

Fall 2019 | No. 111

Chair's Message

Rick Puglielli



As we enter the winter months, I am looking forward to a great upcoming year for the Injection Molding community. ANTEC 2020 is just around the corner and the Injection Molding Division has some great papers and speakers lined up. Be sure to join us for our annual Injection Molding Division (IMD) reception at the ANTEC convention in San Antonio Texas.

The Injection Molding Division has been busy reaching out to local and student chapters of SPE to help develop and promote valuable academic and industry events. Please reach out to us if your local chapter is in need of developing a program or event to support the Injection Molding community.

With two major national events planned for 2020, ANTEC2020 at the end of March and IMTECH2020 in early November, we hope we get the opportunity to re-connect with all our members so we can continue to deliver the value we are committed to providing.

I wish all our members a happy holiday season and a prosperous 2020!

Sincerely,

Rick Puglielli
2019-2020 IMD Chair
Promold Plastics
info@promoldplastics.com

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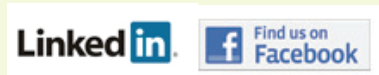
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Keep the connection!

Join us on:



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November 2019**NOVEMBER 6, 2019****49th Automotive Innovation Awards Competition and Gala**

Burton Manor, Lavonia, MI

SPE's Automotive Innovation Awards program is the oldest and largest competition of its kind in the automotive and plastics industries. Dozens of teams made up of OEMs, tier suppliers, and polymer producers submit nominations describing their part, system, or complete vehicle module and why it merits the claim as Year's Most Innovative Use of Plastics. Applications must be on a commercially available vehicle by November 1st of the year in which a nomination is submitted.

February 2020**FEBRUARY 10****Medical Plastics Minitec 2020**

Anaheim, CA

This MiniTec will be held the Monday, February 10th – the day before the opening of the 2020 MD&M West Expo & Conference in the shadow of the Anaheim Convention Center. This conference is expected to host at least 100 conference attendees and will feature up to 20 tabletop exhibitors. At least ten Speakers will present in two sessions covering the latest technology in Medical Device Materials and Processing.

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WEBINARS**Failure Associated with Injection Molding***December 12, 2019 11:00 AM (EDT) - 12:00 PM (EDT)***Fourier Transform Infrared Spectroscopy in the Failure and Compositional Analysis***January 9, 2020 11:00 AM (EDT) - 12:00 PM (EDT)***Introduction to Plastics***February 13, 2020 11:00 AM (EDT) - 12:00 PM (EDT)***ON-DEMAND WEBINARS****On-Demand Webinar: Is Your Project Ready for Injection Molding?**

Learn what design mistakes we commonly see in Injection Molding parts and how they can dramatically alter the finished part from what was initially conceptualized.

Injection Molding Analysis with Moldex3D Studio

Performing an injection molding analysis could be a long and laborious task, involving model preparation and meshing, defining materials, setting up process conditions and analyzing simulation results.



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For more show details visit injectionmoldingdivision.org

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Gas Assist Injection Molding

Gas assist injection molding is a process with a high speed and low-pressure injection method. It involves the injection of high-pressure nitrogen gas into the melt stream instantly. You'll use a short shot method of resin fill and utilize the gas to fill and pack out the remainder of the part. There are four main considerations for a successful application of the technology:

1. A repeatable and precise shot control on the injection-molding machine.
2. Precise control of time, pressure, and speed of the nitrogen being injected.
3. Control of the nitrogen dispersion within the molded part.
4. Appropriate tool design.

It is important to note that the flow path that the nitrogen gas takes is mainly controlled by the resin flow within the cavity. The volume and viscosity of the resin determine flow and not by the nitrogen gas injection.

Advantages

The primary advantage of gas assist is cost reduction by improving productivity. Using lower clamp tonnage means using a smaller machine thus improving the quoting process, not to mention the eliminating the cost of a larger machine. Cycle time reductions save costs as you do not need pack and hold times

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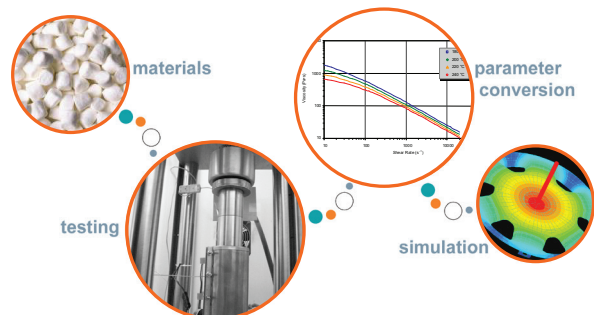
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and pressures. This of course saves time. In gas assist you never completely fill the part. By using a short shot process there is less plastic injected and less plastic to cool. The gas will also promote cooling which slashes cycle time. New methods of tool design flow and fill is improved again saving time. In very thick parts, gas follows the path of least resistance which promotes low pressure fill without packing out the outward features of the part. This means reductions in part weight; even thin walled applications. Thick walled parts can have up to seventy percent less part weight. While using less plastic may weaken the part it actually forms a tube configuration with less stress which actually improves strength. You also have to remember that by eliminating resin especially engineering grades, is quite cost effective. This of course depends on the end use of the part.

Design Options

Design of the tool is critical whether using gas assist or any other molding process. With gas assist it's possible to design a part based on concept for use, rather than limitations of conventional molding capabilities. Features in wall thickness can now be designed directly into the part, rather than limitations using second mold operations. These features can eliminate problems with the part. Gas channels or pins can be used to help fill the cavity and strengthen a feature of an area of the part based on design. The use of mold filling analysis can be used to indicate the outcome of a particular design. Weld lines can be eliminated by design which will help in over-all part appearance.

