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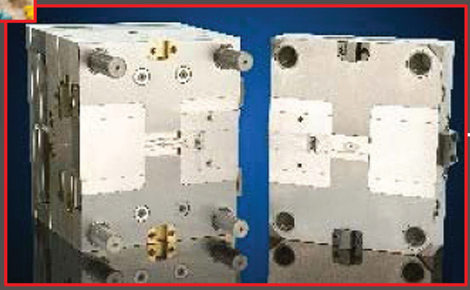


MOLDING VIEWS

Brought to you by the Injection Molding Division of the Society of Plastics Engineers

In This Issue:

This Month's Features:

Chair's Message

As we move through the year, we are looking at our operating plans for the next few years and are working to develop more content that is relative to the mission of SPE. SPE has a mission of providing scientific and engineering knowledge as it relates to plastics. In that, it is up to the special interest groups, sections, and divisions to understand the respective areas and provide content that is relevant to those needs. Many of you may have noticed that we have put together a webinar series for members of the society to do continuing education from the comfort of their home or office. The next two

Chair's Message Continued

webinars are scheduled to take place in November. If you look at the webinar series in totality, these two new webinars will put us up to a total of 5 different topics. We typically run these in the 4th quarter of the year.

We are also in the very early stages of planning an Injection Molding Conference. It has been a number of years since SPE and the Injection Molding Division have put together a conference that is solely focused on Injection Molding. These types of events provide incredible networking opportunities and typically have very practical and applicable content.

As I said in my last letter from the chair, I am very excited about the direction of the division, the hard work that is being done, and the future of the society. I look forward to serving the division and the society for years to come and want to see the society grow with the industry.

Best regards to all,
Ray McKee
2016-2017 IMD Chair
Sonoco
Raymond.Mckee@sonoco.com

Industry Events Calendar

Click the show links for more information on these events!

NOVEMBER 2016

NOVEMBER 9

46th SPE Automotive Innovation Awards Competition & Gala
Livonia, Michican

NOVEMBER 16 - 18

Fabtech 2016
Las Vegas, NV

Fabtech is intended to provide a convenient venue where attendees can meet with world-class suppliers, see the latest industry products and developments and find the tools to improve productivity, increase profits and discover new solutions to all of their metal forming, fabricating, welding and finishing needs.

FEBRUARY 2017

FEBRUARY 26 - MARCH 1

International Polyolefins Conference
Houston, Texas

Over 650 technical and business professionals are expected to attend the conference organized by the South Texas SPE Section, the SPE Polymer Modifiers and Additives Division, and the SPE Thermoplastic Materials and Foams Division. There will be over sixty exhibitor booths, Sunday afternoon Polyolefin tutorials, two evening networking socials and more

MARCH 2017

MARCH 21-22

Thermoset 2017 Conference
Phoenix, Aarizona

The Thermoset Division's annual conference unites industry suppliers, material manufacturers, mold and part designers, processors and OEMs in a technical forum which highlights the most contemporary advancements in material, machine and application technologies. The two day, casual conference is held in combination with exhibits and exclusive networking opportunities.

MARCH 22-24

European Additives & Color Conference
Mestre (Venice), Italy

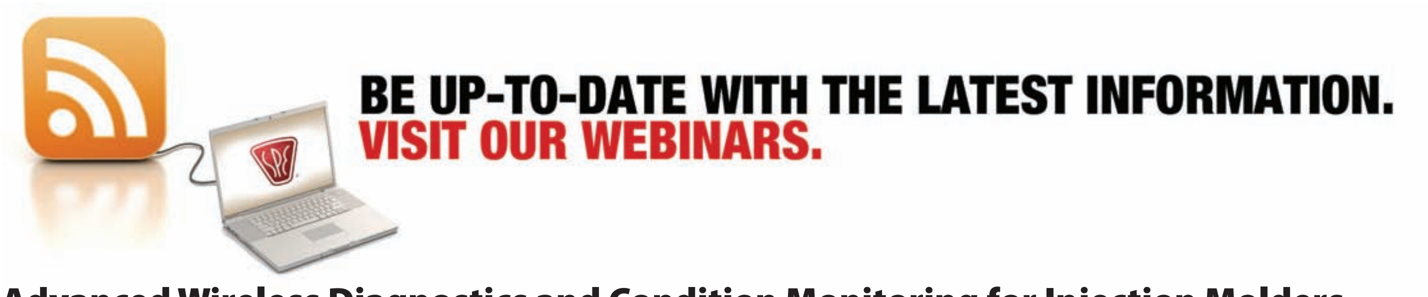
JUNE 2017

JUNE 14 -15

amerimold 2017
Rosemont, IL

Amerimold is a two-day trade show, technical conference and networking event that connects moldmakers, molders, OEMs and rapid product development professionals representing all aspects of a product's development, from concept to manufacture with a unique emphasis on design, engineering and prototyping. Sponsored by Gardner Business Media, the show takes place at the Donald E. Stephens Center in Rosemont, IL.

Webinars



Advanced Wireless Diagnostics and Condition Monitoring for Injection Molders

As production demands continue to increase, injection molding companies are required to reduce scrap and maintain significant uptime with all of their machines, both old and new. While many of the newer machines have internal monitoring systems, the older machines, while still very operational, only have limited monitoring and diagnostic capabilities. In the last few years, sensor technologies have advanced to help make molding machines more modern. With wireless sensors, production managers can now continuously monitor and diagnose issues, reducing machine downtime and scrap rates significantly. This webinar will provide more details about available technologies that can improve injection molding quality in many ways.

Common Challenges with Frequent Material Changes in Form-Fill-Seal Packaging Machines

There are many challenges faced when frequently changing materials in today's Form-Fill-Seal packaging machines. The ability to rapidly and correctly change over materials is critical to achieving proper ROI on expensive packaging equipment. This webinar will discuss some of the most common issues and suggestions on successful change overs.

Webinars

The Design of Experiment (DOE) for Injection Molding

This Webinar will focus on solving injection molding issues using a systematic approach, called Design of Experiments, or DOE, that has been successful in other fields. With plastic processing becoming progressively more scientific, a common practice.

Composite Tooling Webinar Thumbnail Additive Manufacturing for Composite Tooling

Make the production of composite tooling faster, more agile and less costly. In this free 40-minute webinar, you'll learn the benefits and capabilities of FDM composite tooling.

3D Printed Injection Molds

How Companies Are Using 3D Printed Injection Molds to Economically Test Functional Prototypes. Learn how leading injection molding companies are using 3D printed molds to validate their designs using production materials, before they invest in costly metal molds.

Identifying and Understanding the Hidden Influencers of Total Product Cost

Many factors influence the ability to win new contracts, but none more important than cost. Recorded at IMTS 2016, Jim Gibbs, president of Dynamic NC, breaks down the cost of manufacturing with a detailed review of all elements that influence per-piece cost. Learn how to improve cost-control methods through detailed analysis of procedures, processes and in-depth analysis of machine-tool technologies. Gain better control of costs and discover a more accurate model for calculating the return on investment.

The Importance of Maintenance in Today's Hydraulic Cylinder Industry

In order to maintain like-new performance of today's high demand molds and hydraulic cylinders, proper preventativeΩmaintenance is important, as well as recognizing wear early, before a complete failure. Maintenance is, of course, easier when proper application is used. If unreasonable wear occurs, it is most likely due to misuse or improper maintenance. We will address all of these concerns, and address best practice solutions.

SPE Announces a
PRACTICAL NEW PROGRAM

Leveraging a long association with universities and a large number of plastics industry professionals, SPE has created an Industry Academia interface. This activity's goal is:

to promote mutually beneficially collaboration between industry and academia by facilitating research and development projects relating to plastic materials, processes, products and technologies.

Many companies are now unable to find enough technically competent employees to research new material, or to develop new machinery, products and emerging markets. Many universities have the technical expertise to undertake research or development projects of this type on a contract basis. These need not be large-ticket, multi-year projects. Small projects will be treated with equal respect. SPE's Industry Academia Committee members will review project requests and put the applicant in contact with universities equipped and staffed to handle that type of project.

For additional information:

1. log on to www.4SPE.org
2. click on to "Resources"
3. click on to "Industry Academia Collaboration"

Contact by e-mail:
Contact IAC Chairman Dr. David Bigio
at dbigio@umd.edu

Click to Email: dbigio@umd.edu

Proper Sizing of Injection Molding Machine Screw and Barrel

Bob Dealey, owner and president of Dealey's Mold Engineering, Inc. answers your questions about injection molding.

Bob has over 30 years of experience in plastics injection-molding design, tooling, and processing.

You can reach Bob by e-mailing molddoctor@dealeyme.com

Q: Could you shed some light on proper sizing of the injection molding machine screw and barrel size, writes John Camis? We are a custom molder and usually find that the barrel size is either too small or too large for the molds we run. Do other molders have the same problems?

A: First the easy question, yes other molders have similar problems and in particular custom molders. Captive molders typically have information related to the shot size and types of molds they will be scheduling in new equipment and size accordingly. Custom molders who accept previous built molds on the other hand have very little advance notice as to shot size requirements.

The rule of thumb varies among injection molding experts. Generally speaking, shot size should not be less than 25-30%, nor greater than 65-75% of the barrel capacity. The standard specific gravity of 1.06 is used to calculate and then define the shot size of a given machine.

Plug your numbers into the following formula to determine the actual shot size of the material you will be molding:

$$S_s = (S_g / 1.06) \text{ x } M_{sr}$$

Where:

S_s = Shot Size

S_g = Specific Gravity of selected plastic

M_{sr} = Machine Shot Rating

Perhaps the main issue is residence time, that total amount of time the plastic is exposed to the temperature of the barrel. A formula to approximate the residence time when the molding cycle, plastic material and machine shot-size rating is know is:

$$R_t = (1/60 \text{ x } M_c \text{ x } 1.4 \text{ x } {}_{Bc} / 1.06) \text{ x } S_g / M_{sw})$$

Where:

R_t = Residence Time in Minutes

M_c = Molding Cycle in Seconds

B_c = Barrel Capacity in Ounces

S_g = Specific Gravity of Plastics Being Used

M_{sw} = Molded Shot Weight

This is an excellent question. Often the difference between a successful molding project or struggling to make acceptable parts is by utilizing the right match between the mold and machine.

Feature

By Terry Minnick, President
Molding Business Services
terry@moldingbusiness.com

Outside Reps or Salaried Sales People?

Many of our clients ask us the same question: "***Which works better for an injection molding company: manufacturers' reps or salaried salespeople?***"

This is a GREAT question and our usual answer is: "Well, it depends…" There are lot of factors that influence the decision, including the size of the company, the industries served, typical product life cycles, financial circumstances and growth goals – both long term and short term.

Most molders understand the benefits of using outside rep firms or agencies. Here are a few from our perspective:

1. Manufacturers' representatives don't cost much initially.
2. They usually have experience in the molding industry.
3. They have a built-in rolodex of contacts.
4. They pay their own expenses (hopefully!).

But, there are drawbacks to working with outside reps as well:

1. They have other clients/principals competing for their time.
2. They focus their energy and resources on projects with the quickest payback.
3. They are independent and may not take direction well.
4. They may have a hard time fully understanding or grasping your company's sweet spot.

Full-time salaried salespeople have noteworthy pluses and minuses as well. Here are the positives in our view:

1. Full-time salaried salespeople are not conflicted in any way and do not have competing interests.
2. 100% of their efforts are focused on developing business for your company.
3. You can train them to target business in your company's sweet spot.
4. Seasoned salespeople can have established customer relationships that might be valuable to your company.

Feature: Outside Reps or Salaried Sales People Continued

But there are also a few negatives with salaried people that should be considered:

1. Good salaried salespeople are expensive.
2. Long lead-times for new business could make near-term returns seem very weak.
3. They can be flighty, especially if they or the company hit a rough patch.
4. Finding a compensation structure that is good for them AND for the company can be difficult.

So, how do you make the decision between hiring an outside rep and a salaried salesperson?

If your company can afford to hire a salaried person and is lucky enough to find a technically-oriented individual with experience in the custom molding industry, then by all means, hire this person! A former colleague of mine used to say, "The best predictor of future success is past success." If you run across someone who has been a successful custom molding salesperson in the past, they will likely be successful for your company as well. Hire them, incentivize them, train them and then give them clear direction. Give them at least 12 months to prove themselves. Your new salesperson may not immediately land any business, but the company should start seeing more quoting activity within six months.

If your company's typical products are highly engineered and have a long lead-time for development and/or tooling, you should probably stick with salaried salespeople. If a new program takes 18 months to develop, it is hard for an outside rep to justify the up-front work and time investment.

But if your company's financial circumstances will not allow for a full-time salaried salesperson, then hire a manufacturers' representative. Find a rep in your company's geography (or your customers' geography) and also one that has relationships with the customers you are looking to penetrate. A rep with the right relationships can trim months from the business development timeline. You might consider giving them a monthly draw or pay the rep on some existing business – as a way to keep their attention on your company and your company's products.

And, if your molding company has products that are standard or in a catalogue, rep firms may be the fastest and best way to take those products to market. The business development cycle for stock products is usually much shorter than custom molding and outside reps, with their existing customer relationships, may be the best and most effective way to grow your company's revenue.

