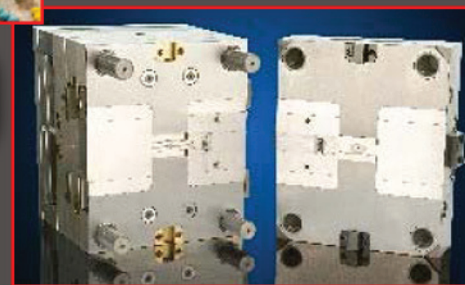
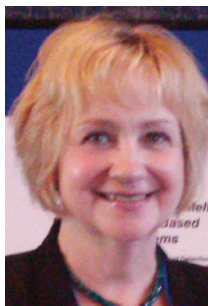
Spring 2013 | No. 92

MOLDING VIEWS



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



Chair's Message

Greetings!

For those of us in the snow belt, we are greatly anticipating the arrival of Spring!

Spring also brings us an opportunity to tap into the newest developments for injection molding technology at ANTEC 2013.

This year's ANTEC will be held from April 22-24 at the Duke Energy Convention Center in Cincinnati, OH. Our Technical Program Chair, Pat Gorton, and the ANTEC Paper Review Team (Peter Grelle, Erik Foltz and Adam Kramschuster) have done an excellent job in arranging a full three day program. Topics include Process Control, Simulation, Materials and Tooling, plus others.

ANTEC also brings a new slate of officers for the Injection Molding Board of Directors (IM BOD). Erik Foltz from The Madison Group will be taking over as IM BOD Chair for the 2013-2014 term. We look forward to the enthusiasm, ideas and programs he and the new officers will be offering our Injection Molding Division.

In This Issue:

This Month's Features:

Chair's Message Continued

I would like to thank the members of the Injection Molding Division, our SPE management (Wim DeVos, Sarah Sullinger and Jon Ratzlaff) and our IM BOD for their support over the past two years. It has truly been an honor and a pleasure to have served in the Division Chair role.

Best regards,
Susan Montgomery
Chair, IM BOD

Industry Events Calendar

April 2013

10-11: **MC² MTConnect: Connecting Manufacturing Conference**
The Millennium
Cincinnati, OH
http://www.mtconnectconference.org/

22-23: **Inside 3D Printing Conference and Expo**
Javits Convention Center
New York City, NY
http://www.mediabistro.com/inside3dprinting/?c=i3dgard

May 2013

6-7: **Advanced Extrusion Seminar, 2 Day Seminar**
Sheraton Sand Key Resort
Clearwater Beach, FL
http://www.rauwendaal.com/AdvancedExtrusion-2013.htm

20-22: **Twin Screw Compounding Seminar 2 Day Seminar**
Sheraton Sand Key Resort
Clearwater Beach, FL
http://www.rauwendaal.com/TwinScrewCompounding2013.htm

June 2013

12-13: **amerimold 2013**
Donald E. Stephens Center
Rosemont, IL
https://register.rcsreg.com/r2/amer2013/ga/index2.html

FREE TECHNICAL SEMINAR ON ADVANCED MATERIALS AND PROCESSES

Crafts Technology

May 8, 2013 & October 9, 2013
Elk Grove Village, Illinois

Crafts Technology is hosting a free technical seminar on "Advanced Materials and Processes". The seminar will be held on May 8, 2013 and October 9, 2013 at their Elk Grove Village, Illinois location. This seminar is designed to provide technical information on Cemented Tungsten Carbide and Advanced Ceramic materials. The team of experts will address all of the properties of the materials, examples of applications, and benefits. They will discuss modes of failure and how proper grade selection plays a major role in solving wear and corrosion problems in the manufacturing process. This half day event is free to qualified enrollees. To attend, visit Crafts Technology website at www.craftstech.net or contact David LeMaistre at **847-758-3100.**

REGISTER TODAY!

ANTEC® 2013, produced by the Society of Plastics Engineers, is **THE LARGEST ANNUAL TECHNICAL CONFERENCE IN THE U.S. FOR THE PLASTICS INDUSTRY,** with 2,500 attendees and over 600 paper presentations.

ANTEC® 2013

April 22-24, 2013

Duke Energy Convention Center

Cincinnati, OH

www.4spe.org

The conference will take place in Cincinnati, Ohio and will also include an NPE powered exhibit floor featuring the industry's top suppliers and solutions providers. Step from classroom theory and trends directly on to the show floor for real-world solutions. The full conference schedule, to include all networking events, can be found here.

Full conference attendees receive the conference proceedings as part of their registration.

Reserve your exhibit space and sponsorship by contacting NPE Sales at exhibit@npe.org or by calling 703-259-6132.

Join your industry at the one annual event that will help you chart your course for the year, register now.

JOIN US AT THE RECEPTION!

5:30-7:30PM AT THE DUKE ENERGY CONVENTION CENTER, CINCINNATI, OH ON TUESDAY, APRIL 23RD.

Moldex3D
MOLDING INNOVATION

Ask the Experts: Bob Dealy

Injection Molding Topics Include:
Dimensional Variations
Qualified Personnel Issues

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: I'm trying to determine what is creating batch to batch dimensional variation in a polypropylene part we are molding on a 220 ton electric 8 ounce machine. Is it the mold, the material or the molding machine??

A: Obviously dimensional variation can be caused by everything associated with the injection molding process. The first step in analyzing what is creating the variation is to understand exactly where the variation is occurring.

This evaluation can take many forms, but one method of identifying the cause is to first eliminate what is not contributing to the problem. As example; is the dimensional variation occurring across the parting line of the mold? If it is then the mold and the machine could be creating the problem. If the variation is occurring on a dimension created solely by a mold component located only in one half the mold and in addition to the variation the mean changes, the mold is typically not the problem.

When the dimensional variation is within the parts tolerance zone but the mean is not on target, then most often a modification to the mold feature is required.

When the dimensional variation exists within one production run where the same material, colorant and/or additives lots are utilized, this typically points to the molding machine. Checking on transfer points, cushion, peak pressures, melt temperature, mold temperature and fill times, to name a few major points, should be analyzed for variations. These variables often correlate with product dimensional variations.

Should the dimensional variation be most evident from one production run to the next the focus should center on the plastics material and/or additives. Things like lot numbers, colorant ratios, percentage of regrind and moisture levels should be investigated. Polypropylene being a semi crystalline material will

Ask the Experts: Bob Dealy Continued

react differently to different colorants and it is common for dimensional variation to result due to its effect on the degree of crystallinity development.

During the elimination phase of the evaluation hints will become apparent as to what parameters could be creating the variation. At this point employing a "Design of Experiments" process usually makes sense.

Taguchi believed that there are three phases for quality; first, the system design; secondly, the parameter or measure design; and, finally the tolerance design. Using a process that includes an analysis of variance is a good method to pin point the problem you've stated.

Utilizing an orthogonal array is a proven method to identify causes and interactions. Often setting up the experiment identifies what is creating the conditions responsible for dimensional variation. If not, after running the experiment you should have a clearer understanding of the causes. Once the variation culprit has been identified, creating the correction phase of the project is greatly simplified.

Q: Changes and downsizing of manufacturing in the USA has resulted in great loss of experienced people, technical knowledge and personnel with specific skill sets in both staff and management positions in the plastics industry. Where can one turn for counseling or mentoring to help fill that vacuum?

A: The first thing I would explore is the possibility of retaining retired former employees that are familiar with your operation. A large untapped pool of talent could be available and many of these people are willing to contribute. Obviously, these people could make excellent mentors as well.

In the likely event your goal is to significantly upgrade your technology base and manufacturing processes a consultant is a viable option. Look for those companies who are associated with organizations in your technology. The Society of Plastics Engineers is a good place to start. Universities with plastics programs are another likely source of up to date technical people.

I will be happy to direct you to people that can be of help if you provide the specific technical, counseling or mentoring technology you need to locate. My e-mail is MoldDoctor@DealeyME.com

As always, if any of our readers know of any rules of thumb or can offer additional advice, please write me at MoldDoctor@DealeyME.com

Bob Dealy *Dealy's Mold Engineering*

Do You Have an Issue With Injection Molding?

Send you question to the Dealy's Mold Engineering

MoldDoctor@DealeyME.com

Ask the Experts: Terry L. Schwenk

Hot Runner Questions

The purpose of this column is to provide valid information concerning hot runner technology. We invite you to submit questions or comments to our hot runner expert. Terry L. Schwenk has over 35 years of processing and hot runner experience. Terry is currently employed with EWIKON Molding Technologies and can be reached by mailing: terry.schwenk@ewikonusa.com.

Q: What are the differences between cold runner and hot runner systems?

A: At first the answer seems obvious. A cold runner tool allows plastic resin to enter the tool flowing in channels usually at parting line suffice to fill the mold cavities. Where as hot runner system is a melt transfer system in which the plastic flows through orifices in a heated vessel to fill the mold cavities. However, when we look how the two systems are processed, it's like night and day. There is a tendency by many processors to apply the same molding techniques they have use on cold runner systems to hot runner systems ending with unexplained results.

It is very important to understand the differences between cold runner tools and hot runner tools as to how the plastics resin flows through each. One must understand how to properly process each system. A processor should have knowledge in the advantages and limitations of each system.

When processing a cold runner system you are time limited during the pack and hold phase of the injection molding cycle. The cold runner begins to freeze off the moment the material stops moving, limiting the amount of time you have to pack the part out. So during the injection process in the cold runner the focus needs to be at the early phase of the injection process making sure you build injection velocity through the runner entering the gate and cavity where you can fill and pack the part out. The injection process ends with the freezing of the gate.

When processing a hot runner system the emphasis will be on the end of the injection phase because you have more time during pack and hold with the gate staying open for a longer period of time. Cold runner systems have one distinct advantage over a hot runner system do to the fact that cold runner system has the luxury of establishing the melt viscosity and melt velocity prior to filling the part. Because you flow through the runner before entering the cavity, you can establish the melt. To simulate the same filling conditions in a hot runner, you would need to have the injection unit up to full velocity in zero time, which

Ask the Experts: Terry L. Schwenk Continued

is impossible. It is for this exact reason you can never apply the same processing techniques from cold runner system to hot runner systems.

Another aspect of the injection process that is not fully understood by a lot of processors is inertia and kinetic energy. Inertia comes in play where as Isaac Newton discovered things in motion tend to remain in motion and things at rest tend to stay at rest. The injection unit is at rest until we force it forward in the injection phase. Once we get it in motion it wants to remain in motion until the plastic pressure creates enough opposite force that it stops the forward movement. The kinetic energy comes in play in way of velocity. The formula is

$$KE = \frac{1}{2} * m * v^2$$

Where m=mass of object
V=speed of object
KE=kinetic energy

This equation reveals that the kinetic energy of an object is directly proportional to the square of its speed. That means that for a twofold increase in speed, the kinetic energy will increase by a factor of four. For a threefold increase in speed, the kinetic energy will increase by a factor of nine. And for a fourfold increase in speed, the kinetic energy will increase by a factor of sixteen. The kinetic energy is dependent upon the square of the speed. As it is often said, an equation is not merely a recipe for algebraic problem solving, but also a guide to thinking about the relationship between quantities.

What this means in the realm of injection molding is for every time you double the injection velocity you quadruple the weight of the injection unit. So a really fast injection velocity can increase the cavity pressure beyond the rated injection pressure of the press. It's the same principal why a simple hammer can become a very efficient nail driving tool. The weight of a hammer head alone cannot drive a nail into a wooden board. However swung at a high velocity the hammer has enough kinetic energy to drive nail into the board. This is the same principle why a high injection velocity has enough kinetic energy to blow open the platen high tonnage press even though the tonnage calculation doesn't show it is possible.

Understanding these simple laws will aid in applying the proper techniques to processing either cold runner tools or hot runner tools.

Terry L. Schwenk *EWIKON Molding Technologies*

SEND IN YOUR HOT RUNNER QUESTION OR TIP TO:
E-mail Terry Schwenk at terry.schwenk@ewikonusa.com

Ask the Experts: Steve Johnson

Maintenance Discipline
How Do I Get It?

Please submit any questions or comments to maintenance expert **Steve Johnson**, *Operations Manager for ToolingDocs LLC, and owner of MoldTrax.*

Steve has worked in this industry for more than 32 years.
E-mail Steve at *steve.johnson@toolingdocs.com*
or call (419) 281-0790.

Q: In the last issue you wrote about the type of experience a person needs to repair tools in today's busy tool room. We hired two employees about six months ago and though both appeared to be highly qualified, the "OJT effect" that you spoke of seems to have kicked in, resulting in both employees noticeably slowing down and seemingly not caring as much. How does one go about improving discipline in a maintenance environment?

A: Discipline is a nasty word to some. Many people don't even like the sound of the word. It resonates something repressive, controlling, unpleasant and harsh. It makes the hair on one's neck stand up. Our Native Americans didn't like it either. If they could have acquired a small degree of it, and worked together as a unified force instead of small bands of disconnected ideas, experts claim that the US would be about 100 years behind where we are now. But there were just too many chiefs and warriors that wanted to do things their own way, so even with large numbers and much bravado; they lost control of the very lands on which they were experts at surviving. Sounds like a few companies I've read about.

What is it?

Discipline, in the life of a tradesman, is a mental skill. It's as important — if not more so — than possessing the physical ability to make your hands do exactly what the mind tells them to.

There are several Webster definitions for it, but somewhere I came upon a good one that described discipline as "having the ability to do what is hard when it is the hardest to do".

Unfortunately, some kind of discipline is required in almost everything we do. The lack of this character trait has been the downfall of many good people, ideas, and opportunities. Why is it so hard to attain? Because it requires a skill not usually acquired until the latter stages of our lives — after we have learned too many lessons the hard way.

Ask the Experts: Steve Johnson Continued

Many U.S. companies have shut down and/or moved overseas because of the lack of discipline. Sure, politics and low wages have played a prominent role in stunting the growth of businesses large and small via unfair trade agreements, tariffs, taxes and regulations. But other factors closer to home include a lack of simple, everyday workplace discipline in performing prescribed tasks, resulting in the general diminishing perception concerning the value of shop floor trade skills. Reversing this exodus to foreign countries will not only require major political moves, but it can also be affected by a single shop floor employee simply doing his job in a more efficient, effective and disciplined manner. In the extremely expensive field of injection mold maintenance, not doing so can most definitely be the last straw.