Quality Improvements

Large concerns of the molder and also cost production is the overall quality of the part. As mentioned, weld lines of the part can be minimized or even eliminated. Sink marks can also be eliminated by utilizing design or placement of the gas channel or pin. Utilizing design options can reduce stress which could result in reductions of dimensional stability. By reducing molded in stress, parts will have less shrinkage much less than a conventional molded part. This leads to more repeatability and less distortion within a part. Weight can become a quality measure, rather than actual measurement of the part. This is due to a repeatable process.

Long Flow Lengths

Gas injection accommodates very long flow lengths by using correct tool design. Even parts that are in excess of five feet long have been molded using one gate. This usually can't be done with conventional molding. Multiple gates or hot runner systems are required to fill very long parts. Not only is this an easy design with gas assist but it eliminates cost of extra tool considerations.

Structural Foam Parts

The easiest tool to convert to gas assist is usually one designed for structural foam. Structural foam parts usually have thick wall sections. This makes it naturally conducive to gas assist. The structural foam process mixes a certain gas agent such as nitrogen. This agent will usually leave a swirl effect on the part surface. Gas assist injects the gas after the resin injection leaving a smooth surface on the part. Structural foam parts usually require secondary operations and several coats of paint. Elimination of paint, surface defects, secondary operations and long cycle times are a huge advantage to convert structural foam tools.

Disadvantages

As with any project there are certain disadvantages. With gas assist, there will be a hole in the part where the gas enters and exits. You usually can't use a tool that has a hot runner system that does not have valve gates.

The gas wants to take the path of least resistance. The gas would prefer to go into the manifold of 500°F, rather than go into the part that is under 200°F in most cases. Another disadvantage is that there will be read out if the design is not correct. Read through of the gas will appear on the wall of the part. Placing gas channels and injector pins correctly will help eliminate this problem.

Two Types of Injection of Gas

Nozzle Injection

Nozzle injection is oldest and easiest way to implement gas assist molding. There are many designs of nozzles and hardware, but some are expensive and simply do not work. It is necessary to use sprue brake with this method, as the mold needs to vent the gas out of the part. There are self-venting check valves that can eliminate the need for sprue break. Gas assist through the nozzle is easy to do, even on tools designed for this process. The nozzle acts as a shut off and gas nozzle both. They simply thread on an existing molding machine. Gas is connected to the check valve located in the device and you are ready to shoot using gas. The only setback in using nozzle injection is you will have a hole at the gate. It is not as controllable using the gas. You must shut off the resin flow to prevent any gas from going back into the barrel. This can cause a stalling effect and can leave a trace of stop and start of the resin flow known as a hesitation line.

Gas Pin Injection

Injection of gas through a small device such as a pin located within the tool has become more renowned as of late. This is because one has precise control while you shoot resin and gas simultaneously. This makes it very beneficial in many applications. You do not have to do tool modifications with gas pins but there will be minimal cost involved. The use of gas pins has become very user friendly by way of injecting and pressurizing a plastic part. Gas pin injection works by connecting a gas line to the side of the mold and then connected via channel to the pin. The pin is mounted to the mold face and the gas is injected into the part. Gas pins can be placed in multiple locations and will require less pressure to penetrate into the part compared to nozzle injection. However, there will always be a hole within the part.

Summary

- Contact an expert when considering gas assist injection molding.
- Control of the short shot is critical. Make sure the barrel and screw tolerances are within specifications.
- Use a highly controllable gas system.
- Gas assist is not always the correct process.
- There will always be a hole in the part.
- Using a mold flow simulation will be very valuable before deciding about gas assist.
- Gas assist will save you money in many ways.
 - Reduced tonnage, cycle time and tooling costs.
 - Increased part design measures.
 - Improved quality, marketability and startup of molds.



Dallas Cada is a highly trained plastics engineer with over 20 years of sales support experience. Owner of a plastic consulting business (DDC Consulting). His experience includes technical service, application development, market engineering, injection molding, design, tooling, material suggestions and problem solving for plastic manufacturing companies. For more information with troubleshooting plastic problems or helping with new plastic applications, contact Dallas Cada by e-mail at dallascada@charter.net. Contact Dallas by phone (507) 458-5785.



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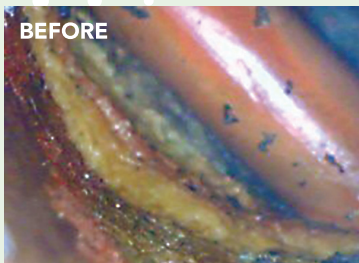
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By J. Coulter, P. Gao, A. Duhduh, A. Kundu
 Manufacturing Science Laboratory
 Lehigh University, Bethlehem, PA, 18015

Vibration Assisted Injection Molding for PLA with Enhanced Mechanical Properties and Reduced Cycle Time

This research was focused on the effect of processing parameters on physical characteristics of poly-lactic acid (PLA) during vibration assisted injection molding (VAIM). In vibration assisted injection molding processes, the travel of the injecting screw is moved back and forth to create an oscillatory motion during the injection stage of the molding process. The frequency, duration and initiation point of the motion can be individually controlled. It was observed that VAIM based PLA products have higher total crystallinity than conventionally molded PLA products under identical conditions sans the vibration. Based on these results it was hypothesized that the vibration primarily affects the molecular arrangement of the polymer chains which in turn affects the nucleation density and thus the crystallinity. In addition, it was observed that the cycle time can be reduced by at least 25% when vibration was applied.



