

Polymer Valley News

The Newsletter of the Akron Section of the Society of Plastics Engineers
Our 47th Year of Education and Service to the Plastics Industry

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Costs, Schedules, Reservations

Member	\$25.00
Member and Guest	\$40.00
Retiree	\$15.00
Student	\$10.00
Tour only	\$10.00
Tour	5:30 p.m.
Dinner	6:30/7:00 p.m.

Call Cathy Herrin before noon, Jan. 18 and specify dietary restrictions.

(330) 849-5287 T; (330) 849-5594 F
cathy.herrin@santoprene.com

Coming Up:

- Next meeting – Feb. 27, 2006
- Board meeting – Jan. 9, 2006, Akron Univ. Polymer Eng. Center

Technical Meeting

January 23, 2006 - 6:30 p.m.
(Tour at 5:30)

Guy's Party Center

500 East Waterloo Road
Akron, Ohio 44319

Polymer Exchange Plant Tour (Plastic Recycler)
and
Eriez Magnetics

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Co-Molded Polymer Scrap
Separation and Recovery Made Easy
By John Collins, Eriez Magnetics



Today's designers and manufacturers are turning to multi-material injection molding, over-molding, co-extrusion and sequential 3-D blow molding to produce the most cost effective new designs. One challenge that the processors face, in producing multi-material moldings, is segregating dissimilar resins for scrap recovery and use in new moldings.

Eriez Magnetics, a worldwide authority in magnetic separation, has introduced a patented material and process to enable the automated separation of dissimilar polymers. This innovative system will be described and example applications will be presented to illustrate how to reduce the cost of waste in multi-material, co-molding operations.

See page 4 for
Mr. Collins' biography

Jan., 2006, Page 1



President's Message

Fellow Members,

As we finish out the year 2005 and look forward to starting a new calendar, we can, through habit, draft some resolutions that resound with good vibes, though they may lack in commitment. I know that I at least have been down that path.

But I am happy to tell you that your Board of Directors has not only drafted some resolutions for more effective Section management, it has already begun taking action on their implementation.

Let me explain. We are concerned about value, about bringing value to you, our members, through our Section programs and activities. And, we are concerned that we have not been doing that very well in the past, because you are in general not responding strongly to these offerings.

So, we have undertaken some remedial steps: first, to find out how we can improve our Section operations and then to communicate that to our membership. We have, last month, met with representatives of neighboring Sections – Pittsburgh, Central Ohio and Cleveland – to compare notes on how to effectively operate a Section. We have discovered some new ideas and uncovered those ideas that we knew of but had buried. These matters have to do with recruitment, program planning and communication. We are taking the advice to heart, and you will hopefully notice the differences in our Section operations as the new year progresses.

Next, we have already undertaken steps to improve our communications with you, our Section membership. Later in January you will each be receiving a mailing that outlines our programs in a way that relates them directly to your interests and needs. We furthermore will highlight the positive results from our activities – for example, educational outreach to young students in the form of information about our industry and ways for them to explore their interests and define opportunities in plastics through essays and scholarship aid. There will also be an appeal to our members and their employers to support our activities both in personal involvement and financially.

We furthermore resolve that these initial steps will not be the end of our efforts to make the SPE a more effective instrument in our members businesses and careers.

With best wishes of joy for the holidays and of success in 2006.

*Lloyd Goettler
President, Akron Section*



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Map to Guy's Party Center

500 East Waterloo Road
Akron, Ohio 44319

*After following most of these directions, Guy's is a very short distance from the exit on the left, just before Giant Eagle and across the street from Scorchers and the Waterloo Restaurant.

From the North (Akron, Cuy. Falls, Hudson, E. Cleve)

Take Route 8 south until it becomes 77 south. Continue on 77 south for a little less than 2 more miles. Take the Waterloo Rd exit. Turn right at the bottom of the ramp.

From the Northwest (Fairlawn, Montrose, W. Cleve)

Follow 77 south until it combines with 76 and then separates again, heading south (Rt 8 will head north, 77 will head south, take 77 south). Continue for a little less than 2 more miles. Take the Waterloo Rd exit. Turn right at the bottom of the ramp.

From the East (Kent, Ravenna, Youngstown)

Follow 76 west to 77 south. Continue on 77 south for a little less than 2 miles. Take the Waterloo Road exit. Turn right at the bottom of the exit ramp.

From the West (I-71, Wadsworth, Baberton)

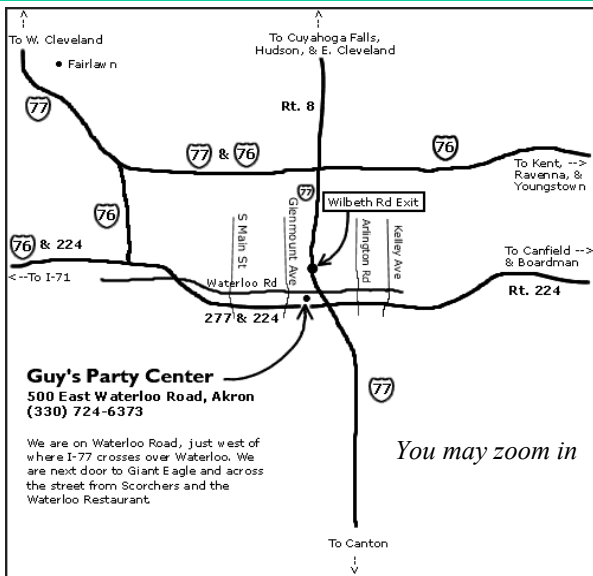
Take 76/224 east until it turns into only St. Rt. 224. Follow St. Rt. 224 east to the Main Street exit. Turn left onto Main at the end of the exit ramp. Turn right at first major intersection -- Waterloo. Guy's is about a mile up on the right, just past Giant Eagle and across the street from Scorchers and the Waterloo Restaurant.