Discipline to Do the Right Thing

For a repair technician, it is the ability to follow prescribed administrative processes such as SOP's, BOP's, work instructions, etc. that provide instruction and continuous training to perform duties in a controlled and systematic way. It's a professional approach, if you will. A conscientious, disciplined tradesman will do the right thing even if no one is watching. By operating in this manner, results are more consistent and predictable. They allow us to make smart decisions behind a bench, in turn allowing a company to optimize labor and tooling costs. The lack of a formalized, strategic and measurable plan leaves repair technicians on their own to determine how best to spend both their time (critical labor hours) and thousands of dollars of company funds (tooling).

It makes no sense to abandon a repair tech at his bench, and then expect him to efficiently and effectively control these thousands of dollars on a daily basis, one repair at a time — and we haven't even begun to consider maintenance decisions that also directly affect part quality.

Ask the Experts: Steve Johnson Continued

Motivation comes in many forms and skilled, disciplined craftsmen who take pride in their trade want to work in a system where their accomplishments are measured against a standard vs. going un-noticed or lost in the fire-fighting cultures of a typical shop.

Difficult To Detect

Discipline is hard to detect and can be difficult for some to acquire, but it is in fact what separates men from boys, or a craftsman from someone who has simply been "doing it all his life." Typical American skilled tradesmen are by nature competitive, proud freelancers. The challenge then is how to harness and manage these individual qualities that separately have good moments, but jointly can achieve great accomplishments.

From a hands-on perspective, discipline at the bench means performing tasks using best practice techniques, and with tools and methods learned through experience with little or no supervision. A

Ask the Experts: Steve Johnson Continued

disciplined craftsman performs in this manner simply because his gut tells him it is the right thing to do. He knows working in a systemized approach, though perhaps not always as interesting, will yield profitable results by reducing costly mistakes on expensive mold components that occur during the disassembly, troubleshooting, cleaning and assembly stages of repair. This goes for anything bench-related that causes production to be halted and a mold repaired before it's scheduled.

With all the American ingenuity and plastics processing technology at our disposal, many tool room supervisors and managers still lack the desire — or discipline — to create a structured and formalized maintenance road map for repair technicians to follow and for skills to be measured with. In most cases, record keeping methods actually promote work that is substandard through ambiguous, illegible, nonstandard terms and incomplete "maintenance stories" in work order systems where accountability is non-existent.

Structure Promotes Discipline

Now, with all that said, a shop's level of maintenance discipline is just as much a factor of the working environment as our individual character is that controls an internal drive towards performance excellence. A structured approach is not only necessary to achieve continuous improvement in our processes and skills but it is a means to accurately measure this improvement over time. A structured approach to maintenance provides order and accountability to common tool room tasks that are viewed subjectively by apprentices and journeyman repair personnel alike.

A "structured approach" cannot take place without accurate data metrics where part and mold defect recognition, corrective actions taken, and tooling and labor used by every repair technician are counted and monitored to gage individual performance. It has to be this way.

Acquiring/improving maintenance discipline will not only save companies thousands of manufacturing dollars, but the metrics involved will provide motivational tools that will yield higher personal standards, increased morale and a renewed dedication to the job through the knowledge that skilled bench work is recognized and appreciated by our administrative leaders.

Bottom line? Maintenance discipline is a prerequisite to the health, prosperity and long term success of any molding company — once you learn how to measure it.

Steve Johnson *ToolingDocs LLC, and owner of MoldTrax.*

ToolingDocs Advancing Mold Performance

MoldTrax Track the Past and Secure the Future

To Refurbish or Replate. That is the Question.

Please submit any questions or comments to **Harry Raimondi**, *harry@balesmold.com or call 800-215-MOLD.*

Q: How can I tell when it is time to refurbish or re-plate my mold?

A: With the wide array of surface treatments, especially mold coatings, available today it makes sense to educate one's molding and repair technicians about how each type of coating helps signal the need for maintenance. This knowledge should be integral to any effective PM program because it ultimately saves time and money.

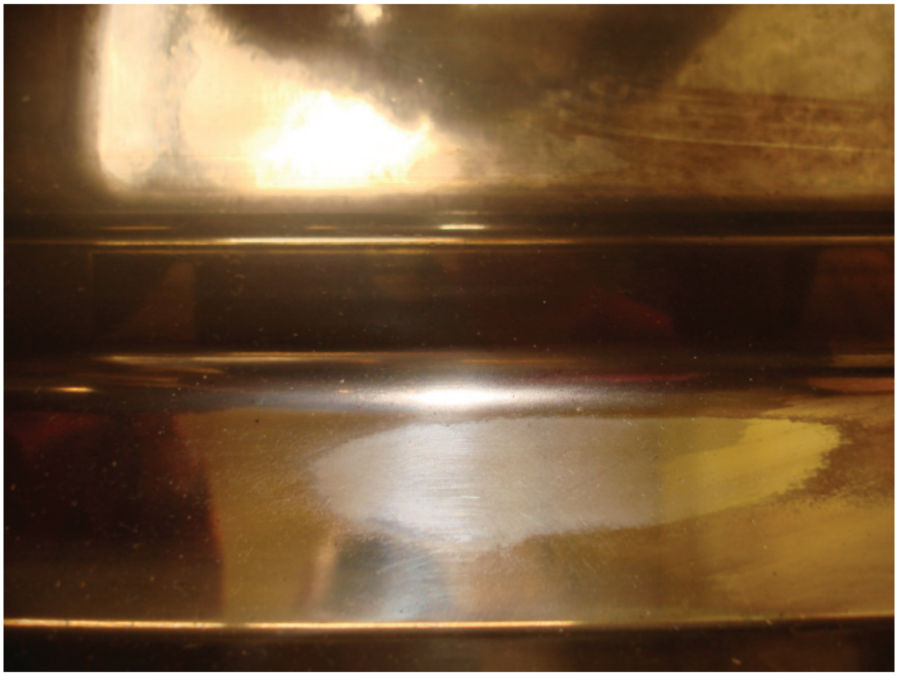
It's equally important that the moldmaker understand coating characteristics because they ultimately choose what coating to use and they are often charged with the care and maintenance of the tooling they build. By understanding the customer's production goals, they can help keep the mold running longer between maintenance stops.

The Wear Factor

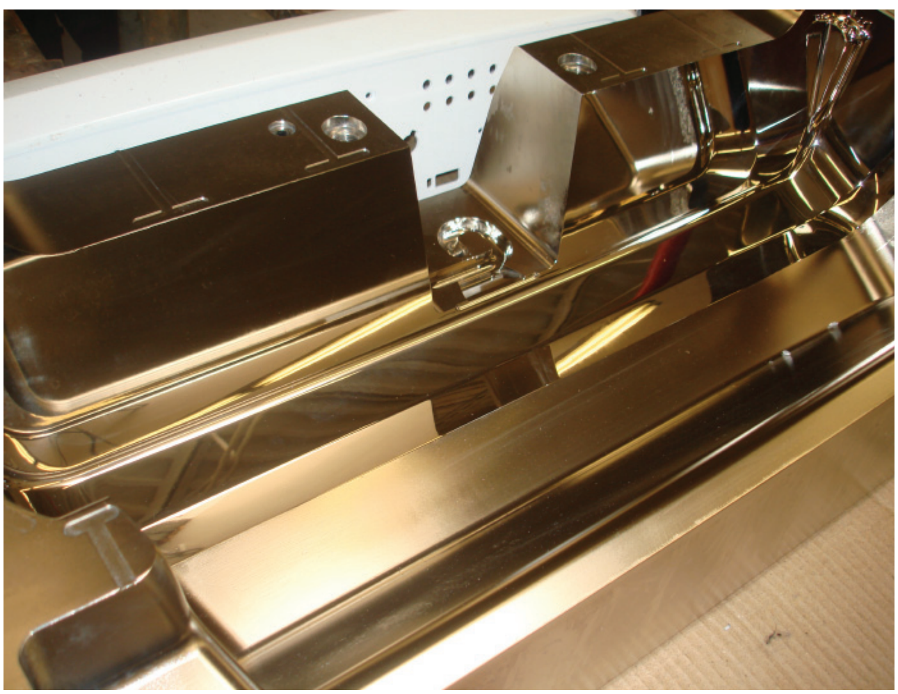
It's common practice to employ a mold coating to improve the performance of a mold. After all, a mold is a valuable investment and the key is to keep it running as flawlessly as possible for millions of cycles. Depending on the desired outcome, mold coatings can improve release or protect against corrosion and abrasion – or they can offer a combination of these benefits. But one thing is certain: every mold coating wears down over time. So it's important to know how to tell when deterioration is occurring, especially around high-wear areas like gates and runners.

It's also true that every coating is different, so here are some things to watch for when using some of the more popular coatings available today.

Ask the Experts: Harry Raimondi Continued



Before:
Mold tooling showing obvious wear of previously applied plating material.



After:
The same tooling after it is properly stripped and re-plated with electroless nickel.

Hard Chrome

The most obvious sign that wear is occurring with hard chrome plating is the appearance of a black spot or a dull brown spot similar to a heat stain. This happens because the chrome coating is approximately 20 RC points harder than the base steel, so exposed steel will wear much faster than the coated surfaces surrounding it. The discoloration will usually also be evident on the molded part.

Nickel

Signs of wear when using nickel are harder to detect. It will wear almost evenly, causing a kind of "feathering" effect on the mold surface. It is usually easier to identify wear by noting the color of the nickel coating, as it will produce a halo or shadow-like effect on the steel while the steel itself will appear more silver by contrast to the discolored or tarnished-looking coating. No step or edge will be evident.

Diamond Chrome

At more than 85 RC hardness, diamond chrome is a popular choice for when superior abrasion resistance is required on such mold components as cores, cavities, slides, ejector sleeves, and rotating and unscrewing cores. Its anti-galling properties are advantageous on moving cores and slides. Signs of wear using diamond chrome will

Ask the Experts: Harry Raimondi Continued

mimic those of hard chrome, so one should be looking for the coating to produce a halo or shadowing effect on the steel and the more silvery appearance of the steel underneath.

Nickel-Boron Nitride

Used on tooling requiring excellent release in combination with resistance to wear, heat, and corrosion, this electrolyzed nickel-phosphorus matrix containing boron nitride particles has a very low COF (0.05 against steel) and an RC hardness of 54, which can be increased to 67 RC after a post-bake process — a unique characteristic. Signs of wear will be similar to that of nickel and very similar in color as well, but it will not happen as quickly due to the composition of this plating matrix.

Nickel — PTFE

Nickel — PTFE is a co-deposition of auto catalytic nickel and PTFE, with PTFE making up 22% - 24% of the matrix by volume. Its excellent release properties and good corrosion resistance, combined with a low COF and a 45 RC hardness rating, make it especially ideal for cleanroom molding. Watch for wear areas similar to nickel except with nickel-PTFE, the color will be grayer while the base color of the steel appears more silver.

Avoid costly repairs and additional polishing expense by recognizing the signs of surface wear on plated molds. Ask your qualified plating professional for additional tips about coating characteristics and which coatings will work best for specific mold projects.

*For more information, contact **Harry Raimondi** at harry@balesmold.com or call 800-215-MOLD.*

SPE Exhibits at the Rochester Museum and Science Center – Holiday Science & Technology Days on December 28, 2012

This past December, SPE Injection Molding Divison went on the road to give lectures and demonstrations in Injection Molding. Students were able to view some of the important processes in molding.

Beginning the lecture on the excitement, romance and adventure of the 5-layer ketchup bottle.

Demonstrating and describing the use of recycled materials and their recycling codes.

Visitors molding screwdrivers on a small manually operated molding machine. Material is PP.

The effect of adding energy (by twisting) to the energy visualizer as seen under the dark field Polariscope

View of the machine. Visitor is clamping the mold. We mold over 1000 screwdrivers plus some other items every year.

Close up of the screwdriver mold.

Dipl.-Ing. Michael Fischer, ENGEL AUSTRIA GmbH, Schwertberg/Austria, www.engelglobal.com
Roger Kaufmann, Georg Kaufmann Group, Busslingen/Switzerland, www.gktool.ch
Alessandro Giordani, SO.F.TER SPA, Forlì/Italy, www.softerspa.com

Dolphin Process

Soft-Touch for the Price of 2-Component Injection Molding

One of the key differentiating features of modern cars is the interior. In addition to the overall design, special attention is being paid to the quality of the surfaces. A variety of manufacturing processes have been created to give interior grained surfaces a soft feel. The Dolphin process, which is unrivalled in cost effectiveness, is set to join the ranks.

Methods for manufacturing parts with a soft-touch surface must strike a balance between high quality requirements, technical feasibility and cost. Conventional processes used to generate a pleasant tactile feel — such as the laminating of compact injection molded thermoplastic parts or in-mold foaming with polyurethane or slush processes — have one thing in common; they are multistage processes, which inevitably involve trimming, folding or bending after the last shaping stage. The linking of the individual process steps and the secondary finishing processes are time consuming, increase the investment costs for the production line, require a logistical effort for conveying the semi-finished products that is considerable in many cases, and — like the production of PVC slush skins — are often very energy intensive.

Figure 1: More comfort in the driver's cabin: blinds and covers of the new Mercedes-Benz Actros are produced with softtouch-surfaces utilizing the Dolphin-method.

Figure courtesy of Daimler.