Whatever course your company decides to pursue, we suggest you be very cautious with the contract language and avoid evergreen commission structures. Every sales commission arrangement, whether it is with an inside salesperson or an outside rep group, should have some kind of sunset provision or declining scale over time. If not, then the individual on the receiving end will eventually become complacent, happy to rest on their laurels and deposit commission checks.

There is no right answer between outside reps and salaried salespeople. It depends on your business and your circumstances. And it might make sense to try both. But keep in mind that most of the larger and more successful molders in North America have grown their business using salaried salespeople.

For more information contact:

Terry J. Minnick
President
Molding Business Services, Inc.
413-584-2899, ext. 100
terry@moldingbusiness.com
www.moldingbusiness.com

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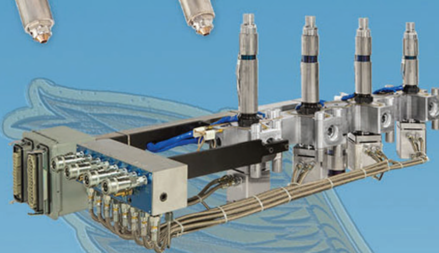

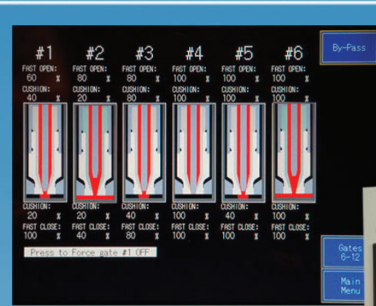

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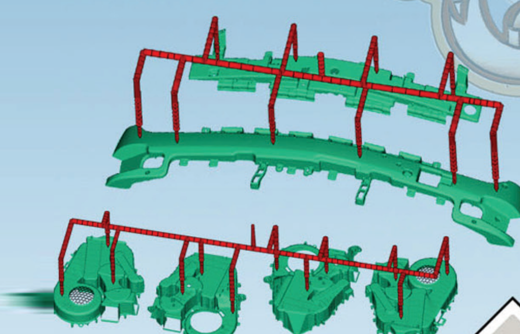

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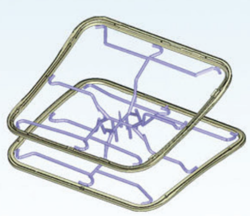

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Plastic Engineering & Technical Services Inc (P.E.T.S.) – HQ
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Southmoor Lane
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+44 (0) 23.9249.2411
sales@petsinc.net

P.E.T.S. Hotrunner (Mexico)
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Col. San Patricio
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011.52.844.1808.1381
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sales@petsinc.net

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Unit 505, Wing On House
71 Des Voeux Rd. Central, HK

Feature

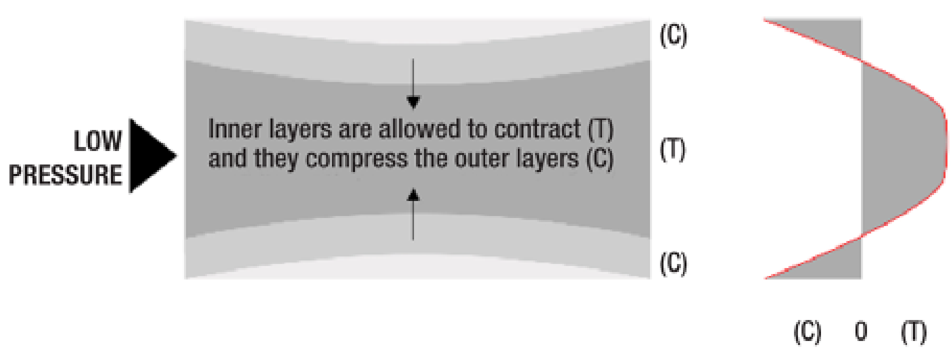
By James LaValle, Steinwall, Inc
jlavalle@steinwall.com

Residual Stress

During the injection molding process a material experiences a variety of deformations, temperature changes and pressure gradients causing the development of residual stress in the final product. These stresses can either benefit or depreciate the quality of the product. In order to ensure the release of a superior product, processors must understand the significance of the residual stress and how to detect the related birefringence.

The terms, compressive and tensile, relate directly to the mechanical properties of a polymer, yet can also be stressors present without the presence of external forces. Points in the part that exhibit compressive stress exhibit higher density, longer fatigue life and residence to physical deformation, yet when above a tensile layer can form a depression (**see Figure 1**) While areas exhibiting tensile stress display a shorter fatigue life due to photochemical degradation by accelerating molecular scission. Both compressive and tensile stress are solidified within a part and known as residual stress. The residual stress within a thermoplastic injection molded product derive predominately from two sources: Flow-induced stress and thermal-induced stress (1.)

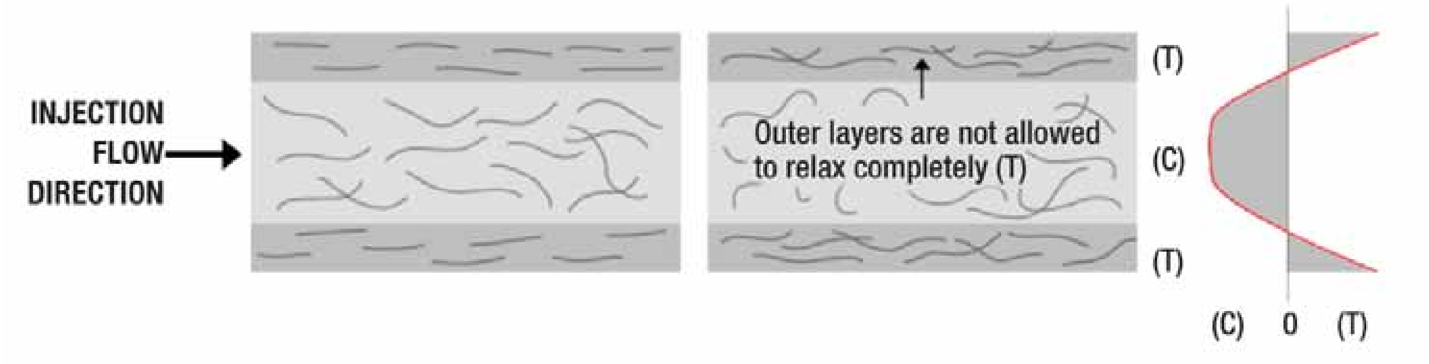
Figure 1: Depression Formation (1)



Flow-induced stress develops when the molten polymer is not allowed to reach equilibrium rather than flow oriented when cooled during the filling and post-filling stages. This sets the orientation of the polymer chains within the final product (**see Figure 2**) This causes the outer layers of the final product to exhibit tensile stress while the inner core exhibits compression stress (1.) The final molecular orientation later

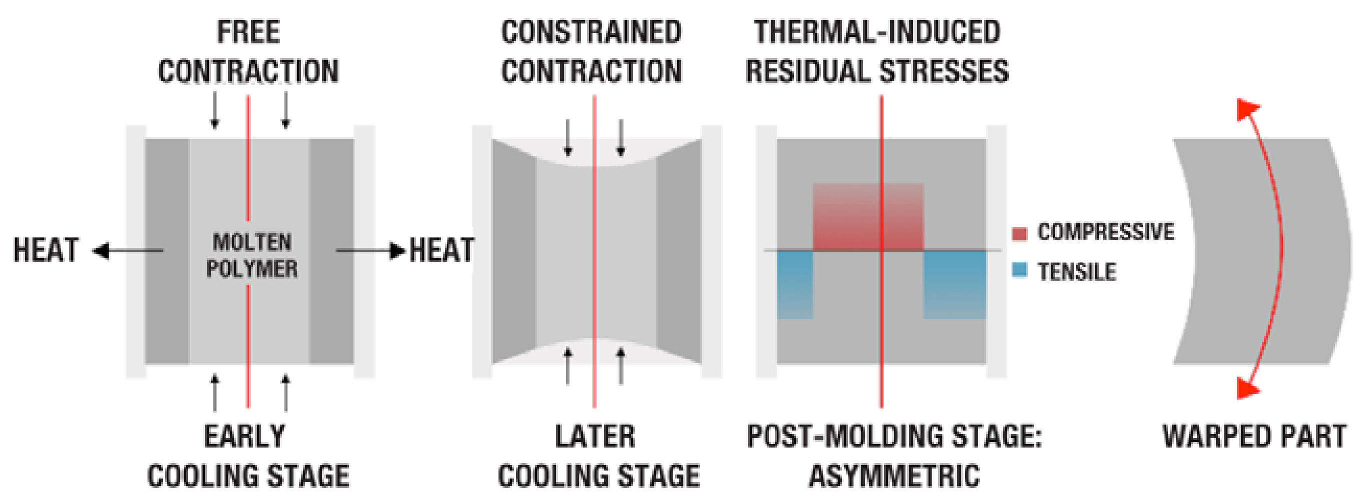
Feature: Residual Stress Continued

Figure 2: Molecular Alignment



affects the warpage/shrinkage behavior of the part perpendicular and parallel to the flow direction (see **Figure 3**) caused by thermal-induced stress (2.)

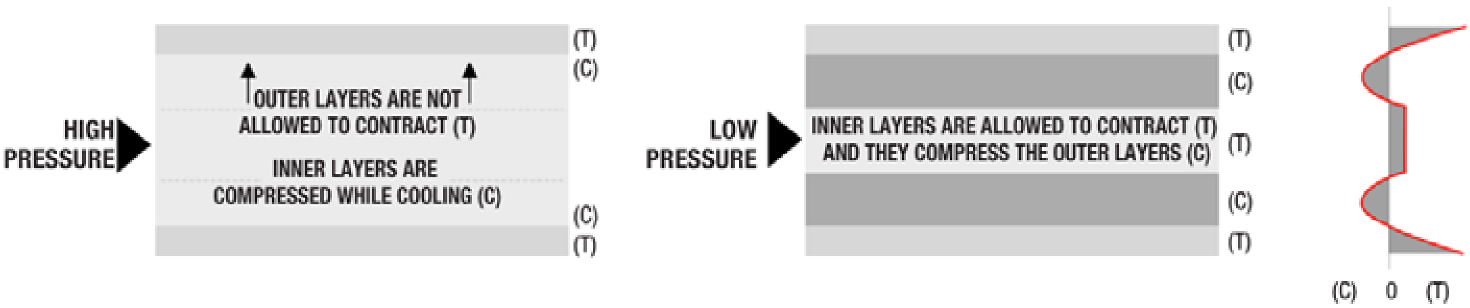
Figure 3: Variable warping/ Shrinkage



At the same time, thermal-induced stresses develop due to the non-uniform cooling of the material involving an intricate relationship between packing pressure, mold volume and mold/melt temperature. As the outer surface solidifies when coming into contact with the mold surface, which occurs relatively stress free, the solidifying of the inner layer must react against the constraints of the outer solid layer and the still molten core. These stresses are compensated by the regulation of the pressure imposed upon the molten material throughout the cooling process. The final product exhibits a tensile skin, a compressive sub-skin, and a tensile core (see **Figure 4**) (1.)

Feature: Residual Stress Continued

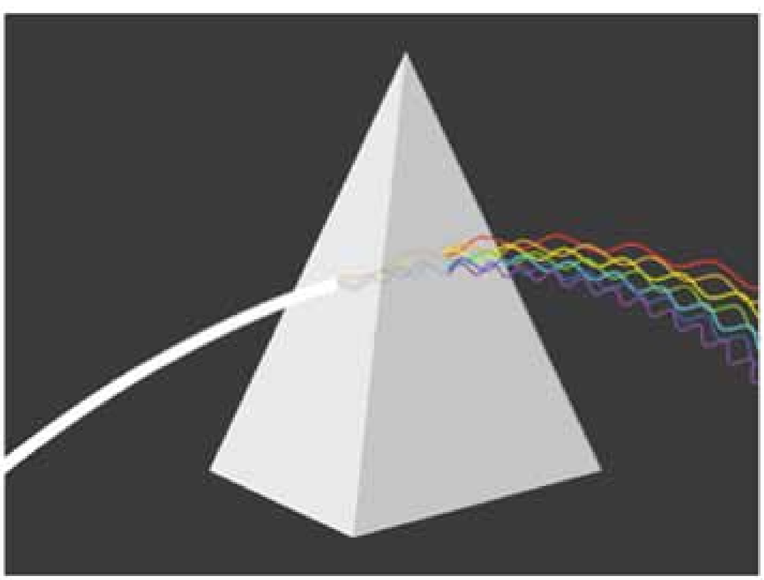
Figure 4: Thermal-induced Stress



Testing for residual stress can be performed prior to manufacturing and after the production of the part. Testing performed prior to manufacturing requires the use of flow simulation software, such as Autodesk's MoldFlow, that assists in the design of the mold and manufacturing parameters. The software defines the stress field under varying conditions and allows the designer to manipulate those fields to optimize product quality and processing time (4.)

Additionally, quality checking can be performed on the finished part determining the stresses utilizing a polariscope in conjunction with a compensator. This device perceives stress in a transparent part by observing an optical property, known as birefringence, related to how an incoming light ray refracts into 2 directions based on the refractive index of a material (see **Figure 5**) (1.)

