



# Thermoforming Quarterly®

A JOURNAL OF THE THERMOFORMING DIVISION OF THE SOCIETY OF PLASTIC ENGINEERS

SECOND QUARTER 2012 ■ VOLUME 31 ■ NUMBER 2

## OPENING DOORS TO NEW OPPORTUNITIES



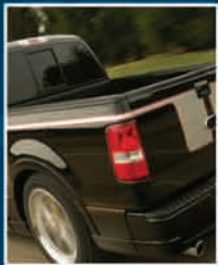
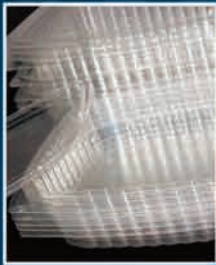
### INSIDE ...

- Beta Nucleation to Improve Thermoforming Characteristics of Polypropylene** *page 6*
- Design Optimization for Improved Packaging Recyclability** *page 14*
- European Thermoforming Conference Parts Competition Winners** *page 32*





# World Class Sheet Extrusion Systems



Barrier Co-Extrusion



J-Stack Roll Stands



High Output Co-Extrusion



2-Up Winding Systems



Heavy Gauge Systems



Cut Sheet Solutions



Horizontal Roll Stands



Thin Gauge Co-Extrusion



Dryer-Less PET Extrusion

Inline | Roll Stock | Cut Sheet Solutions  
[www.ptiextruders.com](http://www.ptiextruders.com)

## Contents

### ■ Departments

Chairman's Corner | 2

Thermoforming in the News | 4-5

Thermoforming and Sustainability | 14-18

University News | 22-28



Page 2

### ■ Features

ANTEC Paper | 6-10

Recent Insights on the Use of Beta Nucleation to Improve the Thermoforming Characteristics of Polypropylene

Student Paper | 22-28

Comparison Between Thermoforming Tooling Materials HYTAC-C and MDF Board

8th European Conference Review | 32-33

Dispatches | 34

By Ken Braney



Page 33

### ■ In This Issue

2012 Conference | 13

Council Summary | 30-31

Sponsorships | 40



Page 13

[www.thermoformingdivision.com](http://www.thermoformingdivision.com)

## Thermoforming Quarterly®

A JOURNAL PUBLISHED EACH  
CALENDAR QUARTER BY THE  
THERMOFORMING DIVISION  
OF THE SOCIETY OF  
PLASTICS ENGINEERS

### Editor

Conor Carlin

(617) 771-3321

[cpcarlin@gmail.com](mailto:cpcarlin@gmail.com)

### Sponsorships

Laura Pichon

(847) 829-8124

Fax (815) 678-4248

[lpichon@extechplastics.com](mailto:lpichon@extechplastics.com)

### Conference Coordinator

Gwen Mathis

(706) 235-9298

Fax (706) 295-4276

[gmathis224@aol.com](mailto:gmathis224@aol.com)

**Thermoforming Quarterly®** is published four times annually as an informational and educational bulletin to the members of the Society of Plastics Engineers, Thermoforming Division, and the thermoforming industry. The name, "**Thermoforming Quarterly®**" and its logotype, are registered trademarks of the Thermoforming Division of the Society of Plastics Engineers, Inc. No part of this publication may be reproduced in any form or by any means without prior written permission of the publisher, copyright holder. Opinions of the authors are their own, and the publishers cannot be held responsible for opinions or representations of any unsolicited material. Printed in the U.S.A.

**Thermoforming Quarterly®** is registered in the U.S. Patent and Trademark Office (Registration no. 2,229,747). |

Cover Artwork courtesy of

Google Images and Renault SA

All Rights Reserved 2012





# A New Vision

I am very excited to be serving as Chairman of the Thermoforming Division for the 2012-2014 term. In my first letter as the Division Chairman, I would like to thank Ken Griep for his enthusiasm and for the time and effort he devoted to the division over the past two years. His dedication, together with the effort of the other board members, has resulted in numerous recognitions for the Thermoforming Division including the 2012 SPE Gold Pinnacle Award and Communications Excellence Award.


The mission of the Thermoforming Division is **to facilitate the advancement of thermoforming technologies through education, application, promotion and research.** Today, we are in the best position to accomplish this mission than we have been for many years. By modernizing and streamlining the Division, we are becoming more efficient at engaging the thermoforming

industry and its customers. The continued growth of the Plastics Innovation and Resource Center (PIRC) at Penn College is a testament to the skills, dedication and collaboration of numerous educators, industry professionals and students alike. As we have seen in these pages before, workforce development continues to be a very important topic for our industry. The PIRC and, more specifically, the Thermoforming Center of Excellence, is making great strides toward its goal of being a hub of thermoforming activity from hands-on training to forming trials for new materials to new product design and development. The Center will host the 3rd Annual Technical Workshop on June 25-27. I invite all members to learn more about this wonderful asset and the talented staff, including Director Hank White and Program Manager Christopher Gagliano.

During this year's NPE Show in Orlando, the Division sponsored a Thermoforming Pavilion. As a group, we were able to showcase the art and science of thermoforming to the entire plastics industry. We also just launched our new Division website – [www.thermoformingdivision.com](http://www.thermoformingdivision.com).

The new and improved website contains the digital version of *Thermoforming Quarterly* magazine, online forums and technical information on material, machinery and process. Through the SPE Thermoforming Division LinkedIn Subgroup, the Division now provides an active and lively discussion forum for all those challenging thermoforming questions. We encourage our members to use these new tools, to participate in the forums and to offer commentary and feedback.

My vision for the next two years is to find better and more efficient ways of reaching out to everyone who is interested or involved in thermoforming. The Grand Rapids Thermoforming Conference from September 23rd through September 25th will be one of the most exciting and informative conferences to date. I hope to hear from many of you between now and then, so please share your ideas, comments and feedback. Together we will continue to advance our industry through inspiration, ideas and innovation.

  
Phil Barhouse  
Chairman



DELIVERING A UNIQUE BALANCE OF  
PERFORMANCE, COST AND SUSTAINABILITY

## Achieve a sustainable balance of performance and cost.

UPES® resin is NOVA Chemicals' proprietary additive resin. When used with polyolefins, this product enables significant source reduction while increasing performance at no additional cost.



## YOUR SOLUTION. YOUR UPES® RESIN.

### Sustainability

- Up to 20% material source reduction
- More efficient machine usage translates to energy savings
- Recyclable

### Benefit

- Improved crush strength - by up to 140%
- 33% faster forming rates
- Better part definition
- Shorter start-ups and reduced scrap rates

### Efficiency

- Downgauge
- Easy processability at loadings up to 20% by weight
- Runs on existing equipment
- Blends well with polyolefins

[www.upesresin.com](http://www.upesresin.com) • [upes@novachem.com](mailto:upes@novachem.com) • 1.724.770.6610

# Thermoforming in the News

## Dart Buying Solo Cup for \$1 Billion

By Lorene Yue, *Plastics News* Report  
Posted March 21, 2012 MASON, MI (10:00 p.m. ET)

**S**olo Cup Co. of Lake Forest, IL, announced recently that it is being purchased by Dart Container Corp.

Solo and Mason, MI-based Dart said they have an agreement for Solo to be sold in a \$1 billion transaction. The deal is subject to regulatory approval and expected to close in the third quarter. Dart is the country's largest maker of foam cups.

Robert Korzenski, Solo's CEO, said in a news release that he believes he is "putting the company in the right hands to succeed and grow going forward."

The company has been struggling financially ever since it bought competitor Sweetheart in 2004 for \$917.2 million. Solo was unable to efficiently integrate the two companies and combined with an economic downturn, began to experience consecutive quarters of losses.

In 2007, Solo sold a portion of the firm to New York-based Vestar Capital Partners IV LP. Vestar Capital had helped finance Solo's Sweetheart deal. Founder Leo Hulseman still maintains majority control of the papergoods and container manufacturer.

Since then the company has closed several plants and trimmed more than 1,000 jobs.

Dart CEO Robert Dart said in the release that because his firm is privately held, it can take the time needed "to integrate Solo in a thoughtful, analytical manner to ensure lasting success."

Dart's foam beverage cup business took a potential blow when McDonald's Corp. said it might have found a replacement for polystyrene foam.

About 2,000 of the company's restaurants, mostly West Coast operations, will be testing a double-walled fiber hot cup in an attempt to phase out the usually landfill-bound foam cups. McDonald's said the objective is to assess customer acceptance, operational impact and overall performance.

In addition to foam cups, Solo and Dart are also major thermoformers of foodservice products, including drink cups. Solo is the No. 2 thermoformer in North America, with estimated related sales of \$790 million, according to *Plastics News*' most recent ranking. The company had total corporate sales of \$1.582.9 million.

Dart was the No. 3 thermoformer in the ranking, with estimated relevant sales of \$480 million. The company has total corporate sales of \$1.455 million. Even the combination of Solo and Dart will be smaller than the No. 1 thermoformer, Lake Forest-based Pactiv Foodservice, with estimated sales of \$3.2 billion. |

## Peninsula Invests \$20 Million in New Washington Plant

By Brandi Shaffer, *Plastics News* Staff  
Posted March 21, 2012 EXETER, CA (1:45 p.m. ET)

**P**eninsula Packaging Co. LLC is expanding operations in Yakima, WA just months after purchasing the agricultural thermoforming division of Packaging Plus LLC.

That acquisition, which took place in December 2011, resulted in an initial 80,000-square-foot facility in Yakima as well as a manufacturing and warehouse facility in Hollister, CA.

Now, the Exeter, CA-based company will move into a larger 180,000-square-foot facility previously occupied by Ace Hardware in Yakima. The expansion has a price tag of \$20 million and will add 50 more to its current 50 employees in that facility through this year.

"We have some business in the Washington area that we have been manufacturing in California," Ed Byrne, CEO of Peninsula said.

"We put the new equipment in the new building and will start doing all our products for the Northwest in Yakima."

That new equipment includes three large bed thermoformers and a PET extrusion line. The line will be up and running within four weeks with the rest of the facility ready to go in the next three months.



In addition to Yakima, Exeter and Hollister, Peninsula has a facility in Wilson, NC, a distribution warehouse in Central Florida, and contract manufacturing and distribution centers in Tijuana and Guadalajara, Mexico.

Peninsula serves the fresh produce and bakery industries. The company made an estimated \$85 million in sales last year according to *Plastics News*' ranking of North American thermoformers. |



**Our mission is to facilitate the advancement of thermoforming technologies through education, application, promotion and research.**

**SPE National Executive Director**

Willem de Vos  
13 Church Hill Road  
Newtown, CT 06470 USA  
Phone: +1 203-775-0471  
Fax: +1 203-775-8490

**Conference Coordinator**

Gwen Mathis  
6 S. Second Street, SE  
Lindale, Georgia 30147  
706/235-9298  
Fax: 706/295-4276  
email: gmathis224@aol.com

**Visit Our Website at:**

**www.thermoformingdivision.com**

**Controllers**

- Hetronik(MultiBA)
- PID or % control
- Lost Heater Detection
- Voltage Regulation
- Allen Bradley Interface
- Siemens Interface
- Multiple channel

**Ovens and Control Panels**

- Individually wired elements to junction box
- Aluminized steel reflectors
- Custom design to fit existing footprint

**Ceramicx Infrared Heaters**

- Ceramic
- Quartz
- Tungsten
- Halogen
- Reflector Trays
- Terminal Block
- Panel Heater
- UL approved

**WECO International, Inc.**  
841 Tacoma Court  
Clio, MI 48420  
810.686.7221 Phone  
[www.wecointernational.com](http://www.wecointernational.com)

**CMT adds new materials to its high-performance lineup**

**HYTAC® Syntactic Foam Plug Material**

- B1X: Ultra tough, excellent material distribution and detail
- FLX: Durable copolymer, most easily (no dust!) machined for smooth surface and plug definition
- FLXT: Ultra smooth, PTFE impregnated for low stick. Excellent for multi-layer and high transparency applications
- W, WF, WFT: 350° and 450° epoxy syntactic for general purpose use.
- LP: Dual Layer syntactic optimized for heavy gauge forming at an economic cost.

**HYVAC® Vacuum Fixture Material**

- Secure hold down for interior and exterior trimming of formed parts
- Can be blocked by section to eliminate porosity where needed
- Easily mixed and formed to shape using an existing part. Cures overnight.

**CTB-44 Copolymer Toolboard**

- High temperature, long life
- Smooth surface finish
- Excellent machinability
- Superior edge definition
- Up to 60" length or cut to size

**Tooling and Machining Guides**

- Tooling designed for long life and smooth finish when machining syntactic foam
- Specific feeds/speeds and optimization techniques

**Innovative Tooling Materials for Thermoforming**

**www.cmtmaterials.com**  
info@cmtmaterials.com  
508-226-3901  
Fax 508-226-3902

A proud sponsor for the **SPE Thermoforming Division**

A Subsidiary of ICC Industries, Inc.

*Large enough to handle your requirements, small enough to handle your needs.*

**Partner with Primex**

- Polystyrene
- Polyethylene
- Polypropylene
- Weather-X
- Clear-X
- Micro-X
- Cor-X
- ABS
- PETG
- Tuff-X
- Print-X
- Luminique Colors

Richmond, IN 800-222-5116  
Garfield, NJ 800-631-7061  
Mesquite, NV 800-421-2936  
Lakeland, FL 800-867-9488

Corsicana, TX 800-332-5808  
Oakwood, GA 800-225-9272  
Co Durham, England 44 1325.315768

**www.primexplastics.com**

# Recent Insights on the Use of Beta Nucleation to Improve the Thermoforming Characteristics of Polypropylene

By Philip Jacoby, Mayzo Corporation, 3935 Lakefield Ct., Suwanee, GA 30024

## Abstract

Polypropylene is commonly used to produce thermoformed food packaging due to its low cost, low density, and good physical properties. It is well known that polypropylene can be more challenging to thermoform compared to amorphous materials due to its sharp melting point and low melt strength that results in a very narrow temperature window for processing. It has also been shown [1] that when high levels of beta crystallinity are produced in an extruded polypropylene sheet, the temperature window broadens dramatically and the final parts have improved thickness distribution and better rigidity. In this paper we will show how the properties of the thermoformed part depend on the processing conditions used, and how new, very high activity beta nucleating agents can lead to lighter weight, lower cost products with unique visual characteristics.