Feature: 2-Component Injection Molding Continued

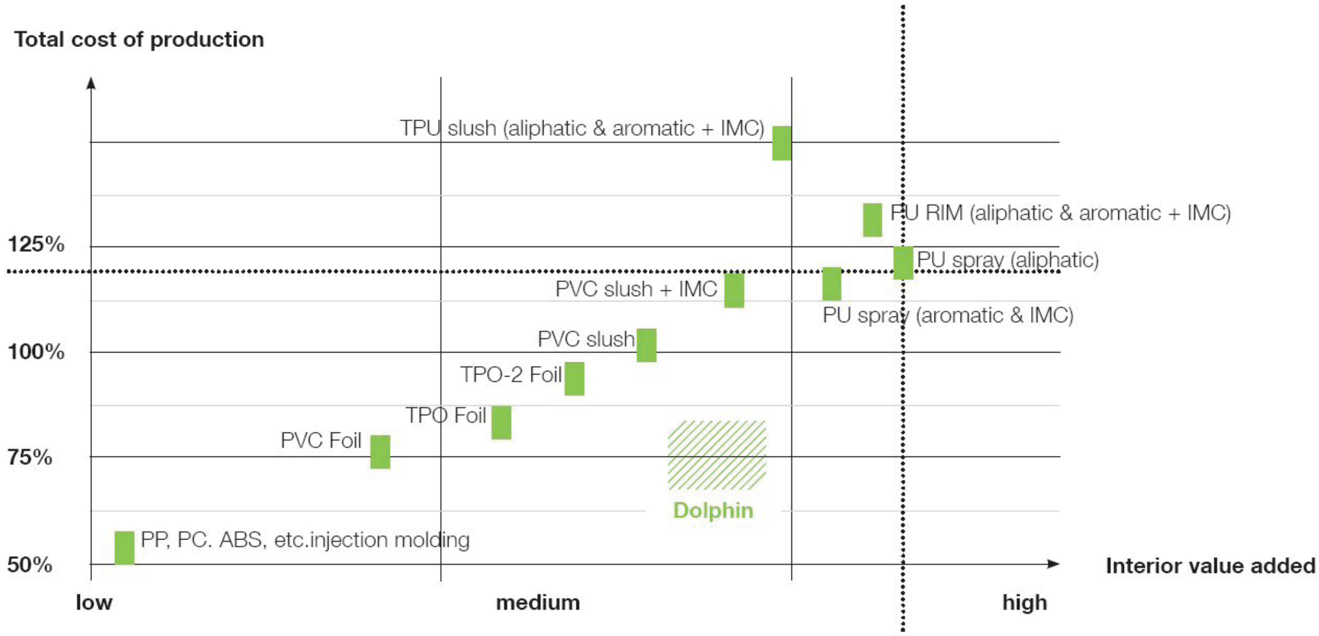


Figure 2: Cost versus quality: market positioning of the Dolphin process compared to conventional techniques. The results are based on a study performed in 2008 on cockpit and door lining parts, which has not yet been published. Figure courtesy of ENGEL

For those reasons, the aim of developing the Dolphin process[1] was to use thermoplastic injection molding to achieve soft-touch surfaces with a good level of softness, acceptable density and foam heights, with no secondary process required apart from sprue cutting. That is to say the soft surface should be applied (created) directly in the injection molding machine to (on) the hard support material. Also, the trend towards greater flexibility of manufacturing technology was taken into account. An injection molding machine that is suitable for this complex process can be used for different injection molds and processes and adapted to future product generations.

Balance Between Quality and Efficiency

According to a study on the market positioning of various surface enhancement techniques (**Figure 2**), the Dolphin process closes the gap between mold skins for extreme quality requirements in high-end automotive engineering and classic film-decorated injection moldings for cost-effective car production. The first applications have confirmed the high efficiency of the process (**Figure 3**).

Figure 3: . Instrument panels, armrests and folding interior elements are among the first products manufactured as prototypes or in small series. Figures courtesy of ENGEL, Daimler.

Feature: 2-Component Injection Molding Continued

Figure 4: The production line manufactures cockpit covers with softtouch-surface in just a single process step. Figure courtesy of SOLE.

The high saving potential of the Dolphin process can be illustrated in reference to a car instrument panel. The material costs for the part are calculated at $15.56 USD for the part, $5.75 for the backing and $9.81 for the foam layer. These values are based on a backing volume of 1,300 cm³. The backing has a surface area of 4,500 cm². With a starting value of approximately. 2 mm for the thickness of the TPE foam layer, this results in a TPE volume of 1,050 cm³. For a final wall thickness of 8 mm, the cycle time is about 150s. The cycle time of the entire process is determined by the machine-specific movement times and the cooling times. The cooling time for the foam components depends on the final layer thickness of the foam. For a 3 mm-thick foam layer, the cycle time is assumed to be about 90s.

From a commercial point of view, the high flexibility of the production line and the associated high plant utilization has a positive effect on the ROI. In addition, less investment is required in the infrastructure and technology-specific plant components. In many cases, production cells of this size have been in use for 15 years.

The Dolphin process was developed together by ENGEL AUSTRIA, Georg Kaufmann Formenbau, BASF and the P-Group (now SO.F.TER), and was presented at K2007 — together with the auto supplier Johnson Controls. In the fall of 2011, the first series application began. The Italian Daimler supplier SOLE S.p.A. used this method to produce cockpit covers for the new Mercedes Benz Actros (**Figure 4**). The Dolphin consortium now includes ENGEL, Georg Kaufmann Formenbau and SO.F.TER.

Close Tolerances in Mold-Making

The Dolphin process combines two-component injection molding (ENGEL combimelt) with physical foaming (MuCell) and compression technology. First, on an injection molding machine equipped with a rotary-platen (**Figure 5**), a thermoplastic backing part is conventionally manufactured in the first parting plane — e.g. from PC+ABS — with the aid of a needle-valve hot-runner system. After cooling, the backing part is transferred to the second parting plane position by swiveling the center rotary mold platen. A thermoplastic elastomer (TPE) is charged with an inert gas in super critical state after plastication in the melt cylinder, and the single-phase plastic/blowing gas solution is injected into the cavity — distributed via multiple cold runners. During the process, the backing structure is flooded to a thickness of about 2mm. The MuCell process unit is mounted on the moving platen of the injection molding machine for this process step.

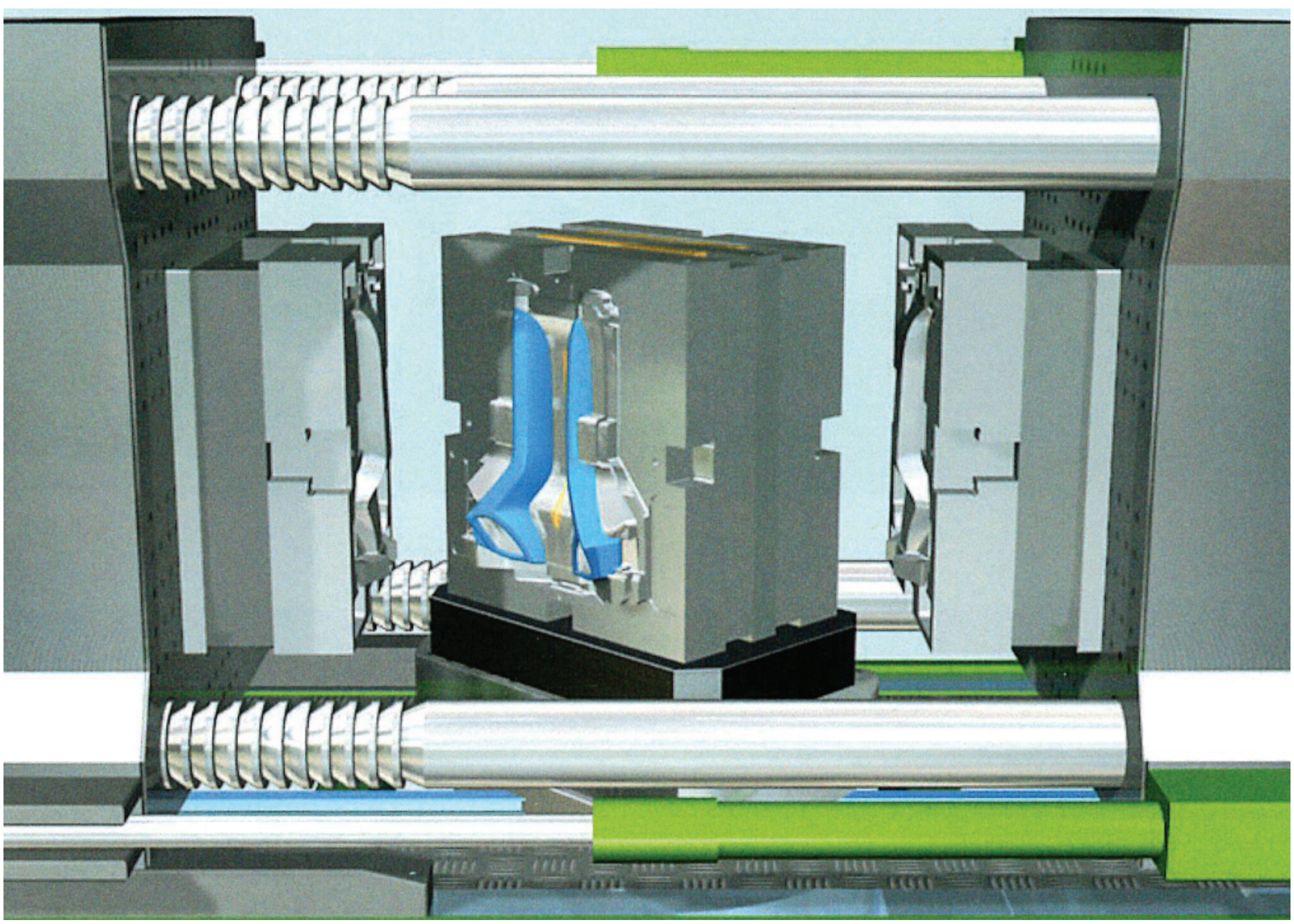


Figure 5: The Dolphin process is based on multicomponent injection molding with two horizontal injection units and swivel platens, combined with physical foaming. Figure courtesy of ENGEL.

Feature: 2-Component Injection Molding Continued

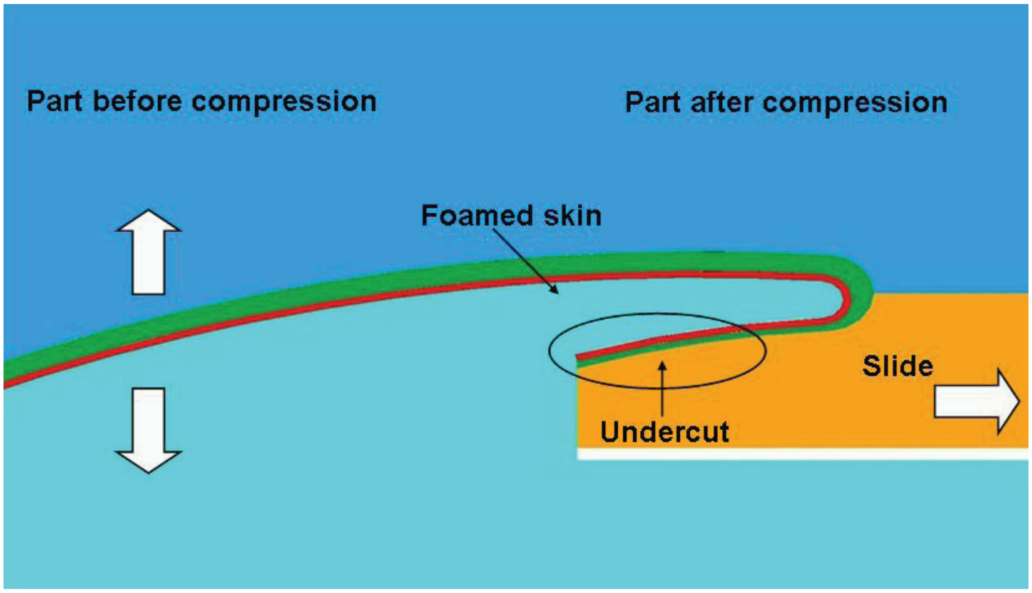


Figure 6: The Dolphin process opens up a high degree of freedom of design. Undercuts and narrow radii are possible. Figure courtesy of SO.F.TER.

During a short cooling phase, the melt solidifies on the mold wall and forms a skin layer which reproduces the grained surface of the cavity. Immediately afterwards, the clamping unit is opened by a defined compression stroke to allow the blowing gas to expand. Since the pressure within the cavity now decreases with a gradient that is equal across the cavity, particularly fine and uniform foam cells form — the prerequisite for a high-quality surface. The cavity is held in the extended position until the TPE has cooled completely and crystallized. Besides the adjustable delay time, the opening velocity and platen parallelism can also be controlled.

Since, simultaneous with foaming, the next backing part is being produced on the other side of the mold, the clamping force must not decrease during the opening stroke. This is ensured by a blocking system on the second mold half. Another special feature of the mold engineering is a surrounding spring strip that

Figure 7: Modified mold design: For invisible parting lines, unobtrusive slide edges are placed.

Figures courtesy of ENGEL.

Feature: 2-Component Injection Molding Continued

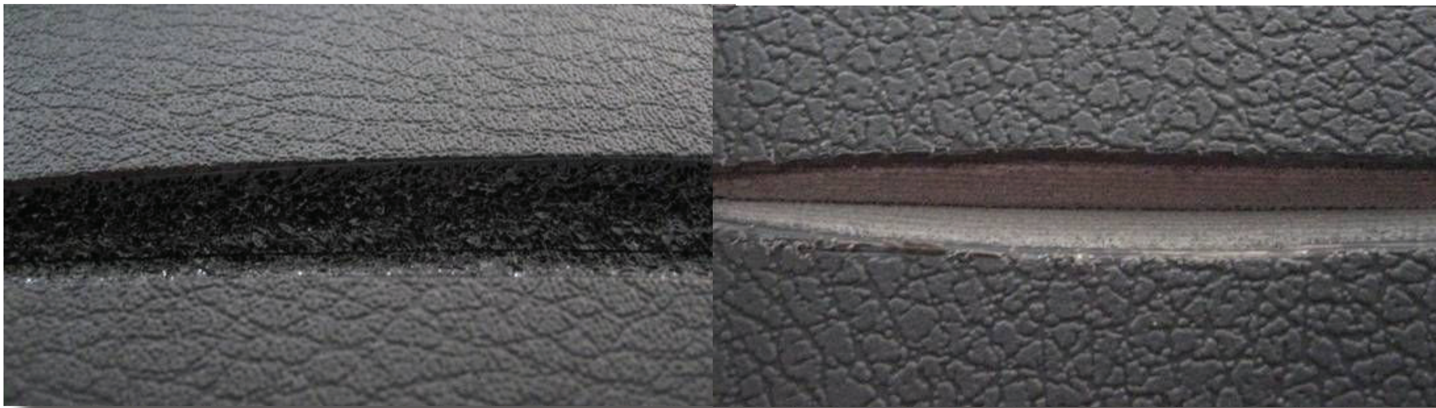


Figure 8: The desired foam quality can be adjusted by varying the process parameters. Figures courtesy of ENGEL.

is incorporated into the plunger, which reliably seals the two mold halves during the opening stroke so that neither melt nor foam can escape. The Dolphin process therefore requires particularly stable and high-precision molds. The tolerance in the temperature-controlled and movable elements is 0.03 mm. The cooling is just as big a challenge. To generate parts of the best quality, the two mold halves must be held at different temperatures. The backing part requires a temperature that is 35°C higher than the over molding of the soft component.