From the South (Canton)

This is a little strange, but the easiest way. There is an exit ramp onto Waterloo from 77 south, but NOT from 77 north, so follow 77 north to the Wilbeth Road exit. Get off on that exit, then make two lefts, thus getting back onto 77 going SOUTH. Take the very next exit - Waterloo Rd. Turn right at the bottom of the exit ramp.

From the Southeast (Canfield, Boardman, Alliance)

Follow St. Rt. 224 west to Kelley Ave/Waterloo Rd exit. Turn right at the end of the exit ramp and then, almost immediately, left onto Waterloo Rd. Take Waterloo Rd past where it crosses under I-77.



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Biography of John Collins

John Collins, Manager-*PolyMag*, has spent 28 years in the plastics industry, most notably with Premix Inc. in North Kingsville, Ohio where he served in various capacities including sales management, corporate purchasing, product engineering, manufacturing and operations. His most recent position was Vice President, Sales & Marketing with K-D Industries in Erie, PA.

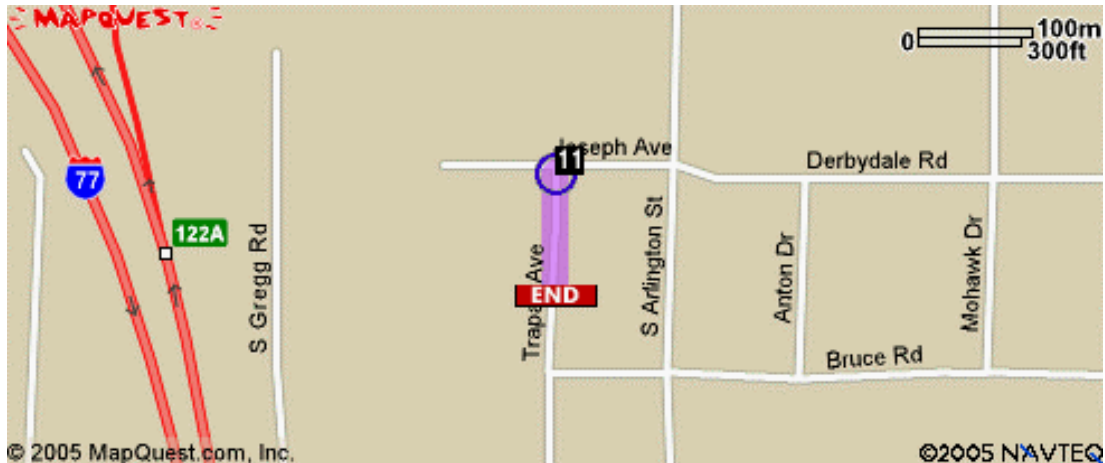
Collins earned his B.A. degree in Economics and History from Denison University with additional education in statistical process control, QS 9000 and ISO 9001, project management and value analysis.

John is a true expert in the plastics industry and brings a wealth of experience to his position. With his knowledge, commitment and passion, John brings strong leadership to the *PolyMag*™ division."



Map to Polymer Exchange 1016 Triplett Boulevard Akron, OH 44306

Phone: (330) 785-0111



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Membership Report – November, 2005

Akron had 9 new members join in November. This puts our total membership up to **423!** See list below for new members

We also had 2 transfers out.

Eight members also renewed in November, thank you.

Membership News from National

- National news, total membership is at 19,733. Down 76 members from last year.
- AIM is at a 21% conversion rate which is still much better than other methods. See the AIM web page for details, <http://www.4spe.org/communities/1d/aim.php>.
- January of 2006 has been designated as National Mentoring Month in the United States. Mentoring can be used to help new members get the most out of their SPE membership. Is there anyone out there who would like to champion this for our Akron section? Please contact me directly at jepfeiffer@santoprene.com. Also, for information on National Mentoring Month visit www.mentoring.org.

Membership chair, Joe Pfeiffer,
Santoprene Specialty Products

New Members

All new members are invited to our January technical meeting for free. Watch flyer on meeting for details. The date is January 23rd so mark your calendars and welcome aboard.

Say “hello and thanks for joining” if you know the following people.

William C. Andrick
Vertex Inc.
Mark J. Bachner
The Little Tikes Company
Phillip J. Creed
Profile Plastics, Inc.
Ralph Dreher
The Harrington Corp.
David Hawley
Recycled Plastic Technology Inc.
Achille F. Paolino
Gerald D. Stethem
Landmark Plastic Corp.
Jim Stewart
CIMA Plastics Group
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Akron SPE Section Meeting Questionnaire

1. What type of meetings would you like to attend (technical, tours, entertainment, special events [auctions, awards], etc.)? Or do you just prefer a mix as we presently do?
2. Our meeting frequency is monthly from October through May. Do you feel this frequency is good and, if not, how often should we meet? Also our meetings have been every 4th Monday evening of the month. Would a different day increase attendance?
3. Do you have a preferred location and, if so, where would that be? Or do you prefer a variety of venues?
4. Is the time after work from 5:30 to 8:00 p.m. convenient, or would you prefer having more luncheon meetings?
5. Any other comments on how we can increase attendance and make our meeting more attended?

Send responses back to jepfeiffer@santoprene.com. Thank you for your thoughts and ideas.