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Vibration Assisted Injection Molding (VAIM)

In vibration assisted injection molding (VAIM), the standard injection molding process is augmented with a dynamic oscillatory motion of the injection screw. A schematic of this setup is illustrated in **Figure 1**. Instead of injecting the polymer melt directly into the mold cavity in a single motion, VAIM utilizes an additional computer system to control the hydraulic system to make the injection screw move in an oscillatory motion at specific frequencies, amplitudes, and durations as the melt is packed and solidified. Additionally, the molding parameters, such as injection temperatures, injection and packing pressure, mold temperature can be separately controlled by the injection molding machine.

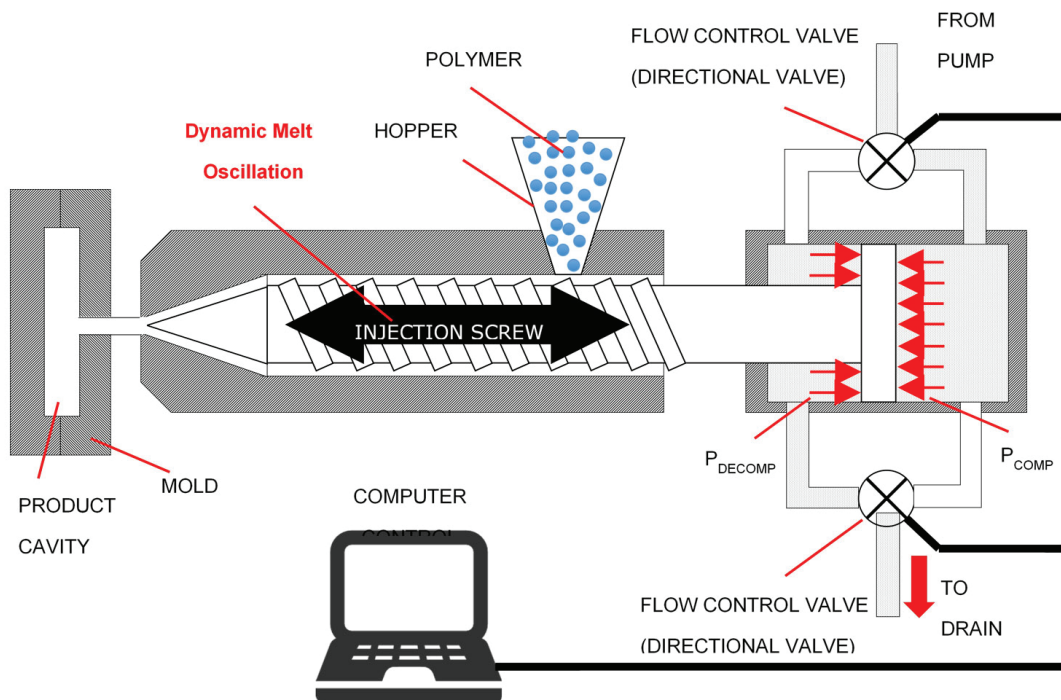


Figure 1: Schematic of the vibration injection molding setup.

VAIM has been reported to promote the molecular orientation of the polymer chain in molded samples [1]. The vibratory motion aids in untangling and orienting the molecular chains as it cools down to temperatures just above its glass transition temperature (T_g). Continuing this as the temperature dips below T_g , ensures that the induced chain orientation is maintained in the solidified polymer, and chain relaxation does not occur. Both the vibration contributed by the oscillatory shearing action (in the melt stage) and to a lesser extent, the hydrostatic pressure (as the polymer solidifies) play a role in altering certain aspects of the molded product's material as well as physical properties. In traditional injection molding, this is not observed since solidification under a quiescent condition would have resulted in a random coil arrangement. A polarized light optical microscopy technique was utilized to investigate the molecular orientation in injection molded PLA parts and the results are shown in **Figure 2** [2]. The dark colored (blue and grey in **Figure 2**) represents the low stress sections while the light colored (red and orange) represents the high stress sections. It can be

Vibration Assisted Injection Molding for PLA

observed that the sample with vibration have more cycles of change in stresses along the melt flow direction, which represents highly molecular orientation.

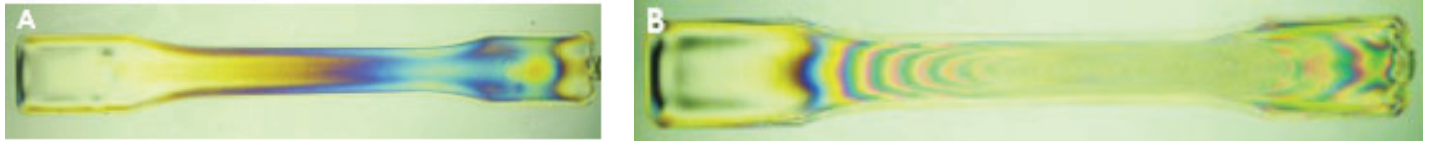


Figure 2: Optical birefringence pattern on amorphous PLA samples (PLA 3051D) prepared by (A) conventional, and injection molding with oscillatory vibration at (B) 4 Hz for 10s. Melt flow direction is from right to left.

Material Selection

Poly(lactide or Poly(lactic acid) (PLA) is a thermoplastic polymer derived from renewable resources. This is in contrast to common commercial grade thermoplastics, such as those from the polyethylene family, and isotactic polypropylene, that are derived from nonrenewable petroleum reserves. PLA can be manufactured with different properties from primarily amorphous to largely crystalline. This is achieved by varying the relative amount of the isomers and additives. PLA has two stereoisomers namely the L-lactic and the D-lactic acid. Three forms of PLA are available commercially: pure L-lactide, pure D-lactide, and a mix of L and D-lactide. Relatively pure L-feed and D-feed PLA is referred to as PLLA and PDLA respectively [3]. Common commercial grade PLA (that requires high crystalline content) contains a majority L-feed mixture, and a minimum of 1-2% D content, whereas those requiring an amorphous product may contain up to 20% D content.