Figure 5: The refraction of a polarized light ray



Feature: Residual Stress Continued

Table 1: Birefringence Color Chart

COLOR	RETARDATION NM	RETARDATION, N FRINGESC
Black: *Zero order fringe*	*0*	*0*
Gray	160	0.28
White-Yellow	260	0.45
Yellow	350	0.60
Orange *(Dark Yellow)*	460	0.79
Red	520	0.90
Indigo - Violet: Tint of passage #1b *(1st order fringe)*	**577**	**1.00**
Blue	620	1.06
Blue-Green	700	1.20
Green-Yellow	800	1.38
Orange	940	1.62
Red	1050	1.81
Indigo - Violet: Tint of passage #2 (2nd order fringe)	**1150**	**2.00**
Green	1300	2.25
Green-Yellow	1400	2.46
Pink	1500	2.60
Violet: Tint of passage #3 (3rd order fringe)	**1700**	**3.00**
Green	1750	3.03

The retardation of the refracted light is visually displayed and quantified as varying colors and intensities wherever stress is present in the material (see **Table 1**) which proportionally correlates to stress (6.) The higher the level of stress the greater the likelihood of product failure.

The presence of residual stress is inevitable, yet regulating the level and type of stress can establish a quality product. The best practice would be to create the mold and process utilizing a flow simulator and follow up production with spot quality checks identifying levels of retardation.

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For more information contact James LaValle at 763.767.7060 or e-mail jlavalle@steinwall.com
Steinwall, Inc www.steinwall.com

By Che-Ping Lin, Shih-Po Sun, Chao-Tsai (CT) Huang, CoreTech System (Moldex3D) Co., Ltd., ChuPei City, Hsinchu County, 302, Taiwan
Kuan-Dian Chen and Shi-Chang Tseng
National Yunlin University of Science and Technology, Yunlin, 640, Taiwan

In-depth Study for the Different Physical Mechanism Between Over-Molding and Co-Injection Molding

Multi-component molding (MCM) has been developed and applied in our life for many decades. However, due to the complicated combination from materials to processes, it is very difficult to control and management for this type of product development. In this study, we have extended our study from over-molding to co-injection to discuss about the physical mechanism for both distinct interface and uncertain interface MCM systems. In over-molding MCM system, due to the unbalance volume shrinkage and heat accumulation or dissipation, the warpage can in inward or out ward. The final warpage quality can be managed and controlled. On the other hand, in co-injection MCM system, the warpage is strongly affected by the core penetration distance. In this study, the critical central core penetration distance is 36 mm. As long as the core penetration is greater than the critical value, the warpage can be improved. However, unlike over-molding MCM, since both corners (A and B) will be shrunk. To catch the target with good quality product, still need to further efforts. Moreover, the experimental conduction for co-injection MCM will be performed in coming future.

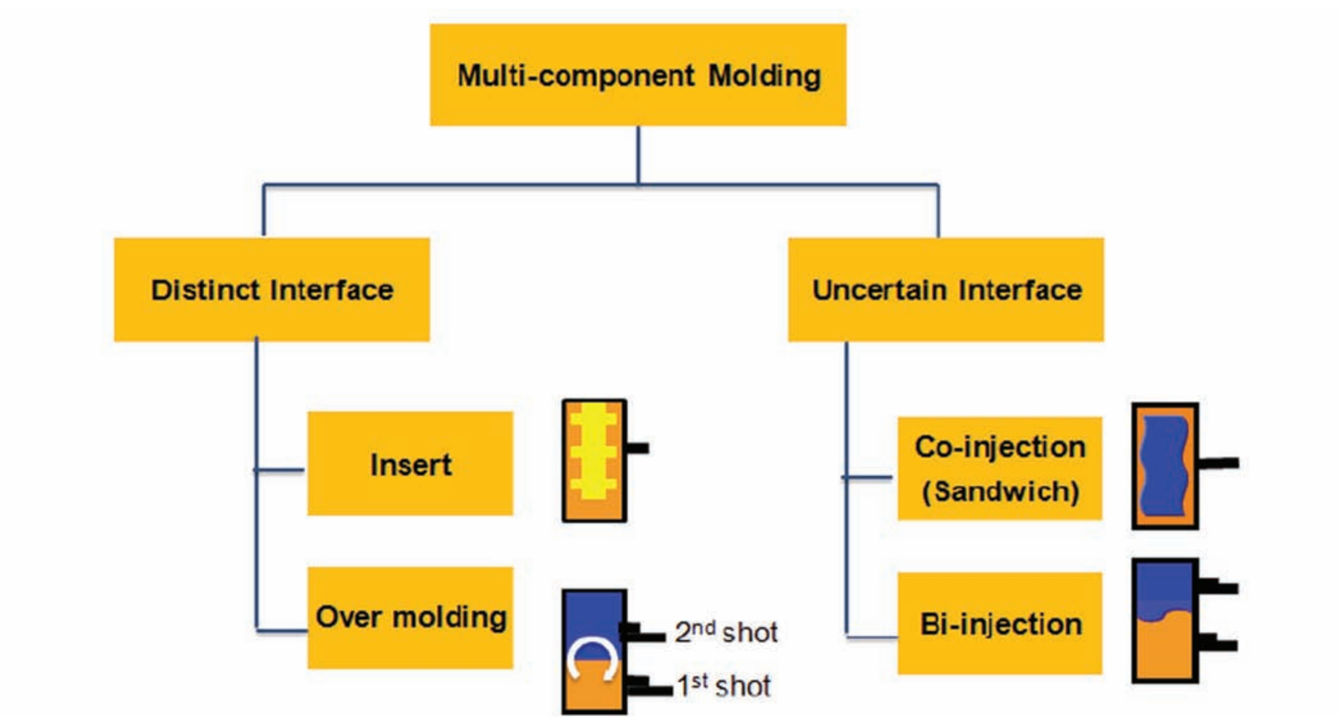
Introduction

Multi-component molding (MCM) is a process in which two or more materials (plastic, metal, or ceramic) are added to a mold to produce a product together. In the modern plastic molded product fabrication, MCM is one of the great methods to diversify the development. In fact, the fundamental idea of MCM is not new. The first patent was announced in 1962 regarding the development of multiple materials tailing light by G. Carozzo [1]. During the past decades, many new technologies and related material combination have been proposed [2-3]. However, how to handle this complicated process to be more understanding and forward the concept into more concrete development are still under endeavors.

Furthermore, from the real industry, there are too many terminology and sub-technologies related to MCM system. To simplify, MCM can be divided as two groups as shown in **Figure 1**. They are distinct interface group and uncertain interface one. For the distinct interface group, the interface is almost fixed during the processing. The major industrial technologies in this group are insert-molding, over-molding, sequential over-molding, etc. On the hand, the uncertain interface group has no fixed interface during the processing. The uncertain interface is strongly dependent of melt flow behavior. The most famous technologies in this group are co-injection, bi-injection, sequential multi-shot, etc.

Regarding the distinct interface group, for example, over-molding process, due to its complicated nature and the unclear physical mechanism, a conventional trial-and-error method cannot catch the crucial factors effectively. To get better understanding, previously, we have focused on the physical mechanism based on product geometrical effects and material selection on sequential over-molding processes numerically and experimentally. In some control conditions, it is possible to manage the warpage quality for over-molding products [4-5]. As we pointed out the physical mechanism of warpage in a sequential over-molded part

Figure 1: The illustration of Multi-component molding family (distinct interface and uncertain interface).



is more complicated than that in a single injected part. Basically, the filling/packing history will introduce the volumetric shrinkage. Then cooling stage will introduce the thermal unbalance phenomena to the final product. The unbalance volume shrinkage and thermal history will affect the warpage quality significantly.

On the other hand, for the uncertain interface group, such as co-injection molding process, has been known for many decades [6]. Co-injection molding process consists of two sequential injection steps. It starts with injecting the first material (skin) for a predetermined short shot volume into the cavity followed by the second shot (core) behind the skin until the cavity is completely filled. The fountain flow behavior of the skin leaves a frozen layer on the cavity wall; while the sequential shot penetrates into the melt core through the path of less resistance to displace the first material. Because of this fountain flow behavior, the first material driven to the melt front forms additional frozen layer all the way forward. Hence, an ideal co-injection molded part exhibits a core completely encased by the skin except for the regions near the gate.

The main challenge of co-injection is to control the material spatial distribution inside the cavity. Also, how to manage the product quality based on warpage control is a key issue [7-8]. This is especially important for structural applications of which product stiffness depends largely on the skin/core distribution. Unlike the multi-component molding which has a distinct interface, skin/core interfacial flow front of co-injection molding cannot be controlled with ease. Past attempts have been made to associate material distribution with important factors of processing conditions and material properties [8-10]. Besides, when consider the geometrical effect, the physical mechanism has not been fully understood yet.

In this study, we have extended our MCM investigation from over-molding to co-injection. The goal is based on warpage quality improvement and what is the physical mechanism behind this quality improvement.

Theory and Model

The numerical simulation was conducted using the Moldex3D software. Both the skin and core materials are considered to be compressible, generalized Newtonian fluid. Surface tension at the melt front is neglected. The governing equations for 3D transient non-isothermal motion are:

$$\frac{\partial \rho}{\partial t} + \nabla \cdot \rho \mathbf{u} = 0 \tag{1}$$

$$\frac{\partial}{\partial t}(\rho \mathbf{u}) + \nabla \cdot (\rho \mathbf{u}\mathbf{u} + \boldsymbol{\tau}) = -\nabla p + \rho \mathbf{g} \tag{2}$$

$$\rho C_P \left(\frac{\partial T}{\partial t} + \mathbf{u} \cdot \nabla T \right) = \nabla \cdot (k \nabla T) + \eta \dot{\gamma}^2 \tag{3}$$

where ρ is density; **u** is velocity vector; t is time; τ is total stress tensor; **u** is acceleration vector of gravity; ρ is pressure; η is viscosity; C_p is specific heat; T is temperature; k is thermal conductivity; $\dot{\gamma}$ is shear rate.

For the polymer melt, the stress tensor can be expressed as:

$$\boldsymbol{\tau} = -\eta\left(\nabla\mathbf{u} + \nabla\mathbf{u}^T\right)$$

The modified-Cross model with Arrhenius temperature dependence is employed to describe the viscosity of polymer melt:

$$\eta(T,\dot{\gamma}) = \frac{\eta_o(T)}{1+\left(\eta_o\dot{\gamma}/\tau^*\right)^{1-n}} \qquad (5)$$

with

$$\eta_o(T) = BExp\left(\frac{T_b}{T}\right) \qquad (6)$$

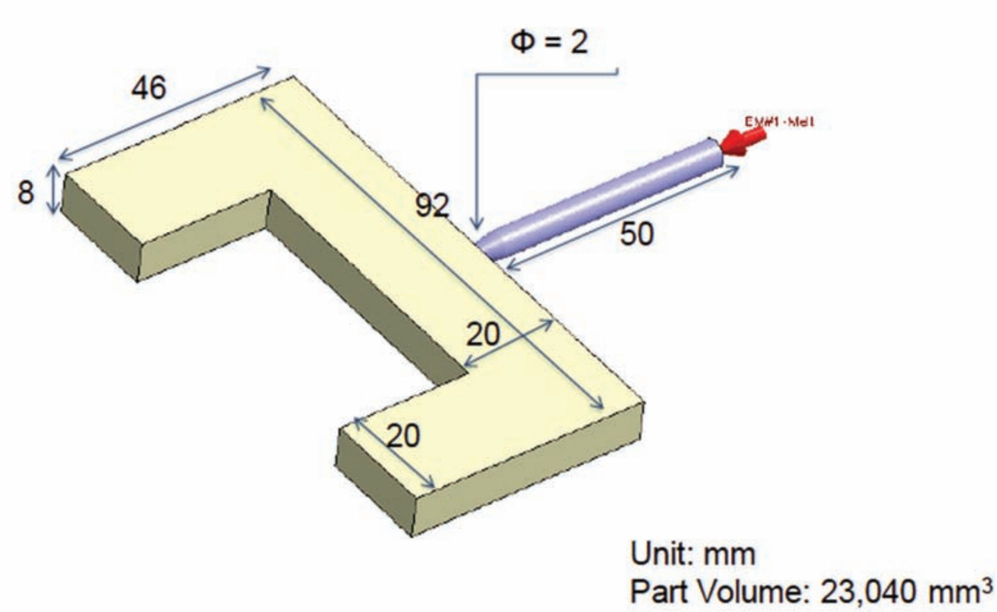
where n is the power law index, η_o the zero shear viscosity, τ^* is the parameter that describes the transition region between zero shear rate and the power law region of the viscosity curve.

A volume fraction function f_i is introduced to specify the evolution of the polymer/air front (i=1) and skin/core front (i=2) interfaces. Here, $f_i = 0$ is defined as no-filled region, $f = 1$ as fully-filled region, and finally the interfacial front is located within cells of an f value between 0 and 1. The advancement of f over time is governed by the following transport equation:

$$\frac{\partial f_i}{\partial t} + \nabla\cdot\left(\mathbf{u}f_i\right) = 0 \qquad (7)$$

During the polymer melt filling phase, the velocity and temperature are specified at the mold inlet. While the core material is injected, the flow rate setting is specified at the mold inlet. On the mold wall, the non-slip boundary condition is applied, and fixed mold wall temperature is assumed.