The University of Akron

The University of Akron Institute of Polymer Engineering

Polymer Processing and Testing Services

Don't want to invest in expensive equipment at this time? Don't know what equipment is best? Only need the use of the equipment for a short period of time?

Perhaps the best answer to these questions is to contract our polymer processing and testing services.

UA's Institute of Polymer Engineering works with all types of clients in the polymer industry, large companies and small firms, well-established businesses and start-ups. Companies turn to the Institute for assistance because they do not have the capabilities (equipment or personnel) to conduct their own research and testing.

The Institute of Polymer Engineering has a wide variety of specialized equipment needed for polymer processing, characterization, analysis and testing. Some of that equipment is listed here below.

To further discuss your needs, please contact Dr Lloyd Goettler at (330) 972-7467 lagoett@uakron.edu or Cameron Fraser at (330) 972-6008 cfraser@uakron.edu

Analysis and Testing

- x-ray
- scanning electron microscopy
- atomic force microscopy
- optical microscopy
- laser microscopy
- TGA
- DSC
- FT-IR
- DMA
- APA
- stress strain testing
- rheology
- biaxial stretching

Polymer Processing

- single-screw extruding
- twin-screw extruding
- film casting
- film blowing
- fiber spinning
- injection molding
- compression molding
- vacuum molding
- blow molding
- compounding

Sample Preparation

- microtoming
- vacuum drying
- sputter coating
- particle size reducing



Programs for 2005 / 2006

Sept. 12-14	Thermoplastic Elastomers TOPCON -- Hilton Fairlawn	Feb. 27	Diamond Plant Tour Dinner Meeting -- Guy's
Oct. 17	JSW "Twin Screw New Technology" Lunch Meeting -- Tangier	Mar. 27	Mini-Tech Joint Meeting with ORPG and Firelands Stabilization of Rubber, TPE and Plastics
Nov. 21	Prof. Renecker of Polymer Science Akron University, "Electrospinning and Applications of Nanofibers" Lunch Meeting -- Tangier		3 to 6 papers on UV and light stabilizers, A.O., color stabilization and process aids Afternoon Meeting -- Guy's
Dec. 15	Student Union -- Univ. Of Akron	Apr. 24	Master Precision Molding "MUDD" Dinner Meeting -- Martin Center
Jan. 23	Polymer Exchange Plant Tour (Plastic Recycler) and Eriez "Plastic Separation and Process" Dinner Meeting	May 12	Spring Golf Outing Joint Meeting with Cleveland - Barberton Brookside
		May 22	Awards Banquet Dinner Meeting -- Martin Center




Akron Polymer Training Center

Provides training classes for plastic and rubber processors taught by University of Akron faculty and industry professionals. Visit our website at www2.uakron.edu/aptc for a complete list of our current course offerings.

Customized Development and Delivery

The Akron Polymer Training Center also specializes in customized training developed specifically for your employees. Depending on your company's particular needs, our courses can be taught on site at your location, or at our state-of-the-art facility on the campus of The University of Akron.

Our programs are designed to enhance on-the-job effectiveness for all professionals working in the polymer field. If you are experiencing difficulty with polymer-related design or processing problems, contact us. Our reliable and dedicated staff will work with your team to develop a training strategy guaranteed to produce results. Contact Tayba Tahir by phone at **330.972.8661** or email Tayba at tahir@uakron.edu. If you don't see what you need, no problem! We have the resources to solve even the most vexing polymer processing and design issues.



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Akron Section SPE Past Presidents

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1959-1960	Donald F. Siddall	1982-1983	James Steiner
1960-1961	Milan Krajcik	1983-1984	Robert G. Hills
1961-1962	Foster J. Young	1984-1985	Anthony F. Dean, Jr.
1962-1963	Dickson L. Stoker, III	1985-1986	Gene Buser
1963-1964	Edward L. Hillier	1986-1987	Harry J. Barth
1964-1965	John R. Russell	1987-1988	Judith A. Fallon
1965-1966	John R. Russell	1988-1989	William E. Tosco
1966-1967	Clyde H. Jones	1989-1990	Robert Wegelin
1967-1968	Alan Corry, Jr.	1990-1991	Geraldine R. Stromquist
1968-1969	Bernard M. Saffian	1991-1992	Spencer Keiser
1969-1970	Harold R. Schick	1992-1993	Robert Wegelin
1970-1971	Robert G. Hills	1993-1994	Tony Dean
1971-1972	John J. Satterfield	1994-1995	Wayne Decamp
1972-1973	Alexis M. Gross	1995-1996	Melanie Stewart
1973-1974	Francis J. Maurer	1996-1997	Kevin Hershfield
1974-1975	Leverett A. Anderson, Jr.	1997-1998	Dave Schultz
1975-1976	Robert M. Hershey	1998-1999	John Raab
1976-1977	Richard L. Fleshman	1999-2000	Gary Taylor
1977-1978	David Curtis	2000-2001	Kevin Malpass
1978-1979	John A. Zelek, Jr.	2001-2002	Ken Sharp
1979-1980	Gerald W. Whitnable	2002-2003	Joe Pfeiffer
1980-1981	Kathleen N. Bechter	2003-2004	Robert Wegelin
1981-1982	Victor E. Giuffrida	2004-2005	Joe Mattingly



The Akron Section of Society of Plastics Engineers (SPE)

Education Committee



Announces:



2006 Essay Contest

First prize: \$100

Second prize: \$50

Sponsoring teacher: \$50

Entries due January 14, 2006

Contacts below or www.akronspe.org for forms and rules

2006 Scholarship Contest

From \$250 – 3000 awarded per student annually

For undergraduate students interested in polymer/plastics careers

Entries due March 1, 2006

Contacts below or www.akronspe.org for forms and rules

For more information contact:

Kathy Perevosnik 330-849-5119 kaperevosnik@santoprene.com

Hemant Thakkar 330-794-6600 hemant_thakkar@ardl.com

Kevin Malpass 330-666-5226 Kevin.Malpass@ge.com

Pankaj Rathi 330-990-7799 pankajr@gmail.com

Minutes of Board Meeting – December 12, 2005

Call to Order: 5:30 PM at Akron University Polymer Engineering Center

Present: Lloyd Goettler, Tony Dean, Kaan Gunes, Dave Schultz, Vivian Malpass, Joe Mattingly, Hemant Thakkar, Josh Wong, Gary Taylor, Amruth Puttarudraiah, Kevin Malpass, Joe Pfeiffer and Cameron Fraser
Absent - Bob Wegelin, Rishi Kumar, Sadhan Jana, John Woodside and Dave Katz

Largest turn out for the year!! Thanks Lloyd for hosting!!

Note: OLD Business now has past Action Items

Minutes: November minutes were Approved

Added items to Agenda: Website host by Polysort of Award Winning Husky Award.

President: Lloyd reported he felt the Avalon Meeting with Pittsburgh, Central and Cleveland was very worthwhile and coined it a "Communication Meeting". Within Section, Cross Section and with Direct Personal Contacts along with Industrial Contacts. Thanks go to John Woodside, Bob Wegelin, Viv Malpass and David Schultz- DRS to forward Notes to entire Akron Board, Lloyd to contact Toth Mold to determine activity level desired -Committee, Board etc .

Treasurer: Gary reports that due to excellent TPE TOPCON, calendar year ended very well. The Board discussed and suggested that \$10,000 should be added to the Education Foundation- single installment. A motion was made by Joe Pfeiffer, and 2nd by Tony Dean, voted on and approved by Board. It was also suggested that we obtain a P.O Box at Akron Post Office- Cameron to check into costs - anticipate standard envelope size at \$20/six months.

Officers, 2005: Nothing noted.

Awards 2005 Update: Joe will enter Newsletter, but once again would like feedback from International after judging complete- Councilor-Viv Malpass noted for Council Meeting- Jan 2006. Husky Award- Hemant reports that plans are underway to meet week Dec 19- suggested get dialog with Committee and Board going soon for Feb deadline. Stretch- Kaan reports that under development at this time. Chase - Still not confirmed to date.

Student Chapter: Student- Kaan- PESO Christmas Party set for Dec 15 Student Union -University Of Akron- 111 attendees 10 from Akron Section.

Newsletter: Joe reports that he needs info to Jenny D, copy Joe Pfeiffer, by Dec 30 , plans to place A. Schulman paper from TPE TOPCON in Newsletter. Lloyd to formulate a quick one page- PR for Akron Section for Dec. Newsletter.

Membership: 415 increasing slowly, steadily- target 430 high for 2004. Joe to get Excel file breakdown of Akron Section Membership by Company and Division to all Board Members.

Councilor's Report: Viv reports he has two candidates for Councilor starting May 2006- Joe Pfeiffer and Joe Mattingly. Joe Pfeiffer to determine appropriate protocol for Election.



Minutes of Board Meeting – December 12, 2005 (cont.)

TPE TOPCON 2005: Basic report has been sent to Lloyd, Josh and Joe for review along with TOPCON Committee 2005/07. Lloyd Goettler, Joe Mattingly and Josh Wong for additional input plus to help in Display Tech TOPCON 2006.

TOPCON TPE 2007: Viv reports we are set in Akron for Sept 2007. Committee in place very similar to 2005. Details to follow.

Education Committee: Hemant reports they are extending the deadline a few weeks for Essay Contest. Husky Award ideas are being formulated and will report to Board.

Education Foundation: Kevin has confirmed Omnova as a contributor for future. Kevin will soon check with Bridgestone re: World Series of Golf for 2006 and possible contribution to Foundation. Goodyear original Scholarship is fully funded, plan to look into second possible scholarship. Plan to discuss possible contribution from ExxonMobil in addition need 3 other companies at \$2000. Plan to add Education Foundation information to a Marketing Brochure for Akron Section. Taxes have been filed.

Advertising: Monies for all ads now collected with exception of one to pay Jan 06.

Website: Tony Dean reported he continues to update all information at site including: Section Meeting locations and topics. He also stated he has set details with Polysort to handle the Husky Award website for 2006 starting in Feb. for a one time fee \$112.50 and \$30/year.

Program: Lloyd reports for John that Jan and Feb Sites and Dinners are set. March -Mini Tech set with 8 speakers including confirmation from Charles Radar agreeing to handle Introduction on Thermoplastic Elastomers. Wallet reminders set and ready to mail in Jan. along with a General letter and a Marketing Brochure.

Mini- Tech set for March 27, 2006 at Guy's. Details about Program are complete plan to invite Pittsburgh SPE Section and Ohio Rubber and Plastics Group- Topic Additives for Plastics, TPE and Rubber. Plan Meeting Time 1:00 PM til 7:00PM, 8 papers, Dinner Cost may be more than typical Meeting.

Topic: Additives for Rubber/ Thermoplastic Elastomers /Plastics. Broad Overview-Rubber Byron To-Flexsys

Thermoplastic Elastomers- C. Rader- Consultant

Plastics- Cathy Hanlin -Americhem

UV Stabilization for Rubber/ Plastic and TPE- Everlight- John Woodside

Ceramic Fillers- CERCO- Jim Jaskowiak-

Color- Bob Charvat-

Specialty type Blending for Profit- Process Controls -TomWorceste

Nano MB's- PolyOne-

April 24- MUD- Cleveland would like to attend- per Gary Casterline and Jeff Dininger.