Injection molding is the primary fabrication method for producing PLA parts. PLA could be a semi crystalline polymer. The crystallinity and other physical properties of these materials can vary with the processing conditions. Presence of certain additives such as nucleants [4], and accelerants, impact modifiers, and mold flow agents can affect the crystallinity and the properties as well.. A drawback of PLA is its low T_g (approximately 60-75 °C) resulting in inferior thermal resistance to other industrial polymers. The thermal resistance can be improved by increasing the crystallinity in these materials. Higher crystallinity is also desirable for stiffness, strength, and other properties of the fabricated parts [4]. However, the crystallization rate of PLA is slow, thus obtaining sufficiently high crystallinity within reasonable manufacturing times is difficult. The typical mold-closed time is ~ 40 – 60 seconds at optimal mold temperature settings (minimum of 85 °C, and preferably above 105 °C). The high mold temperature required also increases the cost of production. Lowering the cycle time and the prescribed mold temperature could lead to parts sticking to the mold, or bend and warp upon ejection. Subsequent annealing to increase the crystallinity of molded products is a viable strategy but would add an additional step (time and cost) to the overall manufacturing process. The crystallization of PLA is of great interest to the research community and studies have focused on influences of axial stretching/strain[5], melt drawing/extrusion[6], annealing[7], and crystallization temperature[8] on PLA crystallization. This research was focused on the effect of processing conditions on the crystallinity during vibration assisted injection molding.

Sample Preparation and Characterization Techniques

An Ingeo TM PLA 2500HP polymer from NatureWorks was utilized in this study. To enhance the properties of the final products, we added 10% proprietary blend of additives that included a nucleating agent, accelerant, impact modifier, and a mold flow agent. PLA pellets were dried in a 40°C oven for 8 hours to reduce the amount of absorbed moisture [9].

The samples were molded into ASTM D638-01 dog bone specimens using a Nissei PS40E5A injection molding machine. Injection molding was performed with and without vibration using the modified setup presented in **Figure 1**. During the processing the melt was dynamically oscillated under 4 different conditions: i. without oscillation (0 Hz), ii. 1 Hz, iii. 4 Hz, iv. 8Hz, and v. 30Hz. Melt oscillation was commenced immediately as the melt was injected and packed into the cavity for the duration of 10 seconds. To ensure a positive pressure on the melt during oscillation, a 55:45 ratio of time was set for the compression stage relative to the decompression stage of each vibration cycle. The temperature of the material in the injection screw was controlled at 4 positions along the screw. The temperature at the nozzle, front, middle and rear sections of screw were maintained at 215°C, 205°C, 195°C and 175°C respectively. Injection pressures in all cases are set at 64 and 36 MPa respectively for injection period and packing period. The injection time for each sample was 15 seconds while the packing/cooling time was 20 seconds. To enhance the growth of crystal, a high temperature mold of 85°C was utilized for manufacturing all samples.

A cross sectional slice at the mid-section of the dog bone sample, weighing approximately 8-10 mg, was extracted from each sample and was utilized to investigate the crystallinity in the parts. A differential scanning calorimetry (DSC) technique using Q2000 DSC device from TA Instruments was utilized for this purpose. Only the first heating scan, from 25°C to 240°C at 10°C /min, was collected to investigate the effect of the vibrational frequency on the crystallinity in the molded material. The degree of crystallinity (XC) was calculated using Equation 1.

$$X_C = \frac{\Delta H_m - \Delta H_c}{93} \times 100 \quad (1)$$

Where ΔH_m is the melting enthalpy [J/g], ΔH_c is the cold crystallization enthalpy [J/g], and 93 J/g is the melting enthalpy of a PLA crystal of infinite size

Results and Discussion

Table I illustrates the effect of vibration and cycle time on the product quality. The cycle time is the total time including injection and cooling times required to produce a dog bone part. A minimum cycle time of 35 seconds was required for fabricating a high-quality part without vibration. But with 1 Hz vibration, a cycle time of 21 seconds was adequate to obtain an optimal product. In contrast, dog bones fabricated without any vibration with 21 seconds cycle time were soft when demolded and deformed on further cooling. There was no visible change in the product quality when the vibration frequency was increased to higher values [10].

A series of DSC tests were performed on the dog bone samples to gain insight on the crystallinity. DSC scan profiles of injection molded samples processed under different conditions in the temperature region from 120°C to 190°C are presented in **Figure 3**. A DSC







	Frequency	Cycle Time (s)	Sample Quality
Without vibration	N/A	35	
	N/A	21	
Vibration assisted	1Hz	21	
	4Hz	21	
	8Hz	21	
	30Hz	21	

Table I: Pictures of dog bone samples using different manufacturing parameters.

plot of the as received material has also been included for comparison. Plot for PLA pellets and conventional vibration samples were similar. But even with 1 Hz of vibration, the material changed significantly. The total area under the peak increased indicating a higher crystallinity in the material. An interesting observation was made when comparing the data for 1Hz and 8Hz samples. Increasing the frequency from 1 Hz to 8 Hz increases the crystallinity of the final product, but the melting point shifted to lower temperatures. It was hypothesized that vibration made the crystallization process faster by introducing shear, but the crystal structures were less perfect with higher frequency. This would indicate that the sample was subjected to higher shear rate. Hence, a lower energy was required for melting those less perfect crystal structures thus decreasing the melting temperature. The sample fabricated at 30Hz appeared to be significantly different from the other samples. The melting point shifted to higher temperatures, the melting curve is wide. A second melting peak was observed at 165°C. It was associated with the melting of the α' phase, one of the several phases of PLA. PLA has been reported to crystallize in four distinct phases, α , α' , β and γ . These structures are different in their sizes and enthalpy. The most stable crystal structure in PLA products is the α structure, and the α' to α conversion is irreversible. The microstructure appeared to be significantly different than the rest for the 30Hz sample.