The Dolphin technique permits a high degree of design freedom since even complex geometries can be easily achieved. For example, undercuts can be generated (**Figures 6 and 7**) with the aid of slides; and the foaming process allows very narrow radii to be produced. For the grained surface structure, Georg Kaufmann Formenbau has developed a special method. In its pilot plant, the mold maker has built a trial mold with interchangeable grain inserts to present a broad range of options to product developers (**Figure 8**).

Decompression Stroke Determines the Softness

During foaming, the initial wall thickness of the foam cavity determines the shot weight of the part and the wall thickness to be obtained after the decompression stroke determines the foam height (**Figure 9 and 10**). The density of the foam can be adjusted accordingly, via the decompression stroke, and is indirectly proportional to the ratio between the initial and final wall thickness. Besides other parameters, the adjustable stroke also determines the softness of the product.

For a test series, with a starting wall thickness of 2

Feature: 2-Component Injection Molding Continued

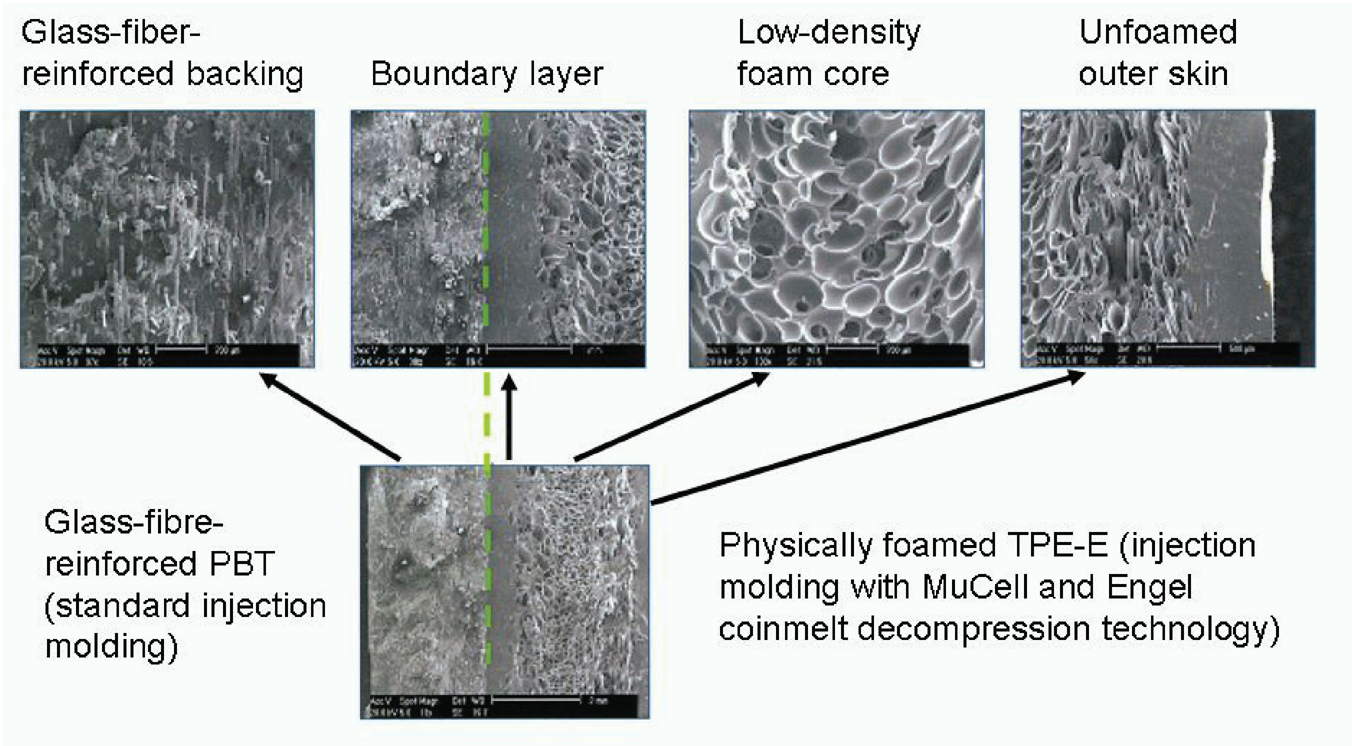


Figure 9: The MuCell technique permits the foam structure in the final product to be selectively controlled. Figures courtesy of ENGEL.

mm and a density of 1.12 g/cm^3, the decompression stroke was varied between 2, 3 and 4mm. The calculated average densities are thus at 0.56, 0.45 and 0.37 g/cm_3, already taking into account the compact top layer. This develops both at the mold wall as well as at the contact surface to the carrier part. The high filling pressure supports the development of a long-life, adhesive connection between the foam layer and backing structure.

Based on its Pibiflex product range, the raw material manufacturer SO.F.TER has developed a TPE grade especially for the Dolphin process. Pibiflex 3567S is characterized by a high

Opening Stroke [mm]	Total foam thickness [mm]	Decom-presion ratio	Calculated Average Density [g/cm³]
	2	1:1	1,12
2	4	1:2	0.56 
3	5	1:2,5	0,45 
4	6	1:3	0,37 

Figure 10: The density of the foam can be adjusted via the decompression stroke and is indirectly proportional to the ratio between the initial and final wall thickness.
Density of Pibiflex acc. To datasheet: 1.12 g/cm^3 Figure courtesy of ENGEL.

Feature: 2-Component Injection Molding Continued

UV stability and scratch resistance, and particularly pleasant tactile properties. The material is currently processed in the colors beige, gray, charcoal and black. And, since it keeps the gas used for foaming in solution, it permits uniform, controlled expansion. In addition, the TPE-E bonds strongly to the thermoplastic backing part. Because of their favorable mechanical properties across a wide temperature range from -45 to 150°C, the products of the Pibiflex series — block copolymers of crystalline PBT and amorphous polyether glycol — are generally predestined for applications in auto engineering. The softness of the material is retained even at very low temperatures, and the hardness and tactile properties can beindividually adjusted.

Foamed Backing Parts for Optimum Areal Weights

In the current series application from Sole and other applications that are in trial, the soft component is foamed on the part surface. However, the backing structure will also have to play its part in future lightweight construction requirements. Therefore, the aim of current R&D is to physically foam the hard component while modifying the part design and mold construction appropriately. This would probably reduce the average density of the backing part by 7 to 10 %.

Foaming of the backing by decompression technology instead of classic foaming opens up an even greater savings potential since the filling volume and weight are determined just as much by the initial cavity and the final backing dimensions — defined by the decompression stroke — as during the foaming of the TPE. During physical foaming of PC+ABS as backing material, area weights of less than 5.1 kg/m^2 appear realistic, particularly when the current backing wall thicknesses are optimized.

The favorable material properties of the Pibiflex material across a broad temperature range make other applications, for example the manufacture of airbag covers, conceivable. The predetermined rupture behavior of this material would be independent of temperature, and the bursting of the cover under both cold and warm conditions would be repeatable.

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Using Design of Experiments for Optimizing Injection Molding.

Stability is the key to a perfect process

It is well known amongst injection moulders, that stability is the alpha and omega for the process. There are several approaches to ensure this, but they build on common principles whether you call it systematic set up, scientific moulding or G&A Process Optimization.

It is all based on a good understanding of the process, whereby optimizing the parameters sequentially ensures that each part of the set up is founded on a correct setting from the previous step.

That has over the years been a well documented way to effectively ensure a good process set up. But more optimization is possible. First of all, you can ask yourself if optimizing the last parameters does not affect the optimum setting of the first parameters? If so, the set up has to be an iteration where you return an re-optimize some parameters. The other interesting question you could ask is, if it is possible to determine some "universal solutions" making future set up or optimizing possible in fewer steps. It could turn out that POM is running at its optimum at the same back pressure in all 30mm screws in your machines or that a certain product range in general should be produced at the same temperature profile.

The Optimization Tool

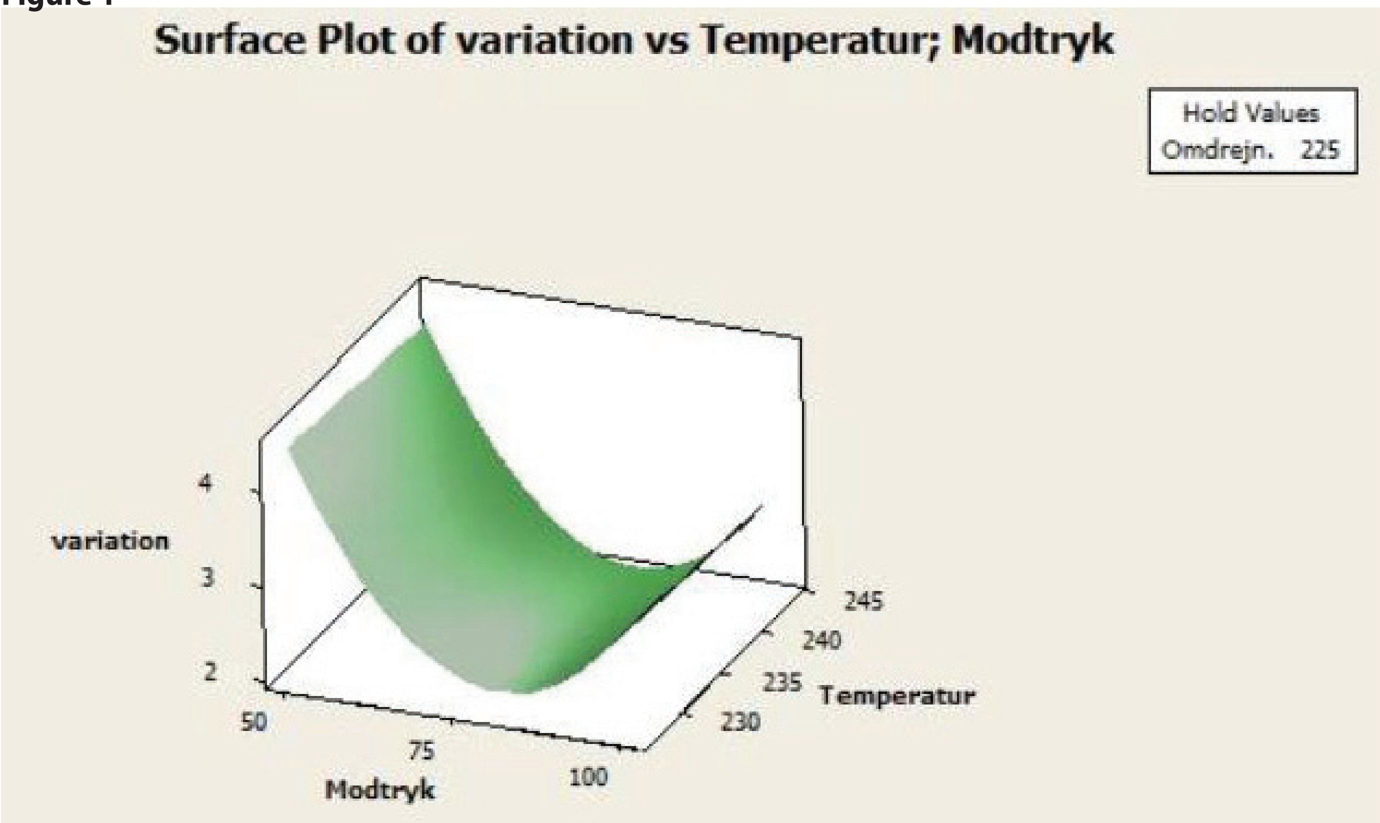
A powerful tool for answering these questions is design of experiments (henceforth DoE). It is a method for planning and analyzing experiments. Or rather it is several methods as several people have developed different approaches: Taguchi, Yates and many more, but as the user of DoE this is of less importance.

The purposes for using DoE are:

- Pointing out the parameters of importance to the process, thereby also the parameters which can rightfully be ignored.
- To determine how much a change of setting will affect product features like dimensions.
- To uncover what happens when parameters interact. That mean something unexpected or unpredictable happens when changing two or more parameters at the same time.

Feature: Using Design of Experiments for Optimizing IM Continued

Figure 1



- To gain as much knowledge about the process as possible running as few tests as possible. That way the interruption of the production is the least possible and using the fewest possible number of parts for testing and measuring afterwards.

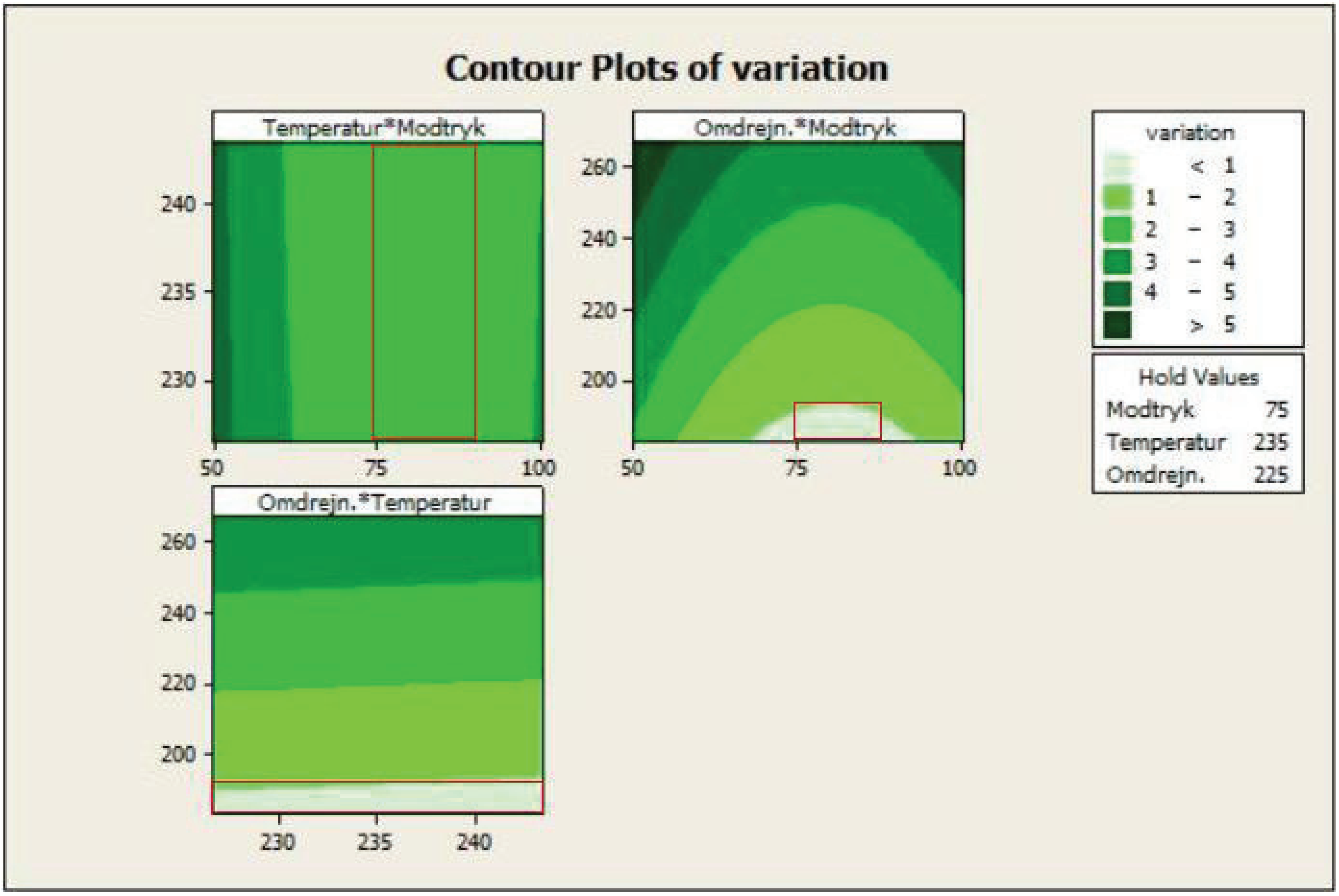
Especially the last issue is important if the test must be used for trouble shooting when you really want to reach a conclusion fast.