House: Meetings are set for Guys the remainder of the year.

Fall Golf: Suggest Clambake for 2006.

Spring Golf: Nothing to report.



Minutes of Board Meeting – December 12, 2005 (cont.)

Past President's Committee: Joe will get together with Bob Wegelin regarding plans for committee. Original plan to run a Meeting for 2005-06.

ACCESS: Lloyd attended last meeting and suggested a formal program be put in place to share schedules. They said they needed to "meet" on that subject.

Old Business: Nothing to report.

New Business: Marketing Plan - Plan to develop a Marketing Brochure for Sales of the Akron Section to include: Section, Education Foundation, Board and Companies. Amruth agreed to handle along with Joe Mattingly and David Schultz. Need to SELL VALUE!!! Possibly to desk top publish a glitzy marketing brochure that is "eye catching". Need to start e-mail dialogue on what it should contain ASAP.

New TOPCON: Josh reports they are progressing steadily. Cameron and Josh need help on logistics- Viv Malpass has handled all Timing Issues, Kevin Malpass agrees to consult on Action steps for Sponsors/ Exhibitors, Bill Greenstreet possibly to help on CD and Book. Kaan has agreed to have Student Chapter help. Plan to check with John Braver for help too. Lloyd to send e-mail of list of all Polymer Display Companies to all Board Members.

Mentoring: Potential new Board Members were discussed including Sharon Kaffen and Mike Mahalik at Lake HS - potential members for VP - 2005-06 year and other positions.

Directors and Officers Insurance: Cameron Fraser confirmed cost was \$1100 not \$200 as originally informed. We will drop interest for that Insurance.

The next board meeting will be Jan 9, 2006 at the Akron Univ. Polymer. Adjourned 7:24 PM
Merry Christmas to ALL!! We will see you in the New Year!!



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Flexible Thermoplastic Elastomer (TPE) Based on Ionomer Technology

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Abstract

Ionomer products have been in the marketplace for more than 30 years. These products offer outstanding toughness, high melt strength, excellent abrasion resistance and superior clarity with hardness values greater than 50 Shore D. A new class of patented flexible ionomer alloy thermoplastic elastomers (TPEs) have been developed with lower hardness and lower modulus for both Consumer and Automotive applications. These products have hardness values in the range of 75 to 90 Shore A with high toughness and tear strength, high mar/abrasion resistance, good chemical resistance, superior stain resistance, and controlled gloss. Designed for injection, extrusion, and calendaring processes, these new ionomer-based polyolefin TPEs offer designers a new alternative to displace traditional, painted and non-painted flexible plastics with an exceptionally durable product.

This paper will address the polymer science and technology for these new ionomer-based TPEs with respect to morphology, physical properties, rheological properties and aesthetics, as compared to traditional TPEs, including thermoplastic vulcanizates (TPV). Emphasis will be given to key properties that are considered important in selected application areas in Consumer, Appliance, and Transportation markets.

Introduction

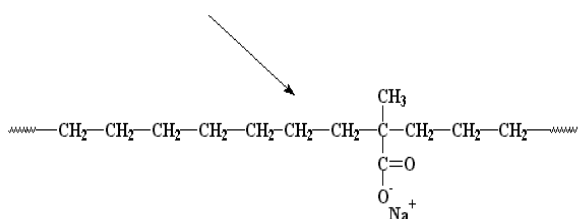
Considerable effort to create softer and more durable olefin compounds is underway due to the desire within the automotive and consumer sectors to displace Polyvinyl Chloride (PVC) and Thermoplastic Polyurethane (TPU) with alternative polyolefin-based materials. Doing so provides environmentally friendly materials, and offers greater opportunity for simplification in the recycle of components and constructions manufactured from multiple polymeric material. This initiative is further complicated in the automotive area when pursuing requirements of uniform low gloss and paint-like surface durability, with elimination of paint or clear coats currently required in certain applications. These requirements, combined with the consumer's request for a supple, warm and dry feel, and the industry's requirement to maintain the economics of PVC, TPU and traditional alpha-olefin plastics, makes the performance/cost balance tenuous. These new ionomer-based polyolefin TPEs offer designers a new alternative to displace traditional, painted and non-painted flexible plastics with an exceptionally durable product.

Ionomer Chemistry

Developed in the late 1950's and introduced to the market in the early 60's, ionomers were initially commercially available produced from ethylene methacrylic acid copolymer¹. Today, however, both ethylene acrylic acid and ethylene methacrylic acid based ionomers are available from a few, select suppliers. Figure 1 shows a typical structure of an Acrylic Acid Ionomer. These materials are produced from a reaction

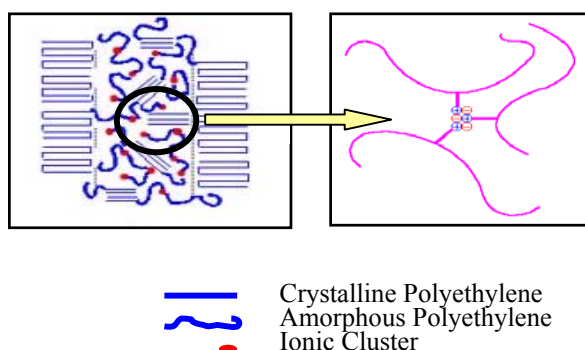
between an ethylene acid copolymer and a metal compound (salt). This salt will neutralize the acid component and form ionic cross-linking clusters within the polymer. The properties of the ionomers are largely dictated by the acid type, the concentration of the acid in the copolymer feedstock, the copolymer's molecular weight, the percentage of the neutralized acid units, and the type of metal ion utilized. The metal ions utilized in commercially available products include zinc, sodium, lithium and magnesium. Additionally, these commercialized ionomers have between 7-20% acid with neutralization levels roughly between 10-75%.