Table II shows the percentage of crystallinity for each sample.

Samples under the same vibration frequency but with different cycle times were also tested to understand the effect of cycle time. **Figure 4** and **Figure 5** show the DSC scan profiles of 1Hz VAIM samples and 30Hz VAIM samples, the degree of crystallization is presented in **Table III**. It is observed that the crystallinity increased from 42% for conventional injection molding to 52% utilizing 1Hz VAIM and with the same amount of cycle time. The crystallinity increased further to 54% even when the cycle time is reduced to 21 seconds instead

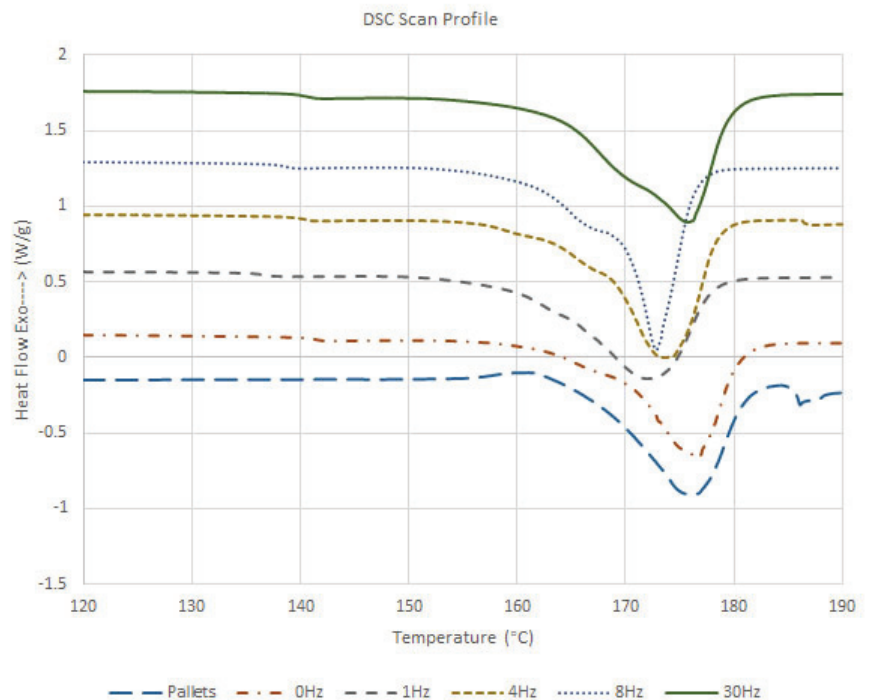


Figure 3: DSC scan profile for PLA dog bone samples. A scan for pellets after drying is also included for comparison.

Sample	Crystallinity (%)
Unmolded Pellets	32
Conventional Molding	42
VAIM 1Hz	52
VAIM 4Hz	59
VAIM 8Hz	59
VAIM 30Hz	66

Table II: Crystallinity for PLA dog bone sample.

Vibration Assisted Injection Molding for PLA

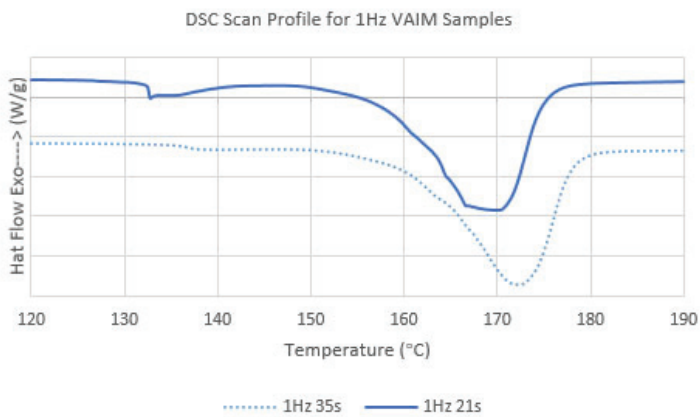


Figure 4: DSC scan profile for 1Hz VAIM samples.

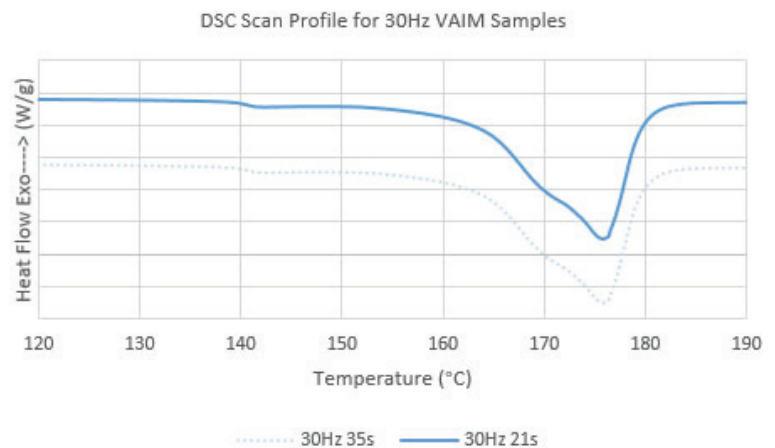


Figure 5: DSC scan profile for 30Hz VAIM samples.

of 35 seconds utilizing 1Hz VAIM. When VAIM was performed at 30Hz, 66% crystallinity can be achieved with 35 seconds cycle time and the crystallinity decreased to 60% when 21 seconds cycle time was employed. But in general, even with reduced cycle time, higher crystallinity can be achieved utilizing 1Hz and 30Hz VAIM.