Figure 2: The geometrical dimensions of part.



Investigation Procedures

To get better understanding of the sequential coinjection molding processes, we have conducted Moldex3D R13.0 software numerically. The geometrical model includes runner system and dimensions are shown in **Figure 2**. The dimension of the part, including 1st and 2nd shots, is 92mm X 46mm X 8mm (Volume: 23ml). The material of 1st shot and 2nd shot in this study is PC (Panlite L-1250Y). During the filling, the melt flow fully developed in the straight channel of this model. The straight channel was also used to verify the skin ratio evolution. At the intersection, the melt hit the cavity wall and diverged. The 90-degree turn after divergence showed how the melt travels through the corner and its resulting core/skin distribution. Flows after divergence could also be used to check symmetry.

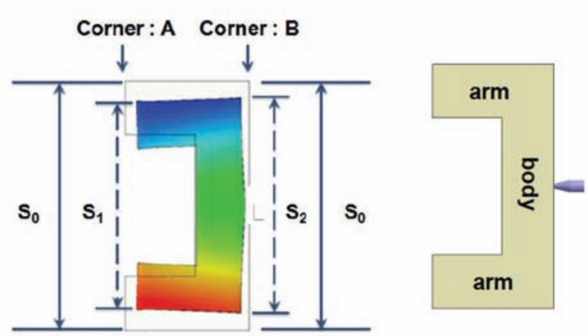
To catch the warpage behavior and its mechanism, we have performed numerical simulation systematically. **Table 1** lists the control factors and their range used in this study. The core filling ratio is the core volume ratio within the entire cavity, V_{core} / V_{cavity}. The predetermined volume of skin and core were injected sequentially. For flow rate study, different flow rates of the skin and the core are tested. Melt temperature 280 and 305° were used in melt temperature effect study. To evaluate warpage quality variation, the definition for warpage is shown as in **Figure 3**. More specific, at Corner A, when $S_1<S_0$, it is inward, where S_0 is the original design length; at Corner B, when $S_2<S_0$, it is Inward. And S_2-S_1 indicates, the warpage trend of two arms. Moreover, the experimental investigation for this co-injection molding system will be also performed later soon.

Table 1: The co-injection processing factors and their range used in this study.

	Shot	Material	Flow rate	Melt temp.
Original	1st	PC	80 cc/sec	305℃
	2nd	PC	80 cc/sec	305℃
Melt temp.	1st	PC	80 cc/sec	**280℃**
	2nd	PC	80 cc/sec	**280℃**
Flow rate	1st	PC	**20 cc/sec**	305℃
	2nd	PC	80 cc/sec	305℃
Flow rate 2	1st	PC	**20 cc/sec**	305℃
	2nd	PC	**20 cc/sec**	305℃

*PC is TEIJIN Panlite L-1250Y

Figure 3:
Warpage behavior definition for Inward or Outward: (1) at Corner A, when $S_1<S_0$, it is inward, where S_0 is the original design length; Similarly, at Corner B, when $S_2<S_0$, it is Inward.



Results and Discussion

Figure 4 shows the melt front behavior of co-injection system in various core ratios and control factors. From the original setting, the core penetration distance is simply proportional to core ratio. The higher core ratio, the longer core penetration distance. When the melt temperature is decreased, in the thickness direction penetration is more difficult, the core penetration is longer in flow direction. When the melt of first shot is slow down, no matter the second shot is faster or slower, the core penetration is increased.

Furthermore, the quality based on warpage is very important in MCM product development. **Figure 5** shows the results of S_0-S_1 (means the warpage at corner A) in various core ratios and control factors. For original setting, when the core ratio is lower (core ratio <20%), which means that the core penetration doesn't extend to arm and still stays in the body; the quantity of warpage almost has no change. Until the core ratio is over than 20%, the warpage is improved. For melt temperature setting (lower melt temperature), when the core ratio is greater than the critical value (20%), the warpage is improved. Similarly, slower down the first shot setting also obtained the results.

To realize what the mechanism happens in systems, we have paid more attention to the relathionship between core penetration distance and warpage. In **Figure 6**, for original and melt tempature setting, when core ratio is larger than 20%, the warp

Figure 4: Melt front behavior of the 2nd shot with different 2nd shot volume ratio and processing factors.

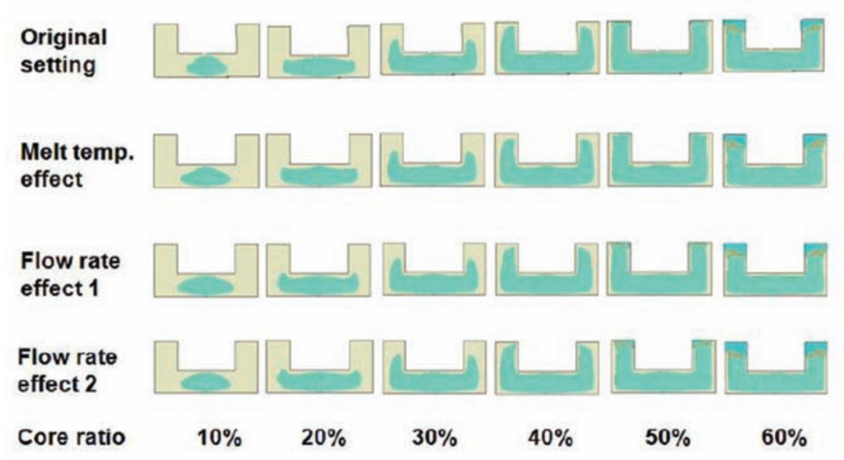
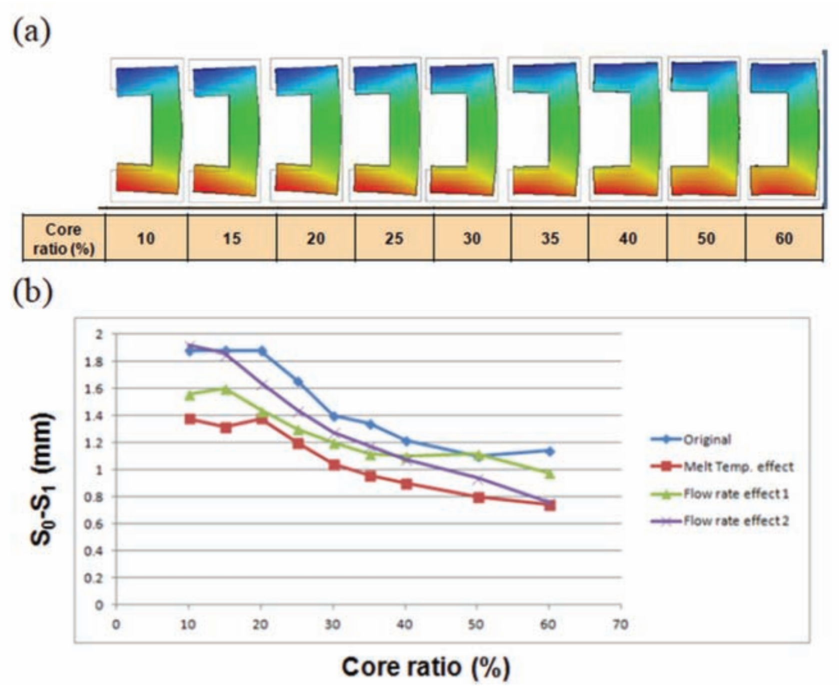


Figure 5: Warpage behavior: (a) the results of total displacement of original setting in different core ratio (warp scale = 10X), (b) the results of S_0-S_1 (means the warpage at corner A) in various core ratios and control factors.



result is improved. Obviously, the improvement is due to the core material penetrated and passed through the corner (diagonal line) to overcome the shrinkage of parts. Although the critical core ratio might not be a constant as shown in **Figure 7**, where the critical core ratio is 15%. Similar to **Figure 6** results, when the core layer passes through the corner (diagonal line), the warpage is improved. Moreover, it is necessary to consider shrinkage for both sides for full part (**as shown as Corner A and B in Figure 3**). In the perfect design and manufacturing, $S_1=S_2=S_0$ as shown in **Figure 3**. However, in reality for this case, $S_1<S_0$ and $S_2<S_0$, it means both sides are shrunk. Also, since $S_1<S_2$, the injected part is inward from corner B to Corner A as shown in **Figure 8** for all different settings. When core penetrates through the diagonal line, the S_2-S_1 value becomes smaller, which means S_1 is approaching S_2. In other words, when the core penetrates through the diagonal, the displacements of A and B reduces and become close to each other.

Furthermore, based on the above investigation, the warpage improvement mechanism is due to the criteria of critical core penetration distance as shown in **Figure 9**. As core acrosses the diagonal line, the warpage can be improved. In this study case, the critical central penetration distance is 36 mm. That means when central core penetration distance is above 36mm, the warpage will be improved. For example, in the original desing

Figure 6: Warpage behavior of original and melt temperature setting.

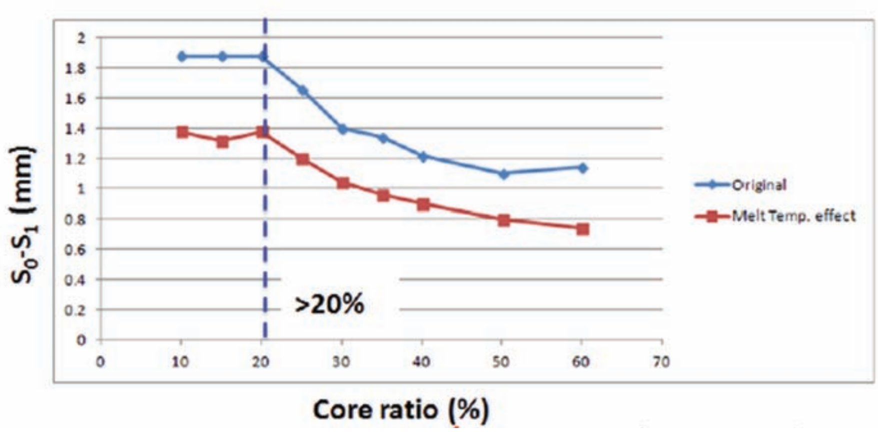


Figure 7: Warpage behavior of flow rate effect setting.

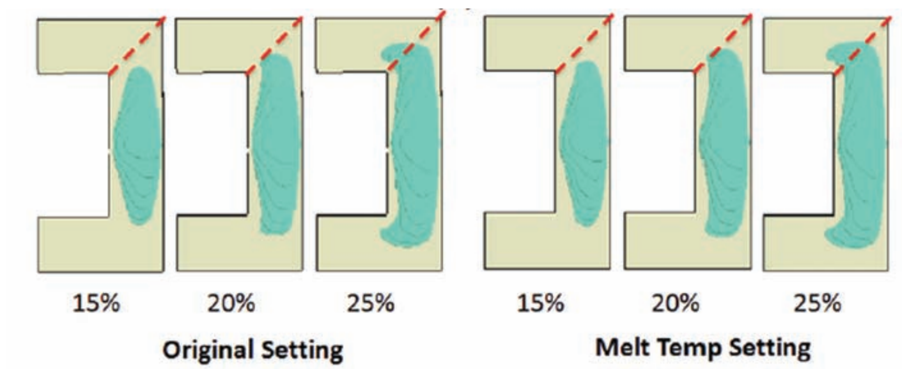
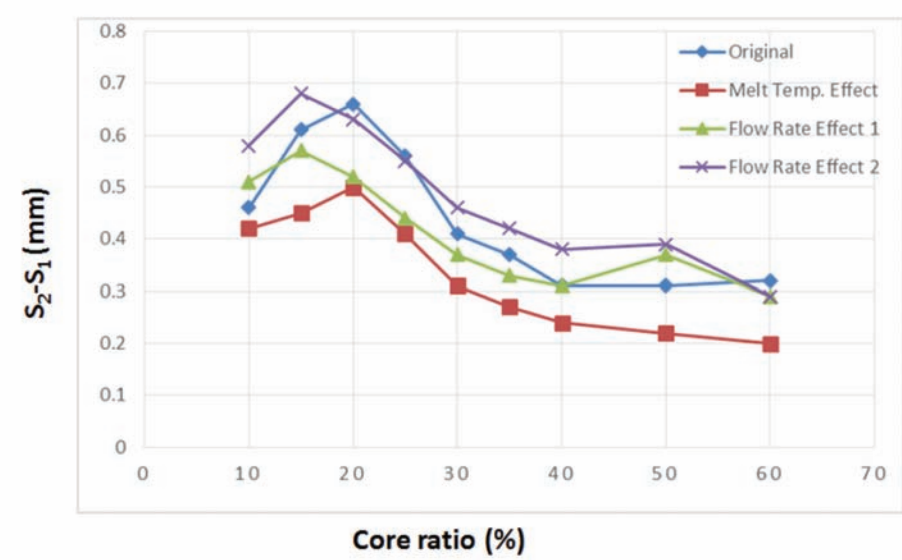


Figure 8: The results of S_2-S_1 in various core ratios and control factors.