The idea behind DoE is that before you even start the experiment it is possible to determine how much detail you will go into how many samples and how to cover several parameters at the same time and how much time must be invested to gain the conclusion. In most situations it is possible to significantly reduce the number of test runs because it might be well known that parameters affect each other, but the main effect is usually from individual parameters or perhaps two interacting parameters. For more information about the background and the math behind DoE a book like Del Vecchios "Understanding Design of Experiments" is a good starting point.

Several tools, such as Minitab® software, for setting up and analyzing DoE are available. These tools are used

Feature: Using Design of Experiments for Optimizing IM Continued

Figure 2



to do the necessary calculations, but the most important factor is of course the technical know how and expertise to set up the criteria for the experiment. What parameters should be investigated, how large intervals must be tested and how should the parts be measured or tested? It is obvious to most that not all parameters have a significant effect on the final part and it is just as evident that there are physical limitations to the possible process adjustments. For these reasons it is very important to involve the persons with technical skills and deep process knowledge when starting to set up a DoE.

Seeing the Process Window

To illustrate the effect of DoE for injection moulding an example could be investigating and optimizing the process for stability. The goal is to make sure all parameters for plasticizing must be investigated to determine the processing window leading to the least possible variation in shot weight. That is the plasticizing settings with the best repeatability and thus least sensitive to effects like raw material variations.

The results from an analysis like that could turn out that screw speed, cylinder temperature and back pressure were the significant parameters. By looking at the effect graphically it is quite simple to point out the ideal processing window, but DoE also includes tools for modeling effects to calculate the optimum setting.

it can be seen in **Figure 1** the variation is at its lowest at a back pressure of approximately 75 bar and the temperature can be chosen at any value. But what happens when the third parameter enters the picture?

The upper left graph in **Figure 2** shows how figure 1 looks "from above". The bright areas show where the shot weight variation is low and the dark areas indicates lack of stability in the plasticizing.

Feature: Using Design of Experiments for Optimizing IM Continued

As shown, the optimal areas can be placed not only to determine specific values, but intervals. It is thus possible to determine the processing window. In this case a back pressure of 75-90 bar has been chosen from the upper left graph (indicated by the red frame). This interval has then been used in the upper right graph to determine that a low screw speed (180-190 RPM) is recommendable.

The temperature can per se be chosen throughout the tested interval, but in the graph at the bottom where temperature and RPM are combined a small interaction is indicated, showing that the best interval (no dark areas) would be 235-245°.

The conclusion is that it is possible to determine a processing window where it is certain that the stability is acceptable even if the parameters are changed.

Not only processing parameters can be part of a DoE. Using another machine, type of screw or type of material can be used as a variable in the experiment. That way it can be determined if the selection of machine

Feature: Using Design of Experiments for Optimizing IM Continued

is critical to part quality or not. At the same time one will obtain data describing what process setting might need to be changed and how they should be adjusted if the machine has a significant effect on the product .

By mapping your processes, machines etc. this way, it is possible to build a library of know how for tool setters and others to use for simplifying and standardizing the process set up for new tools and as a help for trouble shooting.

Another useful situation where DoE came in handy was in a situation where a sealing of two parts had to be fully documented for regulatory reasons. In that case more than 1000 settings had to be tested without DoE to cover all possible situations. But using DoE the total number of runs was reduced to below 80. Still a lot, but possible to run within a week and providing not only evidence that the process was valid but also reduced the future need for inspection.

It is not only for optimizing existing processes DoE is useful. In the development phase of a new product where it has to be decided if a technical problem must be solved by adjusting the process, changing the material or by redesigning the product. Often one will experience a step by step trouble shooting, where all sorts of processing tests has to be tried before investigating the material and finally deciding to redesign the part. It would be much faster if all questions were asked and answered simultaneously by running a DoE covering process parameters, materials and two or more design features. This is even sometimes possible to set up in the Mold Flow analysis even before building the tool – and in simulations the DoE is just as useful since simulations, interpretations and reporting takes time and costs money.

DoE is an efficient way to control your tests and make well-informed conclusions even if one experiment ends in a need for more testing as part of the analysis is finding the right course for further improvements. It can be used for very detailed analysis but is just as useful if you only need a general course of direction for further investigations.

The statistics behind DoE can seem intimidating, but if you are familiar with basic statistics it is not an insurmountable task and by using dedicated software for the calculations you will through it fast and easy.

As the analysis of the results is based on well know statistical methods, the DoE also gives you a strong documentation for the process and the product which is highly useful whether it is for validation purposes or simply because you see the value in a well documented process that would ease future trouble shooting.

About the Author

Epsilon was established in September 2009 by M.Sc. Carsten Lund, who has a black belt Lean/Six Sigma training at SBTI and has been working with injection moulding and process optimizations for more than a decade. DoE is one of many types of tasks and projects Epsilon handles. High level of process knowledge within injection molding, setting up experiments and analyzing data from trial runs — even data from trials not run as a DoE since much valuable information can be found in existing data.

Epsilon rests on three pillars: Process Analysis, GMP and Six Sigma.

These three concepts supports each other well as validation must be founded on statistical evidence and because the optimization of many processes can be rather complex Six Sigma is very advantageous. Epsilon addresses companies who need help for optimizations, validation, quality management, process mapping, data analysis and measurement system analysis. More information can be found at www.epsilonplus.dk/eng

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An Experimental Study on the Dimensional Characteristics of 7 Inch Light Guide Plate Manufactured by Injection/Compression Molding With Rapid Heating of a Mold

From micro featured optical products made by conventional injection molding(CIM) the defects of inhomogeneous shrinkage and incomplete filling of micro pattern can be found easily because of concentrated residual stresses near gate and the formation of frozen layer. To reduce the inhomogeneous shrinkage in thickness direction injection/compression molding(ICM) can be used by applying compression of mold rather than applying packing pressure through the gate. To achieve better transcription of micro pattern on the product from the mold rapid heating and cooling molding(RHCM) has shown the advantages by heating the mold surface above glass transition temperature of polymer used. In the present study a series of experiments using ICM combined with RHCM named RICM(RHCM+ICM) was conducted to increase both the transcription ratio of micro pattern and the uniformity of thickness for 7 inch sized BLU-LGP(Backlight unit-light guide plate). As a result, the standard deviation of thickness was reduce from 0.024(ICM)~0.025(RHCM only) mm to 0.005(RICM) ~0.007(ICM) mm by apply compression process. In the cases of CIM and ICM average transcription ratio of micro pattern showed 42.0% and 63.2%, respectively. On the other hand, the transcription ratio of micro pattern in the cases of RHCM and RICM showed almost 100% while the mold temperature reached above glass transition temperature. By the application of ICM combined with RHCM both the transcription ratio of micro pattern and the uniformity of thickness can be improved dramatically even the maximum mold temperature of RICM was 10! lower than the case of RHCM only.

Introduction

The conventional injection molding(CIM) process has been one of widely used polymer processes in the plastics industry. Because the application of high pressure through the gate in the packing phase, differential volumetric shrinkage is unavoidable. Relatively low mold wall temperature gives rise to the formation of frozen layer near the surface of products and incomplete filling of micro pattern on it, too. For manufacturing DVD having thinner wall thickness with high dimensional accuracy of micro pattern on the surface or thick lenses for projection TV, injection/compression molding(ICM) process has been a good substitute for CIM. By applying the partial or total compression of mold surface instead of packing through showed many advantages. i.e., reducing residual stresses and birefringence, minimizing molecular orientation and increasing dimensional accuracy, etc.[1~5].

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Rapid heating and cooling molding (RHCM) process is useful tool to achieve better surface finish or to remove weld/meld line in many applications such as TV bezels[6~10]. By heating the mold surface above glass transition temperature of polymer used or using insulated layer under the mold wall, depression of the formation of frozen layer is a key in this process.

Especially, as display industry requires the products such as LGP's having thinner wall thickness and larger dimension with even higher dimensional accuracy of micro pattern on the surface than ever(for example, over 42 inch sized LGP in 3D-LCD TV), new process is needed to meet the requirement.

In the present study, a hybrid process called rapid injection/compression molding(RICM) which uses both ICM and RHCM was investigated to improve the transcription characteristics of micro pattern and the uniformity of thickness in 7 inch size LGP. To compare the results of RICM quantitatively with CIM, ICM and RHCM only, the various molding tests were carried out under different conditions.

Experiments

Methodology

The conventional injection molding(CIM) process consists of filling, packing and cooling phases as shown in **Figure 1(a)**. The formation of frozen layer and incomplete filling of micro pattern on the mold surface are unavoidable phenomena while the polymer is filling the cavity. Similarly, in RHCM-only process heating the mold wall surface above glass transition temperature of polymer and extra cooling phases are added before injection starts as shown in **Figure 1(b)**. Except heating and cooling phase all the other procedures are the same as CIM. In contrast, ICM starts the mold with a fixed open distance (δ) before injection, and the mold is compressed and closed with a given clamping force after polymer is injected and filled the cavity completely

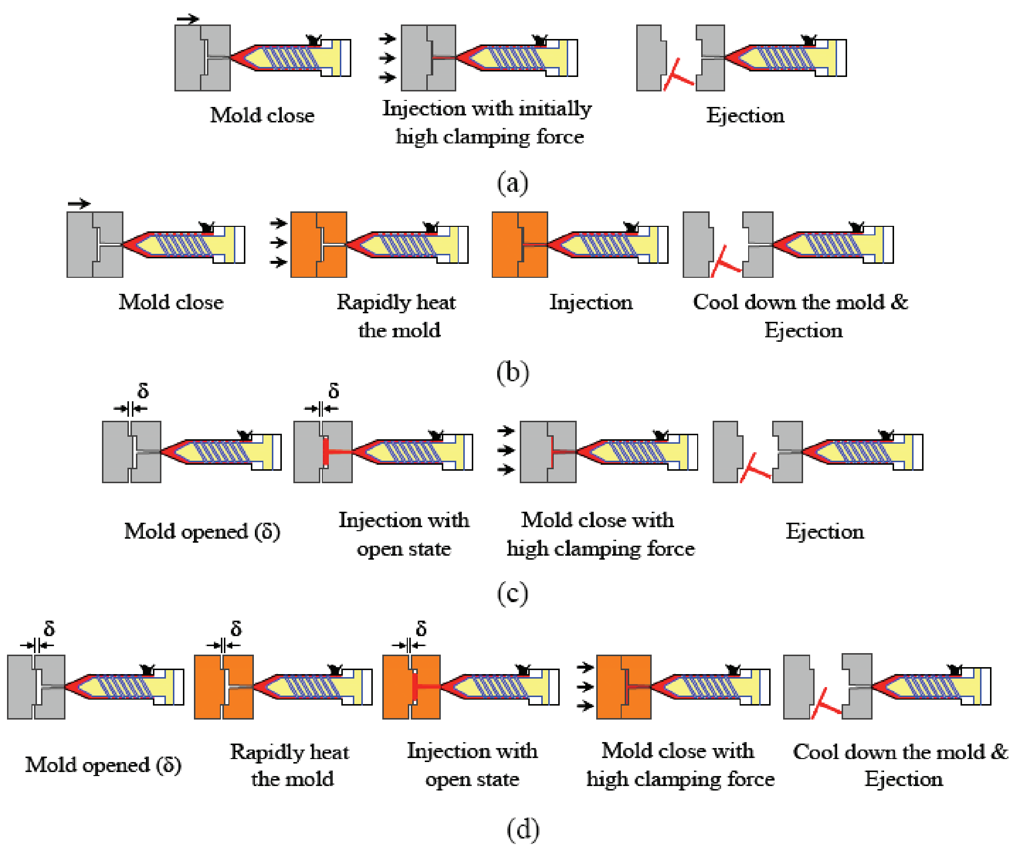


Figure 1: Molding schematics of (a) CIM, (b) RHCM, (c) ICM and (d) RICM.

as shown in **Figure 1(c)**. So, the molten polymer experiences relatively low and uniform pressure in the cavity. Because of this relatively low and uniform pressure distribution the ICM process can show many advantages explained previous[5].

The RICM(RHCM + ICM) contains rapid heating and cooling scheme additional to the ICM process as shown in **Figure 1(d)**. Initially mold cavity is set to be larger than nominal thickness of the part, heat the mold rapidly with steam before injection, and inject the melted polymer into the cavity. Then the mold is closed with high clamping force to apply uniform force to the product as in ICM. Finally, the mold is cooled down and the product is ejected. In RICM, it takes advantages both of RHCM and ICM such as low pressure required for the injection molding machine, high transcription ratio was achieved at relatively low mold temperature, reduction of residual birefringence/stress, high dimensional accuracy. However, some additional facilities such as steam generation boiler, and injection molding machine including compression mechanism are necessary.

