Masato	Tom Giovannetti
2026 - 2027	TBD	Janam Shah	Saeed Farahani	Davide Masato
2027 - 2028	TBD	TBD	Janam Shah	Saeed Farahani
2028 - 2029	TBD	TBD	TBD	Janam Shah

We need volunteer for Secretary 2027 & 2028 who will progress to TPC for ANTEC 2028 & 2029 etc.

Budget update (Ray sent email and Jeremy presented)

- We should expect our next Quarterly rebate any time. We also need to update our website maintenance that comes as a small cost. I don't expect any other costs for this fiscal year. The fiscal year ends at the end of June.

Councilor meeting (Edwin Tam)

- **David K:** Is SPE collecting answers to the questions asked in the first slide? No information available. It was a planned discussion for ANTEC but not enough time. How should we expand the brand of SPE with IMD activities?

***Action:* Lynzie:** There is an open call for councilors to join a subcommittee. Ed is thinking of volunteering. Vikram attended the meetings and shares frustration from other councilors (feel like they have been put in a corner). Vikram made the suggestion to form a subcommittee with old and new councilors.

***Action:* Jeremy:** Will setup a separate discussion with the councilor. Let Jeremy know if you want to be invited.

Technical Programs

ANTEC (Davide/Chad):

Schedule:

Action: Can we bring the board on 3/3 to the U of Delaware? Or Sunday 3/2?
Sunday is likely going to work best with day-long meetings and reception in the evening.

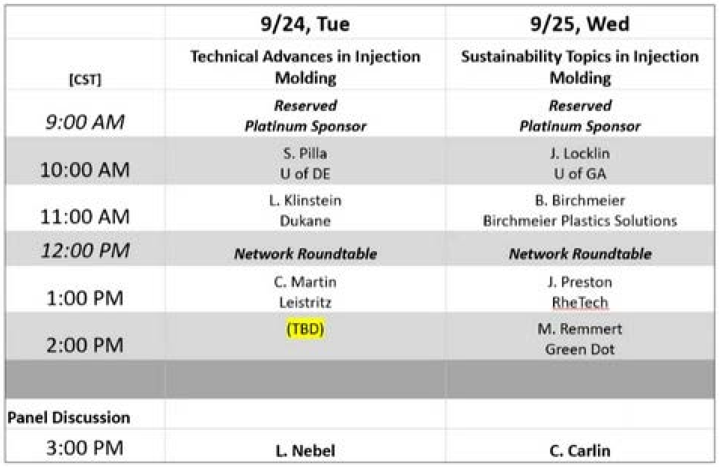
Reception:

- Finding a time may be difficult. Cost vs. return?
- Ed – suggest planning a small event.
- Do other divisions organize receptions?
- IMD reception in the past was a good outreach opportunity, awards, board recognition, share info about events.

Action: Davide to reach out to HQ and then organize a subcommittee. Can the Chair-elect lead the organization of the reception?

National Week of IM:

- Registration is free for board members.
- ***Action:*** Consider volunteering for networking roundtables.
- The website is ready. Information have been shared on Linkedin.
- Chad on the technical agenda:
  - ***Action:*** Still need a speaker. Sriraj and Srikanth provided suggestions.
  - Network roundtables. Opportunities for companies to sponsor.
  - Panel discussions will be live.



	9/24, Tue	9/25, Wed
[CST]	Technical Advances in Injection Molding	Sustainability Topics in Injection Molding
9:00 AM	***Reserved*** ***Platinum Sponsor***	***Reserved*** ***Platinum Sponsor***
10:00 AM	S. Pilla U of DE	J. Locklin U of GA
11:00 AM	L. Klinstein Dukane	B. Birchmeier Birchmeier Plastics Solutions
12:00 PM	***Network Roundtable***	***Network Roundtable***
1:00 PM	C. Martin Leistritz	J. Preston RheTech
2:00 PM	(TBD)	M. Remmert Green Dot
Panel Discussion		
3:00 PM	**L. Nebel**	**C. Carlin**

- *Sponsors*:
  - Different levels have been defined.
  - Sriraj has already interest from companies to sponsor.