## Introduction

Polypropylene can crystallize in more than one crystal form [2, 3]. The most common crystal form of polypropylene is the alpha, or monoclinic form, which melts at about 165 °C for Zeigler-Natta polymerized homopolymer. In an injection molded or extruded part over 95% of the crystals are typically of the alpha type. A less common form, known as the beta or hexagonal crystal form, generally comprises less than 5% of the crystals. The beta crystals have a melting point that is typically 12-14 °C below that of the alpha form

In addition to the melting point differences, the beta crystals produce other physical property changes, such as an improvement in impact strength [4,5], a lowering of the tensile yield strength, and a change in the drawing characteristics of extruded and injection molded polypropylene. The change in drawability of the polypropylene leads to more uniform thickness in the oriented polymer produced in the drawing process. Also, solid state stretching of beta crystalline sheet results in the production of microvoids in the drawn product. These microvoids increase the opacity of the drawn material causing it to take on a white appearance due to light scattering from the voids. The presence of voids also

lowers the density of the final part. In extreme cases it is possible to produce a very high level of interconnected voids that result in a breathable, microporous film [6,7].

These changes in the melting and physical property characteristics of beta nucleated polypropylene lead to several benefits in the production of thermoformed products. The broad melting range due to the presence of both alpha and beta crystals in the extruded sheet dramatically broadens the thermoforming processing window. Also, the higher ductility and lower yield strength of the beta crystalline phase makes it much easier to thermoform polypropylene in the solid state. Both of these changes allow beta nucleated PP sheet to be thermoformed over a temperature range of more than 15 degrees C (from about 146 – 163 °C) vs. the very narrow range seen for alpha crystalline PP (about 160 – 163 C). It is also possible to dramatically increase the cycle rate thereby improving productivity due to the lower forming temperatures that are required.

The more uniform drawing characteristics of beta crystalline PP produces thermoformed containers with a more uniform wall thickness distribution, and this in turn leads to higher rigidity and greater top load crush strength. This higher strength and rigidity then allows the converter to lower the weight of the container and still achieve the same physical properties as that of a container made from an alpha crystalline PP sheet.

The microvoiding effect that one sees when the extruded sheet is thermoformed below the melting point of the beta crystal phase can produce a white container without the use of white pigment or with much lower levels of white pigment. This also results in further cost savings.

In this paper we will show various examples of these benefits using beta nucleated PP. We will also discuss how the control of the various process conditions can affect the nature of the final thermoformed container and also how to optimize the property benefits.



## Experimental

### Materials:

The various samples discussed in this paper were produced on a variety of commercial and lab-scale extrusion and thermoforming equipment. In all cases the beta nucleant was added in the form of a masterbatch to a non-nucleated polypropylene resin at the hopper of the sheet extruder. The masterbatches used included our 1<sup>st</sup> generation beta masterbatch identified as MPM 1101, and our 3<sup>rd</sup> generation beta masterbatch identified as MPM 2000. The actual beta nucleants used in these masterbatches is proprietary. The 3<sup>rd</sup> generation masterbatch contains a more active nucleant and it produces higher levels of beta crystallinity in the extruded sheet and it can be used at lower addition levels. The MPM 1101 was used at addition levels of 1-2% while the addition levels of the MPM 2000 ranged from 0.65% to 2.0%.

The extruded sheets were cooled using a 3-roll stack containing polished rolls that were heated using circulating water. The temperature of the middle roll, where the sheet solidified, was in the range of 80 – 95 °C, since high crystallization temperatures are required in order to produce high levels of beta crystallinity in the sheet.

The thermoforming was done either using a continuous process where the extruded sheet was fed directly into a heated oven and forming unit, or by a discontinuous process where finished sheet rolls were made first and then thermoformed in a second step.

### Characterization and Testing:

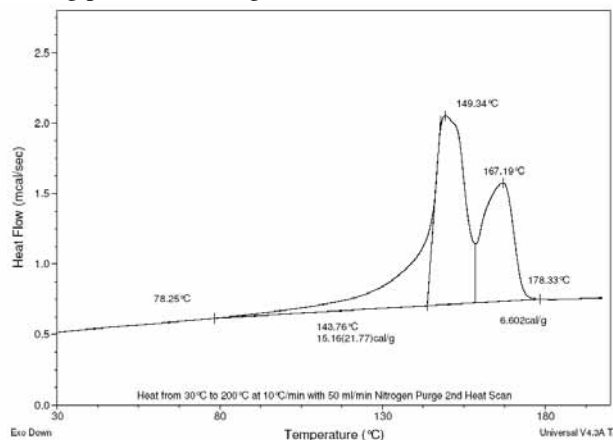
A portion of the extruded sheet was run in the DSC to assess the level of beta crystallinity in the extruded sheet, and the degree of nucleation. The 1<sup>st</sup> heat scan showed the melting of both the beta and alpha crystals in the sheet, and the relative area under these endothermic peaks (heats of fusion) can be used as a rough guide of the degree of beta and alpha crystallinity. During the cool-down scan the peak crystallization temperature,  $T_c$ , is a measure of the nucleation activity, with higher  $T_c$  values reflecting more rapid crystallization. The 2<sup>nd</sup> heat scans show the melting of the two crystal phases produced during the cool-down scan, and the relative size of the beta melting peak is also an indication of the beta nucleation activity of the nucleant. All heating and cooling scans were done at a rate of 10 °C per minute.

The thickness uniformity of the final thermoformed container was assessed by measuring the thickness of the container sidewall at various locations. The degree of microvoiding was assessed visually by comparing the appearance of containers made with and without the beta masterbatch.

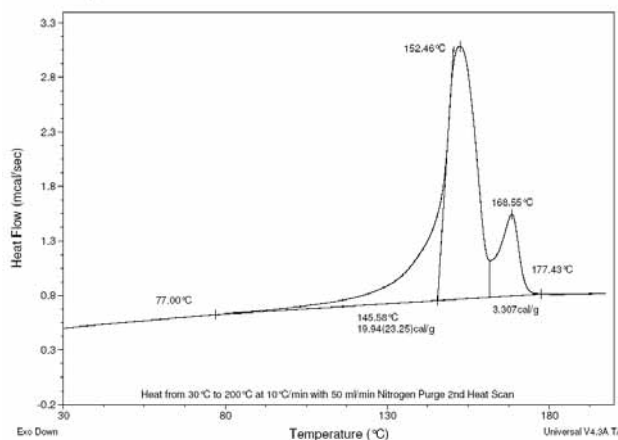
## Results and Discussion

### Comparison of Various Beta Masterbatches in Non-nucleated Polypropylene

In Figures 1 and 2 we compare the 2<sup>nd</sup> heat DSC scans of non nucleated polypropylene containing 2% of either the MPM 1101 or MPM 2000 beta masterbatches. These figures illustrate that the MPM 2000 is a more powerful beta nucleant masterbatch compared to the MPM 1101 as judged by the larger size of the beta melting peak and the higher  $T_c$  values.



**Figure 1. Second heat DSC scan of PP with 2% MPM 1101 (1st generation nucleant).  $T_c = 118.9^\circ\text{C}$**



**Figure 2. Second heat DSC scan of PP with 2% MPM 1112 (2nd generation nucleant).  $T_c = 122.6^\circ\text{C}$**

In Figures 3 and 4 we see the 1<sup>st</sup> and 2<sup>nd</sup> heat DSC scans of extruded sheet (1.85 mm thick) that was used to produce 8 oz juice cups that are discussed later on in this report. The middle cooling roll temperature was 95 °C, and the polypropylene was a blend that contained 70% homopolymer PP and 30% impact copolymer PP.

(continued on next page)

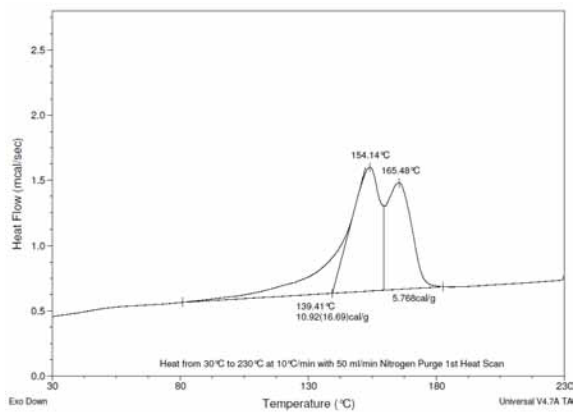


Figure 3. 1st Heat DSC scan of extruded sheet.

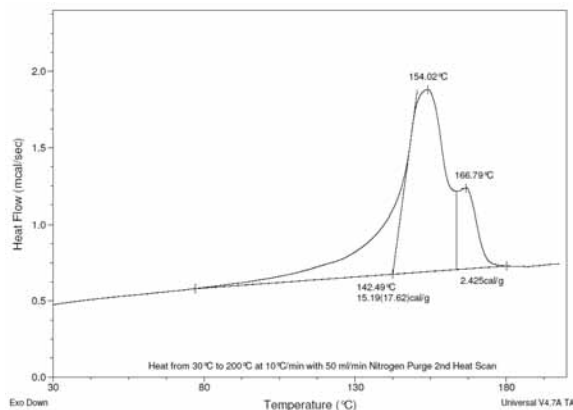


Figure 4. 2nd Heat DSC scan of extruded sheet.

We can see from the 1<sup>st</sup> heat DSC scan that although the extruded sheet contains a high level of beta crystallinity, there is also a substantial level of alpha crystallinity present as well. Much higher beta crystallinity is seen in the 2<sup>nd</sup> heat scan since the very slow cooling rate in the DSC is very conducive for the formation of beta crystals

It should be noted that the DSC scan always underestimates the level of beta crystallinity present in the original sheet sample. This occurs since the melted beta crystals begin to re-crystallize into alpha crystals using the existing alpha crystals as seed nuclei, even while the sample continues to heat up in the DSC. This means that the alpha melting peak is larger than it would have been had no re-crystallization occurred. When wide angle x-ray measurements are used to quantify the beta and alpha crystal content of a sample, the % beta content is always higher than that obtained using the DSC heat of fusion measurement.

### Discussion of Sheet Transformation During the Thermoforming Process

During the processing of normal (alpha crystalline) PP, the sheet in the oven is gradually heated to a temperature where it is soft enough to form into the final container

with good definition and sharp detail, but it is not heated beyond its melting point since this would lead to uncontrollable sheet sag due to the low melt strength of PP. When the sheet contains beta crystals the melting process begins at a temperature that is generally below 150 C, and by the time that the sheet temperature is around 155 °C all of the beta crystals have melted, and the sheet is soft enough to form.

Since the alpha crystals have not yet melted, the sheet sag is minimized while the partially molten sheet is now soft enough to thermoform with excellent detail and part definition. In Figure 5 we see the appearance of two light weight drinking cups (about 2g) that were formed from non-nucleated PP and PP that contained 1% of the MPM 1101.



Figure 5. Beta nucleated and non-nucleated cups.

We see here that the beta nucleated cup has a hazy translucent appearance compared to that of the non-nucleated cup. In Figure 6 we see a plot of the sidewall thickness distribution of the two cups.

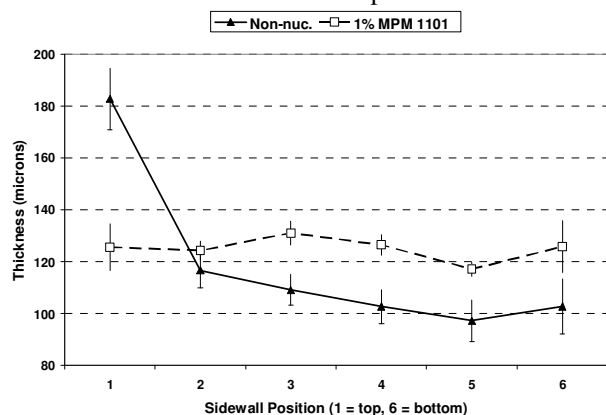


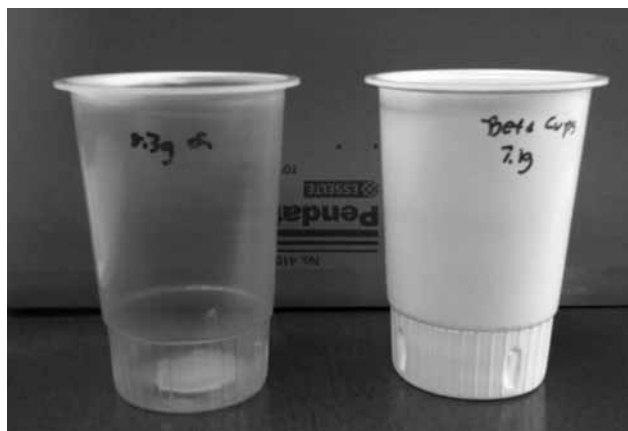
Figure 6. Sidewall thickness distribution of cups.

Since the beta nucleated cup is hazy but not white we can infer that the forming of the sheet took place above the melting point of the beta crystal phase. We can



also see that the beta nucleated cup has much more uniform thickness distribution compared to that of the control cup. The beta cup was also noticeably more rigid. This observation shows that the beta nucleated cup could have been significantly down-weighted to give comparable rigidity and the same minimum sidewall thickness as that of the control cup.

In Figure 7 we see the appearance of a beta nucleated juice cup and a control cup where the thermoforming took place below the melting point of the beta crystal phase. Here the beta nucleated cup contained 0.65% of the MPM 2000 in a resin blend of 70% homopolymer and 30% impact copolymer.



**Figure 7. Appearance of control and beta nucleated cups.**

The beta nucleated cup had a very uniform white appearance, even though no white pigment was used. The beta nucleated cup was also made from a thinner extruded sheet (1.85 mm) so that the cup only weighed 7.1g compared to a weight of 8.3g for the control cup (2.15 mm). Both cups had similar sidewall rigidity and similar minimum sidewall thickness. These observations demonstrate the ability of beta nucleation to allow PP to be thermoformed at low temperatures, and to produce white colored containers using less raw materials.