Setup and Materials

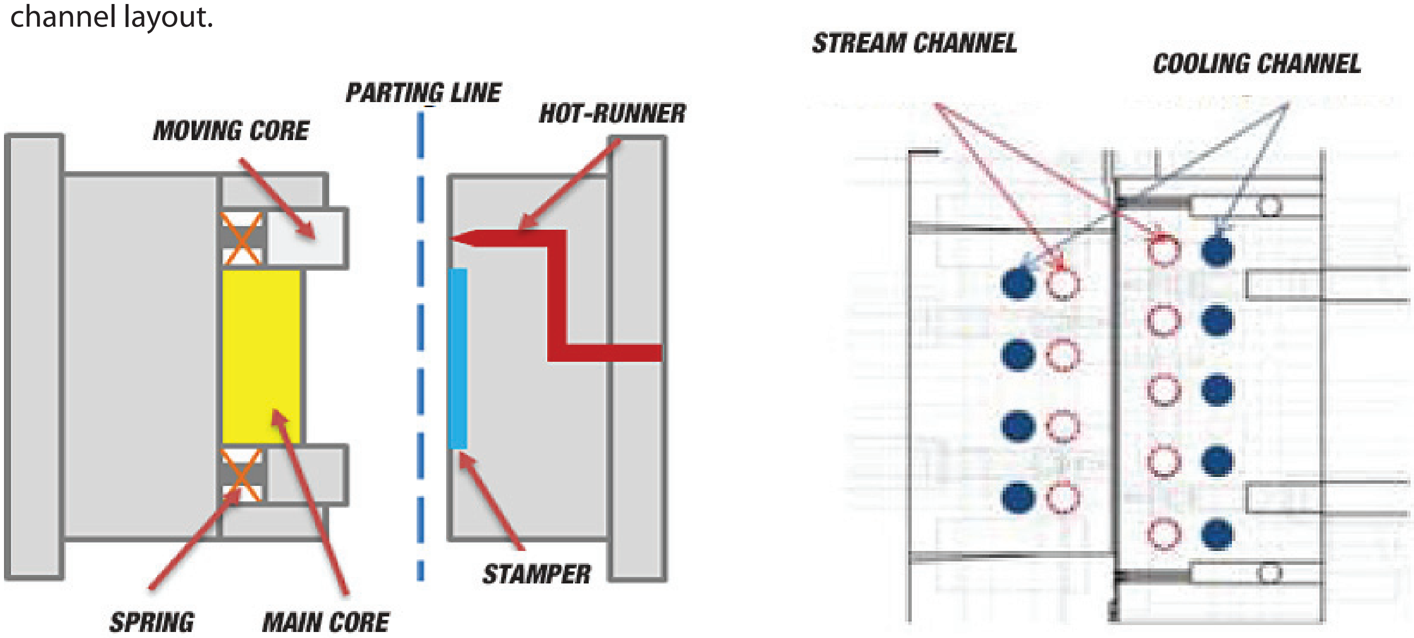
The injection molding machine used in the present study was LGE-110D(LS-Mtron Co., Ltd), designed for optical product molding. All control systems are full electronic and the machine includes compression control mechanism in the clamping unit. The machine has 110 tons of clamping force, 2500 kgf/cm^2 of maximum injection pressure and 350 mm/s of injection speed, respectively.

PMMA resin (TF-8) supplied by Teijin Chemicals Ltd. was used as a molding material. It has a specific gravity of 1.19 g/cm^3, transmittance of 93%, glass transition temperature of 102°C.

For rapid heating and cooling the mold, the steam boiler and controller(manufactured by Booyeo Tempcon Co. Ltd.) were SP8100 and ITC-4050, respectively. The boiler could generate the steam 150 kg/hr and the controller could supply the maximum steam temperature of 180°C and the maximum flow rate was 200 liter/min.

The structure of mold used in the present study comprises two plates mold, as shown in **Figure 2**. A micro patterned stamper can be attached in the stationary part and the compression mechanism is driven by 3 side blocks by springs in the movable plate. Also, the hot runner system was installed in the stationary part to pre-

Figure 2: The composition of the mold; (a) moving core mechanism for compression and (b) cooling/steam channel layout.



vent backflow in compression process. There are four and five rapid heating steam channels in stationary and movable part, respectively.

A cavity is 7 inch rectangular plate having 160 mm x 90 mm x 1.12 mm(W x H x t) in dimension. The stamper was fabricated by UV-lithography and electroforming processes[11]. The micro patterns form cylinder shapes and the height and diameter are measured 13.65 μm and 29.24 μm, respectively, which is the average of 81 points. The SEM images of pattern were showed in **Figure 3**.

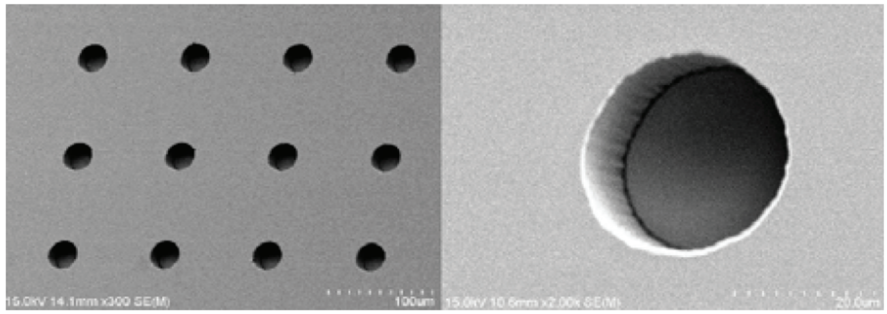


Figure 3: SEM image of the stamper.

Experimental Conditions

The basic process conditions used for molding the LGP samples are listed in **Table 1**. The 80°C of water was used through the normal coolant circuits. In RHCM and RICM experiments, the polymer was injected to the cavity when the temperature at measured position near the mold surface reached desired mold surface temperatures of 90, 100 and 110°C, respectively, which is achieved by heating the mold with steam. The initial mold open distance was 0.1 mm in ICM and RICM experiments and the cooling time was 25 sec for all molding processes.

Table 1: Process Conditions for Various Molding Processes

Factor	Condition	Unit
Melt temp.	270	℃
Mold temp.	80	℃
Injection speed	140	mm/s
Injection time	0.43	sec
Cooling time	25	sec
Packing pressure	500	kgf/cm^2
Packing time	2.0	sec
Mold temp. (RHCM, RICM)	90, 100, 110	℃
Mold open dist. (ICM, RICM)	0.1	mm
Compression force (ICM, RICM)	110	ton

To examine the transcription ratio of micro pattern onthe product and thickness distributions, the 3D profiler(micro-surf, Nano-Focus Co., Ltd) and micrometer(TESA Technology, micro-master IP54) were used, respectively. Also, the 9 points with an interval of 5 mm in flow direction were selected for the measurement as shown in **Figure 4**. As a definition of the transcription ratio of micro pattern, the ratio of the height of product to the pattern on a stamper was used as shown in equation(1). **Figure 5** illustrates the geometry of micro patterns replicated between stamper and LGP. Also, the standard deviation of the thickness of the product for those 9 points was used to express the thickness deviation.

$$\text{Replication ratio } (\%) = \frac{h}{H} \times 100 \quad \text{.............................(1)}$$

where h and H denote the pattern filling height of the part and pattern depth of the stamper, respectively.

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In all the experiments the samples were obtained at cyclic steady state.

Results and Discussion

Figure 6 shows the transcription ratio of micro pattern on the product vs the distance from the gate for different molding processes. In CIM, the transcription ratio shows about 93.6% at the nearest region and 2.6% near the end region. In this case, the transcription ratio tends to decrease as the distance increases from the gate, which is well known in CIM process. It is a typical phenomenon when the pressure is not transferred up to the end of the part and the formation of frozen layer is dominated.

In the case of ICM at the mold temperature of 80°C the improvement of the transcription ratio of micro pattern can be found compared with CIM. The RHCM process shows incomplete filling of micro pattern in the cases of the maximum mold temperature of 90°C and 100°C, but it shows almost 100% of replicationat 110°C. Similar to RHCM, the

Figure 4: The positions of measuring thickness and pattern replication.

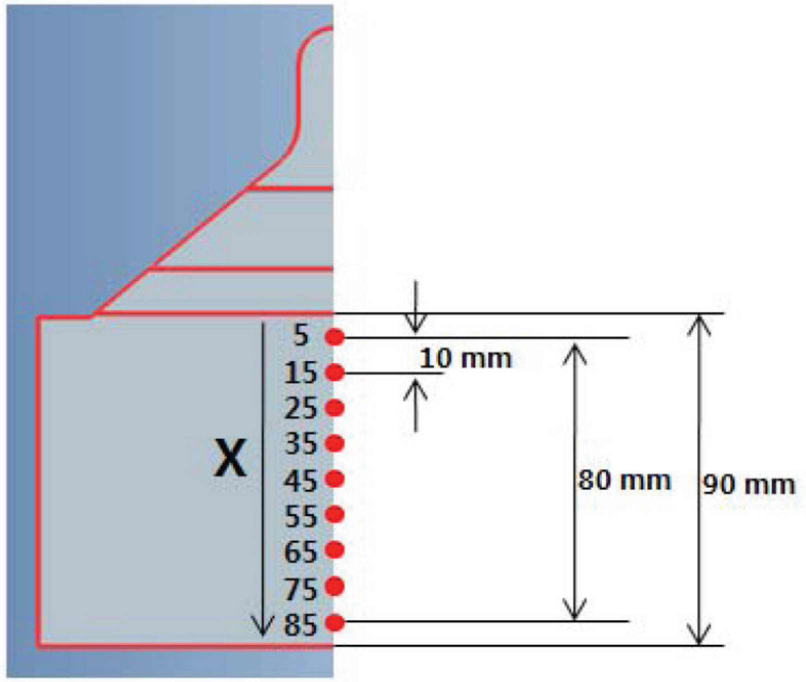
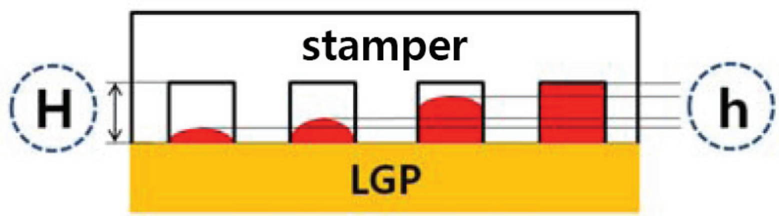


Figure 5: Description of transcription ratio.



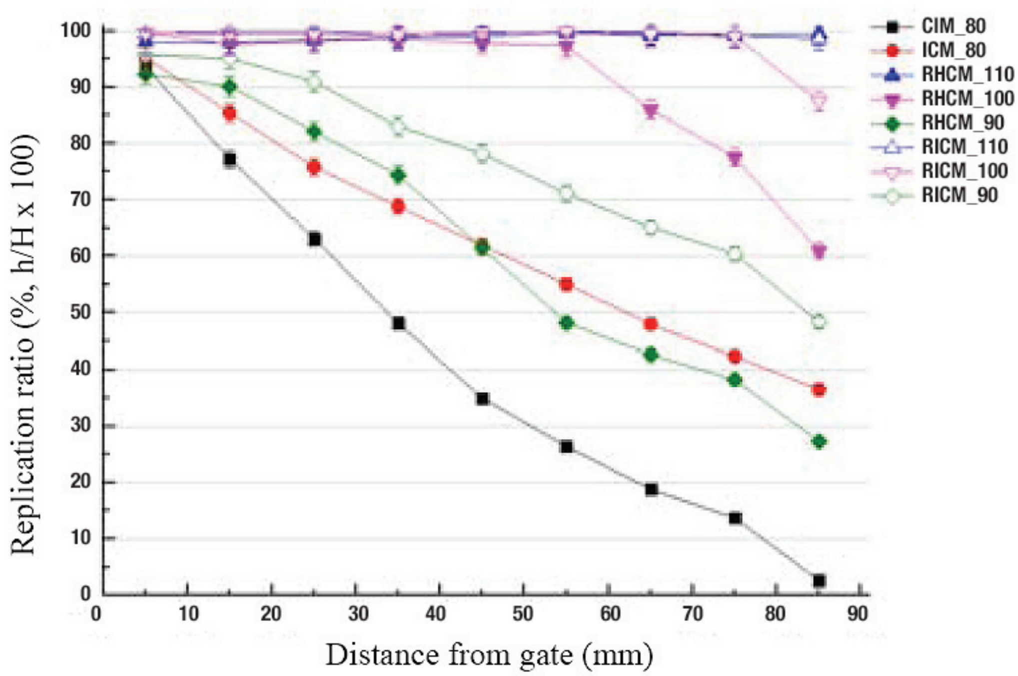


Figure 6: The distribution of transcription ratio of micro pattern for different molding processes.

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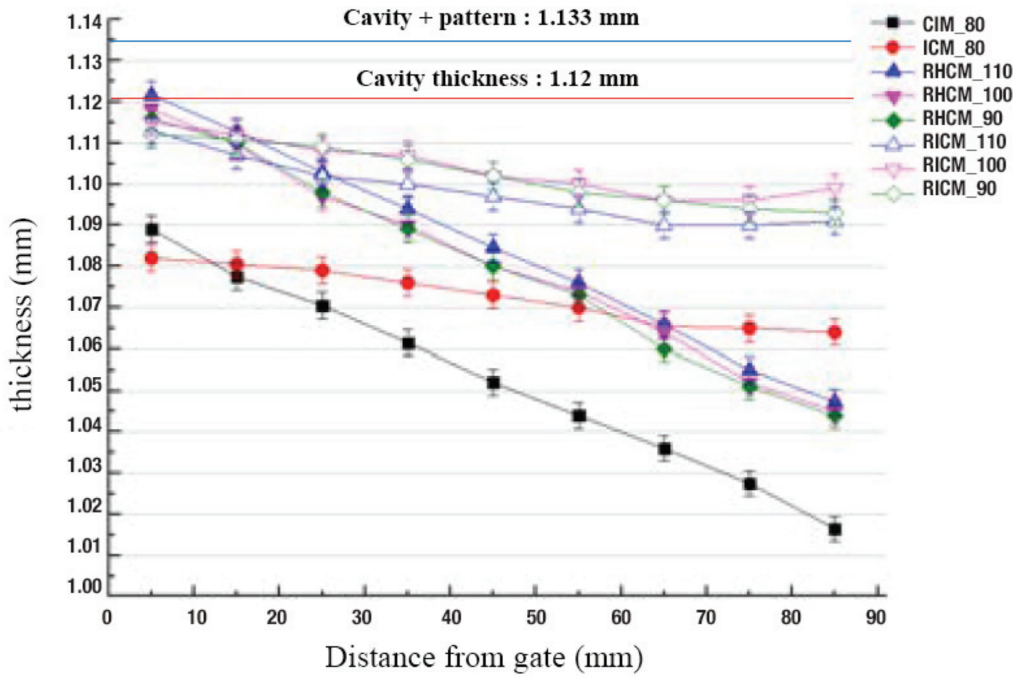

Figure 7: Thickness distributions vs the distance from the gate for different molding processes.