Figure 1: Structure of an Acrylic Acid Ionomer (EAA)



In the solid state, three distinct phases will appear within an ionomer: 1) amorphous domains; 2) ionic regions or clusters, and 3) crystalline domains. These ionic clusters create the intermolecular bonding or 'cross-linking'. Translation of this intermolecular bonding results in excellent melt strength. Figure 2 shows a general schematics of the ionomeric clusters.

Figure 2: Schematic of Ionomeric Cross-linking



Ionomers are well known for their toughness, high mar resistance, excellent weathering performance, low haze, and excellent stain resistance. However, with a copolymer hardness between 55D to 70D, ionomers would appear to have a slight disadvantage in applications, where lower hardness is desired (70 - 90 A). However, with excellent abrasion resistance as an attribute, the addition of this unusual alpha-olefin became the obvious choice for compounds that require an edge over traditional, painted systems. From that start point, the primary task at hand was to provide increased softness without reducing the mar resistance characteristics of the ionomer.

Material Used

The developmental ionomer-based TPEs and comparative materials evaluated in this study are shown in Table 1. For the simplicity of this paper, we have assigned the following nomenclature to the materials: Flexible Ionomer TPE (labeled "FX"), Styenic Block Copolymer (SBC) TPE (labeled "TPE"), and Thermoplastic Vulcanizate (labeled "TPV").

Sample Preparation

All FX, TPE, & TPV samples were produced using ZSK-25mm Twin Screw Extruder (Coperion) with L/D ratio of 48/1. All the samples were injection molded into plaques using a Battenfeld 88 Ton injection molding machine. The dimensions of the injection molded plaques were as follows: 12.7 cm x 17.8 cm x 3.2 mm (5 x 7 x 0.125 inch) to test basic physical properties and 10.2 cm x 15.2 cm x 3.2 mm (4 x 6 x 0.125 inch) with Ford Motor Company's Monticello grain to test for scratch, mar & abrasion resistance.

Experimental Set-Up

The experimental set-up used to measure the scratch & mar resistance was done according to Ford Motor Company's method of FLTM-BN-108-13. This is also known as the Ford five-finger scratch test shown in Figure 3. For the scratch test, a stylus of 1 mm in diameter is used with various weights providing the load force on the stylus. For the mar test, a stylus of 7mm in diameter is used along with various weights. The results are tabulated according to a "best-worst" rating from 1 to 5.

The cloth abrasion test was conducted based on a modified Ink Rub Tester. Figure 4 shows the Ink Rub apparatus. A 1,857 gram weight was attached to the top contact plate. The plate cycles over the grained plaque surface, similar to a pendulum. We attached abrasive cloth (406 Muslin Bleach cloth) to the bottom of the top contact plate of the Ink Rub Tester and monitored weight loss after 10,000 cycles. The cycle rate was 100 cycles/min. We utilized both weight loss and visual grained surface quality to rank the results.

For the morphology analysis Scanning-Probe Microscopy (SPM) was used. All images were collected using Veeco Instruments Dimension 3000 SPM with a Nanoscope IIIa controller. The microscope was operated in tapping-mode with height and phase images simultaneously collected. Each sample was prepared using a cryomicrotome, with sample and diamond knife held at -100°C. Three separate regions on the cryo-faced surface were examined for each sample.

Basic physical properties (hardness, specific gravity, tensile properties, tear strength, etc.) were tested following standard ASTM procedures.

Results

The overall physical properties of FX-75, FX-85, & TPE-75 samples are shown in Table 2. These were measured according to the corresponding ASTM methods. The results of scratch, mar & cloth abrasion tests are tabulated in Table 3. As shown in Table 3, FX-75 has a lower scratch, mar, & cloth abrasion resistance numerical results as compared to both TPE-75 & TPV-75. FX-75 has superior cloth abrasion rating of 2 after 10,000 cycles as compared to rating of 4 for TPE-75 & 6 for TPV-75. The results of stain resistance exposed to warm Marinara sauce for 24 hours are shown in Table 4. Both FX-75 & FX-85 show superior stain resistance as compared to both TPE & TPV samples. Further, FX-75 and FX-85 show superior chemical resistance to TPV-75 and TPE-75, as shown in Table 5. This is attributed to the ionomer continuous phase. Ionomers exhibit outstanding chemical resistance to many alkalis and solvents².

Figure 5 shows SPM image of FX-75 in cross-flow direction. This sample displays multiple distinct levels of contrast in the phase images, indicating different types of polymer present. The observed morphological texture for the FX samples is consistent with a dominant thermoplastic ionomer matrix phase having dispersed thermoplastic elastomer and polyolefin phases.

Apparent shear viscosities of FX-75, FX-85, & TPE-75 as a function of shear rate at 200°C are shown in Figure 6. This is a typical viscosity curve for a thermoplastic elastomer showing shear-thinning behavior, exhibiting decreasing viscosity with increasing shear rate. TPE-75 shows lower viscosity at a given share rate as compared to FX-75.