Table III indicates that under VAIM, samples would have higher crystallinity compared with traditional injection molding samples even with reduced cycle time. This would result in reducing cycle time at the same time, keeping the same or even enhance the properties of the final products.

Sample	Crystallinity (%)
0Hz 35s	42
1Hz 35s	52
1Hz 21s	54
30Hz 35s	66
30Hz 21s	60

Table III: Crystallinity for samples with different processing parameters.

Conclusion

The primary conclusions of this research are as follows:

1. VAIM appeared to affect the structure of molded PLA part and resulting in the increase of crystallinity as inferred from the DSC results. Even with 1Hz VAIM, a 24% increase can be observed on degree of crystallinity. If frequency was increased to 30Hz, a further 27% increase in crystallinity was achieved compared to 1Hz VAIM samples. It is also noted that the microstructures of the crystals also changed with different vibration frequencies.

2. Experiments show that the cycle time to manufacture a dog bone sample can be reduced from 35 seconds to 21 seconds using VAIM without inducing any negative impacts to overall product quality. This could lead to a large reduction in production time and enhanced production speeds during mass-scale production of the PLA parts.

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About the Author



John P. Coulter is a professor in the Department of Mechanical Engineering and Mechanics at Lehigh University who also serves as the Senior Associate Dean for Research for the P.C. Rossin College of Engineering and Applied Science. On two separate occasions, the latest taking place from 2015 through 2016, Dr. Coulter has served as the Interim Dean of the College of Engineering and Applied Science at Lehigh. In that capacity he was responsible for the operation, coordination, financial management, advancement, and oversight of all engineering related activities at the University. He holds Bachelor of Science and Master of Science degrees in mechanical and aerospace engineering from the University of Delaware, and completed his doctoral studies in mechanical engineering at Delaware in 1987. His graduate studies were supported by a prestigious and nationally competitive DoD Fellowship awarded through the Office of Naval Research.

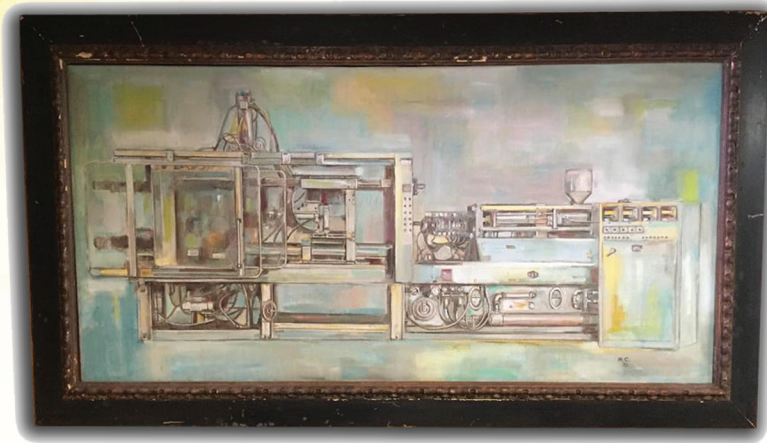
Coulter has 29 years of teaching and research experience at Lehigh, as well as several years of industrial experience with Lord Corporation, a multi-national company specializing in materials and devices for vibration and acoustic control. During his time at Lehigh, he has taught several thousand undergraduate students, mentored 25 doctoral students and 65 master's students, and won several awards for curriculum innovation that incorporates K-12 students from diverse backgrounds. His accomplishments at Lehigh have been recognized through continuous federal, state, and industrial research support as well as numerous awards for teaching and research including a prestigious NSF National Young Investigator (i.e. CAREER) award, Lehigh's first-ever NSF Presidential Faculty Fellow (i.e. PECASE) award, a Future Technology Award from the Society of Plastics Engineers, and two Innovative Curriculum Awards from the American Society of Mechanical Engineers.

As an individual scholar, he has more than 200 publications and several patents in the areas of material processing, manufacturing science, and intelligent materials/systems. He has led funded research projects involving faculty Co-PIs from all eight departments in the college of engineering, and generated more than \$9 million in individual research and teaching grants along with intellectual property donations to Lehigh valued at approximately \$100 million. He has also organized a number of international conferences, workshops and symposia, served on three international journal editorial boards, and currently serves on the Board of the ASEE Engineering Research Council.

SILENT AUCTION

A Michael Crosby painting of a Impco, Nashua, New Hampshire, Model MB350.