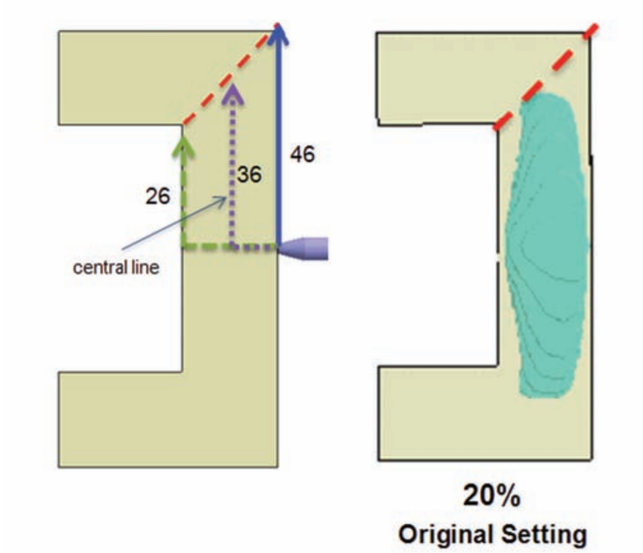


Figure 9: The diagram of critical penetration distance

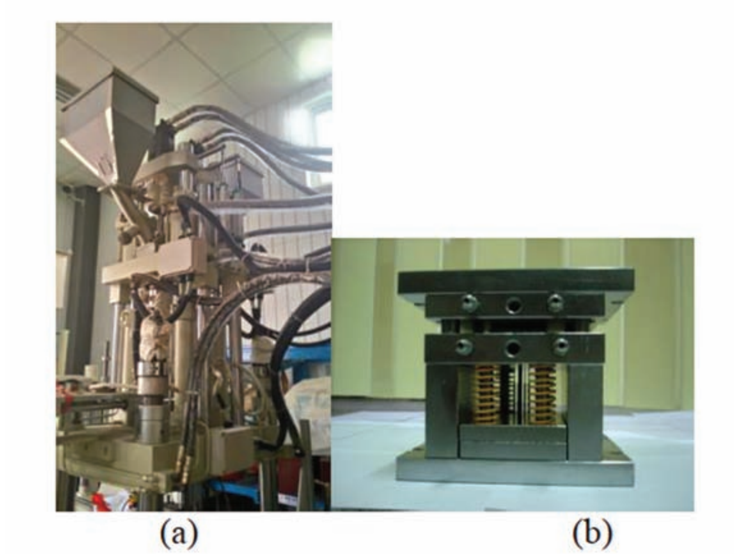


Figure10: Experimental study: (a) Injection molding machine: TA-4.OST-2ST-80T; (b) the mold design and construction.

setting, when the core ratio is larger than 20% (with central core penetration is over 36 mm), the quality is improved significantly.

Finally, to validate the simulation investigation, the experimental study will be performed in the near coming future. So far, the machine and mold design (under construction) are as shown in **Figure 10**.

Conclusions

In this study, we have extended our study from over-molding to co-injection to discuss about the physical mechanism for both distinct interface and uncertain interface MCM systems. In over-molding MCM system, due to the unbalance volume shrinkage and heat accumulation or dissipation, the warpage can in inward or out ward. The final warpage quality can be managed and controlled. On the other hand, in co-injection MCM system, the warpage is strongly affected by the core penetration distance. In this study, the critical central core penetration distance is 36 mm. As long as the core penetration is greater than the critical value, the warpage can be improved. However, unlike over-molding MCM, since both corners (A and B) will be shrunk. To catch the target (**$S_1=S_2=S_0$ as shown in Figure 3**), still need to further efforts. Moreover, the experimental conduction for co-injection MCM will be performed in coming future.

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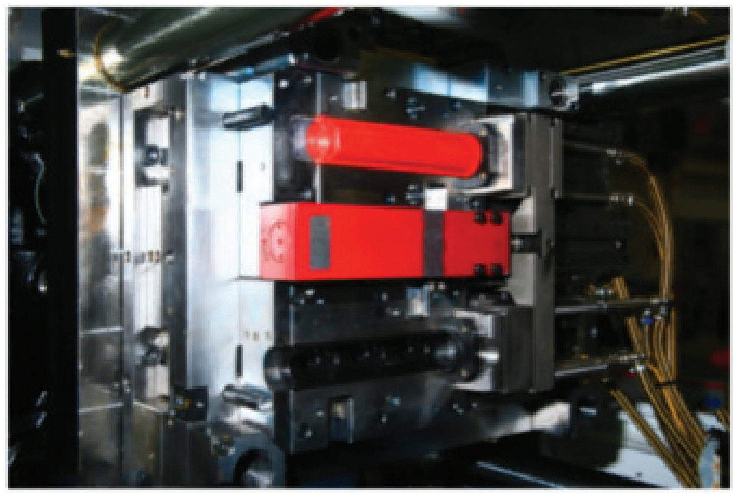
Key words: injection molding, co-injection, multi-component molding (MCM), warpage

By David Matthews

The Pernoud Group Presents a New and Innovative Addition to its Multitube Technology

The French Mold Maker Georges Pernoud, has over the last six months, been developing a new and innovative process to further enhance their Multitube Technology. This new process consists of over molding an LSR (silicone) gasket on its Multitube applications.



The Georges Pernoud Multi-Process Mold integrates the over molded LSR (silicone) gasket

The need for this new innovation was identified, during the last NPE 2015 show in Orlando, as a real request from the automotive market.

This newly developed LSR application will be presented during the K2016 showcase at the Billion booth located in Hall 15 – B24. The Billion booth is presenting four innovative applications, that all improve productivity and technology.

For review: Multitube Technology utilizes a Multi-Process-Mold that plastic injection molds a multi-shot part, that includes over molding 4 threaded inserts. The demo part shown at the K2016 will be an air intake manifold but the technology is also applicable for air ducts, water manifolds and tubes, turbo ducts and filter assemblies.

The main strengths, of Multitube, are productivity and cost savings due to the integration of processes within the mold and the elimination of post molding, secondary operations, i.e. welding.

The injection molding process on display at the K2016 Showcase will be a 200 ton multi-shot all-electric

LSR Temp. Management System

	Celsius	Fahrenheit
Cold sprue bush for LSR molding	20°	68°
Cores water cooling circuit temp.	90°	194°
Cores heating temp. (1st Cav.)	130°	266°
Cores heating temp. For LSR vulcanization (2nd Cav.)	180°	356°

Case Study

plastic injection molding machine from Billion, as was previously used at the NPE 2015 exhibition.

For the K2016 showcase, Mold Masters (Milacron) has provided the third auxiliary electric injection unit specific for LSR over molding and directly attached to the top of the injection mold. The process has been developed to run an average cycle time of 55 seconds for a complete finished part.

To manage the LSR Temperature System, Georges Pernoud R&D has designed and produced a specific cold sprue bushing.

Georges Pernoud is pleased to invite all interested people to visit and discover this amazing new application and to meet with our salesforce to discuss this new process, its application and technical details.

The Georges Pernoud Group is an International French Mold Maker with locations in France, Slovakia and the United States. (Annual Sales of 15.9 Mill. US$, over 100 employees – located in 4 plants, headquartered in the French Plastic Valley).

Certified ISO 9001 (2008), The Pernoud Group is also accredited Research Center by the French Ministry of Higher Education and Research. In 2001, they founded their own Mold Makers Cluster called AGP DEVELOPMENT in order to form a worldwide task force of skilled resources.

For more information contact:

David Matthews at 1-(248) 724-6695 or via e-mail d.matthews@pernoud.com

www.pernoud.com

Feature

By Ken Rumore
Progressive Components International Corporation, Wauconda, IL

Data Driven Decision Making For the Injection Mold Designer

The science of Tribology is generally known only to certain specialists who focus on its study and the effects on industrial materials. It can drive many decisions that are made daily by the injection mold designer. In many molds there are assemblies that benefit from optimizing a surface, to minimize the effect of wear, which can be the result of one surface coming in moving contact with another. The basics of Tribology are important for all designers to understand because it may improve the longevity, of the assembly, through design or to advise the end user of adequate, required maintenance.Component longevity is the goal, but ultimately cost savings is the outcome, when replacement components and lost man-hours make an assembly unaffordable to maintain and maintenance replacements are required too often.When Tribology knowledge can be used to extend the life of specific components so they will last longer and insure the assembly's practical life, everyone benefits.

Introduction

Tribology is the science and engineering of interacting solid surfaces in motion. It includes the study and application of the principles of friction, lubrication and wear. The word itself can be broken into two parts: Tribo meaning "to rub" and "ology" meaning the knowledge of. The tribological interactions of two solid surfaces interfacing, with consideration to environment, can result in a loss of material or more commonly known as wear.

Types of wear include: abrasion, adhesion, cohesion, erosion and corrosion. Wear can be minimized by modifying the surface properties of solids, or by using lubrication to help combat friction or adhesive wear. Government data shows a gross domestic product loss of 1-2% due to wear. Engineered surfaces that extend the working life of equipment can save large sums of money, conserve equipment and save energy.

These principles can apply to many areas of plastic injection mold tooling. There are many wear surfaces in a mold that affect the overall cost of tooling and its longevity. Tribo wear locations in a mold should be considered and the designer should possess the basic knowledge of the materials and treatments to formulate a solution. The following report relates principles the designer can refer to for best results.

Steel Selection Basics

Any time a mold designer creates the geometry for a non-standard mold component, the second thought in his mind is what steel should be used. This combined with the knowledge of significant properties, hardening and surface treatment allows the correct choices to be made.

Holder blocks or plates of a mold, for example, generally don't receive much if any wear. This is the reason pre-hard holder block steel, which is high in compressive strength, is selected. This attribute allows the plates to remain stable, crush resistant and able to be machined with a milling cutter. No other hardening process is required, if used as recommended, in this example. These pre-hard mold steels are not the focus of this paper, even though they have a specific purpose for molds.

Steels with qualities best-suited for molds to defend against abrasive and adhesive wear resistance, are defined by their individual data sheets. Each has properties that are determined by their chemical makeup, milling or processing. One can't affordably choose the most wear resistant steel because one that suits every application does not exist. The primary function, price, availability and other factors impact making the best choice.

The following are initial considerations when selecting the tool steel for a Mold component (in no particular order):

- What key performance qualities does the steel grade possess that apply to the application?
- Machine ability
- Grind / finish capability
- Operating temperature range / stability
- Hardness or surface treatments
- Price & availability

Since methods of machining, grinding, price and availability can constantly change, we'll focus on the factors that are relatively consistent when considering cold work steel grades, key performance qualities, effective hardness and surface treatment relevance.

Cold Work Grades

Cold work tool steels include many types. The term 'cold work' speaks to the application, where the service temperature will be lower than 600 degrees F. This broad category includes many tool steels, offered by many manufacturers.

In the American Iron and Steel Institute classification system, tool steels are arranged into groups based on application, alloying elements and heat treatments. Cold work tool steels include ingot, cast and forged steels. These tool steels are divided into categories, a few examples include:

O - Oil hardening

A - Air hardening

D - High carbon / high chrome

H - Hot work steels (included because they offer certain benefits for molds)

M - High speed steels

T - High speed steels (Molybdenum free)

S - Shock resistant steels

L - Special purpose steels
(***See Figure 1***)

Data Driven Decision Making for the IM Designer Continued

Steel Grade	C	Mn	Si	Cr	W	Mo	V	Other
O1	0.94	1.20	0.30	0.50	0.50			
O6	1.45	1.00	0.90			0.25		
L6	0.70	0.60	0.25	0.70				1.40 Ni
A2	1.00	0.75	0.30	5.00		1.00	0.25	
A8	0.55	0.30	0.95	5.00	1.25	1.25		
A9	0.55	0.35	1.05	5.15		1.55	1.00	1.50 Ni
A10	1.35	1.80	1.20	0.20		1.50		1.85 Ni
D2	1.50	0.30	0.30	12.00		0.75	0.90	
D3	2.15	0.40	0.40	12.25			0.25	
D7	2.30	0.40	0.40	12.50		1.10	4.00	
S1	0.53	0.25	0.25	1.35	2.00		0.25	
S7	0.50	0.75	0.25	3.25		1.40		
H13	0.40	0.40	1.00	5.25		1.35	1.00	
Viscount 44	0.40	0.80	1.00	5.25		1.35	1.00	0.12 S
M2	0.85	0.28	0.30	4.15	6.15	5.00	1.85	
CPM 1V	0.55	0.40	0.50	4.00		4.25	1.00	0.50 Ni
CPM 3V	0.85	0.30	1.00	5.00		1.35	2.75	
CPM M4	1.45	0.25	0.25	4.50	5.50	5.20	3.85	
CPM 9V	1.80	0.50	0.90	5.25		1.35	9.00	
CPM 10V/A11	2.45	0.50	0.90	5.25		1.35	9.80	

Figure 1

Cold work tool steels were developed to provide high wear resistance, hardness and fracture toughness. These properties are provided by primary carbides and a tempered, high carbon Martensite. Typically, heat treatment is hardening and repeated tempering to remove retained Austenite to reach a required hardness-toughness combination. The high alloy content, in tool steels, provides high hardenability.

Specifying by Properties

Some examples of cold work tool steels used for molds, with typical through hardness, notable properties and surface treatment options for wear resistance are:

S-7: 57 Rc. Shock resistant air hardening tool steel with high-impact resistance at relatively high hardness. Good toughness to resist chipping, breaking with good wear resistance. Also, air quenched for minimal distortion.