In Figure 8 we see the resulting change in container appearance from translucent to white as the sheet temperature was lowered. These cups were made on a pilot line where the surface temperature of the sheet was measured as it exited the oven and entered the mold. For the translucent cup in the middle the sheet temperature was about 157 °C, while for the white cup on the right, the sheet temperature was 147 °C.



**Figure 8. Non-nucleated, beta nucleated (157°C), and beta nucleated (147°C) thermoformed cups.**

In a lab experiment using a single cavity mold, we systematically shortened the residence time of beta nucleated sheet in the oven by varying the cycle rate in order to see the effect on the appearance of the final part. The appearance of the cups illustrated in Figure 9.



Longer Cycle Time = Higher Sheet Temperature

**Figure 9. 16 oz. cups thermoformed at different cycle rates.**

We see here that the cups become progressively whiter as the cycle time was decreased since this shorter cycle time resulted in reduced residence time in the oven and a colder sheet during the forming step.

It should be noted that when the thermoforming is done in the temperature region between the melting points of the beta and alpha crystal phases, the crystal morphology of the sheet and its thermoforming characteristics become a strong function of the residence time in the oven. Since the beta crystals have already melted, the percentage of alpha crystals in the sheet steadily increases with time due to the recrystallization of the molten PP as has been noted previously. Therefore, if the oven is long and the cycle rate is low, the sheet will have a long residence time in the oven, and this can lead to a loss of the benefits that can be attributed to the presence of beta crystals in the extruded sheet. The final thermoforming behavior of the sheet such as the improved thickness distribution may be no different from that of a typical alpha crystalline sheet, since the final forming takes place in a sheet that is mainly alpha crystalline.

*(continued on next page)*

## Conclusions

We have demonstrated that beta nucleation can dramatically broaden the thermoforming processing window of polypropylene and also improve the thickness uniformity of PP containers leading to better rigidity and top-load crush strength. The thermoforming characteristics of the PP and the appearance of the final containers is sensitive, however, to the temperature regime in which the thermoforming takes place. When thermoforming occurs below the melting point of the beta crystal phase, white containers are produced that contain microvoids, with the whiteness due to the light scattering from the voids. When the thermoforming takes place above the melting point of the beta crystal phase but below that of the alpha crystal phase, translucent containers are produced. The thermoforming behavior in this intermediate temperature range is very dependent on the residence time of the extruded sheet in the pre-heat oven. Long residence times allow the molten PP derived from the melted beta crystals to recrystallize into alpha crystals, and this recrystallization diminishes the benefits resulting from the beta crystals in the extruded sheet. It is therefore recommended that beta nucleated PP be run using rapid cycle rates and low oven temperatures in order to prevent this recrystallization from occurring. |

## References

1. Jacoby, P.; *U.S. Patent # 5310584*.
2. Turner-Jones, A., Aizlewood, J.M. and D.R. Beckett, *Makromol. Chem.*, **75**, 134, (1964).
3. Karger-Kocsis, J., "Polypropylene: Structure, Blends, and Composites," Vol. 1, Chapman & Hall, 1995.
4. Jacoby, P.; Bersted, B.; Kissel, W.J.; Smith, C.E.; *J. Polym. Sci. B Phys.*, 24:3, 461-491 (1986).
5. Obadal, M.; Cermak, R.; Stoklasa, K.; Petruchova, M.; *ANTEC 2003*, 1479-1483 (2003).
6. Jacoby, P.; *U.S. Patent # 5594070*.
7. Jacoby, P., R. Lee; *ANTEC 2005*, 3310-3313 (2005).

# Why Join?



It has never been more important to be a member of your professional society than now, in the current climate of change and volatility in the plastics industry. Now, more than ever, the information you access and the personal networks you create can and will directly impact your future and your career.

Active membership in SPE – keeps you current, keeps you informed, and keeps you connected.

The question  
really isn't  
"why join?"  
but ...

Why  
Not?



## Need help with your technical school or college expenses?



If you or someone you know is working towards a career in the plastic industry, let the SPE Thermoforming Division help support those education goals.

Within this past year alone, our organization has awarded multiple scholarships! Get involved and take advantage of available support from your plastic industry!

Here is a partial list of schools and colleges whose students have benefited from the Thermoforming Division Scholarship Program:

- UMASS Lowell
- San Jose State
- Pittsburg State
- Penn State Erie
- University of Wisconsin
- Michigan State
- Ferris State
- Madison Technical College
- Clemson University
- Illinois State
- Penn College

Start by completing the application forms at [www.thermoformingdivision.com](http://www.thermoformingdivision.com) or at [www.4spe.com](http://www.4spe.com).



**Thermo  
Forming**  
Division



## Spartech Introduces the Next Generation of Extrusion Technology

Extreme TPO sets Spartech apart from the competition and offers some of the highest-performing processing characteristics in the industry:

- New extrusion line in Cape Girardeau, MO built from the ground up and exclusively designed for Extreme TPO. This means the highest standards of quality and expanded capacity for your needs.
- High melt strength formulation for a consistent and wide thermoforming window
- Tough, high-impact structure
- Superior weatherability
- Low coefficient of linear thermal expansion for dimensional stability
- Resistance to cracking under high vibration applications
- Available in both high gloss to low gloss surfaces

**SPARTECH**

For more information, call us at **1-855-292-8324** or visit [www.spartech.com](http://www.spartech.com)

The Premier Supplier of Sustainable Plastic Sheet Solutions



**REDUCE! REUSE! RECYCLE!**



**Clamp Frames Pin Chain  
Heaters Valves  
& More**

**Slide Rails  
Toggle Pins Bushings  
Cylinders Peening Hammers  
Toggles Mold Seal Lube Fittings**

Thermoformer Parts Suppliers  
isn't just what we do  
...IT'S WHO WE ARE.

**TPS INC**

**Thermoformer Parts Suppliers**  
3818 Terry Diane  
Beaverton, MI 48612  
1-800-722-2997  
Fax: (989)435-3825

# Control Your Destiny

**BROWN IS INNOVATION**



## Control over product.

What gives the Quad greater control over your finished product? Combining high-tonnage stamping (coining) force with high-tonnage holding force, and without platen deflection. This powerful combination produces consistent material distribution, ensuring better part consistency at higher speeds. It all adds up to producing quality parts faster, with less scrap.



## Quad Series™

*The Brown Quad Series high-tonnage power and user-friendly operation provides process engineers greater control over the thermoforming process and their finished products more than ever before.*



## Control over process

All machine control functions and diagnostics are easily managed at the HMI level. An Allen-Bradley open and integrated architecture control system with user-friendly HMI and Logix 5000 single program solution. This solution optimizes and synchronizes the functions of logic, motion, and oven control. The system is fully supported worldwide by both Brown and Allen Bradley.



**Global Leader in Thermoforming Solutions**

**Find out more at:**  
[www.brown-machine.com](http://www.brown-machine.com)  
or call 989.435.7741



# Extend Your Reach into the Thermoforming Market Become an Exhibitor at the 2012 Conference!



2012

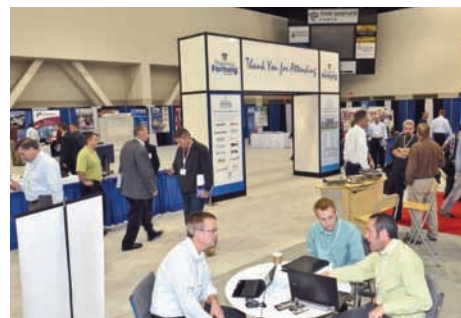


## Thermo Forming

### Thermoforming Today

*New Venue!*  
*New Location!*  
*New Customers!*  
*New Attendees!*

*New Marketing Approach!*



Exhibiting sponsors from past conferences have spoken and the Thermoforming Division has listened.

You asked for deeper customer base, increased exposure to key decision makers and OEMs into the thermoforming market to achieve diversification, profitability, and long-term value.

Well, here's how we're answering your needs in the 2012 Thermoforming Conference:

- Specifically target increased **OEM** attendance, in the conference and on the exhibit floor, to gain knowledge of the industry, equipment, tooling advances, lean principles and new materials.
- Enhanced marketing disciplines to entice those professionals who are active in the plastics industry, but haven't previously participated.
- Increase the involvement of major **Processors** into our sessions to discuss their views and walk your exhibitor floor, comparing their abilities to new technologies.

*Don't miss this exclusive opportunity!*  
*September 23 – 25, 2012*  
*Devos Center - Amway Grand Plaza Hotel*  
*Grand Rapids, Michigan*



Enjoy the advantages that a captive audience and focused trade show will offer by signing up today.

Booth assignments and commercial presentation opportunities are made on a first-come basis.

Contact: Gwen Mathis - [gmathis224@aol.com](mailto:gmathis224@aol.com)

### Design Optimization for Improved Packaging Recyclability

By Shane Dunne, Project Manager, EPI

Sustainable packaging can be defined using many different criteria, from its source materials and manufacturing to its disposal and recyclability. As these criteria continue to evolve and new industry guidance emerges, many companies are challenged to develop packaging that integrates the latest environmental considerations to positively influence the end of life treatment of the materials they place on the market.

To enhance the potential for reuse and reprocessing of thermoformed plastic bottles and packages, design decisions should be guided by the following steps:

- Create a Packaging Protocol
- Follow Packaging Design Standards
- Figure in Fees
- Label Appropriately

#### Create a Packaging Design Protocol

Whether driven by internal corporate sustainability targets, growing consumer demand, or legislative requirements, the responsibility to design packaging for waste stream avoidance shows no signs of slowing down. To meet the demands designers increasingly face, organizations should develop a standard, yet flexible, protocol for ensuring critical environmental considerations are reflected.

Key steps in the process should include:

- Identify packaging functional requirements
- Identify relevant regulations
- Create a packaging design
- Gather data from the design (weights, materials, area/volume)
- Assess for compliance
- Estimate packaging fee costs
- Review labeling
- Obtain approval for packaging design
- Implement

Throughout the process, organizations should keep in mind general guidelines for recycling plastic containers, the infrastructures and rates for which

vary from country to country (and even municipality) depending on the components, color/pigment, coatings, labels, and other materials used. For example, while unpigmented, transparent #1 PET plastic is recyclable in most countries, LDPE and PP are only sorted for recycling in a few. Components such as caps, labels, and sleeves present issues everywhere.

To maximize recyclability, the following guidance generally applies to plastic packaging:

- The best choice is clear or green PET or unpigmented or clear HDPE
- Caps, closures, hangers, etc., when removed, should completely detach from containers
- The same plastic resins should be used for all of the container's components (closures, safety seals, coatings and layers)
- Use the same color throughout
- Avoid paper labels
- Label adhesives should be water soluble or dispersible from 140°F to 180°F
- Metallic hot stamps make plastic containers or tubes less recyclable
- Avoid use of inks that bleed

Also, be aware that RFID and similar security tags, which typically contain a paper or PVC substrate and various metals, are contaminants within the recycling stream. During the design stage, plan for the use of the packaging throughout its life cycle and consider alternatives to joining dissimilar materials with adhesives.

#### Follow Packaging Design Standards

In addition to the requirements published by individual countries, several global frameworks govern everything from reuse and source reduction of materials to empty space and minimum recycled content requirements across a wide range of jurisdictions.

#### *EU Packaging Directive and CEN Standards*

The European Union (EU) Packaging Directive's Essential Requirements, which relate to packaging minimization, reduction of toxic or hazardous constituents and suitability for reuse, material recovery, energy recovery, and composting, are designed to shift

the responsibility of packaging waste management to the manufacturers.

To implement the Essential Requirements, the EU Packaging Directive called for the establishment of standards due to the large range of packaging types and available recovery and disposal possibilities. The European Committee for Standardization (CEN) created a management system approach aimed at ensuring a continuous effort to improve the environmental profile of packaging placed on the market.

The CEN standards address:

- **Source Reduction.** This mandatory standard requires that the packaging system constitutes the minimum adequate packaging to serve necessary functions. It also addresses the composition of packaging, including heavy metals and dangerous substances and preparations.
- **Recovery.** Under this requirement, packaging must meet at least one of the following standards:
  - **Material Recovery:** The design of the package must take into account recyclability in each EU country in which the product is marketed, and must not interfere with those countries’ recycling systems. The company must declare the percentage (by weight) of material available for recycling and identify the intended material recycling stream(s).
  - **Energy Recovery:** Packaging to be incinerated must meet a minimum inferior calorific value during energy recovery of 5 MJ/kg.
  - **Organic Recovery:** Materials known to be harmful to the environment during biological treatment may not deliberately be introduced into biodegradable packaging or packaging materials. Additional heavy metals limits,

biodegradability, and disintegration requirements also apply.

- **Reuse.** This optional standard states that reusable packaging, including any components claimed as reusable, must be conceived and designed for reuse, be capable of being refilled or reloaded a minimum amount of times within its life cycle, be reused for the same purpose as originally conceived, and be part of a reuse system in each market where it is introduced.

To be compliant, every company must incorporate the “Essential Requirements” into its packaging design protocol, document how each standard was applied, and be able to provide data and certifications regarding its packaging material. Packaging (primary, secondary or tertiary) that does not comply with the requirements can be banned from EU markets.

***Global Protocol on Packaging Sustainability (GPPS)***

Last year, the Global Packaging Project, part of the Consumer Goods Forum, released the Global Protocol on Packaging Sustainability to give companies a common language for assessing the environmental impact of their packaging. The Protocol, based on existing, recognized international standards, includes indicators and metrics in three categories: Environmental, Economic and Social. The selection of a particular metric depends on the business, and relevance and significance to an organization’s packaging, as well as the availability of data.

Environmental metrics are divided into Attribute Indicators and Life Cycle Indicators.