Oil extension of the dispersed rubber phase as well as the rheology (viscosity profile) of the hard plastic phase (whether PP, PE, ionomer, or

other) contributes to the shear viscosity behavior. FX-75 and FX-85 exhibit no surface oil exudation from -30°C to $+75^{\circ}\text{C}$. This is significant since the ionomer continuous phase is polar, and the relatively non-polar hydrocarbon (paraffinic and naphthenic) oils are not compatible within this phase.

Discussion

From Table 3 it is clear that both FX-75 & FX-85 have lower numerical values with respect to scratch, mar, and cloth abrasion tests. The lower values in the above rating means superior scratch and mar properties. This superior performance is attributed to the presence of a continuous ionomer matrix with ionic clusters within the matrix that provide resistance to deformation. Furthermore, we see that both FX-75 & FX-85 have improved stain and chemical resistance as compared to both TPE and TPV samples. The continuous phase in both TPE and TPV are polypropylene-based and therefore, they are susceptible to staining. The morphology of the FX-75 via SPM image supports the presence of a continuous phase of ionomer with well-dispersed phases of polyolefin and thermoplastic elastomer. This new type of ionomer-based TPE shows both superior abrasion and stain resistance as compared to traditional TPV or TPE materials.

Conclusions

Scratch/mar/abrasion resistance, stain resistance, and chemical resistance of various samples of new patented ionomeric flexible TPE technology were compared to traditional TPE and TPV materials of similar hardness. This new type of ionomer-based TPE exhibits superior scratch/mar/abrasion resistance, stain resistance, and chemical resistance as compared to traditional TPV or TPE materials. This improvement stems from the continuous ionomer phase in the matrix, which was supported by empirical test results and verified by SPM imagery.

Overall flexible ionomer TPE based materials gave the best balance of scratch/mar/abrasion resistance, stain resistance, and chemical resistance. These “soft touch” materials have performance attributes that should provide a high performance, system cost-effective replacement of PVC, PP/EPDM TPV, Styrenic Block Copolymer (SBC) TPE, TPU and other plastics for Consumer, Appliance, and Transportation applications.

Key Words

Ionomer Alloy, Flexible Ionomer, TPE, TPV

Table 1: Materials used in the study

Product Name	Material Coating
Ionomer TPE 75A	FX-75
Ionomer TPE 85A	FX-85
TPE - SEBS based, 75A	TPE-75
TPV- EPDM/PP based, 75A	TPV-75

Table 2: Physical properties summary of selected materials

Property	ASTM Method	FX-75	FX-85	TPV-75	TPE-75
5X7 injection molded plaques					
Hardness, Shore A (15 sec. dwell)	D2240-91	75	85	75	75
Specific Gravity	D792-91	0.96	0.96	0.97	0.95
Tensile Strength, MPa	D412-92, Die C	5.6	8.2	5.7	6.7
100% Modulus, MPa	D412-92, Die C	3.5	5.5	3.5	4.2
Ultimate Elongation, %	D412-92, Die C	415	390	380	490
Tear Strength, kN/m	D624-91, Die C	49	54	35	43
Heat Aging, 168 hrs @ 80°C					
Tensile Strength Retention, %	ASI Method (Crossflow)	110	108	98	101
100% Modulus Retention, %		116	112	95	98
Ultimate Elongation Retention, %		105	102	92	97
Tear Strength Retention, %		106	108	90	94
Volatiles Loss @ 95°C, %	GM9305P	5.5	3.8	12.0	9.5
Gas Fade Resistance, Delta E 168 hrs @ 60°C	ASI Method	0.45	0.41	1.2	1.5

Table 3: Overall scratch, mar & cloth abrasion results

Property	Method	FX-75	FX-85	TPV-75	TPE-75
Monticello grained plaques					
Scratch test*					
7N on 1mm stylus tip	FLTM BN108-13	1	1	4	3
10N on 1 mm stylus tip		2	2	4	4
Mar test*					
10N on 7mm stylus tip	FLTM BN108-13	1	1	4	3
Cloth abrasion test** (10K Cycles)	Modified Ink Rub Test	2	1	6	4

* Rating based on a visual observation on a scale of 1 to 5 (1 being no scratch and 5 being severe scratch)

** Rating based on a visual observation on a scale of 1 to 10 (1 is very little to no surface abrasion, while 10 is complete surface abrasion or no grain left)

Table 4: Stain resistance test in warm Marianna sauce (Tomato based)

Property	Method	FX-75	FX-85	TPV-75	TPE-75
Stain test # After 1 hours in warm sauce	Visual	1	1	4	4
After 2 hours		2	1	5	5

#Rating based on a visual observation on a scale of 1 to 5:

1 = No stain

2 = Slight stain

3 = Moderate stain

4 = Heavy stain

5 = Severe stain

Table 5: Chemical resistance test results, immersion+wipe, 1 hr @ 23°C

Chemical	Method	FX-75	FX-85	TPV-75	TPE-75
	Visual				
Gasoline		1	1	3	3
Kerosene		1	1	3	3
Adhesive Remover		1	1	2	2
Ammoniated Cleaner		1	1	1	1
Chlorinated Cleaner		1	1	1	1
Ammonia (Pure)		1	1	1	2
White Vinegar		1	1	1	2
Liquid Detergent, 30% in Water		1	1	1	1
Cooking Oil		1	1	2	3
Paraffin Wax		1	1	2	3
Isopropanol		1	1	1	2
Turpentine		1	1	2	3
Acetone		1	1	1	2
Suntan Lotion, SPF 30		1	1	2	3
Insect Repellent		1	1	1	1

Rating based on a visual observation on a scale of 1 to 5:

1 = No swelling or discoloration

2 = Low-Moderate swelling or discoloration

3 = Severe swelling or discoloration

Figure 3: Ford Motor Company scratch & mar resistance test apparatus (method FLTM-BN-108-13)

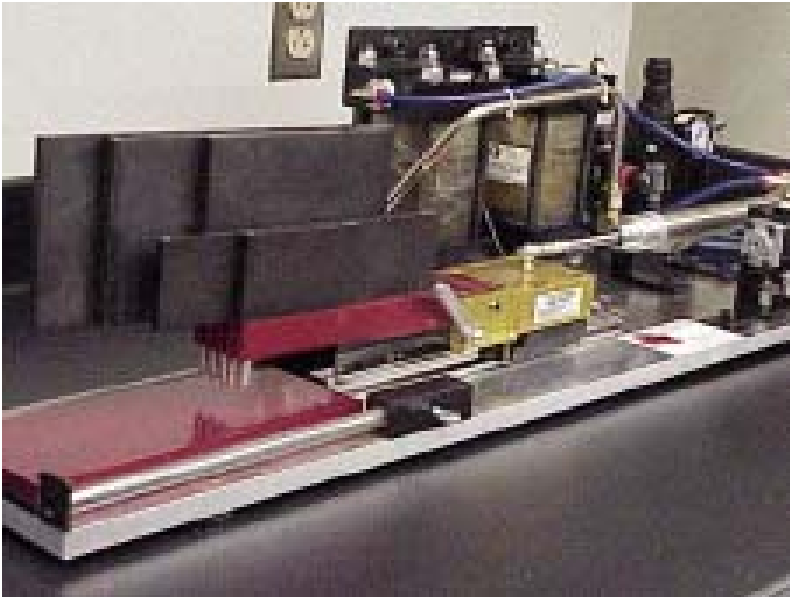


Figure 4: Modified Ink Rub apparatus used for the cloth abrasion test



Figure 5: SPM phase image (10 μm) of FX-75 sample in cross-flow direction

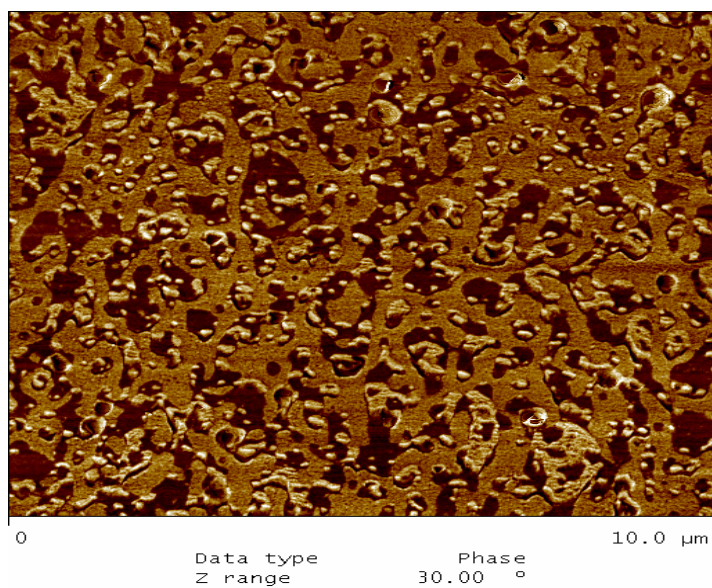
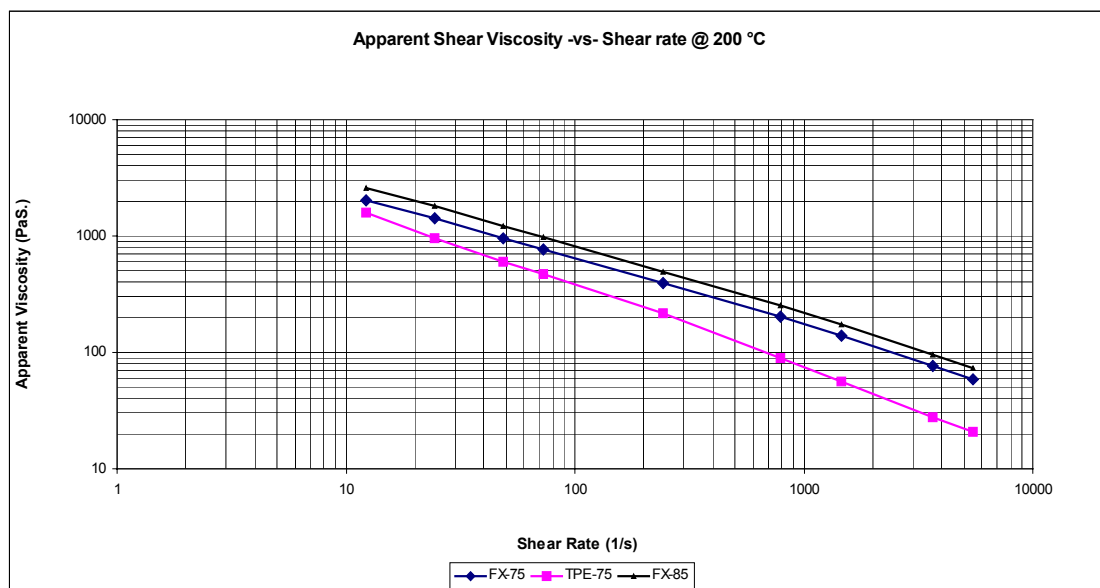


Figure 6: Apparent Capillary shear viscosities at 200°C



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