A-2: 58-60 Rc. High wear resistance and good toughness rating. Will hold an edge and is resistant to abrasive plastic resins. It can be treated with Nitride or Titanium Nitride. Cryogenic treatment can improve long term dimensional stability after first temper.

D-2: 60 Rc. High wear resistance and resistant to abrasive plastic resins. It can be Nitride treated, Titanium Nitride treated and PVD treated. (Double temper prior to these treatments, at the treatment process temperature.)

H-13: 48 Rc. This is one exception as H-13 is hot work steel, popular for die-cast dies, it is also used widely for plastic injection molds. H-13 is a great choice for Nitride surface treatment.

Data Driven Decision Making for the IM Designer Continued

L-6: 57 Rc. This is an oil hardening steel for use in applications that require a good combination of hardness, toughness and wear resistance. The additional nickel contained in this grade provides an alloy with greater toughness than most oil hardening steels.

O-1: 60 Rc. This is a commonly available, low alloy, oil hardening tool steel. It may be hardened from fairly low temperatures with little size change. It combines deep hardening qualities with a fine grained structure.

These few examples are intended to show some of the properties to be considered when selecting a common cold work tool steel. A chart is included below that provides a more comprehensive rating system and more steels to choose from. To quickly choose the steel for a certain application identify the properties that are most significant to your application. (**See Figure 2**)

Stress Relieving

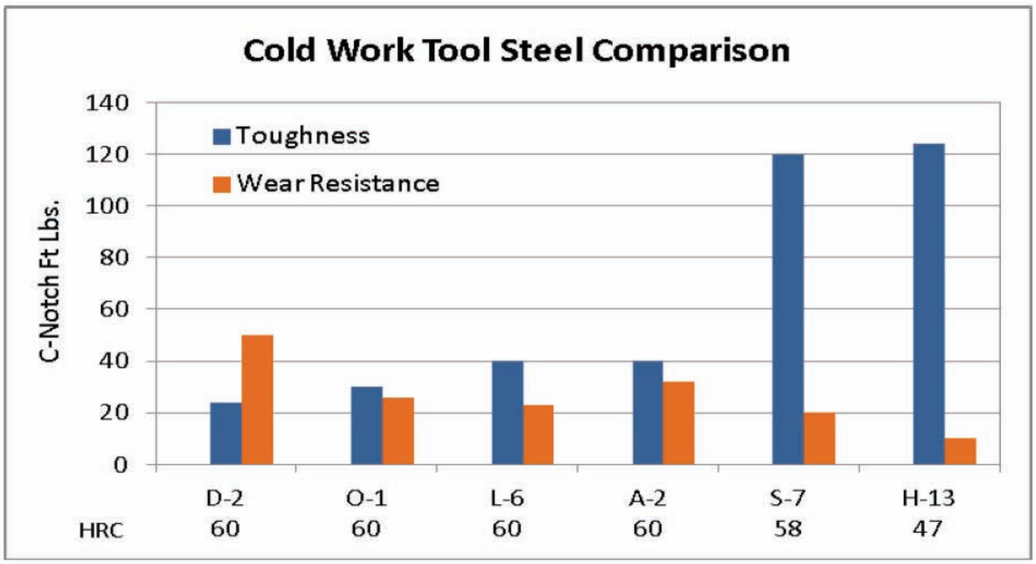


Figure 2

The stress relieving process can be as important to the finished product as the treatment. Microscopic cracks and tears, at a surface, could cause premature wear and lead to larger failure fractures. Seldom seen with the naked eye, during manufacturing a large amount of stress is induced to a relatively small area and should be examined.

Questionable areas should be pointed out to the Metallurgist, who will be well equipped to examine and provide size and depth information for a problem area. Request microscope photos of the condition that can be kept with your project for future reference.

When stress relieving of annealed material is necessary, it involves heating the material to 1000-1200 Degrees F and holding for about 2 hours.

Specifying Heat Treatment

At some point in manufacturing it may become time to heat treat a component. This will usually be determined by the shop process and perhaps finish grinding or hard machining will conclude the manufacturing cycle. The heat treating process is far too often taken for granted and products brought to the heat treating company have as few specifications as "I need these hardened".

In general, when cold work tool steels require heat treatment it's best to choose a process that is compatible with the user conditions and what is necessary for any final surface treatment. Tempering requirements will vary depending on the steel selected and the temperature of the process. In many cases it's best to temper as high as the final process, so your parts will maintain maximum stability. Cryogenic treatment can have great

Data Driven Decision Making for the IM Designer Continued

value in stabilizing a part, your Metallurgist or a technical service representative can help you make all of these decisions. (**See Figure 3 and Figure 4**)

A consultation to help you find the optimum process for common tool steels can be very short; provide the Metallurgist with the critical elements of your design. What you expect to receive: straightness, flatness and growth or distortion, when your parts have been processed, is paramount to developing a process that suits your needs.

ASTM	Description	MI[1]	HRC	TOUGHNESS / WEAR RESISTANCE / GRINDABILITY
O1	An oil-hardening, non-shrinking tool steel with good toughness and moderate dimensional stability in heat treatment.	90	60	
O6	An oil-hardening, graphitic tool steel with excellent non-seizing properties. The graphite particles provide self-lubricity and hold applied lubricants.	125	60	
L6	An oil-hardening, general purpose tool and die steel. The nickel content provides enhanced impact toughness.	75	57	
A2	A general purpose, air hardening tool and die steel.	70	60	
A8	An air hardening steel with good toughness which can be used in cold work and some limited hot work tooling applications.	75	59	
A9	An air hardening steel with enhanced toughness which can be used in both cold work and hot work tooling applications.	70	56	
A10	An air hardening graphitic tool steel. More dimensionally stable during heat treatment than O6 graphitic tool steel.	85	60	
D2	A general purpose, 12% chromium, air hardening, wear resistant tool steel. Good dimensional stability during heat treatment.	50	62	
D3	An air hardening, high carbon, 12% chromium tool steel with improved wear resistance.	45	63	
D7	An air-hardening tool steel with maximum wear resistance for an ingot cast steel. Large, hard carbides resist wear from abrasive particles.	35	63	

Figure 3

ASTM	Description	MI[1]	HRC	TOUGHNESS / WEAR RESISTANCE / GRINDABILITY
S1	An oil hardening, shock resistant tool steel designed for applications involving high impact or sudden shock loading.	75	57	
S7	An air hardening, shock resistant tool steel with better dimensional stability in heat treatment.	75	57	
H13	A 5% chromium hot work steel which is often used in cold work tooling applications which need high toughness but not high strength.	70	48	
H13S	Resulfurized (machinable) prehardened H13 which can be used for a variety of tooling and maintenance applications.	40	44	
M2	A general-purpose, high speed steel which is sometimes used in cold work applications which require high strength but not high toughness.	55	64	
CPM 1V	A powder metal tool steel with a unique combination of high toughness and high strength for both cold and hot work applications.	70	57	
CPM 3V	A powder metal tool steel with a balanced alloy composition that provides high toughness and wear resistance for many cold work applications.	55	62	
CPM M4	A powder metal tool steel with a unique combination of high strength, toughness and wear resistance for both cold and hot work tools.	45	63	
CPM 9V	A powder metal tool steel which provides high toughness and wear resistance at a moderate strength level.	40	53	
CPM	A powder metal tool steel which provides extremely high wear resistance in	40	63	

Figure 4

Data Driven Decision Making for the IM Designer Continued

Make sure you receive a data sheet or process ticket that shows all of the recommendations from the Metallurgist and verify specifications from the steel supplier have been included. There are so many steels where formulations vary by supplier; missing any recommendations can results in a failed process.

Ask the person taking your order for a copy of the internal process document that was used to process your components. This can provide valuable information you would save with a project; at minimum, this will show all of the process profiles. The times and temperatures in these profiles can be referenced for future projects or point out anything that might have been left out of a process. This is not to be confused with a heat treat certification and should not carry any additional fee. (**See Figure 5**)

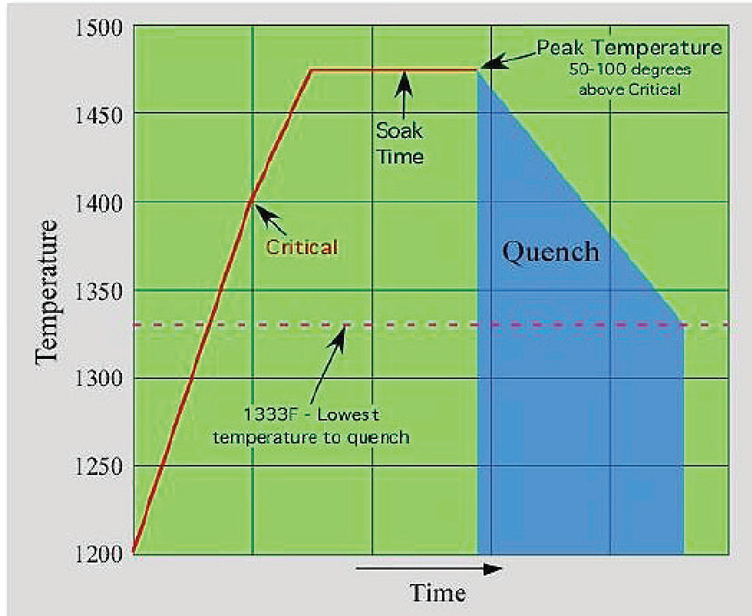


Figure 5

Powder Metallurgy Steels

There is an entire category of tool steels with outstanding wear resistance; many were designed to replace carbide in tooling applications. They are specific to their manufacturer and many carry a high price by comparison to cold work tool steel, due to the process required to make them.

The process starts similarly to conventional tool steel. The base metals are melted and the alloying elements are added to the melt. Next, the molten metal is poured through a high pressure nozzle and into an atomization chamber. The steel is flash frozen by a blast of nitrogen causing the steel to separate into droplets less than 100 microns in size. Each one of these micro droplets has the exact same composition as the spherical shape which has eliminated any segregation that would normally occur using the standard process.

These micro spheres are collected and passed through the micron mesh leaving a powder made up of only very accurately sized particles. It is transferred into capsules that are vacuum evacuated and welded shut so the contents will not be contaminated.

The capsules are loaded into an isotonic press, heated to the proper forging temperature and forged under pressure, compacting the powder into one solid homogenous high purity ingot. These ingots are 100% dense steel with a super fine grain and uniform microstructure.

The ingots are passed through the mill for additional forging and rolling operations as in the standard steel production process. The compacted steel maintains the superb microstructure throughout the milling process.

Examples of commonly known PM tool steels used for molds are shown below with typical through hardness and notable properties and surface treatment options for wear resistance:

A-11: 59-61 Rc. Super high wear resistance with slightly lower than average toughness. It can be Nitride or Titanium Nitride treated. Not preferred for CVD treatment or welding for tooling repairs. This applies to most PM steels.

A-11LV: 52-54 Rc. Very high wear resistance. Its crack resistance is higher than other wear resistant cold work

Data Driven Decision Making for the IM Designer Continued

tool steels. Use when A-11, D-2 or high speed steels do not have the desired crack resistance. It can be limited to a hardness of 56 or lower Rc. and is not intended for applications that require high compressive strength. CVD Titanium Nitride does not adhere well due to low hardness. A-11 and A11LV are important choices to consider and not mentioned in the chart below.

CPM3V: 58-60 Rc. This steel provides more wear resistance and toughness than cold work A-2 or D-2 with less of a price increase over many PM steels. Nitride treatment and Titanium Nitride can be accomplished when a minimum tempering temperature of 1000 degrees F for CVD TiN is used. Tempering must be repeated three times for any application. It accepts cryogenic treatment for optimum stability after the first temper and followed by another temper.

Z-Wear PM: 58-62 Rc. Offers better wear resistance than A-2 or D-2 and a high degree of toughness even at 63 Rc. Excellent machining, grinding and heat treat response. Common tool coatings adhere well and it's a suitable sub-straight for most surface treatments. This steel is not found in the chart below but is mentioned as it offers superior properties.

M-4 PM: 60-62 Rc. Better wear resistance than M2 and M3 cold work steel. With such superior edge wear resistance it can be used for cutting dies. Salt quenching will provide maximum response to heat treatment and it can be Nitride treated or TiN coated.