<b>Attributes</b>	
Packaging Weight and Optimization	Assessment and Minimization of Substances Hazardous to the Environment
Packaging to Product Weight Ratio	Production Sites Located in Areas with Conditions of Water Stress or Scarcity
Material Waste	Packaging Reuse Rate
Recycled Content	Packaging Recovery Rate
Renewable Content	Cube Utilization
Chain of Custody	

*(continued on next page)*



<b>Life Cycle Indicators – Inventory</b>	
Cumulative Energy Demand	Land Use
Fresh Water Consumption	
<b>Life Cycle Indicators – Impact Categories</b>	
Global Warming Potential	Photochemical Ozone Creation Potential (POCP)
Ozone Depletion	Acidification Potential
Toxicity, Cancer	Aquatic Eutrophication
Toxicity, Non-Cancer	Freshwater Ecotoxicity Potential
Particulate Respiratory Effects	Non-renewable Resource Depletion
Ionizing Radiation (Human)	

Although the attributes are relatively easy to measure, they provide information only and do not necessarily assess positive or negative environmental consequences. For example, a reduced or increased attribute value may or may not mitigate the package's environmental impacts. To give feedback to the designer on the environmental consequences of decisions made in the development process over the entire packaging life cycle, a streamlined Life Cycle Analysis (LCA) tool is useful. Numerous tools are available and intended for use by packaging designers; they vary in level of detail, packaging materials included, LCI data used, methodology and assumptions, and output format.

**ISO Standards**

New international standards on packaging and the environment, currently accepted in draft form and set for a final review in the coming months, will address the optimization of packaging to minimize its environmental impact, the responsible use of heavy metals and other hazardous substances, the possible reuse of packages and the different modes of recycling (material, energy or organic).

The new ISO world standards will be voluntary and will be available for use by industry, retail and any other interested organization by the end of 2012.

**Figure in Fees**

In many countries worldwide, companies must pay packaging fees. These charges are primarily based on the amount of packaging (by weight) and the type of packaging materials used. In general, the more packaging a product bears and the more difficult the packaging material is to recycle or manage in a given country, the higher the fees.

Packaging fees vary greatly from country to country. In some countries, the material composition can impact fees by as much as fivefold. In general, fees for plastic and composite materials are much higher than those for paper, glass, and metals. In fact, plastics, laminates and composites can cost up to 500% more than other materials.

An example of a fee analysis of a plastic thermoformed clamshell reveals the following components and costs in seven major global markets:

Packaging Name	Component	Material Type	Weight (grams)
Clamshell	Clamshell	Plastic - PVC	58.52
	Insert Card	Paperboard - Half Coated SBS	22.68
	<b>Total Weight</b>		<b>81.20</b>

### International Fee Comparison (per 1,000 units)

Country	Fee
Austria	\$49.59
Belgium	\$26.43
Canada (Ontario)	\$17.57
France	\$27.10
Italy	\$9.89
Japan	\$16.04
Spain	\$39.31
<b>Average Fees</b>	<b>\$21.98</b>

Fees are based on 12/01/2011 exchange rates: 1 USD = 0.74840 EUR, 1.02711 CAD, 77.82 JPY

Since packaging fees can directly affect the competitiveness of a company's products, it is useful to perform a fee analysis that addresses the following questions:

- What are the fees for the packaging system in the intended countries of sale?
- What factors (e.g., use of plastics, volume, number of components, etc.) are driving the fees in each country?
- How do the fees compare for comparable packaging systems used for similar and/or competing products?

### Label Appropriately

Environmental labels such as recycling symbols, materials codes, and other marks can be an integral component of packaging design. Use of some environmental labels is mandatory, while use of other labels is voluntary. The requirements vary by country.

### Material Coding

In many countries, material identification marks are mandatory for plastic containers and packaging and PET bottles. In the EU, the Packaging Directive called for the development of a material coding system. While the EU coding system is voluntary, several of the member states have laws requiring material coding of packaging using the EU system.

The use of Society of the Plastics Industry (SPI) resin identification codes is required in **39 states in the United States** and in **Taiwan** (where it is required on "controlled" containers subject to recycling fees) and is used (although not required) in Mexico and other Latin American countries. In the 39 U.S. states, the SPI code is required on plastic **bottles** 16 ounces to 5 gallons and rigid plastic **containers** of 8 ounces to 5 gallons (Wisconsin requires use of the code on bottles of 8 ounces to 5 gallons).

### SPI Codes

MATERIAL	MATERIAL #	ABBREVIATION
Polyethylene Terephthalate	1	PETE
High Density Polyethylene	2	HDPE
Polyvinyl Chloride	3	PVC
Low Density Polyethylene	4	LDPE
Polypropylene	5	PP
Polystyrene	6	PS
Other*	7	OTHER

\*Note that multilayer containers should be marked as a "7-OTHER"

(continued on next page)

The symbol – recommended to be between one-half inch and one inch – is generally molded or embossed into the base of the container. The SPI code is not a recycling or environmental symbol and may not be placed prominently on the container or label.

### ***Environmental Marketing Claims***

Many countries have fair trading acts that give government agencies authority to bring enforcement actions against companies who make deceptive environmental claims. In the United States, under the Federal Trade Commission (FTC)'s Guides for the Use of Environmental Marketing Claims, it is deceptive to misrepresent, directly or by implication, that a product, package or service offers a general environmental benefit. Consequently, the following types of general claims are discouraged unless they are accompanied by qualifying text:

- Sustainable
- Eco-friendly
- Green
- Natural
- Environmentally Safe

Every express and implied environmental claim must be qualified or avoided altogether. All claims must be substantiated. For example, the guidance from the FTC on substantiation of recyclability claims is based on the availability of recycling collection and facilities for the package or product:

- If recycling programs for the packaging are available to a “*substantial majority*” of consumers or communities where it is sold, then no qualifying text is required. “Substantial majority” has informally been defined as 60% or more.
- If recycling programs for the packaging are available to a “*significant percentage*” – as yet to be defined by the FTC – of consumers or communities where it is sold, then qualifying text is needed, e.g. “Package may not be recyclable in your area” or “Recycling programs for this package may not exist in your area.”
- If recycling programs for the packaging are available to “*less than a significant percentage*”

of consumers or communities where it is sold, then qualifying text is needed, e.g. “Product is recyclable only in the few communities that have recycling programs.”

Consequently, packaging materials such as thermoform clamshells, blisters and trays that are not traditionally accepted for recycling must include a basis for any recyclable claims (e.g. study or survey results of municipal recycling facilities) since these materials fall into the “*less than a significant percentage*” category listed above. Several industry associations regularly sponsor studies measuring the availability of recycling systems in the U.S.

*A variety of stakeholders from MRFs/reclaimers and packaging manufacturers to brand owners and consumers continue to shape the dialogue around plastic packaging and its recyclability in current systems. Being mindful of the issues discussed in this article will help those involved in the package design process to understand the landscape in which thermoformed plastics are being produced, utilized, and disposed of and determine the most appropriate strategies for their packaging – and organization. |*

## **RECYCLING CODES**





*Heartful Technology*

**Yushin**

## **INTRODUCING... THERMOFORMING STACKING ROBOT**

**Yushin High-Speed Robots for Thermoforming will pick your thermoformed parts as they disengage from the web and stack them onto an indexing conveyor for downstream inspection or pack-out.**



**THERMOFORMING STACKING ROBOT**



- ▶ Fast, safe set up with quick-change tooling
- ▶ Adjustable end-of-arm tooling to pick several products
- ▶ A/B alternate part stacking capabilities
- ▶ User-selectable stack heights
- ▶ Industry-leading touchscreen controller is powerful and easy to use
- ▶ Fast and reliable
- ▶ Inline or perpendicular placement
- ▶ Ultra high-cycle
- ▶ Cleanroom ready
- ▶ Integrated frame and safety guarding
- ▶ 24/7 technical support, help line, and spare parts availability

Yushin America, Inc.  
35 Kenney Drive. Cranston, RI 02920  
[www.yushin.com](http://www.yushin.com) [salesinfo@yushin.com](mailto:salesinfo@yushin.com)  
p: 401-463-1800 f: 401-463-1810

*"Automating plastic processing machinery since 1971"*

**Call today for more details on how field-tested Yushin technology can help increase productivity and reduce costs.**

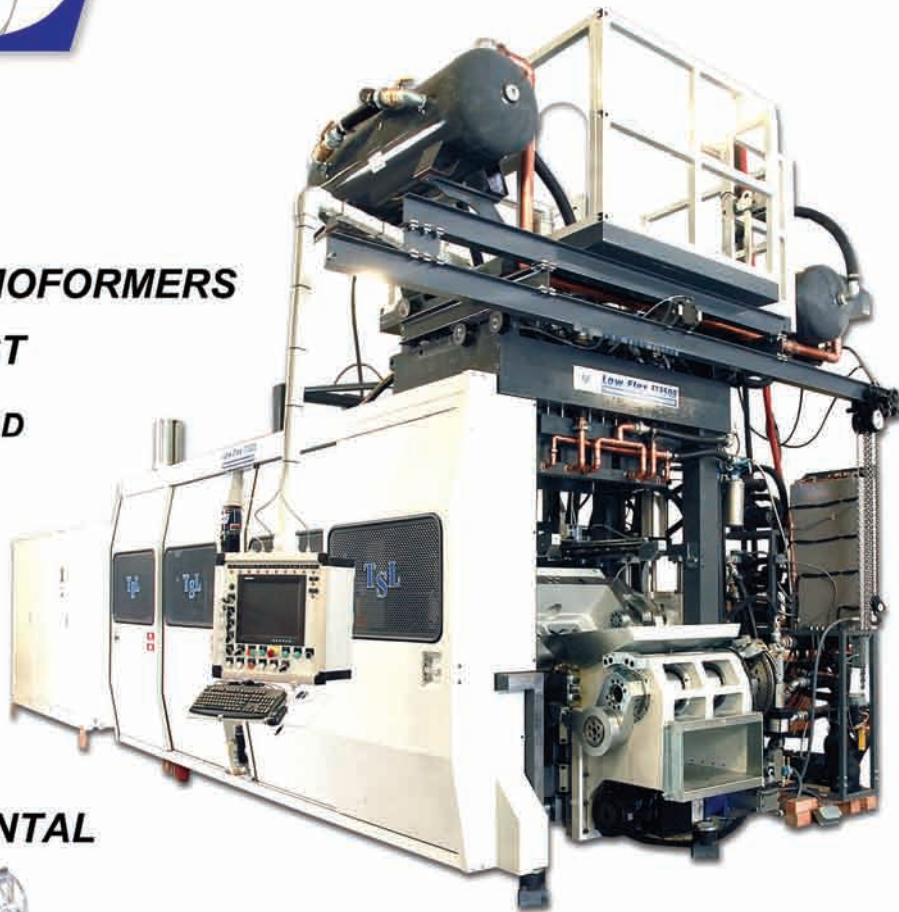




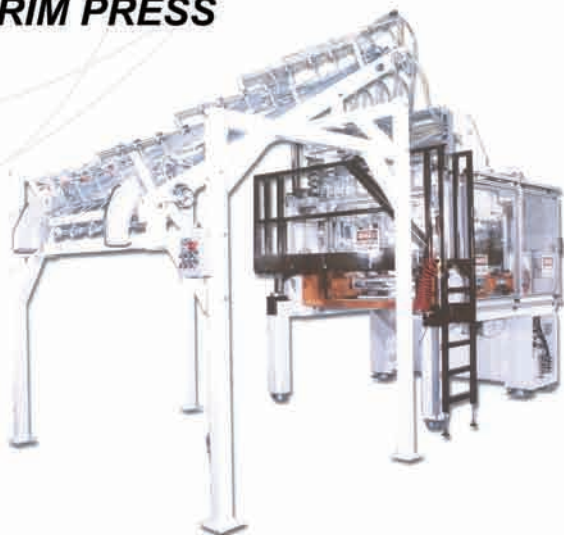
**NORTH AMERICA'S LEADING  
THERMOFORMING MACHINE BUILDER**

**9 MODELS OF THERMOFORMERS**

**INDUSTRY'S LARGEST  
THERMOFORMER -  
A MAXIMUM 65" X 67" MOLD**



**7 MODELS OF THE  
VERTICAL & HORIZONTAL  
TRIM PRESS**



- *Innovative, Quality Engineering*
- *Superior Technology Results in Unequaled Performance*
- *Industry's Top Service and Support Team*



**THERMOFORMING MACHINERY – PLASTICS PROCESS TECHNOLOGY**

**FORMING CUSTOMER PROFITS**

Union Gap, Washington • 509.454.4578 • [www.tsllusa.biz](http://www.tsllusa.biz)

PRESSURE FORMING MACHINES  
FOR THE PACKAGING INDUSTRY

**KIEFEL**  
A Member of Brückner Group

## SPEEDFORMER KMD

**KIEFEL Technologies, Inc.**  
200 International Drive,  
Suite 105  
Portsmouth, NH 03801

Phone: (603) 929-3900  
Fax: (603) 766-6348  
info@kiefeltech.com  
www.kiefeltech.com

High quality,  
high output  
thermoform  
machines with a  
quick tool change  
system.

## From the Editor

If you are an educator, student or advisor in a college or university with a plastics program, we want to hear from you! The SPE Thermoforming Division has a long and rich tradition of working with academic partners. From scholarships and grants to workforce development programs, the division seeks to promote a stronger bond between industry and academia.

**Thermoforming Quarterly** is proud to publish news and stories related to the science and business of thermoforming:

- New materials development
- New applications
- Innovative technologies
- Industry partnerships
- New or expanding laboratory facilities
- Endowments

We are also interested in hearing from our members and colleagues around the world. If your school or institution has an international partner, please invite them to submit relevant content. We publish press releases, student essays, photos and technical papers. If you would like to arrange an interview, please contact Brian Winton, Academic Programs, at:

[bwinton@lyleindustries.com](mailto:bwinton@lyleindustries.com) or 989.435.7718, ext. 32



1700 Chablis Avenue  
Ontario, CA 91761

909/390-9906  
800/423-7859  
Fax 909/390-9984  
www.rayplastics.com

**ZED INDUSTRIES, INC.**  
Thermoforming Machinery, Tooling,  
and Automation Solutions  
(937) 667-8407, Fax (937) 667-3340  
www.zedindustries.com

**ALLEN**  
CUSTOM THERMOPLASTIC SHEET  
**ALEXTRA™ ALLEN6000 ALLEN EFG**  
ABS, ABSPC, CENTREX, LURAN, SOLARKOTE,  
HIPS, FRHIPS, TPO  
(800) 833-1305 www.allenx.com

**PROFILE PLASTICS CORPORATION**  
65 South Waukegan Road  
Lake Bluff, IL 60044  
*Custom Engineered Plastic Parts*  
*Vacuum • Pressure • Twin Sheet*  
**We Deliver Parts Under Pressure!**  
ISO 9001:2000  
(847) 604-5100 FAX (847) 604-8030

**Productive Plastics, Inc.**  
*Award Winning Thermoforming*  
ISO 9002  
103 West Park Drive • Mt. Laurel, NJ 08054  
(856) 778-4300 • Fax: (856) 234-3310  
<http://www.productiveplastics.com>

**REDUCE! REUSE!  
RECYCLE!**  
  
**REDUCE! REUSE!  
RECYCLE!**



## Comparison Between Thermoforming Tooling Materials HYTAC-C and MDF Board

By Andrew W. Sneeringer, Pennsylvania College of Technology, Williamsport, PA

### Abstract

An experiment was conducted to compare two different mold materials against each other to prove that a plug assist thermoforming material can be a suitable mold material. An MDF board mold and a HYTAC-C mold were set up and run equally to prove which would be more suitable for production use. Results show the condition of before and after molding as well as temperature testing and heat transfer throughout the forming of parts.