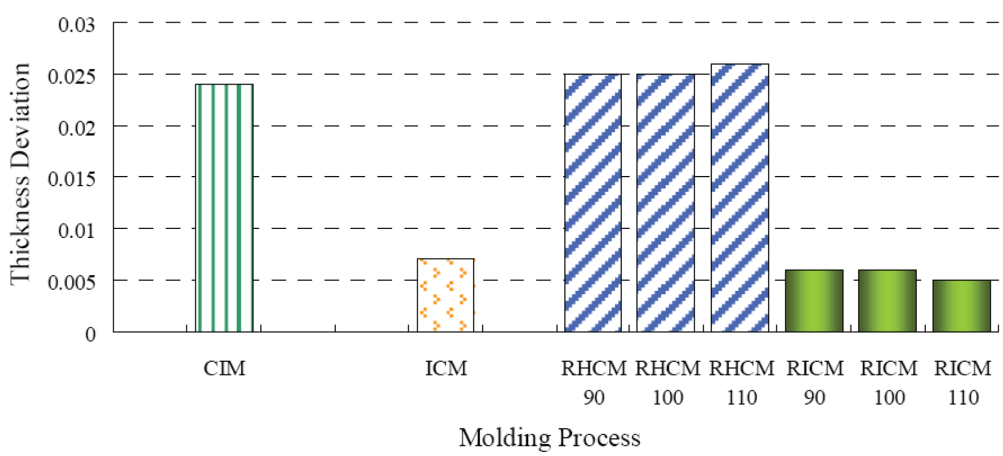

Figure 8: Thickness deviations for different molding processes.processes.

RICM process shows a good transcription ratio of micro pattern as the maximum mold wall temperature increases. Comparing the results of RHCM-only and RICM, the better transcription ratio of micro pattern can be found in the case of RICM, especially, under glass transition temperature. It can be concluded that the better transcription in RICM was owing to the uniform pressure by additional compression mechanism. In other words, in RICM process, it is enough to fill the pattern around the glass transition temperature, while the maximum mold surface temperature is needed 100°C higher than the glass transition temperature in RHCM -only.

Next, **Figure 7 and 8** show the thickness distribution and deviation for different molding processes, respectively. CIM and RHCM process show relatively high thickness deviation because of the high volumetric shrinkage during cooling phase. The average thickness and the standard deviation were about 1.05±0.024 mm and 1.07±0.025 mm for CIM and RHCM, respectively. In ICM and RICM, average thickness and the standard deviation were about 1.07±0.007 mm and 1.08±0.005 mm for ICM and RICM, respectively. Both cases showed relatively uniform thickness distribution at all temperature condition. In summary, the compression mechanism added to RHCM improves the uniformity of part thickness and the transcription ratio of micro pattern on the product.

By reporting all results, in RICM process, a good pattern replication and comparatively uniform thickness were obtained in 7 inch sized LGP.

Conclusion

In the present study, an experimental study on the thickness distribution and the transcription ratio of micro pattern was conducted under various molding processes. A high replication ratio could be achieved by using RHCM process and the ICM leads a good thickness distribution. Also, RICM process was investigated as a hybrid process of ICM and RHCM. From the mechanism of rapid heating and cooling the mold, the transcription ratio of micro pattern was achieved at high level. And, from the compression mechanism, the uniformity of part thickness could be increased. In concluding, the RICM process which compressing the mold after rapidly heat the mold is useful process in views of improving both the replication ratio and thickness distribution for thin products with micro pattern.

Acknowledgement

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IMD Board of Directors Meeting

February 1, 2013

Submitted by Hoa Pham, Secretary

Welcome

Since Chair Susan Montgomery and Chair-Elect Erik Foltz attended via teleconference, Pat Gorton, ANTEC 2013 TPC was asked to preside over the meeting. Pat called the meeting to order at 9:00 am, and turned over to Susan for the official welcome.

Susan welcomed all attendees joining at Orlando and via teleconference. On behalf of the IMD Board, she thanked Tupperware for their generous support of the Board meeting. She also welcomed special guests: Willem De Vos, SPE Chief Excecutive Officer, Jon Ratzlaff, SPE President-Elect, Sarah Sullinger, SPE Staff, and Ram Thanumoorthy from 3M.

Roll Call

Present were:

Susan Montgomery (Chair), Jim Wenskus; Peter Grelle; Hoa Pham; Pat Gorton; Erik Foltz, Brad Johnson, Adam Kramschuster; Jack Dispenza, Nick Fountas; Larry Schmidt; Jeremy Dworshak, David Kusuma; Lee Filbert, Tom Turng, David Okonski, Raymond McKee, Mal Murthy (Emeritus), Jim Peret (Emeritus), Rick Puglielli, Srikanth Pilla.

Guests were: Willem De Vos, Jon Ratzlaff, Sarah Sullinger, and Ram Thanumoorthy.

Absent were: Michael Uhrain and Kishor Mehta
This attendance constituted quorum.

Opening Remarks

Susan welcomed Jose Timmerman to make the opening remarks, and David Kusuma introduced Jose.

Jose Timmerman is currently the Executive Vice President of Global Supply Chain at Tupperware. He is responsible for global operations.

Jose gave a broad overview of the Tupperware current business. He then discussed the need for ongoing training, mentoring and coaching engineers to support the growth of the plastics industry. He commended the IMD through its Board for advancing the education mission.

Approval of August 24 Meeting Minutes

Motion: Hoa Pham moved that the August 24, 2012 meeting minutes be approved, as written and distributed. Peter Grelle seconded and the motion carried.

Financial Report – Jim Wenskus, Treasurer

The updated financials of July 1 through December 31, 2012 were reviewed. Jim reported that the overall financial state was in very good shape.

IMD Board of Directors Meeting Continued

Under Expenses, Jim noted that Line item 28 was added to account for 'Grants'. This line item would capture the payment for the Division's scholarship.

Motion: Jim moved that the Board approve the resumption of payment in installments of $5000. Jack Dispenza seconded, and the motion carried.

Hoa reported that Susan received a letter from Lance Neward at SPE Headquarters, and ths letter would be discussed at the next meeting.

Jim presented the 2013 – 2014 budget. Pat asked what type of cost would be anticipated for the 2014 ANTEC to be held in Las Vegas. Jon Ratzlaff indicated that SPE Headquarters expected the expenses in Las Vegas to be similar to those in Cincinnati.

Motion: Jim moved that the Board approve the 2013 – 2014 budget as presented. Lee seconded, and the motion carried.

Action Item 1: Jim to send check of $5000 to SPE Foundation for the Division scholarship.
Action Item 2: Erik to include Lance Neward's letter in the agenda of the next meeting.

Rochester Section Activities

Jim gave a presentation highlighting the activities of the Rochester Section in community outreach. For over 30 years, the Rochester Section has been participating in the local science and technology days to show plastics demonstration to over 100,000 attendees. The Board applauded the Rochester Section and Jim's efforts.

ANTEC 2013 Technical Program Committee – Pat Gorton, Chair

At the ANTEC 2013 to be held in Cincinnati in April, the IMD technical program will include six presentations in the morning and seven in the afternoon. Plenary sessions will be organized on each of the three conference days.

The IMD paper review was completed in December with participation from Pete Grelle, Erik Foltz, Adam Kramschuster and Pat Gorton. The paper submission deadline was extended to November 26. A total of 68 papers were submitted. Except for one poster paper, all papers were returned to the committee with acceptable revisions.

The IMD technical program would present six papers in the morning and seven in the afternoon. Plenary sessions would be organized on each of the three conference days. Pat would email the board asking for volunteer moderators.

Tentatively, the sessions would include Simulation, Materials, Process Control, Machine Control, Microcellular Molding, and Emerging Technology. The poster session had 9 papers.Pat proposed to add a Fundamentals session to be held on Tuesday afternoon with no other competing IMD sessions. He would be seeking keynote speakers, preferably two.

The best paper would be selected from the top five papers. A brief discussion on possibly changing the format of the awards was made.

IMD Board of Directors Meeting Continued

IMD Reception

Continuing with tradition, Pat would arrange to have the IMD reception on Tuesday evening (5:30p – 7:30p). Autodesk was the sponsor last year, and Erik confirmed that they wanted to return this year.

SPE Discussion – Willem DeVos

SPE CEO Willem Devos presented a brief overview of the SPE financial status. The budget for 2013 is designed to break even, with some negative cash flow due to investments. After a decreasing trend, membership has stabilized at about 15,000. The target is to grow membership with focus on emerging markets.

Events in 2013 include: Arabplast in Dubai (January), JEC Europe in France (March), SPE-ANTEC in Cincinnati-USA (April), Polyolefins Arabia in Oman (May), SPE-Eurotec in France (July), K-Show in Germany (October), China TOPCON (Q4). Discussions have begun to consider events for 2014, such as ANTEC Mumbai, and ANTEC Dubai.

Operational projects in 2013 will be necessary to support the strategy:

- Upgrade the Association Management System (AMS) to the Enterprise system, which is scheduled to go live at the end of May, 2013. This new system will provide easy registrations for world wide conferences, link memnership from online databases, etc.
- Create a new SPE website and integrate the Plastics Engineering web page. This new website, which will go live at the end of September 2013, will be able to host individual Division or Section websites. An invitation was offered to the IMD to have its website hosted on the SPE HQ website.
- Launch SPeconnect, which is a professional platform similar to Facebook. This e-platform is designed to attract young professionals, enhance communications, and facilitate the formation of new groups. This project will be rolled out at the end of 2013.
- Develop SPE Mobile App to launch at the end of 2013. A test case of this app will be available at ANTEC in April.
- Overhaul Plastics Engineering magazine to give it a new look and feel, with more technical and business content. Willem called on Divisions to support by providing content.

Willem and Jon encouraged the IMD to consider a TOPCON in China. The SPE can create the framework and the IMD provide a conference chair and the technical content. Further discussions were moved to the New Business section of the agenda.

Technical Director Report – Peter Grelle, Chair

ANTEC Papers

Pete presented an overview of the trends in the IMD papers over the years. The declining trend of the number of papers has reached a plateau since last year. Academia is still the main source of the papers. The two years that the IMD saw a jump in the number of commercial papers seem to coincide with the NPE years (2009, 2012).

For ANTEC 2013, the number of papers from Europe increased. Using the APQ index to measure the quality

IMD Board of Directors Meeting Continued

of the papers, an overall improvement was observed since 2010. However, the quality of papers from the US industry was of concern.

TOPCON Update

Plan continues for the Penn State Erie Injection Molding Conference, to be held on May 22 – 23, 2013 in Erie, PA.

Injection Molding Webinar

Pete, Raymond McKee, Jeremy Dworshak and Nick Fountas worked on a survey to determine our customers' needs in a training program. The survey, which will be sent out to the membership, covers seven topics and three levels of training.

Action Item1: Nick and the team to send out the survey by end of February 2013.

Councilor Report – Brad Johnson

Report to be presented at next meeting.

Communications Report – Adam Kramschuster, Chair

Sponsor Articles

Adam reported that he and Heidi worked on the option to offer sponsor articles as a new sponsorship opportunity. The basic guideline was to run the sponsor articles once for a set price. Larry Schmidt suggested adding a disclaimer to the sponsor articles, and the Board agreed.

Motion: Adam moved that the Board approve the new sponsorship pricing. Pete Grelle seconded and the motion carried.

Action Item: Adam to inform Heidi to add the disclaimer to the sponsor articles when they are published.

Current Newsletter Contract

The current contract with Heidi was ending. Adam reported that the options were to continue with a one-year renewal or proceed with an on-going agreement. The performance terms remained the same.

Motion: Adam moved that the Board approve for him to use the on-going agreement to renew the contract with Heidi to publish the newsletter and recruit sponsorships. Jeremy seconded and the motion carried.

SPE IMD Website

Kate Kramschuster was developing the website, and has completed a framework. Adam provided a link for the Board to preview the site. The goal was to have the website functional by March 15, 2013. Any Board member could add or update the content by e-mailing the website editor. The future plan would be to make the website more attractive, and have consistent branding with the SPE. Adam asked for three volunteers to provide ideas for content. Jeremy, Srikanth and Rick volunteered and together with Adam would be the website working team. Per Jon's request, this team would also be the IMD voice to critique the SPE HQ website.

IMD Board of Directors Meeting Continued

IMD Facebook Page (Raymond, Adam, Heidi)

Adam showed the IMD Facebook page, and asked the Board to add content.

Nominations Committee – Hoa Pham, Chair

Hoa presented the nominees for Board Officer positions: Pat Gorton-Chair Elect, James Wenskus – Treasurer, Peter Grelle – Technical Director, Hoa Pham – Secretary.

Motion: Hoa moved that the Board approve the nominees. Jeremy seconded and the motion carried.

Hoa asked Board Directors to consider Officer positions for 2014.

A list of nominees for Board Directors for the term 2013 – 2016 was presented.

Motion: Hoa moved that the Board approve this list of nominees to place on the general ballot. Jack seconded and the motion carried.

Hoa asked the nominees to provide a short biography by 2/11 to be include in the ballot.
Action Item: Nominees to provide a short bio to Hoa by 2/11/13

ANTEC TPC

2014 – Adam Kramschuster
2015 – Raymond McKee
2016 – Jeremy Dworshak
2017 – 2019 David Kusuma, Rick Puglielli and Srikanth Pilla will commit to which year at the next meeting.

Education – Jeremy Dworshak, Chair

Jeremy provided a free phone and tablet app from his company Steinwall to search for plastics properties. He also reiterated the benefit of bringing in trainers from industry to get a sense of their training style, which would be helpful in recommending the trainer when necessary.

Pinnacle Award – Sarah Sullinger/Erik Foltz

The Pinnacle Award application was submitted. Sarah indicated that she would start reviewing all applications the following week.
Jim informed that he contributed to Chapter 6 in the 'Plastics Handbook' published by Wiley.

IMD Membership Committee – Nick Fountas, Chair

Nick informed that he had been unable to access the active member roster at SPE HQ website for a year. He also cautioned that as the Society grew globally, part of the focus still needed to be in the US because the rate of member attrition here has been high.
Nick presented and discussed the trends in membership distribution. In reviewing the number of lapsed members, Nick noted that the IMD had a significant lead over other Divisions such as EPSDIV, Extrusion, Medical Plastics and Thermoforming.
Willem confirmed the issue with the current system and noted that it would be resolved with the new AMS. Overall, the renewal rate of all membes was ca. 79%. Efforts have been underway to improve this rate.