(**See Figure 6 and Figure 7**)

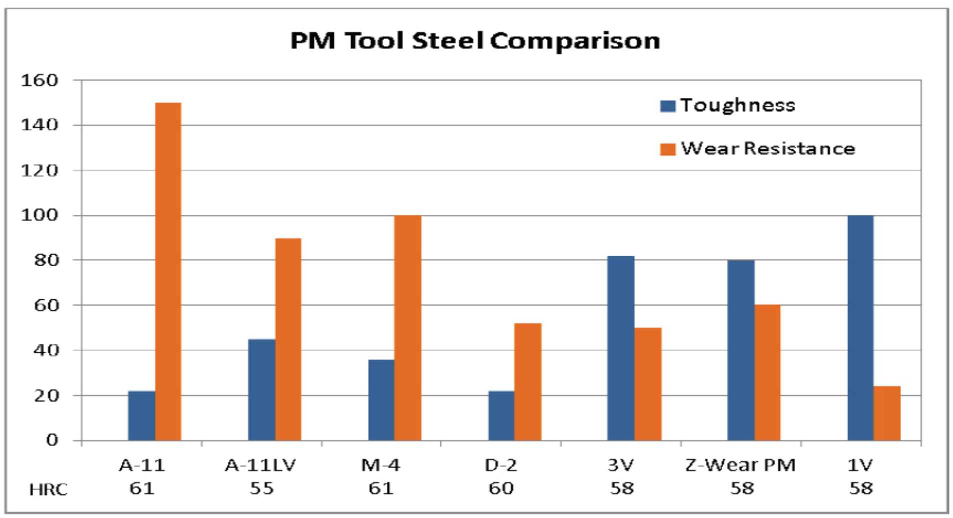


Figure 6

Surface Treatments

There are so many surface treatments available today for wear resistance; this could easily be the subject of many other papers. Volumes of books and research materials exist on the topic. I have mentioned the four most common surface treatments for wear resistance.

Nitride has long been a substantial solution for wear resistance of tooling components. Overall, there are three major types of Nitride common today, each defined by how it is applied:

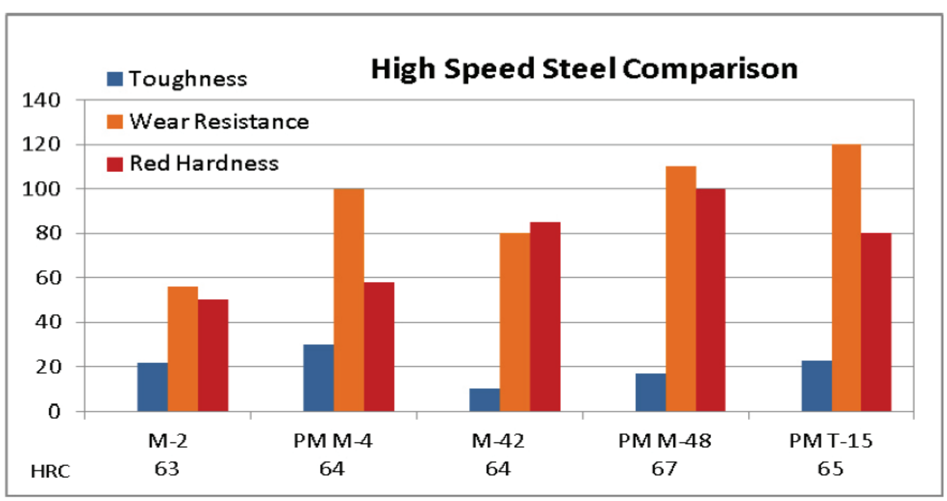


Figure 7

Data Driven Decision Making for the IM Designer Continued

Gas Nitride: As it implies, this process uses a furnace with a Nitrogenous atmosphere to apply the treatment to the surface. The work piece is through hardened and tempered prior to this process.

ION Nitride: This is applied to the surface in a vacuum. High voltage is used to form a plasma through which Nitrogen ions are accelerated and bombard the surface. This ion bombardment heats and cleans the work piece and provides active nitrogen. Conducted at low temperatures, this process provides stability and production repeatability.

Liquid Nitride: Applied to the surface by fully immersing a component into a molten chemical salt bath. The advantage of the salt bath is the uniform surface and depth of Nitride. The disadvantage is maintaining the salt bath and regenerating it for optimum performance.

Titanium Nitride: The most common methods are physical vapor deposition or chemical vapor deposition. In both methods, pure titanium is sublimated and reacted with Nitrogen in a high energy, vacuum chamber.

All of the Nitride processes add valuable corrosion resistance to the surface of the treated area.

Metallurgical Examination

To verify the quality of heat treatment and to find post mortem defects, metallurgical examination is a valuable tool. When testing can't be conducted or product history provides ample recommendation, for a like component, many times metallurgical verification is all that is necessary. It can be as simple as checking the hardness and microstructure of through hardened tool steel or to include the additional examination of a surface treatment.

At extreme circumstances, the elemental makeup of the steel itself can be found to identify the steel type. (**See Figure 8 and Figure 9**)

Photos supplied by North America Die Casting Association http://www.diecasting.org/default.php

Maintenance / Corrosion Detection

Any wear surface, in a mold, requires some basic maintenance for longevity. If the precise aligning surfaces are ignored, erosion from

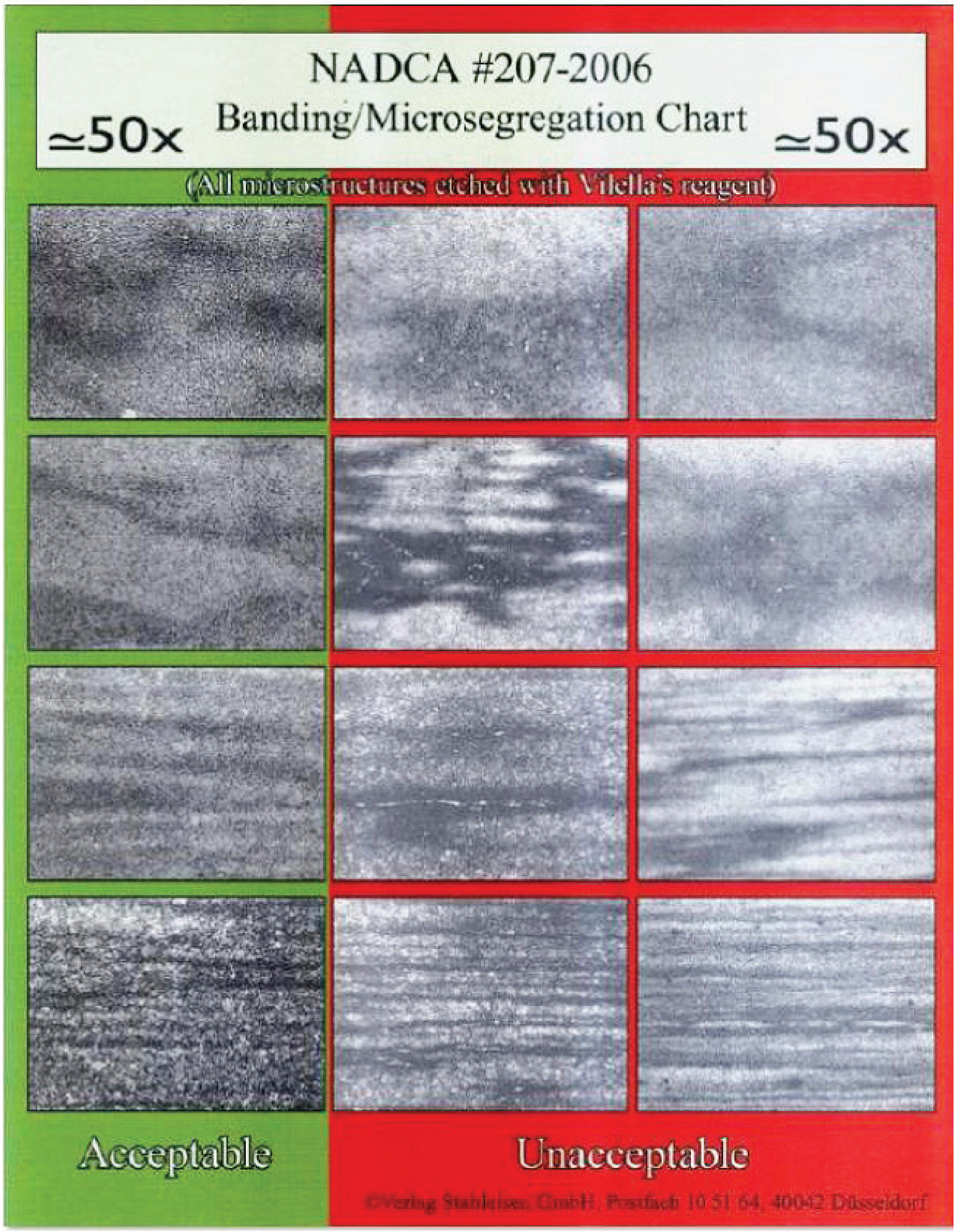


Figure 8

Data Driven Decision Making for the IM Designer Continued

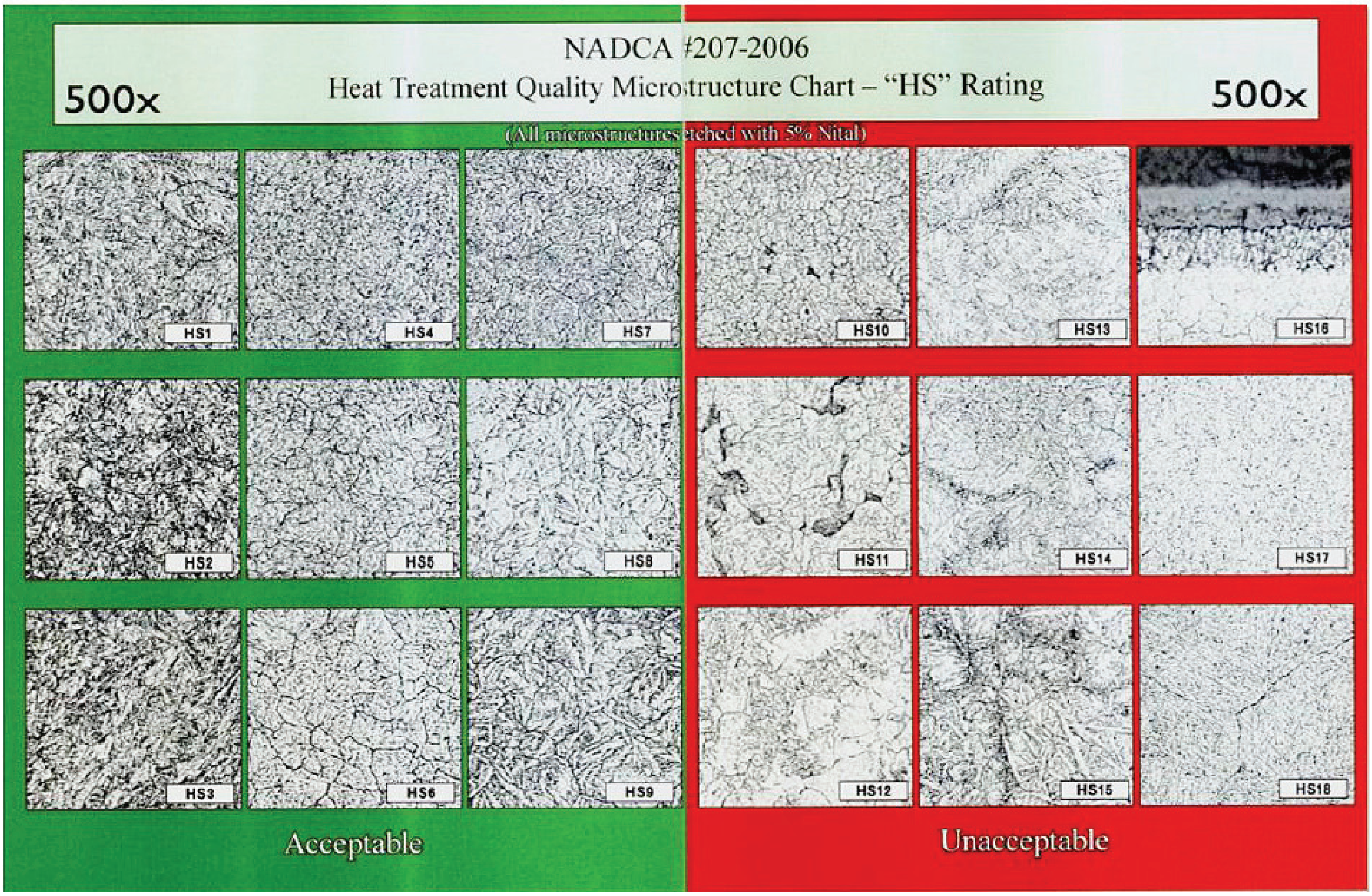


Figure 9

particle build up or corrosion can occur. Airborne abrasive particles that would also be detrimental to the mold need to be controlled. These particles, collecting in the mold, can cause steel erosion that will shorten the life of precise clearance components. Corrosion is probably the most detrimental as it can cause a smooth running surface to become a microscopically, stippled, grinding/lapping tool that can eat away at mating surfaces. Corrosion can be accelerated by the caustic gas of some molding resins and should be directed away from and not into interlock locations; a common error since they are many times located on center of the plates. Other factors that can accelerate corrosion are lack of cleaning and lubrication and little protection against moisture. Moisture can be from dew point condensation due to mold cooling and air temperature differentials, but also from air systems that aren't using a dryer or lubricants that over time have collected moisture or contaminants. Maintenance inspection of wear surfaces should be scheduled on a routine basis to protect their precision and only the highest quality components used to insure longevity.

Conclusion

Choosing the proper steel and treatment, for an application, can eliminate problems that could cause a mold to be pulled from service and sent for repairs to a mold maker. Customers will be left with an unpleasant reminder, if inexpensive, knock-off components that break or wear prematurely are used. Always chose a component supplier that knows the difference and is proven to provide the best in class materials and treatment to meet the task.