### Introduction

In today's competitive environment, companies always strive to save money somewhere throughout processing whether it's materials, tooling or workers. This project is designed to make a functioning mold out of a material that is only used as a plug assist thermoforming tool yet is very inexpensive. By using a HYTAC-C Syntactic resin, the production of a functioning thermoforming mold will be created and will be comparable to an MDF board mold yet will yield a working intercooler splitter. This project is not only to compare two different molding materials, but also to create a working prototype mold for future production of a vehicle performance part. This project was chosen because many benefits are envisioned upon completion. Not only will this save money in the long run for parts and materials cost, but the comparison of MDF board and HYTAC-C epoxy syntactic will be hugely beneficial information for industry use. The industry has never used this epoxy syntactic resin as a mold; it has only been used and designed for plug assist thermoforming. Therefore, this project will be presenting the benefits of an epoxy syntactic mold versus a wooden MDF board mold.

When doing something new in industry, there is always a risk factor. The risk factors in using an epoxy syntactic as a mold include possible mold failure, internal and external shrinkage, damage upon molding

or bad release, to name a few. This experiment is designed with enough material for two molds which allows for redesign or repair if necessary.

### Experimental

#### Thermoformer

Figure 1 shows a MAAC industrial scale thermoformer. This is a twin sheet thermoformer with heavy gauge and thin gauge capabilities. The machine has mold capabilities of up to 890mm x 1220mm with independent and motion plug assist.

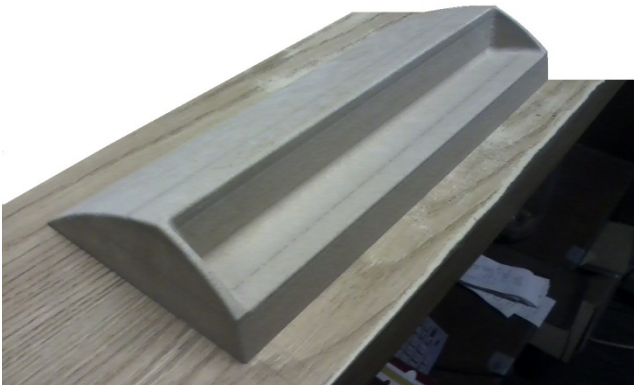


*Figure 1<sup>(1)</sup>: 890 x 1220mm MAAC thermoformer used for all testing.*

#### Tooling

Figure 2 shows the MDF board mold that was CNC machined by Bassler WPW. This type of mold is what some companies use for smaller production and prototyping runs.

Figure 3 shows the HYTAC-C Mold fresh out of casting. The mold still needed to be sanded for proper smoothness for forming, but came out perfectly. One thing



**Figure 2: MDF Mold.**

that you need to know about the casting of HYTAC-C molds is that you need to allow for up to 5% shrinkage during casting.



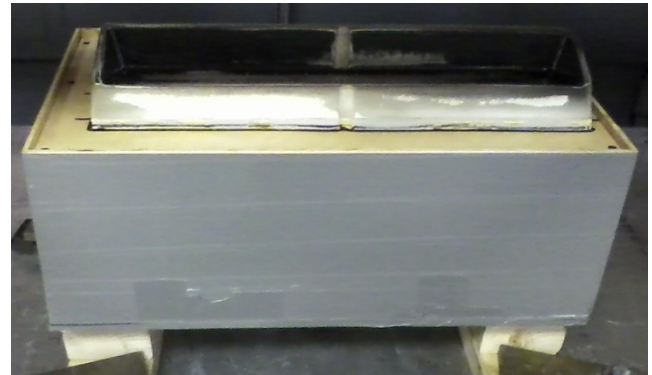
**Figure 3: HYTAC-C Mold.**

Figure 4 shows the vacuum box that was fabricated for the molds. The mold mounting piece is interchangeable between the molds so that the only variable that is changed throughout the experiment is the mold itself.



**Figure 4: Vacuum box ready for mold mounting.**

Figure 5 shows the vacuum box with the MDF mold mounted on the bottom platen of the MAAC thermoformer. This shows the MDF mold after it was completely sanded smooth and high heat paint was applied in attempt to make a better challenge for the HYTAC-C mold.



**Figure 5: Mounted MDF mold.**

## Materials

Royalite® R12 is a heat-resistant, rigid ABS thermoplastic sheet. It has high tensile strength, high impact strength and stiffness, good ductility, excellent formability and good low temperature performance. Figure 6 shows the summary of properties.

PHYSICAL PROPERTIES (units)	AVERAGE VALUES	TEST METHODS
Specific Gravity	1.02-1.08 *	ASTM D-792
Tensile Strength, machine direction	(psi) 5400	ASTM D-638
Impact Strength @ 72°F	(ft-lb/in notch) 4.5	ASTM D-256
Notched Izod @ -20°F	(ft-lb/in notch) 1.8	
Flexural Strength	(psi) 8900	ASTM D-790
Flexural Modulus	(10 <sup>6</sup> psi) 2.8	ASTM D-790
Hardness	Rockwell Scale R 96	ASTM D-785
Heat Deflection @ 264 psi Temperature (annealed)	(°F) 220	ASTM D-648
Thermal Conductivity	(BTU/in/hr/ft <sup>2</sup> /°F) 1.7-2.1	ASTM C-177
Coefficient of Thermal Expansion	(in/in/°F/x10 <sup>-6</sup> ) 4.2-5.6	ASTM D-696
Thermoforming Temperature Range	Low (°F) 340 High (°F) 400	Machine
Mold Shrinkage	(in/in) 0.005-0.007	
Flammability Rating**: Motor Vehicle Standard	Passes	FMVSS 302

**Figure 6<sup>(2)</sup>: Summary of properties of Royalite R12 Sheet.**

## Thermoforming Conditions

Figures 7, 8 and 9 show the process conditions on the MAAC thermoformer. Figure 7 shows the encoder values for the bottom platen retract and advance stages. The encoder values are essentially platen communications depending on the vacuum box and

*(continued on next page)*



mold height. Figure 8 shows oven values and how they are entered into the machine. The oven values are percentages to which the individual heating elements will heat. The final heat setting was 650F after all of the heat elements were at full heat. Figure 9 shows the forming and heating timers that were used for the experiment. While there was a set timer for the heat, the infrared eye was set to the exact temperature I wanted for the sheet.

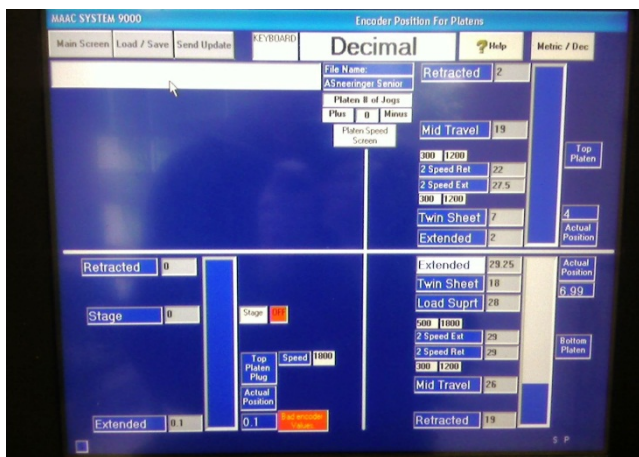


Figure 7: Encoders values.



Figure 8: Oven heater settings.

### Individual Performance Objectives

While planning and executing this experiment, several objectives regarding personal performance were to be achieved. These objectives were to:

- Design a part and a mold for experimental procedure.
- Outsource mold making CNCing for MDF mold.

Timer Description	Value in Seconds	Timer Description	Value in Seconds	Timer Description	Value in Seconds
1. Heating	150	15. CP #1 ON	0	29. Top Plug ON	0
2. Platen Delay	0	16. CP #1 OFF	3	30. Top Plug OFF	0
3. Platen Return	40	17. CP #2 ON	0	31. CP #6 ON	0
4. Eject	0.5	18. CP #2 OFF	0	32. CP #6 OFF	0
5. Forming	90	19. CP #3 ON	0	33. Jog On Delay	0
6. Safe/Sag	5	20. CP #3 OFF	0	34. Jog Off Delay	0
7. Cool Down	300	21. CP #4 ON	0	35.	0
8. Heating Twin	30	22. CP #4 OFF	0	36.	0
9. Heating Twin	30	23.	0	37.	0
10. Hold Timer	0	24. Oven 100% On	0	38.	0
11. Hold Timer	0	25. Hold Timer	1	39.	0
12. Hold Timer	0	26. Hold Timer	3	40.	0
13. Fan Delay On	5	27. PU Fan Delay	0	41.	0
14. Vacuum Delay	0	28.	0	42.	0

Figure 9: Timer settings.

- Outsource mold making material for a HYTAC-C mold.
- Run process parameters and create molding experiment.
- Run production on MAAC thermoformer.
- Run all experiments and collect all data.

All of the objectives stated above were achieved and will be described in this paper. The objective of producing a functioning and comparable mold for thermoforming was a task that used all of the knowledge that I had gained over the course of my education at PA College of Technology.

### Process

MDF board is a great starter mold for making small production runs (10-25 pieces) but the HYTAC-C material will be a great alternative that will hold up longer while being slightly less expensive to fabricate. The first step was to research and design the exact part for the car that would eventually become the final prototype. In the next step, the fabrication of a type 304 stainless steel prototype was tested and working in a vehicle for months. This next step was a very important part of this whole process. It began with research to find the right mold making material for the design. There were many options for materials including wood, aluminum, steel and epoxy resin. Wood is the least expensive option, however it has a tendency to break down after high heat and pressure runs. Metal is the best option for a thermoforming mold, however it can be very expensive for both labor and material. Cooling systems are also needed when running a metal mold so that consistent



temperatures are held throughout production runs. In turn, the choice of an epoxy resin was made because the material can withstand high heats and continuous runs. It is also a relatively inexpensive material to purchase, and is normally used for plug assist thermoforming. The chosen material was supplied by CMT Materials, who donated the supplies for mold making. This material is one part syntactic epoxy called HYTAC-C.

After the tooling materials were chosen, the material selection process began. In this step, I made an educated guess about three different thermoplastic sheets to use for the splitter. This educated guess came from the help and knowledge of Roger Kipp of McClarin Plastics. The three choices were ABS-PC, ABS and TPO, since most car manufacturers will use these materials under the hood. The material chosen ended up being an inexpensive and easily formable ABS plastic, 3.175mm in thickness. Spartech Corporation supplied the material. Next came the mold making process. This step is where the 304 stainless steel prototype mold was used to make a negative mold so that a fiberglass part could be laid out. This fiberglass part was used to aid in the process. With this fiberglass part, I was able to have a perfect representation of the size of mold I needed for the part. From here, I was able to design a mold to take to a company who was able to create the comparison tooling MDF mold. This company was Bassler WPW and they were able to take my design and make a CNC machined replica out of the MDF material that I was eventually going to compare to the HYTAC-C tooling. This mold was quoted at \$750 including the MDF board, the process to glue, the setup of the CNC map and the CNC machine time. This is what would be charged to industry just to have a wooden MDF mold made for a simple prototype. The process to make the HYTAC-C mold was a learning experience for me because of the specific geometry of my mold. Using the fiberglass female mold I had created with a little mold release, I was able to pour the thawed HYTAC-C gallon in and send it into an oven for the reaction to occur. The oven process parameters were as follows for the HYTAC-C:

<u>Oven Temperature</u>	<u>Minimum Cure Time</u>
90 Degrees C. (160°F)	18-24 Hours
110 Degrees C. (200°F)	8-10 Hours
140 Degrees C. (250°F)	4- 8 Hours <sup>(3)</sup>

The option I chose was 90 degrees C (160°F) for 18-24 hours. This option was the right decision for my mold because slower cure times were the best option.

The mold then had to be de-molded and post-cured to 135 degrees C (275F) for a minimum of 6 hours. This HYTAC-C material is unique to CMT Materials for plug assist thermoforming only and costs \$60/gallon of the material. This proved to be a perfect savings opportunity for any company looking for a better option when prototyping or even building production-run mold tooling.

In the next step for the process I took both the MDF and the HYTAC-C molds and sanded them for a smooth finish. Once these molds were completed, I was able to make a mold base for the MDF tooling and HYTAC-C tooling. This consisted of making a mold base completely air tight with a vacuum hole for the thermoformer. The instruction and help making this box came from school's own Chris Gagliano of the Thermoforming Center of Excellence. With his designs and industry experience, he was able to aid me in the process of proper vacuum box making technique and function. Next was the installation of the mold and the start of part processing. This stage is where the process parameters needed to make good parts for the different molds and materials were investigated. In finding the correct start points in forming ABS plastic, the knowledge gained working for the Plastics Innovation & Resource Center very much helped in knowing where to start and what process parameters were to be used throughout the experiment. Typically, ABS sheet is thermoformed at a temperature between 171 degrees C (340°F) and 188 degrees C (370°F). I chose 5 different infrared oven temperatures for processing after a few test runs on the MDF tooling. The temperatures I decided upon were 350, 355, 360, 365 and 370 degrees F.

The last step in the process was to measure mold temperature and shrinkage see which material was better suited for the process. During this step, mold and final part measurements were collected to compare the different molding materials. Also, during this step, I performed in-car testing to make sure the part fit and functioned properly. This entailed proper fit and function while driving the car. The total for the whole project was estimated to be \$7,500. This cost includes molding materials, tooling, labor, education, and industry consulting.