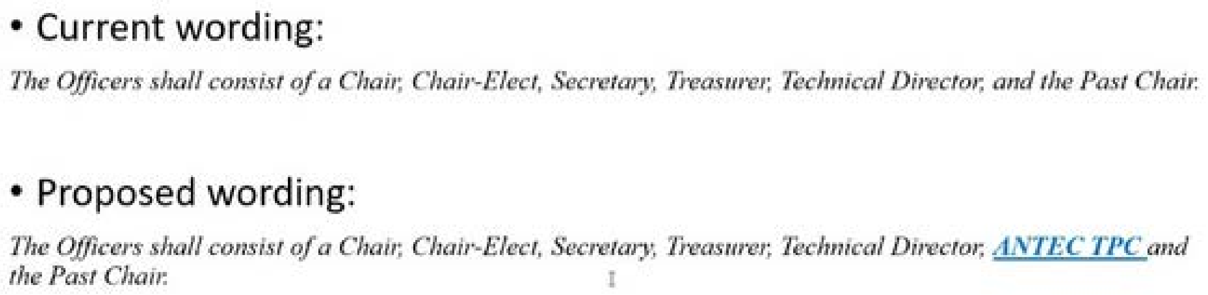
Communications

- The LinkedIn page is live.
- Newsletter is status quo. Any updates on sponsorship for the newsletter? Something to be considered in the future, as of now we don't seem to have any sponsorship income. Heidi has been working on the newsletter, but she has not been soliciting sponsorship.

Bylaws Update

- Proposing to have ANTEC TPC (1 year term) as an officer to ensure continuity in the role.

Ed makes the motion to approve. Davide second. All in favor, motion carries.
Jeremy will update the bylaws.



- Current wording:

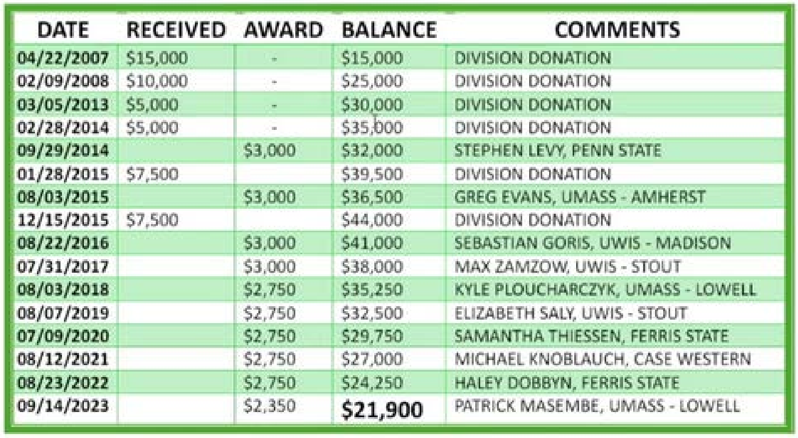
The Officers shall consist of a Chair, Chair-Elect, Secretary, Treasurer, Technical Director, and the Past Chair.

- Proposed wording:

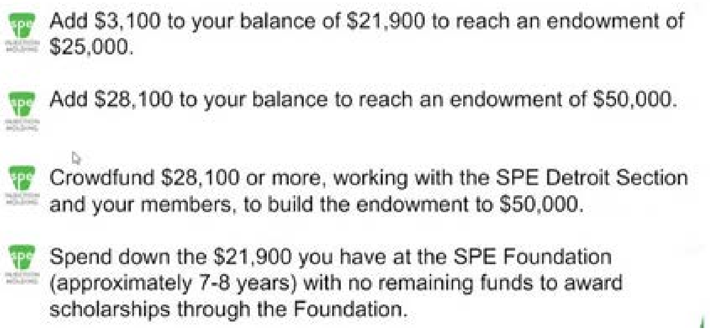
The Officers shall consist of a Chair, Chair-Elect, Secretary, Treasurer, Technical Director, ANTEC TPC and the Past Chair.

New Business

- Susan is on a 1-year term and will be on the ballot in March 2025.
- Pete Grelle scholarship: Jeremy spoke with Eve Vitale and prepared a PowerPoint. Endowment needs $50K and gives out at least $2.5k/yr. IMD has $21,900 with the foundation. This is not an endowment so keeps decreasing as scholarships are awarded. The money can be moved into an endowment. Ed mentions that we can also name one of the current scholarships. Brad Johnson was Chair when the balance was started in 2007. The understanding was that reaching $50k would make it an endowment.



DATE	RECEIVED	AWARD	BALANCE	COMMENTS
04/22/2007	$15,000	-	$15,000	DIVISION DONATION
02/09/2008	$10,000	-	$25,000	DIVISION DONATION
03/05/2013	$5,000	-	$30,000	DIVISION DONATION
02/28/2014	$5,000	-	$35,000	DIVISION DONATION
09/29/2014		$3,000	$32,000	STEPHEN LEVY, PENN STATE
01/28/2015	$7,500		$39,500	DIVISION DONATION
08/03/2015		$3,000	$36,500	GREG EVANS, UMASS - AMHERST
12/15/2015	$7,500		$44,000	DIVISION DONATION
08/22/2016		$3,000	$41,000	SEBASTIAN GORIS, UWIS - MADISON
07/31/2017		$3,000	$38,000	MAX ZAMZOW, UWIS - STOUT
08/03/2018		$2,750	$35,250	KYLE PLOUCHARCZYK, UMASS - LOWELL
08/07/2019		$2,750	$32,500	ELIZABETH SALY, UWIS - STOUT
07/09/2020		$2,750	$29,750	SAMANTHA THIESSEN, FERRIS STATE
08/12/2021		$2,750	$27,000	MICHAEL KNOBLAUCH, CASE WESTERN
08/23/2022		$2,750	$24,250	HALEY DOBBYN, FERRIS STATE
09/14/2023		$2,350	**$21,900**	PATRICK MASEMBE, UMASS - LOWELL