IMD Board of Directors Meeting Continued

Honored Service Member & Fellows – Larry Schmidt, Chair

Honored Service Member

Larry mentioned that Mal Murthy was nominated in a previous meeting for HSM, and his application was in progress.

Larry also proposed that the Board considered Tom Turng as a candidate for HSM. Tom gave a summary of his contributions to the IMD.

Motion: Larry moved that the Board approve the nomination of Tom Turng as the IMD candidate for HSM. Raymond seconded and the motion carried.

Fellows

John Bozelli was nominated for Fellows in a previous meeting, and his application would go forward this year.

Larry proposed that the Board consider Jose Timmerman as another nominee for Fellows. David gave a brief background on Jose's achievements in management, strong advocacy for training engineers, and technical leadership at Tupperware.

Motion: Larry moved that the Board approve the nomination of Jose Timmerman as a candidate for SPE Fellows. Peter seconded and the motion carried.

Jon reminded the Board that the SPE has the prestigious SPE Business Award. Given Jose's achievements and his steadfast support of the SPE IMD, he could be a candidate.

Motion: Larry moved that the Board nominate Jose Timmerman for the SPE Business management Award. Jeremy seconded and the motion carried.

Old Business

None discussed.

New Business

Discussions on China TOPCON resumed. David Kusuma mentioned that he could help with this activity.

Motion: Jeremy moved to approve proceeding with the project and nominate David Kusuma as the China TOPCON Chair. Jack seconded, and the motion carried.

The Board formed a committee to assist David. The members are Jack Dispenza, Peter Grelle and Jon Ratzlaff.

Next Meeting

The next Board meeting is planned to be on the Sunday before ANTEC in Cincinnati; location to be determined.

Adjournment

Motion: Jeremy moved to adjourn the meeting. Pete seconded.

The meeting was adjourned at 3:05pm ET.

IMD Leadership

DIVISION OFFICERS

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Susan E. Montgomery
Priamus System Technologies
s.montgomery@priamus.us

Chair-Elect
Erik Foltz
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Treasurer
Jim Wenskus
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Secretary
Assistant Treasurer
Nominations Committee Chair
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Avery Dennison
hp@0802@live.com

Technical Director
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Councilor, 2011 - 2014
Brad Johnson
Penn State Erie
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BOARD OF DIRECTORS

TPC ANTEC 2013
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TPC ANTEC 2014
Communications Committee Chair
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TPC ANTEC 2015
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TPC ANTEC 2016
Education Committee Chair
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China TOPCON Chair
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Membership Chair
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fountas@jli-boston.com

HSM & Fellows Committee Chair
Historian
Larry Schmidt
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Reception Committee Chair
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Ideal Jacobs
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Engineer-Of-The-Year Award Chair
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David Okonski
General Motors R&D Center
david.a.okonski@gm.com

Meet IMD's Members

The Injection Molding Division Welcomes 170 New Members...

Mark Wallace Alexander
Peter Allan
Andrew James Angros
Dave Anthony
Yasir H. Arain
Sohail Asghar
David Ross Astbury
Dave S. Axford
Jane Barefield
Mark C. Baysinger
Clemens Behmenburg
Roy Biederman
Edmund T. Bird
John Birle
Andrew Blemings
Robert H. Boutier
Alvin Bromberek
Troy D. Campbell
Caleb Alexander Carter
Jacob Cartwright
Chris Cerasani
Sarath Chandran
Dyan N. Chong
Kyle J. Clare
John Clyne
Mark Colella
Steven Colquitt
Ron Conley
Bob Cook
Phillip A Cox
Justin E. Crawford
Sean T. Crowley
Stephen Cunningham
Lisa L. D'Amico
Shannon Claire Davey
John Edward Davis
Leo Devellian
Mark W. Dixon
Michael G. Eck
Chelsea Marie Ehlert
Joerg Ehmann
John A. Elder
Mark Enlow
Michael Evans
George Faber
Steven Fage
Andre Faria
Pat Fenell
Rosa Fernandez
Pascal Andre Ferrandez
Michael E. Foote
Gwendolyn Frederick
Jason Frendo
Renato Michelin Galesi
Joseph S. Gano
Anthony Genova
Kevin T. Glass
Jason Gotch
Michael Griffitts
Justin R. Grumski
Steve Hagerman
Larry Harris
Bruce Harrison
Benjamin Philip Heine
Daniel Hille
Mike Hoeppner
Martin Höer
Eric A. Honeycutt
Donovan Rhett Hubbart
Richard Huchko
Mohammed Islam
Xin Jing
Gerald Johnson
Curt Johnstun
Ronald J. Juedes
Raju Kalidindi
Joel T. Kaminski
James Kegelman
Dharmendra Khanolkar
Clinton Kietzmann
Leslie Klar
John Klever
Greg Koob
Bryan Kraft
Alexander Kudakkachira
Qi Li
Peter Lucas
Kelsey Lynn Luibrand
Leroy D. Luther
Anthony Lytsikas
Yasuhiko Machitani
Ray Mallet
Richard Markham
Walter Masnyk
Jimmy Masrin
Susan Michaeli
Raj Mody
Guillermo Molteni
Steven G. Morgan
Ronald L. Mudd
Kevin S. Newland
Daniel Noriegn
John Nowell
Sami Obeid
Eddie Oropeza
Greg Osborn
Gernot Alois Pacher
Muthu Pannirselvam
John Parrington
Anup Patel
Sriraj Patel
Eric B. Pennell
Mario A. Perez
Randy Peslar

IMD New Members Continued

John Peterson
Tyler John Phelps
Gregory Andrew Plotts
Gregory Pracy
Ryan M. Prunty
Kelly Puckett
Gerardo Puig
William Purcell
Jeff Putnam
Peter Quinn
Rick Quinn
Sean Rainsford
Eben Solomon Rajan
Alvaro Jose Ramirez

Joe Reimer
Jess T. Rhodes
Christopher E. Richards
Don Rodda
Mark Roodvoets
John A. Ross
William R. Rousseau
Al H. Rouwenhorst
Mehdi Saniei
Michael John Scott
Stephen Scott
Brett Smith
Nitin Sood
Alex J. Sorenson

Henry J. Sorgen
Jim Stewart
Desmond B. Street
Fritz Strehlow
Willard Sullivan
Dennis Swartz
George Thirlaway
Evan G. Thomas
Wayne Bredefeld Thomas
Jamie Thomson
Muluken Tilahun
Eduardo Tineo
Mitch Turnipseed
Varthanan Vishnu

Mikael Steven Wagner
Paul Walach
Michael K. Waldrep
Thomas Walker
Brian Walsh
Sharon Willaims
John Williams
Robert A. Wilson
David S. Wolf
Stephen R. Wolfer
Andrew Wooley
Michael C. Wright-Dowd
Hongyue Yuan

...from 14 countries:

Argentina
Australia
Austria
Brazil
Canada
Colombia
Denmark
Germany
Greece
India
Japan
Oman
United Kingdom
U.S.A.

...representing more than 125 organizations including:

5 Nines Automation LLC
A&A Global Industries
A. Finkl & Sons Co.
Acushnet Co.
Advanced Fluid Systems, Inc.
ALBA Enterprises
Amsted Rail
Anderson Power Products
Aspen Research Corp.
Auriga Polymers
Autodesk Australia Pty. Ltd.
BPC Manufacturing
Barbury Co.
Bemis
Bennett Precision Tooling Pty. Ltd.
BIC Violex S.A.
Bluestar Silicones
BMS Vision
Boucherie USA Inc.
Carvajal Empaques
Central Carolina Community College
Chase Plastic Services Inc.
Chemplast Inc.
CIMA Plastics Group
Clariant Australia Pty. Ltd.
CommScope
Comtec IPE
Cooper Standard
CRE Enterprises Inc.
Currier Plastics Inc.
Custom Engineered Wheels
Dana
Deb Dispensing Inc.
Demag Plastics Group
Dept. of Printing Technology
Dollplast Machinery Inc.
Draexlmaier Automotive of America LLC
E. I. DuPont India Pvt. Ltd.

IMD New Members Continued

EMD Millipore Corp.
Evonik
Fast Heat Inc.
Fenner Advanced Sealing Technologies
Ferris State U.
Formosa Plastics Corp.
GE India Tech. Center Pvt. Ltd.
GLE Enterprises LLC
Global Mould and Design Pty. Ltd.
Goettfert
Guateplast
Hewlett Packard
Hoosier Pride Plastics Inc.
Houston Plastic Products
Industrial Scientific
Ingredion Inc.
Institut for Plastics Processing (IKV) Aachen
ITW Filtertek
JR-Cape Management Consulting Group
KPMG LLP
Kraft Foods
Laird Technologies
Lehigh University
LioChem Inc.
Marplex Australia Pty. Ltd.
Meadoworks
Meridian Medical Technologies
Metro Mold and Design
Mid-Florida Plastics
Milacron LLC
Munro & Associates
Nike Inc.
Oman Cables Industry
Orbis Corp.
Parker Hannifin
Penn State U. - Behrend
Pentair
Pikes Peak Plastics Inc
PIM Machinery
Plastic Injection Molding Inc.
Polymer Competence Center Leoben GmbH
PolymerOhio Inc.
Polymers International Australia Pty. Ltd.
Ravago
RJS Quinn
RMIT University
Robert Bosch GmbH
Rochester Midland Corp.
Rosti Technical Plastics
SABIC Innovative Plastics
Sanluis Rassini
Scan Tool & Mold Inc.
Schoeller Allibert Inc.
Schuler Inc.
Senninger Irrigation
Siemens
Silgan ipec
Smiths Medical
Stant
Stemmerich Inc.
Sumitomo Bakelite North America Inc.
Supplier Technology & Engineering
Support SVC LLC
SUSSEXIM
Synventive Molding Solutions
TE Connectivity
Technical Polymers
Technical University of Denmark
The Mentor Group
Toyo Seikan Kaisya Ltd.
Triangle Tool Corp.
TS Tech North America Inc.
United Plastics Group
U. Massachusetts - Lowell
U. Toronto
U. Wisconsin - Stout
U. Wisconsin - Madison
Washington Penn Plastics
Weiler Engineering
WES Plastics Pty. Ltd.
Winona State U.
Wisconsin Engraving
WittmanBattenfeld Aust. Pty. Ltd.
Wolfson Centre for Materials Processing
Xaloy Inc.

Membership Application

Society of Plastics Engineers Membership Application

13 Church Hill Road, Newtown, CT 06470 USA
Tel: +1 203-775-0471 Fax: +1 203-775-8490
membership@4spe.org www.4spe.org

European Member Bureau
Tel: +44 7500 829007
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Applicant Information

Name:
first last mi

Company Name and Business Address (or College):
company/college:
job title:
address:
address:
city: **state:**
zip: **country:**

Phone/Fax Format: USA & Canada: (xxx) xxx-xxxx All Others: +xx(xx) x xxx xxxx

Work Phone: **Fax:**

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Home Address:
address:
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Home Phone:

(✓) **Preferred Mailing Address:** ❑ **Home** ❑ **Business**

Gender: ❑ Male ❑ Female

Birth Date: (mm/dd/yyyy)

Demographics

Job Function *(choose only one)*
- ❑ Consulting
- ❑ Design
- ❑ Education (Faculty)
- ❑ Engineer
- ❑ General Management
- ❑ Manufacturing
- ❑ Marketing/Sales
- ❑ Other
- ❑ Purchasing
- ❑ Quality Control
- ❑ R & D
- ❑ Retired
- ❑ Self-Employed
- ❑ Student
- ❑ Tech Support

Materials *(choose all that apply)*
- ❑ Composites
- ❑ Film
- ❑ General Interest
- ❑ Nylon
- ❑ PET
- ❑ Foam/Thermoplastics
- ❑ Polyolefins
- ❑ Polystyrene
- ❑ TPEs
- ❑ Thermoset
- ❑ Vinyls
- ❑ No Interest

Process *(choose all that apply)*
- ❑ Blow Molding
- ❑ Compression
- ❑ Compounding
- ❑ Engineering Properties
- ❑ Extrusion
- ❑ Fabrication
- ❑ Foam
- ❑ Injection Molding
- ❑ Mold Making
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- ❑ Rotational Molding
- ❑ Thermoforming
- ❑ General Interest
- ❑ No Interest

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- ❑ Decorating & Assembly (D34)
- ❑ Electrical & Electronic (D24)
- ❑ Engineering Properties & Structure (D26)
- ❑ European Medical Polymers (D46)
- ❑ Extrusion (D22)
- ❑ Flexible Packaging (D44)
- ❑ Injection Molding (D23)
- ❑ Marketing & Management (D37)
- ❑ Medical Plastics (D36)
- ❑ Mold Making & Mold Design (D35)
- ❑ Plastics Environmental (D40)
- ❑ Polymer Analysis (D33)
- ❑ Polymer Modifiers & Additives (D38)
- ❑ Product Design & Development (D41)
- ❑ Rotational Molding (D42)
- ❑ Thermoforming (D25)
- ❑ Thermoforming, European (D43)
- ❑ Thermoplastic Materials & Foams (D29)
- ❑ Thermoset (D28)
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Students must supply graduation date: ______

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Primary Division FREE

Additional Division(s)
costs for each Additional Division

	1yr.	2 yrs.
US	$10.00	$20.00

______

TOTAL ______

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card number

expiration date (mm/yyyy)

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SPE membership is valid for twelve months from the month your application is processed.
*extra savings.

By signing below I agree to be governed by the Bylaws of the Society and to promote the objectives of the Society. I certify that the statements made in the application are correct and I authorize SPE and its affiliates to use my phone, fax, address and email to contact me.

signature date

recommended by member (optional) Id #

WWW

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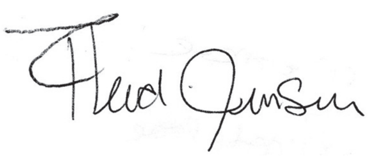
Message from the Publisher

Take Advantage of Some New Opportunities Available Through Molding Views

I hope you enjoyed this issue of *Molding Views*. *Molding Views* strives to find useful information for all of the Injection Molding members. New opportunities for companies are available for anyone wishing to promote their services or company. Sponsorship articles and product releases are a great way to publicize company services and or products to the Injection Molding readers.

As always, if you have a paper or article related to Injection Molding, please send it in! Member contribution is greatly appreciated each issue.



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