*(continued on next page)*

## Difficulties

While setting up processing conditions and running testing to make sure everything was going to work, the MDF mold apparently did not have enough of a draft on the tip right edge. Figure 10 shows just how fragile this MDF material is.

During the demolding of the first HYTAC-C casted mold, it was found that the wrong mold release was used. Figure 11 shows that the HYTAC-C ended up bonding to the mold material. The problem was that the wrong mold release was used in this process, so a call to John Shpack made for a quick solution in finding the right mold release. John had also offered to cast a mold for me at CMT and also to coat the mold with the right mold release so that I could experience a proper HYTAC-C casting for myself. After I received the mold, I re-casted the HYTAC-C and had perfect results.



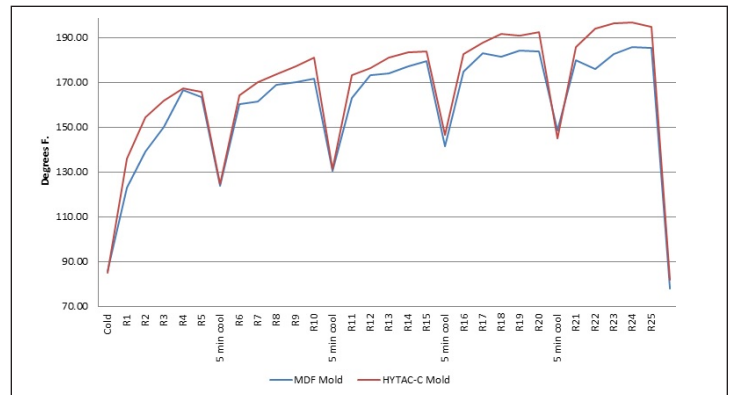
**Figure 10: Broken MDF mold.**



**Figure 11: Failed de-molded HYTAC-C casting.**

## Results and Discussion

During processing, the following temperatures were recorded and compared in figure 12. This graph shows the comparison between molding temperatures and heat retention for both of the molds. As shown, the MDF and HYTAC-C molds were very comparable with retaining heat and keeping the heat in. However, average temperatures in the HYTAC-C mold were 8 degrees F. higher. While this is not a drastic problem, the real question was whether it hold dimensions and/ or break down?



**Figure 12: Mold temperature comparison throughout processing.**

Figure 13 shows the notes/results that were taken during the experiment of the MDF mold. These notes essentially describe how the molding process went and what happened during every 5 runs.

Last test run (run 5): Changed lower platen raise from 28 to 28.25 due to the amount of time it took for the plastic to form correctly. This may have been one of the reasons that 350 degrees F. could not form good parts.

335 degrees F. (runs 6-10): Noticing small particles of the MDF starting to come off (on top edge and middle edge) as if the epoxy that holds it together is failing. However, no dimension changes are present currently.

330 degrees F. (runs 11-15): I can see why this MDF mold would not be good for high volume. Every part I take off has just a small amount of MDF fibers on the sloped side and the edges. I may be running 25 parts on it, but I don't expect it to last more than 100-200 without crumbling or making the surface finish terrible.

Parts 16-25 ended up being the same as the last 5 parts. They had MDF particles on them throughout the whole process.

END: The mold surprisingly held through every part when mold release was sprayed in between every cycle. Every part has a small amount of wood fibers on it from the MDF, however, and will not be used for further testing. This is because the epoxy that holds the wood fibers together

cannot withstand the high temperatures for long periods of time. The MDF Mold exceeded my expectations for the 25 part run. We will compare results on a perfection level with the HYTAC-C. Mold dimensions still did not change throughout the processing; therefore, they were not recorded into this report.

**Figure 13: MDF mold production results.**

Figure 14 shows the notes/results that were taken during the experiment of the HYTAC-C mold. These notes essentially describe how the molding process went and what happened during every 5 runs.

350 degrees F. and 355 degrees F. (runs 1-10): Makes a good overall part, however does not pull 100% tight in the corners. Mold release was only needed to be applied once every 5 parts. The mold seems to be holding up very well and not leaving any signs of decay.

360 degrees F. (runs 11-15): These have slightly more definition in the parts as compared to the 350 and 355's. Mold release on every 5 parts seems to be working just fine. Mold is still perfectly intact and still does not show any types of decay.

365 degrees F. (runs 16-20): I took measurements at this point because I just wanted to make sure everything was good while the material was in the oven. The mold still has yet to lose any dimensions and is still releasing perfectly with no signs of decay.

370 degrees F. (runs 21-25): 370 degrees F. is too hot for this material ... I'm getting definition from the draw holes! I am now trying to ruin the mold by keeping going at this temperature. Still no signs of decay.

370 degrees F. (runs 21-25): I have not run ANY mold release since part 16. The parts are still demolding perfectly without any signs of decay still.

End: Using HYTAC-C as a mold material is outstanding. There was no problem demolding even at 370 degrees F. with no mold release through 10 parts. Every part was formed flawlessly with no types of residue left from the mold. The mold did not lose any dimensions nor does it display any type of failing surface.

**Figure 14: HYTAC-C mold production results.**

After conducting the experiment for each of the molds, the molds were both left to completely cool. Taking the ideal part processing temperature (360F) for both molds, I attempted to create 25 more parts on the HYTAC-C mold (continuously). I did not make any more production parts with the MDF mold because of its degraded condition.

The HYTAC-C mold was run for 25 additional cycles to see if it would hold up. The mold was not given any sort of mold release due to the confidence level I had felt while running it earlier. From parts 1-25, the mold help up 100% perfectly with no decay, no particles left on processed parts. Even after running 25 extra parts on it, I decided to keep running it until all of the plastic I had was gone. Essentially, this mold ran for 78 parts and did not have any signs of breaking apart.

### Conclusions

This paper provides a working experiment of how a material meant for plug assist thermoforming can be used to replace more expensive materials for small production runs. This paper also provides proof that MDF molds are not suitable for running a unique dimensioned mold with the mold simple of materials for thermoforming.

- MDF board is not a suitable mold material for small production runs by any means and typically will leave molded parts with wooden fibers all over them
- HYTAC-C is inexpensive and can be used for molding production parts for medium and maybe even higher volume (still to be tested) runs.
- The casting process for HYTAC-C is much easier and less time-consuming than the MDF board when the right casting supplies are present.

### Acknowledgments

I would like to thank the following people and companies for their generous donations and/ or help with contacts, consulting and general knowledge throughout this experiment:

- John Shpack and Kathleen Bovin: these kind people at CMT Materials helped me with generous donations of materials such as the HYTAC-C for this experiment and also donated other supplies to aid in trimming, mounting and even casting throughout the experiment.
- Roger Kipp and Todd Christmer: these gentlemen from McClarin Plastics generously allowed a tour of the Hanover facility while aiding in processing conditions for setup, consulting, finding contacts for materials and the general knowledge of certain thermoforming techniques.

*(continued on next page)*



- Christopher Gagliano of the Plastics Innovation Resource Center helped me tremendously with developing a proper vacuum box, thermoforming guru information and technique, setup of some major processing parameters that would have been overlooked throughout this experiment and some major hands-on help throughout the process.
- Robert Wilson from Spartech Plastics Inc. was kind enough to set up the donation of plastic ABS sheet for this experiment.
- Lou Bassler and Aaron Bassler: these gentlemen at Bassler WPW were kind enough to go through the proposed mold design and point out some flaws and possible difficulties I may have had for thermoforming the MDF mold. They were kind enough to heavily discount the work and CNC machining of the MDF mold while doing so very promptly.
- Michael Cardwell at Southbend Decorative Plastics was kind enough to provide the help of some extra donated ABS plastic sheet to aid in the setup process before production runs were done.
- Other thanks: Dr. Kirk Cantor, Gary McQuay

### References

1. <http://maacmachinery.com/products/detail/clampframes>. Copyright © 2011 MAAC Machinery Corporation.
2. Corporation, ©1999 Spartech (). *Royalite R12 Rigid sheet ABS*. Retrieved 14 April 2012 from Spartech Corporation: <http://www.spartech.com/plastics/R12-4-low.pdf>.
3. CMT Materials © 2006-2011 All Rights Reserved - CMT Materials, Inc. (). *HYTAC-C*. Retrieved 14 April 2012 from CMT Materials, INC. <http://www.cmtmaterials.com/HYTAC-C.html>.

## Are You



[http://www.linkedin.com/groups?gid=3992496&trk=myg\\_ugrp\\_ovr](http://www.linkedin.com/groups?gid=3992496&trk=myg_ugrp_ovr)

Group Name:  
Thermoforming Division, a subgroup of SPE

Moderator:  
Mark Strachan

Trending Topics  
(as of May 30th, 2012)

1. *Collapse screening on deep-draw parts*
2. *Discussion of T-SIM modeling software*

With over 380 members and growing, the Thermoforming Division is using LinkedIn to expand the conversation. Meet fellow professionals, ask tough technical questions, explore related groups.

## Join us today!



# GN

Thermoforming Equipment

www.GNcanada.com



**new**

**GN 760 Plug-Assist** (30" x 21" forming area)

GN Thermoforming Equipment • Canada 902 275-3571

## WHAT DOES TPO NEED?



-  **UNIFORMITY**
-  **CONTROL**
-  **REPEATABILITY**

Retrofit Today with Solar Products  
**ELECTRIC INFRARED** heaters.

Custom heater technology – from America's  
largest supplier of infrared heaters.



**Call 1-800-616-2601**

For complete information visit our website at [www.solarproducts.com](http://www.solarproducts.com)

THERMOFORMING · FIBERGLASS MOLDING

**Mc McClarin**  
Plastics, Inc.  
SOLUTIONS IN PLASTICS

Helping companies worldwide find  
creative solutions using plastics  
and composites since 1953.

(800) 233-3189 [www.mcclarinplastics.com](http://www.mcclarinplastics.com)  
email: [mcclarin@mcclarinplastics.com](mailto:mcclarin@mcclarinplastics.com)

**PCM**

[www.pcmwi.com](http://www.pcmwi.com)

Quality Thermoform Molds  
Since 1972

Portage Casting & Mold, Inc.  
2901 Portage Road, Portage, WI 53901  
1-800-356-5337 – Fax 1-608-742-2199

## PROSPECTIVE AUTHORS

Thermoforming  
Quarterly® is an  
“equal opportunity”  
publisher!

You will notice that  
we have several  
departments and  
feature articles. If you  
have a technical article  
or other articles you  
would like to submit,

please send to  
Conor Carlin, Editor.  
Please send in  
.doc format.

All graphs and photos  
should be of sufficient  
size and contrast to  
provide a sharp printed  
image.

# COUNCIL SUMMARY



**Roger Kipp**  
Councilor

I am pleased to provide the following report regarding activity at SPE. Due to another commitment, I was unable to attend the council meeting in Barcelona. I want to thank **Paul Alongi** personally and on behalf of the board for representing the Thermoforming Division as proxy. These notes are a summary from that meeting as well as the spring meeting at ANTEC.

The search for the new Executive Director has been completed with the selection of **Willhem (Wim) DeVos**. Mr DeVos is a resident of Belgium and the former CEO of Vitalo Group, a global supplier of packaging and thermoformed sheet components. He has recently served as chair-elect of the European Thermoforming Division and was the keynote speaker at the 2010 Thermoforming Conference in Milwaukee. His 20+ years in the plastics industry, experience and activity within SPE, and global networking background, coupled with his extensive

business experience will provide valuable leadership as SPE furthers our focus on growth and extended business activities into emerging global markets.

As a member of the Finance Committee, I voted in favor of distributing the “SPE Investment Account” funds back to the management of the Divisions and Sections. This fund was originally established to provide groups with limited resources a place to invest their surplus funds and take advantage of being lumped together for investment management by a professional financial management firm. SPE provided a fixed rate in order to allow those groups the opportunity to plan. Over the years SPE absorbed some losses and realized some gains. When the Finance Committee reviewed the history over a 10-year period, we saw that those losses and gains were almost even. With that in mind and the in belief that SPE did not need to be in the finance business, the time was right for change.

The financial condition of SPE remains sound. In 2011, revenues were up 10.5% and net income was up nearly 25% over 2010. These results are based on an increase in membership of 3%, member retention of 81%, event income of 44%, and slight increases in Publications and the Foundation. The 2012 numbers through February 2012 are on budget and project a positive income in non-restricted funds.

The only revenue line item to underperform compared to 2010 was the SPE Store. The store includes the sale of books, webinars and other learning materials. This is an area where, as members, we should take advantage of all the Society has to offer. I have found the webinars to be great value and they offer tangible benefits to our engineering group.

The results of this strong financial performance are a strong balance sheet and an overall financial condition of good health. That said, I will



note that SPE continues to operate with a line of credit. The line was paid down to zero in September 2011 but at the end of the year the Finance Committee approved drawing on the line to cover expenses through the traditionally slow revenue-generating winter months. I mention this to offset any concerns that may be generated through rumor.

A portion of the negative cash flow was created by the upfront costs related to ANTEC with income delayed through NPE processing. The early estimates suggest that ANTEC 2012 at NPE Orlando was extremely successful, so the line will be paid down as those revenues are received.

Speaking of ANTEC, the Thermoforming Division presented five papers this year. The topics covered materials and processing technology that will be of interest to both roll fed and sheet fed processing. I was pleased to serve as moderator and want to thank **Brian Winton** from Lyle Industries for coordinating the authors and presentations. At the ANTEC awards presentation, the Thermoforming Division received the Gold Pinnacle Award for outstanding division performance and the

Communications Excellence Award for providing unique and varied communications to members, academia, and industry. Congratulations to the Thermoforming Division Board and their industry sponsors for providing the dedication and support necessary to complete the projects and programs leading to these prestigious awards.

In November 2012, SPE held the first EUROTEC. The event staged in Barcelona had 333 attendees and netted 91 new members with a \$65,000.00 positive contribution to net income.