- Add $3,100 to your balance of $21,900 to reach an endowment of $25,000.
- Add $28,100 to your balance to reach an endowment of $50,000.
- Crowdfund $28,100 or more, working with the SPE Detroit Section and your members, to build the endowment to $50,000.
- Spend down the $21,900 you have at the SPE Foundation (approximately 7-8 years) with no remaining funds to award scholarships through the Foundation.

Action: Jeremy will check with Eve on this to discuss how we can revamp this.

What are the fund fees for the endowment? There is a percentage taken on the profit before the scholarship is paid every year.

- Additive manufacturing conference (Susan)

Organized by the Cleveland section for October 17th 2024. Needs for IMD: speakers, sponsors, exhibitors. Brad Johnson is planning to bring students.

- Transition to David Kusuma and new chair presentation

Thank you Jeremy for all the work! Initiatives will continue in the next year. Focus will be extending on these initiatives with particular focus on:

- Publications to promote visibility.
- Opportunities for students and faculty to present technical papers.
- Building membership back up.
- How can we leverage partnerships within SPE and outside?
- Sponsoring a parts competition?
- Sponsorships and supporting scholarships.

Next board meeting will be in September. The plan is to have meetings every other month and meet in person if possible. Can we find more companies to visit (e.g., Husky, …).

Let David know if you want to nominate someone for a board position.

David will send out the next year plan/playbook to collect further inputs.

Meeting Adjourned at 12.41 pm EST

SPE INJECTION MOLDING

REACH YOUR TARGET AUDIENCE AND GROW YOUR BUSINESS WITH A SPONSORSHIP!

The Injection Molding Division offers sponsorship advertising with the newsletter and website.
Reach the IMD membership with your ad to professionals in the injection molding industry.

injectionmoldingdivision.org

JOIN US MARCH 20TH FOR THE TOUR OF MAGNET – NE OH MANUFACTURING PARTNERSHIP

SUSTAINABILITY: CHALLENGES INCORPORATION RECYCLATE WEBINAR

JOIN US JANUARY
PLASTICS RECYC

Chair's Message
David A. Okonski

The SPE Injection Molding Division Newsletter readership is composed of individuals involved in all aspects of the injection molding industry. These issues are made possible through the support of sponsors shown in this Newsletter and injection molding website.

OPTION 1: $2,500/yr
- Full page ad placed in 3 newsletters
- Side Button on website for the year
- First right of refusal for tabletop at ANTEC
- Company logo recognizion on signage at SPE IMD events
- Plastchick interview
- Technical article in newsletter & website
- Company press releases for website, social media and newsletter

OPTION 2: $1,500/yr
- Half page ad placed in 3 newsletters
- Side Button on website for the year
- Company logo recognizion on signage at SPE IMD events
- Technical article in newsletter & website
- Company press releases for website, social media and newsletter

OPTION 3: $1,000/yr
- Full page ad placed in 3 newsletters
- Side Button on website for the year
- Company press releases for website, social media and newsletter

OPTION 4: $750/yr
- Half page ad placed in 3 newsletters
- Side Button on website for 6 months
- Company press releases for website, social media and newsletter

OPTION 5: $450/yr
- Half page ad placed in 1 newsletter
- Side Button on website for 3 months

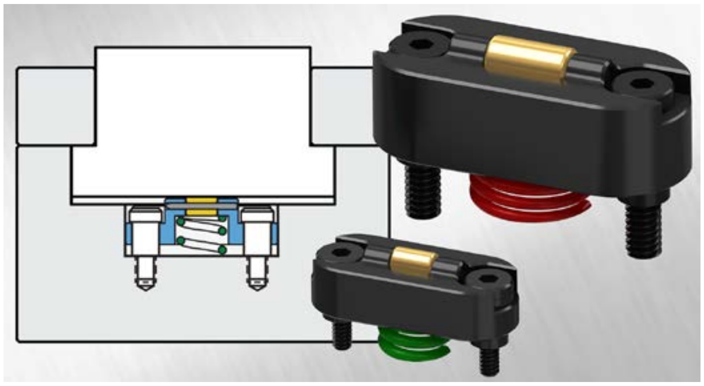
To schedule your ad contact: publisherIMDNewsletter@gmail.com

Injection Molding Division Board of Directors

Division Officers 2024-2025:

Chair:	David Kusuma
Chair-Elect:	Tom Giovannetti
Treasurer:	Raymond McKee
Secretary:	Davide Masato (Saeed Farahani)
Technical Director:	Chad Ulven
Past Chair:	Jeremy Dworshak
Councilor:	Edwin Tam
ANTEC TPC:	Davide Masato
Membership	Erik Foltz
Nominations:	Hoa Pham
Communications:	Angela Rodenburgh
Scholarship:	Davide Masato
Education:	Srikanth Pilla
Sponsorships:	Sriraj Patel
TopCon Chair - Penn State Plastics Conference:	Brad Johnson
HSM & Fellows:	Lih-Sheng (Tom) Turng
Board Member:	Joseph Lawrence
Board Member:	Kishor Mehta
Board Member:	Janam Shah
Board Member:	Lynzie Nebel

Progressive Components Releases New Slide Lock Style Slide Retainer



Progressive Components expands its line of SRT Slide Retainers with the new Slide Lock Style Slide Retainer.

Compatible with previous standards, the Slide Lock Style Slide Retainer's roller design will not wear the bottom of slides, providing greaseless performance in medical and cosmetic applications.

Reliably holding 25 to 50 pounds each and featuring color-coded springs to indicate force rating,

Progressive's Slide Lock Style Slide Retainers are offered in three sizes:

- SRTLK-25A with a green spring to hold 25 lbs
- SRTLK-25B with a longer blue spring to hold 25 lbs
- SRTLK-50A with a red spring to hold 50 lbs
- Use optional cleats for retention on the slide or machine the V-groove for roller retention at the bottom of the slide.

For more information on Progressive's extensive line of standard and exclusive mold components, visit www.procomps.com, email tech@procomps.com, or call 1-800-269-6653.

Quality Management: an Important Control Instrument for the Future

TÜV CERT

ZERTIFIKAT

DAR

Die TÜV-Zertifizierungsgemeinschaft e.V. bescheinigt hiermit, daß das Unternehmen

HASCO-Normalien
Hasenclever GmbH + Co
D-58513 Lüdenscheid

für den Geltungsbereich

Normalien im Formen-, Werkzeug-, Vorrichtungs- und Maschinenbau sowie Sonder- und Spezialanfertigungen

ein Qualitätsmanagementsystem eingeführt hat und anwendet.

Durch ein Audit, Berichts-Nr.
wurde der Nachweis erbracht, daß die Forderungen der
EN ISO 9001
erfüllt sind.

Dieses Zertifikat ist gültig bis

Zertifikat-Registrier-Nr.

RWTÜV

ZERTIFIKAT

TÜV NORD

HASCO

Quality management plays a major role in consistent product quality, and that applies particularly to tool and mouldmaking. The key aspect here is the reliable integration of suppliers' products, which are manufactured according to defined quality criteria.

Since the mid1990s, HASCO, as a leading manufacturer of standard mould units, has been certified in accordance with the valid quality standard, DIN EN ISO 9001. All processes in the company are geared to consistent high-quality production. As such, HASCO is able to successfully integrate itself into the quality assurance system of its customers, and permanently helps them to comply with the quality standards laid down for the relevant end-product.

Mouldmakers can easily and reliably achieve their own quality demands, and those of their customers, via continuous quality management. The demands are especially high in the fields of automotive, packaging and medical technology. Only certified partners can verify and also guarantee process and production safety and reliability as well as economical working. This means that HASCO is able to ensure that its customers' products fully comply with the certification criteria.

The topics of quality, quality management and certification rank among the key criteria for selecting reliable suppliers because this offers protection against faulty products, minimises the risk of failure, and ensures overall economic viability of the customer's own production process.

HASCO's quality creates, for the customers, the basis for a serious and economically successful mouldmaking process. For HASCO, quality is something that, in addition to productivity and innovation, is a key component of the brand value "simplicity" – the consistent simplification and standardisation of the HASCO components for mouldmaking.

HASCO products are comprehensively labelled for the purpose of continuous traceability. This clear labelling gives users, when taking account of prescribed specifications, maximum certainty for distinguishing between original products and copies.

In the event of deviations, sources of error in the process chain can be directly identified and eliminated. The result is fewer complaints and lower rates of return. Consistently high quality such as this can only be achieved through the continuous implementation of a quality management system, which in total creates the basis for lasting competitiveness and maximum process reliability for all HASCO customers.

SPE®

INJECTION
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Top Reasons to Join SPE and its Injection Molding Division

JOIN!

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Technical Journals – FREE
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Listing in Member Director
Salary Survey
Weekly Plastics Insight Newsletter
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Eligible for Committee & Chapter Participation, including Voting
Access to the Materials DatabaseLIG Association Health Program
And More!

Visit www.4spe.org to join today.