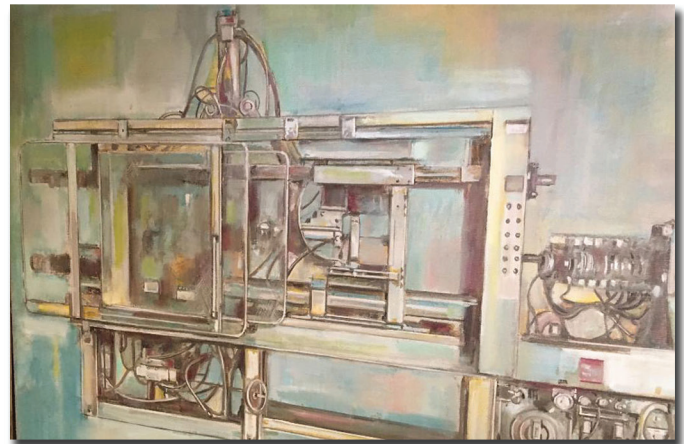
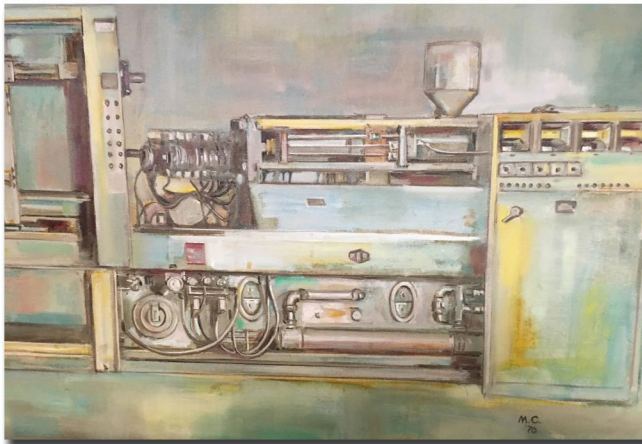
The IMD Division is hosting a silent auction for a Michael Crosby painting. All proceeds will be donated to the SPE scholarship fund.



4' x 2' Michael Crosby painting from the Karl Mann Gallery, 57th Street in New York City.



This painting is originally owned by Saul Blitz, owner of Tico Plastics. Saul was a past president of the NY section of SPE and a member of the Plastic Hall of Fame. This painting is a side view of a Impco plunger and pot configuration machine.



Place your bid at injectionmoldingdivision.org

The winner is responsible for shipping expenses F.O.B. NY

By Matthew Stevenson
Polyfuzer / Mold In Graphic Systems

Fusion Labeling Technology Makes Low Surface Energy (LSE) Polyolefin Durable Goods Safer

Safety Labeling Standards

From the late 1970's to present, Consumer Safety has become the driving force behind safety labeling standards that test everything from label construction and adhesion, to chemical and environmental durability as warning/informative labels have become more prominently used on durable goods products made for a variety of industries.

Much of that drive has been a result of the U.S. Consumer Product Safety Commission (CPSC).

Founded in 1972, their mission is to "protect the public from unreasonable risks of serious injury or death from thousands of types of consumer products under the agency's jurisdiction. The CPSC is committed to protecting consumers and families from products that pose a fire, electrical, chemical, or mechanical hazard or can injure children."

Some examples of the first safety label standards:

1978: First UL 969 Standard for Marking and Labeling Systems written. UL 969 is the self described "de-facto safety label standard" that firmly illustrates the UL mission statement by providing direction to manufacturers using adhesive-based or In-Mold labels for use as permanent nameplates or markers in their products.

1979: ANSI Z535 Committee on Safety Signs and Colors formed. ANSI's mission is "to enhance both the global competitiveness of U.S. business and the U.S. quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems, and safeguarding their integrity." 1991: ANSI Z535.4 Standard for Product Safety Signs and Labels written. Language within the standard mandates "permanent" labeling to warn against specific hazards and accident prevention to industries like PowerSports and Outdoor Power Equipment.

In addition to the organizations listed, there are additional safety standards from organizations like ASTM, ANSI, OSHA, FINAT, ISO, NHTSA and more, that continue to oversee the protocols for manufacturing of durable goods products within children's products, automotive, waste/recycling and consumer durable goods products just to name a few.

Name a product within any industry and there's a very good chance that a standard is written for it with guidance on permanent safety and warning labeling.

Definition of Permanent

Permanent: [pur-muh-nuhnt] adjective - existing perpetually; everlasting, especially without significant change.

A great example is used within the ANSI Z535.4 safety standard, specifically sections 4 and 10 shown below. First published in 1991, the language describing permanent has not changed now for over 30 years.

4 Definitions

4.12.2.1 permanent safety sign or label: A sign that is to be permanently affixed to the product so that it cannot be easily removed. Permanent safety signs typically provide information about potential exposure to hazards inherent in the normal use associated with the product, or which might be created during other reasonably anticipated product use or misuse.

10 Expected Life and Maintenance

10.1 Expected Life

Reasonable expected life shall take into consideration whether the safety sign is permanent or temporary, the expected life of the product, and the foreseeable environment of use.

Pressure sensitive adhesive labels (PSA's) are the most prominent and well-known labeling system in the world which is why they have been the label choice for durable goods products made from metal and other types of materials. So it comes as no surprise the phrase "permanent labeling" has become synonymous with pressure sensitive adhesive labels. Yet the real question is, are they really permanent?

Unfortunately, manufacturers and original equipment manufacturers (OEMs) who believe they are acquiring permanent safety/warning labels for their LSE polyolefin plastic durable goods are actually getting labels that were engineered and tested for high surface energy metals and composites.

Knowing that even the most aggressive adhesives are susceptible to easy removal through mechanical or chemical means, the PSA industry "loosely defined" permanent adhesive based labels to a measurable result outside of the true definition. For manufactures, OEMs, or anyone seeking permanent safety/warning labels for their LSE polyolefin plastics, the term "permanent labeling" has been disguised and the PSA industry is misleading.

Labeling Durable Goods



Product Highlight: High Chairs

Because of durability and the ease to sanitize, infant high chairs are commonly made from nonporous molded plastic, polyethylene, and polypropylene. This is just one example of many durable good products made from LSE polyolefin plastic.