The months following EUROTEC and the council meeting in Barcelona were difficult for SPE regarding staff resources. Until the hiring of Wim DeVos in mid-January, the Society functioned without a director. As we are all aware, **Susan Oderwald** was a dedicated and hands-on executive. In addition, **Leslie Kyle** announced her resignation for personal reasons immediately after Barcelona. During this 6-week period, **Gail Bristol** provided the seasoned leadership and the entire staff stepped up to cover all issues with a high priority focus. There may have been some slipping back

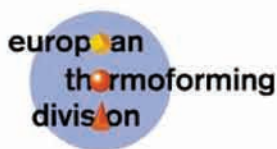
on committee and group support; however, I see those issues being resolved after the upcoming council meetings and will keep you advised. In the meantime, **Sarah Sullinger** remains an excellent resource for help.

Please mark the dates and be sure to attend this year's Thermoforming Conference in Grand Rapids, Michigan September 23 – 25, 2012. I look forward to seeing you there. |

Roger Kipp  
Division Councilor



# 8th European Thermoforming Conference



Society of Plastics Engineers  
European Thermoforming Division  
Eric Sasselaan 51 ~ B - 2020 Antwerp ~ Belgium  
Tel. +32 3 541 77 55 ~ Fax +32 3 541 84 25  
E-mail: [spe.etd@skynet.be](mailto:spe.etd@skynet.be)  
[www.e-t-d.org](http://www.e-t-d.org)

## Press Release

May 2012

### 8th European Thermoforming Conference in Venice (Italy), April 26<sup>th</sup> - 27<sup>th</sup> 2012

#### “Overall, an excellent conference”

***The European Thermoforming industry's main event of the year, the 8th European Thermoforming Conference, was recently held in Venice and the two days of expert presentations and workshops managed to attract many of the industry's experts to attend***

The biennial conferences are proving to be the most important platform for leading business decision makers, suppliers and technologists to meet, network and to discuss the latest developments within the thermoforming industry. It is agreed that they are fast becoming the major international forums for technological advancement within our sector.

The unique and beautiful City of Venice provided an outstanding venue for the event, which attracted nearly 200 attendees.

A combination of excellent technical presentations, discussion workshops and an exhibition of associated technologies which ran in parallel, all contributed to ensure the event was relevant and informative to the international participants.

This year's subjects presented by industry experts were again comprehensive and all-encompassing, covering advancements in terms of the materials and processes technology.

The discussion workshops focussed on the subjects of “Transformation within Plastics Packaging”, “Handle the Output of Thin Wall Production” and “Mechanical Fixation / New Bonding Techniques in Thick Gauge Applications”.

The Thermoforming **Parts Competition** attracted a diverse range of entries which offered the visitors a unique insight of how innovative product design combined with modern materials and processes can produce inspirational structural, cosmetic and highly functional parts. There were several examples of how thermoformed parts can support demands in completely new market sectors.

# ference Parts Competition Winners

The winners of this year's **Parts Competition** were:

## Heavy Gauge Automotive

Winner: Company Walter Pack (Spain).

Part: Window for Renault Twizy.

Jury's motivation: "Winner due to processing highly complex polycarbonate sheet material free from moisture and dust contamination on an industrial scale which requires high level of processing control, careful logistic management and well designed tooling. A light weight innovative product in a demanding environment"



## Heavy Gauge Non-Automotive

Winner: Company Solera Thermoform Group (Italy).

Part: Long Chair Avus.

Jury's motivation: "Winner due to originality of design, clever use of cosmetic materials, and an excellent example of a high performing light weight structure produced using the twin sheet processing technology"



## Thin Gauge

Winner: Company Generation Tech (France).

Part: Paint Tray multi-layer.

Jury's motivation: "Winner due to thermoforming 5 layers simultaneously, also using recycled material; the product is not only environmentally friendly, but also potentially opens up new application areas for the thermoforming industry."

The Thermoforming Parts Competition Award goes to outstanding and innovative designs or processes in the field of thermoformed components.



**The next European Thermoforming Conference is scheduled to take place in April 2014.**

For more information, please contact Yetty Pauwels  
E-mail: [spe.etd@skynet.be](mailto:spe.etd@skynet.be)  
[www.e-t-d.org](http://www.e-t-d.org)



By Ken Braney, SPE Past President

Since ANTEC 2012, which was held in conjunction with NPE in Orlando, FL, I seem to have been busier than when I was on the SPE Executive Committee. I have done a great deal of traveling as of late and I'd like to share my thoughts on some recent global SPE events.

The 2012 SPE European Thermoforming Conference was held in Mestre, a suburb of Venice. Anyone who has either seen photos or visited the magical city of Venice will know that the decision to hold a conference here would ensure a large amount of support from fellow SPE members, as well as newcomers from all over the world.

Over 170 attendees packed the conference on April 27-28. Initial estimates suggest that between 40-50 people were new members. The SPE European Thermoforming Division uses a delegate fee system whereby those who sign up to attend the conference become members automatically for two years.

Reinhold Plot, Outgoing Chair, opened the Conference. Incoming Chair, Daniele Versolato, who was also the Conference Chair, made some introductory remarks. Jim Griffing, SPE President 2012-2013, made a short speech about how SPE is changing and growing in this difficult marketplace. He emphasized how there are many opportunities for members to learn from the vast amounts of knowledge stored in our libraries of past technical conferences. He also stressed that gatherings such as the SPE European Thermoforming Conference provide excellent networking opportunities, where attendees can share knowledge with a variety of people during sessions and in hallway conversations. This is the type of knowledge that cannot be found on the internet. This sentiment was clearly borne out as there were visitors from many different countries beyond the borders of Europe, eager to learn about the many aspects of thermoforming. India, Saudi Arabia, USA and Australia were all represented in Mestre.

The next speaker was Wim DeVos, SPE's new CEO. Wim had a very nasty accident the weekend before the conference when he fell from his racing bike and broke his collarbone. We were not sure if he was going to make it to the Conference, but fortunately for us he was able to speak, though he did not stay for the whole event. As a seasoned, global CEO at Vitalo, Wim has a great deal of experience in working with the wide cultural differences in plants around the world. His presentation focused on what to expect when you set up a subsidiary plant in an emerging market, including challenges with hiring and retaining the best employees. He gave an example of a typical situation in China. When New Year comes, all of the workers go home to their native village or town. There could be 3 or 4 or even 5 days travel away from the plant. At the end of the holiday period, up to 40% of the workers never return so the management of the plant should always have new staff trained to take those newly-vacated positions.

We then had a presentation from the Director General of the British Plastics Federation who discussed the future markets for plastics.

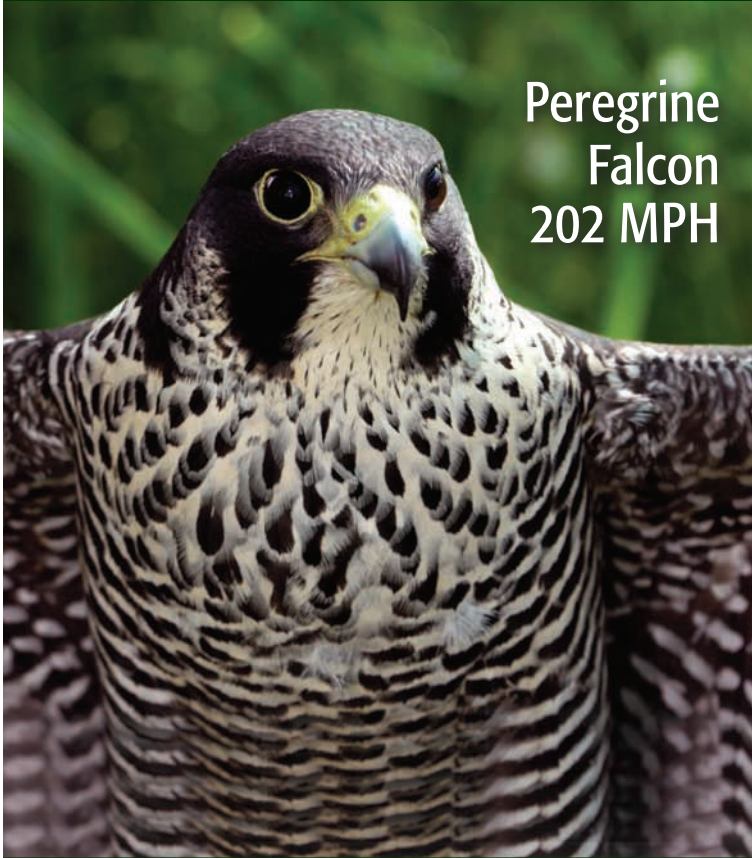
In the afternoon of the first day there were workshops on thick gauge thermoforming and sponsor presentations on developments in thin gauge forming. Friday's sessions included the parts competition. These were judged and various awards were made. The winning entries included a side door/window for a new car design, an armchair whose base had been made via twin sheet, while a third was a dentist's mouthwash stand, again made out of twin sheet plastic.

The Gala Dinner was a spectacular event. The Conference hotel was about 40 minutes by water taxi from the Grand Canal in Venice. SPE ETD organized two very large water buses holding up to 100 people each.

The Conference was a great success and everyone is looking forward to the next one in 2014 when it is expected to be in Prague. |

Ken Braney  
[kbraney@4spe.org](mailto:kbraney@4spe.org)

# Meet the Two Fastest in the World.



Peregrine  
Falcon  
202 MPH

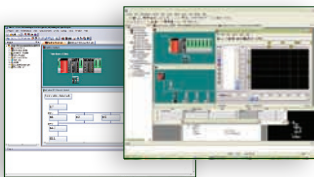
MR-J3 Servo  
2100 Hz  
Speed  
Frequency  
Response  
Time



**Empowering  
Industries**

**Maximize** your **solution** with  
our **Servos** and **Motion Controls**.

MT Works2 Motion Software



Single-Axis  
Stand-Alone



Motors up to  
6000 RPM

Multi-Axis for iQ Series

Blazing fast response time means one thing: maximum throughput. This is paramount to achieving the lowest total of cost ownership (TCO) with your investment. But there's much more. An auto-tuning function saving hours of set-up and tuning time. A patented design for the most compact and efficient motors in the industry. Bus speeds of 50 Mbps when you combine our servos and motion products. And the widest range of motors available from 50 watt up to 220 kW. All this adds up to why Mitsubishi is ranked #1 in the servo and motion business worldwide. Get with the best to be the best and watch your competitors take a swan dive.

 **MITSUBISHI  
ELECTRIC**  
www.meau.com



## Society of Plastics Engineers, Inc.

Promoting the Scientific and Engineering Knowledge of Plastics

SPE Plastics Environmental Division

[www.sperecycling.org](http://www.sperecycling.org)



# GPEC® 2013 Call for Papers

The Society of Plastics Engineers' (SPE) Plastics Environmental Division (PED) produces the premiere environmental conference each year at the Global Plastics Environmental Conference (GPEC®). The theme of GPEC® 2013 is **"The Latest Need to Know: From Recycling to Sustainability of Plastics"** with focus on the unique blend of recycling, reclamation and bioplastics. We are soliciting papers for the GPEC® 2013 which will be held on 20-22 March, 2013 at The Sheraton New Orleans in downtown New Orleans, LA.

You can be part of GPEC® 2013's success by sharing your company's recent advances.

Do you have new, exciting, innovative technology or research that you would like to showcase?

The PED is looking for high quality, technical, business and marketing papers for presentation at the upcoming GPEC.

## Technical Program

21,22 March, 2013

The Technical Program for GPEC® 2013 is looking for papers on topics including:

- Recycling Industry
- Recycling Markets
  - Packaging
  - Automotive
  - Electronics
  - Carpet
- Reclamation and Supply
- Bioplastic Industry
- Bio-based Plastics
- Biodegradable Plastics
- LCA and Carbon Footprint
- Latest Processing Technologies
- Regulatory Ribbon

Please submit your abstracts by e-mail to me at [merrington@mmi.org](mailto:merrington@mmi.org)

<i>Abstracts</i>	are due by December 15, 2012 notification of acceptance will be sent out by January 3, 2013
<i>Final papers</i>	are due by February 18, 2013 (early submissions gladly accepted!)
<i>Final presentations</i>	are due no later than March 4, 2013

Adrian Merrington, Ph.D.  
GPEC® 2013 Technical Chair  
Phone: 989-832-5555 ext. 638  
Email: [merrington@mmi.org](mailto:merrington@mmi.org)



# 2012 EDITORIAL CALENDAR

Quarterly Deadlines for  
Copy and Sponsorships

**ALL FINAL COPY FOR  
EDITORIAL APPROVAL**

15-FEB Spring      30-APR Summer

31-JUL Fall      15-NOV Winter  
Conference Edition      Post-Conference Edition

All artwork to be sent in .eps  
or .jpg format with minimum  
300dpi resolution.



**Become a  
Thermoforming  
Quarterly Sponsor  
in 2012!**

Additional sponsorship  
opportunities will include  
4-color, full page, and  
1/2 page.