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For more information contact:

Raymond McKee
Sonoco
Raymond.Mckee@sonoco.com

Heidi Jensen
IMD Newsletter
PublisherIMDNewsletter@gmail.com

IMD Board of Directors Meeting

October 2nd, 2016

Troy, Michigan

Submitted by David Okonski

Welcome – Raymond McKee, Division Chair & David Okonski, Past Chair & Secretary

Chair Raymond (Ray) McKee called the meeting to order at 9:00 AM and welcomed all attendees to the Fall IMD Board Meeting. Past Chair and Secretary David Okonski welcomed all in attendance to the SPE Detroit Section 2016 Automotive Engineered Polyolefins Conference (otherwise known as the "TPO Conference").

Roll Call – David Okonski, Secretary

Present in person were:
Jeremy Dworshak (Chair-Elect), Pete Grelle (Technical Director), Joseph Lawrence, Ray McKee (Division Chair), Susan Montgomery (Councilor), David Okonski (Secretary), Hoa Pham, and Tom Ellingham (Guest).

Present via teleconference were:
Vikram Bhargava, Eric Foltz, David Kusuma, Kishor Mehta, Srikanth Pilla (ANTEC 2017 TPC), Rick Puglielli, Tom Turng, and Jim Wenskus.

This constituted a quorum.

Absent were:
Jack Dispenza, Nick Fountas, Brad Johnson, Adam Kramschuster, Lynzie Nebel, Sriraj Patel, and Mike Uhrain.

Approval of May 22nd, 2016 Meeting Minutes

The meeting minutes from the IMD Board Meeting of May 22nd, 2016 were presented.

Motion: Pete Grelle moved that the May 22nd, 2016 meeting minutes be approved, as written and distributed. Jeremy Dworshak seconded, and the motion passed at 9:10 AM.

Financial Report – Jim Wenskus, Treasurer (presented by Ray McKee)

For the 2015/2016 fiscal year, total expenses exceeded total income by $7,464 USD leaving a remaining balance of $40,942 USD. The 2016/2017 balance sheet was reviewed; current income of $11,211 USD exceeds current expenses of $2,035 USD leaving a current balance of $50,118 USD. The Division appears to be in good financial standing.

Action Item: Jim Wenskus needs to confirm the receipt of the SPE rebate monies.

Action Item: At the February (Winter) Meeting, the IMD Board needs to further discuss, establish, and implement a reimbursement policy (including the necessity of a trip report) for conference expenses incurred by IMD Board members who attend a conference and spend time marketing the Division for the purpose of generating membership.

IMD Board of Directors Meeting Continued

ANTEC 2017 Update – Srikanth Pilla, TPC

Srikanth Pilla informed the Board of the following:
1) Submission Deadline for ANTEC papers is January 17th, 2017
2) Final paper due date is February 28th, 2017
The ANTEC paper review will be conducted at the winter meeting in Orlando, Florida on or about February 3rd, 2017.

Action Item: Pete Grelle is to review and evaluate the use of eTouches for the purpose of reviewing papers.

Technical Director Report – Pete Grelle, Technical Director

Pete Grelle presented an update on IMD involvement in future TOPCONS as well as future IMD webinars. egarding TOPCONS, the IMD will once again provide technical content to the SPE Automotive Division & Detroit Section AutoEPCON Conference to be held in May 2017; the conference theme is "Plastics on the Move". The IMD will receive a share of the conference profits for our participation. Pete also informed the Board that the IMD will once again participate as a sponsor of the Penn State Erie TOPCON – "Innovations & Emerging Plastics Technologies Conference" – to be held in Erie, Pennsylvania on June 22nd & 23rd, 2017.

Regarding the IMD webinar series, three webinars will be offered during the 2016/2017 fiscal year. IMD Board member Vikram Bhargava will be presenting two webinars: "New Process Technologies" and "Material Selection for Injection Molding." The final webinar "Troubleshooting the Injection Molding Process" will be presented by Division friend and supporter Jon Ratzlaff.

Communications Committee Report – Rick Puglielli, Chair & Adam Kramschuster, Co-Chair

Newsletter (Rick Puglielli): Rick Puglielli informed the Board that newsletter editor Heidi Jensen needs our content submissions by October 10th, 2016.

Website (Adam Kramschuster): No website report/update was provided.

Membership Committee Report – Erik Foltz, Chair

Erik Foltz informed the Board that updated membership numbers would be available on October 5th, 2016; but based on what data was currently available, IMD membership stands at 2,463. The geographic regions having significant membership numbers are India, the Detroit Michigan area, and the Akron Ohio area. Division demographics indicate that the majority of our members come from: 1) universities/academia and 2) material suppliers. Based on historical data, Eric estimates that half of our current membership will let their membership lapse for a period of about two years. Eric looked at drop/lapse data for those members that are 40+ years old; out of 972 queries, only two responses were found as to why the drop/lapse – no company reimbursement. An observation was made that we need more than just quarterly communications that promote the value of membership as a means for professional development, continued technical education, and the establishment of a professional network. Lastly, an increase in membership dues is expected.

IMD Board of Directors Continued

Nominations Committee Report – Hoa Pham, Chair

Hoa Pham provided the following update on the Call for Nominations for the 2017 Ballot:

Current IMD Board Officer Positions with terms ending at ANTEC 2017:

1) Chair:	Raymond McKee	Nominee for 2017:	Jeremy Dworshak
2) Chair-Elect:	Jeremy Dworshak	Nominee for 2017:	Srikanth Pilla
3) Treasurer	Jim Wenskus	Nominee for 2017:	Open
4) Technical Director:	Pete Grelle	Nominee for 2017:	Open
5) Secretary:	David Okonski	Nominee for 2017:	Open
6) Councilor:	Susan Montgomery	Nominee for 2017:	Open

Regarding the ANTEC Technical Program Chair (TPC), Hoa reaffirmed the following:

1) ANTEC 2017 TPC is Srikanth Pilla,

2) ANTEC 2018 TPC is Rick Puglielli,

3) ANTEC 2019 TPC is David Kusuma,

4) ANTEC 2020 TPC is David Okonski,

and issued a call for volunteers for TPC Chair for ANTEC 2021 and beyond.

Note: IMD Board members that are due for election in 2017 include: Jack Dispenza, Brad Johnson, Susan Montgomery, Hoa Pham, Vikram Bhargava, Joseph Lawrence, Sriraj Patel, and Lynzie Nebel.

HSM & Fellows Update & Awards Committee Report – Tom Turng & Kishor Mehta, Chairs

HSM & Fellows Update (Tom Turng): Tom Turng informed the Board that he is working with Vikram Bhargava to complete the Fellows application for Suhas Kulkarni. Also, Vikram Bhargava is being considered for Honored Service Member.

Engineer of the Year Award (Kishor Mehta): No report/update was provided.

Education Committee Report – Srikanth Pilla, Chair

No education report/update was provided.

Councilor Report – Susan Montgomery, Councilor

Susan Montgomery informed the Board that the Executive Committee becomes the Governing Body at ANTEC 2017. The Governing Body will consist of a Treasurer, the Chief Staff Executive plus ten other positions; two of the ten will be filled by progression, six will be voted on by Council, and the remaining two voted on by

IMD Board of Directors Meeting Continued

the membership at large. The Council will retain the full control of a simplified set of bylaws, and Council has veto power to overturn Governing Body actions.

Pinnacle Award & Discussion of 2016/2017 Goals & Work Plan – Ray McKee, Chair

It is the responsibility of Chair-Elect Jeremy Dworshak to complete the Pinnacle Award Application with the assistance of all IMD Committee Chairs (as well as all remaining Board members). Ray McKee reaffirmed the importance of making the 2016/2017 Goals & Work Plan relevant and much discussion ensued to accomplish that and to establish reasonable metrics upon which to judge success. Having already recognized the strong demographic contribution to membership from universities/academia, the major points of the ensuing discussion focused on: 1) attending more university events to create a one-on-one/face-to-face connection with students and 2) creating a webpage tab for "Careers & Opportunities". Another goal was established to create an IMD TOPCON that would be solely managed/executed by the IMD Board of Directors and to accomplish this task in the next 12 to 24 months. Putting on a conference on our own is a formable task and will require the Board to be populated with members having the appropriate skill sets.

Action Item: Identify the required skill sets needed to host and execute an IMD TOPCON and identify & recruit Board members that fulfill these needs.

Old Business – Ray McKee, Division Chair

At the ANTEC 2016 Board Meeting, David Okonski petitioned the IMD Board of Directors to create a Sponsorship Committee that would report directly to the Division Chair, and the First Presentation requirements were fulfilled. After some discussion, the Board decided to amend our bylaws to include a Sponsorship Committee.

New Business & Round Table – Ray McKee, Division Chair

No new business was discussed. No Board member had any round table items for discussion.

Adjournment – Ray McKee, Division Chair

Motion: Ray McKee made a motion to adjourn the meeting. Jeremy Dworshak seconded, and the motion passed. The meeting was adjourned at 1:50 PM Eastern Time.

The next meeting will be held on February 3rd, 2017 at Tupperware World Headquarters.

Tupperware World Headquarters
14901 South Orange Blossom Trail
Orlando, Florida 32837

Respectfully Submitted by David Okonski
November 22nd, 2016

IMD Leadership

DIVISION OFFICERS

IMD Chair
Raymond McKee
Sonoco
Raymond.Mckee@sonoco.com

IMD Chair Elect
Jeremy Dworshak
Steinwall Inc.
jdworshak@steinwall.com

Treasurer
Jim Wenskus
wenskus1@frontier.com

Secretary
David Okonski
General Motors R&D Center
david.a.okonski@gm.com

Education Chair,
Reception Chair and
TPC ANTEC 2017
Srikanth Pilla
Clemson University
spilla@clemson.com

Technical Director
Peter Grelle
Plastics Fundamentals Group, LLC
pfgrp@aol.com

Past Chair
David Okonski
General Motors R&D Center
david.a.okonski@gm.com

Adam Kramschuster
University of Wisconsin-Stout
kramschustera@uwstout.edu

Erik Foltz
The Madison Group
erik@madisongroup.com

Councilor, 2014 - 2017
Susan E. Montgomery
Lubrizol Advanced Materials
susan.montgomery@lubrizol.com

BOARD OF DIRECTORS

TPC ANTEC 2016
Education Committee Chair
Srikanth Pilla
Clemson University
spilla@clemson.com

TPC ANTEC 2018
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Rick Puglielli
Promold Plastics
rickp@promoldplastics.com

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David Kusuma
Tupperware
davidkusuma@tupperware.com

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Sponsorship Chair
David Okonski
General Motors R&D Center
david.a.okonski@gm.com

Membership Chair
Erik Foltz
The Madison Group
erik@madisongroup.com

Engineer-Of-The-Year Award
Kishor Mehta
Plascon Associates, Inc
ksmehta100@gmail.com

Awards Chair
HSM & Fellows
Lih-Sheng (Tom) Turng
Univ. of Wisconsin — Madison
turng@engr.wisc.edu

Web Content Masterr
Adam Kramschuster
University of Wisconsin-Stout
kramschustera@uwstout.edu

Assistant Treasurer
Nominations Committee Chair Historian
Hoa Pham
Freudenberg Performance Materials
hp0802@live.com

Jack Dispenza
jackdispenza@gmail.com

Lee Filbert
IQMS
lfilbert@iqms.com

Brad Johnson
Penn State Erie
bgj1@psu.edu

Michael C. Uhrain IV
Sumitomo
michael.uhrain@dpg.com

EMERITUS

Mal Murthy
Doss Plastics
Dosscor@gmail.com

Larry Schmidt
LR Schmidt Associates
schmidtlra@aol.com

IMD New Members

The Injection Molding Division welcomes 54 new members…

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David Kubank
Rachel Randall
Cesare Lorenzetti
Gerard Wondrasek
Lloyd Martin
Ryan N Troiano
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Robert D. Poupard
Kyle Fossey
Norio Ozawa
Scott Kushion
Rudy Flores
Hudson Moody
Jason Carr
Dany De Kock
Gerald M Ferrara
William Grice
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Musa R Kamal
William J Gould
Adam Mullin
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Katie Kozub
Mark Harburg
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Lukas Steven
Jared Johnson
Matthew S Piatek
Kylie DeClue
Kyle Tarr
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David Rewalt
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Timothy Spurrell
Dr. Alicyn Marie Rhoades
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Message from the Publisher

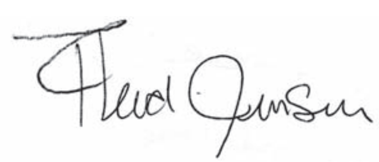
Hello members!

I hope you enjoyed this latest edition. As the year is drawing to an end, SPE is gearing up for the 2017 year. ANTEC 2017 planning is underway and is open to paper submissions as well as, exhibitors and sponsors. If you are interested in any of these areas please visit 4spe.org/events for all deadlines for paper submissions, floor plan and sponsorship programs.

The next edition of the newsletter will be this Spring 2017 Articles, technical articles and sponsors are now being accepted for this issue. Reach out to your fellow SPE members with your knowledge, experience and support for SPE

Thank you to all the authors and sponsors for their continued support this year. I hope all of you have a safe and enjoyable holidays.

Heidi Jensen PublisherIMDNewsletter@gmail.com



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