**RESERVE YOUR PRIME  
SPONSORSHIP  
SPACE TODAY.**

Questions? Call or email  
**Laura Pichon**  
Ex-Tech Plastics  
847-829-8124  
lpichon@extechplastics.com

**BOOK SPACE  
IN 2012!**

## REDUCE! REUSE! RECYCLE!



## REDUCE! REUSE! RECYCLE!

**Fast  
Flexible  
Reliable**



- Over 50% of the top 25 North American heavy gage thermoformers use KMT Robotic Solutions trimming systems
- Up to 50% higher throughput and more flexibility than a 5 axis CNC
- Automatic fixture locating and spindle alignment
- Improved personnel safety and product quality
- High flexibility allows a variety of part sizes

1.248.829.2800  
solutions.na@kmtrobotic.com  
www.kmtrobotic.com

**KMT ROBOTIC SOLUTIONS**

*Creating value through automation.*

**MAAC**  
THERMOFORMING MACHINERY

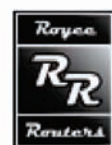
**Leader in Twin-Sheet  
Pressure Forming Technology!**

- Single Stations
- Double Enders
- Three-Station Rotaries
- Four-Station Rotaries
- Multi-Station Shuttles
- Oven-Over
- Custom Machines



**NOW OFFERING:**

- 5-Axis CNC Routers
- Thermoforming Molds
- Part Prototyping
- Machine Replacement & Trade-in Programs



WWW.MAACMACHINERY.COM

590 Tower Blvd, Carol Stream, IL 60188, Tel: (630) 665-1700

# Executive Committee

## 2012 - 2014

### CHAIR

Phil Barhouse  
Spartech Packaging Technologies  
100 Creative Way, PO Box 128  
Ripon, WI 54971  
(920) 748-1119  
Fax (920) 748-9466  
phil.barhouse@spartech.com

### CHAIR ELECT

Mark Strachan  
Global Thermoforming Technologies  
1550 SW 24th Avenue  
Ft. Lauderdale, FL 33312  
(754) 224-7513  
mark@global-tti.com

### TREASURER

James Alongi  
MAAC Machinery  
590 Tower Blvd.  
Carol Stream, IL 60188  
(630) 665-1700  
Fax (630) 665-7799  
jalongi@maacmachinery.com

### SECRETARY

Bret Joslyn  
Joslyn Manufacturing  
9400 Valley View Road  
Macedonia, OH 44056  
(330) 467-8111  
Fax (330) 467-6574  
bret@joslyn-mfg.com

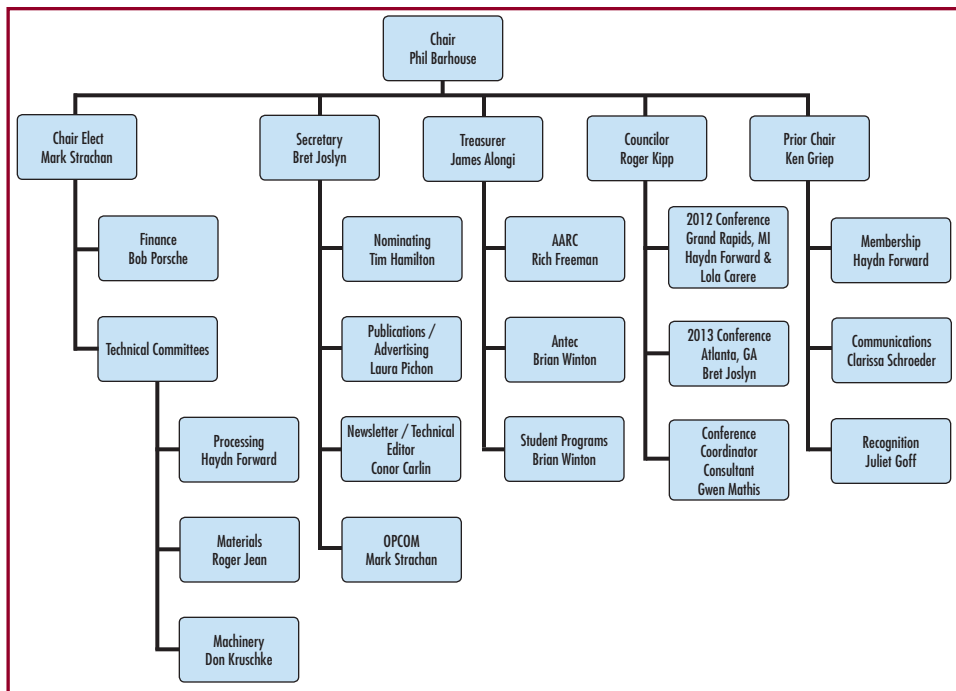
### COUNCILOR WITH TERM ENDING 2015

Roger Kipp  
McClarin Plastics  
P. O. Box 486, 15 Industrial Drive  
Hanover, PA 17331  
(717) 637-2241 x4003  
Fax (717) 637-4811  
rkipp@mcclarinplastics.com

### PRIOR CHAIR

Ken Griep  
Portage Casting & Mold  
2901 Portage Road  
Portage, WI 53901  
(608) 742-7137  
Fax (608) 742-2199  
ken@pcmwi.com

## 2012 - 2014 THERMOFORMING DIVISION ORGANIZATIONAL CHART



**PLASTIC CONCEPTS & INNOVATIONS LLC**  
Guiding Innovations in the Development and Production of Thermoformed Products



**James M. (Jay) Waddell**

**Thermoforming & Extrusion Consulting**  
**Manufacturing Process Cost Reduction**  
**Product & Design Development**  
**Training & Seminars**

PH: 843.971.7833 • Fax: 843.216.6151

On the Web at [www.plasticconcepts.com](http://www.plasticconcepts.com)

1127 Queensborough Blvd • Ste 102 • Mt. Pleasant • SC • 29464



**PLASTICS MACHINERY GROUP**

THERMOFORMING | BLOWMOLDING | EXTRUSION | ROTATIONAL | AUXILIARY

~Machinery Sales ~ Appraisals ~ Liquidations ~  
Mergers & Acquisitions

*Striving to have the highest quality service and machinery*

31005 Bainbridge Rd. ~ Solon ~ Ohio ~ 44139

Phone: 440-498-4000 ~ Fax: 440-498-4001

[www.plasticsmg.com](http://www.plasticsmg.com)

**MACHINERY COMMITTEE**

James Alongi  
MAAC Machinery  
590 Tower Blvd.  
Carol Stream, IL 60188  
T: 630.665.1700  
F: 630.665.7799  
jalongi@maacmachinery.com

Roger Fox  
The Foxmor Group  
1119 Wheaton Oaks Court  
Wheaton, IL 60187  
T: 630.653.2200  
F: 630.653.1474  
rfox@foxmor.com

Don Kruschke (Chair)  
Plastics Machinery Group  
31005 Bainbridge Rd. #6  
Solon, OH 44739  
T: 440.498.4000  
F: 440.498.4001  
donk@plasticsmg.com

Mike Sirotnak  
Solar Products  
228 Wanaque Avenue  
Pompton Lakes, NJ 07442  
T: 973.248.9370  
F: 973.835.7856  
msirotnak@solarproducts.com

Brian Ray  
Ray Products  
1700 Chablis Drive  
Ontario, CA 91761  
T: 909.390.9906  
F: 909.390.9984  
brianr@rayplastics.com

Brian Winton  
Lyle Industries, Inc.  
4144 W. Lyle Road  
Beaverton, MI 48612  
T: 989-435-7714 x 32  
F: 989-435-7250  
bwinton@lyleindustries.com

**MATERIALS COMMITTEE**

Jim Armor  
Armor & Associates  
16181 Santa Barbara Lane  
Huntington Beach, CA 92649  
T: 714.846.7000  
F: 714.846.7001  
jimarmor@aol.com

Jim Arnet  
Kydex LLC  
3604 Welbourne Lane  
Flower Mount, TX 75022  
T: 972.724.2628  
arnetj@kydex.com

Phil Barhouse  
Spartech Packaging  
Technologies  
100 Creative Way  
PO Box 128  
Ripon, WI 54971  
T: 920.748.1119  
F: 920.748.9466  
phil.barhouse@spartech.com

Lola Carere  
C and K Plastics, Inc.  
512 Fox Creek Crossing  
Woodstock, GA 30188  
T: 732.841.0376  
lcarere@candkplastics.com

Juliet Goff  
Kal Plastics, Inc.  
2050 East 48th Street  
Vernon, CA 90058-2022  
T: 323.581.6194  
Juliet@kal-plastics.com

Tim Hamilton  
Spartech Corporation  
11650 Lakeside Crossing Court  
Maryland Heights, MO 63146  
T: 314.569.7407  
tim.hamilton@spartech.com

Donald Hylton  
McConnell Company  
646 Holyfield Highway  
Fairburn, GA 30213  
T: 678.772.5008  
don@thermoformingmc.com

Roger P. Jean (Chair)  
Rowmark/PMC  
PO Box 1605  
2040 Industrial Drive  
Findlay, OH 45840  
T: 567.208.9758  
rjean@rowmark.com

Laura Pichon  
Ex-Tech Plastics  
PO Box 576  
11413 Burlington Road  
Richmond, IL 60071  
T: 847.829.8124  
F: 815.678.4248  
lpichon@extechplastics.com

Robert G. Porsche  
General Plastics  
2609 West Mill Road  
Milwaukee, WI 53209  
T: 414-351-1000  
F: 414-351-1284  
bob@genplas.com

Clarissa Schroeder  
Auriga Polymers  
1551 Dewberry Road  
Spartanburg, SC 29307  
T: 864.579.5047  
F: 864.579.5288  
clarissa.schroeder@us.indorama.net

Eric Short  
Premier Material Concepts  
11165 Horton Road  
Holly, Michigan 48442  
T: 248.705.2830  
eshort@rowmark.com

**PROCESSING COMMITTEE**

Haydn Forward (Chair)  
Specialty Manufacturing Co.  
6790 Nancy Ridge Road  
San Diego, CA 92121  
T: 858.450.1591  
F: 858.450.0400  
hforward@smi-mfg.com

Ken Griep  
Portage Casting & Mold  
2901 Portage Road  
Portage, WI 53901  
T: 608.742.7137  
F: 608.742.2199  
ken@pcmwi.com

Steve Hasselbach  
CMI Plastics  
222 Pepsi Way  
Ayden, NC 28416  
T: 252.746.2171  
F: 252.746.2172  
steve@cmiplastics.com

Roger Kipp  
McClarin Plastics  
15 Industrial Drive  
PO Box 486  
Hanover, PA 17331  
T: 717.637.2241  
F: 717.637.2091  
rkipp@mcclarinplastics.com

Bret Joslyn  
Joslyn Manufacturing  
9400 Valley View Road  
Macedonia, OH 44056  
T: 330.467.8111  
F: 330.467.6574  
bret@joslyn-mfg.com

Stephen Murrill  
Profile Plastics  
65 S. Waukegan  
Lake Bluff, IL 60044  
T: 847.604.5100 x29  
F: 847.604.8030  
smurrill@thermoform.com

Mark Strachan  
Global Thermoforming  
Technologies  
1550 SW 24th Avenue  
Ft. Lauderdale, FL 33312  
T: 754.224.7513  
globalmarks@hotmail.com

Jay Waddell  
Plastics Concepts & Innovations  
1127 Queensborough Road  
Suite 102  
Mt. Pleasant, SC 29464  
T: 843.971.7833  
F: 843.216.6151  
jwaddell@plasticconcepts.com

***Director Emeritus***

Art Buckel  
McConnell Company  
3452 Bayonne Drive  
San Diego, CA 92109  
T: 858.273.9620  
artbuckel@thermoformingmc.com



## Sponsor Index

These sponsors enable us to publish Thermoforming Quarterly

- Allen .....21
- Brown Machine.....12
- CMT Materials .....5
- GN Plastics .....29
- Kiefel .....21
- KMT.....37
- Kydex .....Back Cover
- MAAC Machinery.....37
- McClarin Plastics.....29
- Mitsubishi Electric.....35
- Nova Chemicals.....3
- PCI .....38
- Plastics Machinery Group .....38
- PMC..... Inside Back Cover
- Portage Casting & Mold.....29
- Primex Plastics .....5
- Productive Plastics .....21
- Profile Plastics Corp. ....21
- PTi.....Inside Front Cover
- Ray Products.....21
- Solar Products.....29
- Spartech .....11
- Tempco .....40
- TPS .....11
- TSL.....20
- Weco Int'l. Inc. ....5
- Yushin .....19
- Zed Industries.....21

### TEMPCO Infrared Technology

#### Product Showcase



**GEMINI™**

Medium Wave, Twin Bore,  
Quartz Tube Heaters with Gold  
or White Ceramic Backing for  
Optimized Performance



**VIRTUAL SOLAR  
GLOW™**

Precise Wavelength  
Halogen Lamp Infrared  
Technology with High  
Efficiency Reflective Ceramic Housing



U.S. & Foreign Patents Pending

---

#### Ceramic E-Mitters® & Panel Housings



- Metamorphing Colors to Indicate Operation
- Solid or Insulated Hollow Heater Bodies
- Edison Screw-In Bulbs Available
- Custom Arrays with Power Control Panels will complete your Thermal Loop System



---

#### Infrared Quartz Heaters & Radiant Panels



- High Intensity Quartz Mini-Tube E-Mitters and Assemblies
- Radiant Panels available in Black Quartz, Black Glass and Translucent Quartz Glass





**TEMPCO Electric Heater Corporation**  
Contact factory for technical and engineering assistance.  
Request our 864 page Visionary Solutions Catalog  
for complete product details.  
Phone: 630-350-2252 • Toll Free: 888-639-7707  
Email: info@tempco.com • Web: www.tempco.com

© Copyright TEHC 2008. All Rights Reserved.

Committed to Excellence

## Thermoforming Division Membership Benefits

- Access to industry knowledge from one central location: [www.thermoformingdivision.com](http://www.thermoformingdivision.com).
- Subscription to Thermoforming Quarterly, voted "Publication of the Year" by SPE National.
- Exposure to new ideas and trends from across the globe
- New and innovative part design at the Parts Competition.
- Open dialogue with the entire industry at the annual conference.
- Discounts, discounts, discounts on books, seminars and conferences.
- For managers: workshops and presentations tailored specifically to the needs of your operators.
- For operators: workshops and presentations that will send you home with new tools to improve your performance, make your job easier and help the company's bottom line.

JOIN D25 TODAY!



Experience the synergies PMC and Southtech Decorative Laminations can bring to your business.

We offer a one-stop-shop approach for custom extruded sheet, roll stock, decorative and pigmented films and foils and an expertise in lamination. Our technical team and resources set us apart from our competitors with innovation, service and convenience.

Contact us today and let us help you with your next extrusion, film and lamination project.



Premier Material Concepts (PMC)  
2040 Industrial Drive, Findlay, OH 45840  
1-877.BUY.PMC6 (289.7626) or 419-429-0042  
sales@buypmc.com  
www.buypmc.com

Southtech Decorative Laminations  
182 Industrial Park, Trenton, NC 28585  
252-448-9900  
sales@southtechdl.com  
www.southtechdl.com

**PMC and Southtech Decorative Laminations are divisions of Rowmark LLC.**





# IMPOSSIBLE

Everyone says it

Then someone  
**DOES IT**

**KYDEX**  
THERMOPLASTIC SHEET

**We're turning impossible into  
endless possibilities.**

Our bold new colors and breakthrough materials will help you deliver on the toughest challenges. And wow your customers with the unexpected. It all starts with collaboration at our designLab. With a universe of customized solutions that only KYDEX can offer. Including yours.

**What can this do for your business?  
You'll be surprised.**

**Ask us for a preview today.**