(ASTM) first approved and published ASTM F404 Standard Consumer Safety Specification for high chairs in 1975. ASTM has since revised the standard over the past 5 years including requirements for visibility and permanency of labels among other things. The most recent mandatory version, ASTM F404-18a, required certified compliancy by June 19, 2019 and states the following about permanent labeling.

5.10 Labeling:

5.10.1 Warning labels, whether paper or non-paper, shall be permanent when tested per 7.9.1 – 7.9.3.

8.2 The marking and labeling on the product shall be permanent when tested per 7.9

8.4 Warning Design for Product:

8.4.3 The warnings shall be permanent.

ASTM F404-18a then references ASTM D3359 Standard Test Methods For Measuring Adhesion By Tape Test as a test for label permanency.

7.9.4 Adhesion Test for Warnings Applied Directly onto the Surface of the Product:

7.9.4.1 Apply the tape test defined in Test Method B – Cross-Cut Tape Test of Test Methods D3359 eliminating parallel cuts.

Yet ASTM D3359 specifically states that it cannot be used with plastic as seen below.

X1.4 Peel Adhesion Testing on Plastic Substrates

X1.4.1 ...The central issues are that the test on plastics lacks reproducibility and does not relate to the intended application...More importantly, in this instance the test is being applied beyond its intended scope...The unique functional requirements of coatings on plastic substrates cause the usual tape tests to be unsatisfactory for measuring adhesion performance in practice.

Remember! Safety and warning labels are only effective in keeping consumers safe and manufacturers / OEM's free from litigious risk if they remain in place for the life use of LSE polyolefin!

Steel, Aluminum and Glass Part 1

“Permanent labeling” has always been a term synonymous with pressure sensitive adhesive labels. Since pressure sensitive adhesive labels are considered “permanent” when achieving a peel strength of two pounds or more from stainless steel (per GPI’s latest edition of its Industry Standards and Practices Manual for Product Identification), it’s important to understand why stainless steel, aluminum and glass were initiated as standard substrates for testing purposes.

In 1956, George Grossman founded the company Q-Lab to serve paint and coatings customers a consistent, reproduceable test surface. George wanted to ensure if a coating failed during testing, it was because of “bad paint, not a contaminated test surface.”

By the early 1990s, the Sherwin-Williams Company had published research on metal panels tested according to an alternating schedule of exposure in a fluorescent UV weathering test chamber (Q-Lab QUV® tester). Their work led to the development of ASTM D5894 used throughout the petrochemical industry today.

Q-Lab, along with other test panel manufacturers, provide R&D and 3rd party laboratories steel, aluminum and glass test panels to minimize the variability of paints, adhesives and more during testing.

For PSA testing, using standardized steel, aluminum and glass test panels was a natural fit and has been ever since. But what about PSA testing on LSE plastic panels?

To minimize variation in testing, stainless steel, aluminum and glass are specified test panels not only for coatings and paints, but adhesives and adhesive based labels as well.

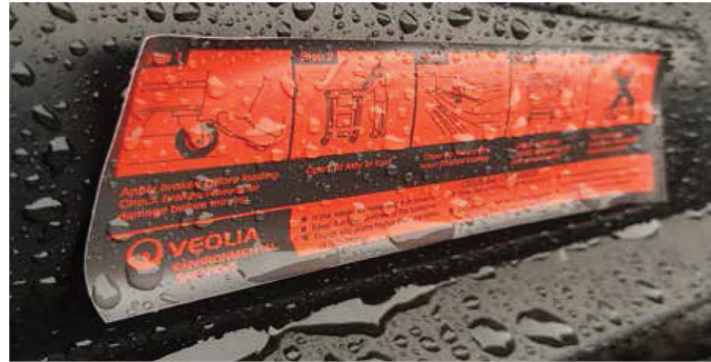
Surface Energy?

A technical yet rarely discussed topic is Surface Energy, the molecular force of attraction between two unlike materials (adhesive & substrate) that determines adhesion and is measured in energy units called dynes/cm.

The first version of ASTM D6252 Standard Test Method for Peel Adhesion of Pressure-Sensitive Label Stocks was written back in 1998. Along with the 2019 revision, it has been used to verify whether adhesive based labels achieve two pounds or more of peel strength from stainless steel to be called “permanent.”

A great real-world example of low vs. high surface energy you’ve probably experienced is the difference a good waxing does for your car. Before waxing, your car has a higher surface energy than rain causing the water to easily wet out over the surface. A fresh coat of wax lowers surface energy below the rain causing water to bead and run off freely. Keeping it simple, remember this point: High Surface Energy attracts adhesion, Low Surface Energy REJECTS it!

Fusion Labeling Technology



Examples of both high and low surface energy substrates.

Stainless Steel	700-1100	High Surface Energy
Aluminum	840	High Surface Energy
Glass	250-500	High Surface Energy
LSE Polyethylene	31	Low Surface Energy
LSE Polypropylene	29	Low Surface Energy
Teflon®	18	Low Surface Energy

Referencing the facts above, LSE Polyethylene and Polypropylene are only a few dynes/cm away from Teflon®, one of the most non-stick surfaces known to man. They are however many dynes/cm away from stainless steel. Therefore, “permanent” pressure sensitive adhesive labels achieving an initial two pounds or more of peel strength from stainless steel (700-1100 dyne/cm surface energy) are going to have different results when applied to LSE polyolefin plastics like Polyethylene or Polypropylene at only (31 & 30 dynes/cm surface energy).

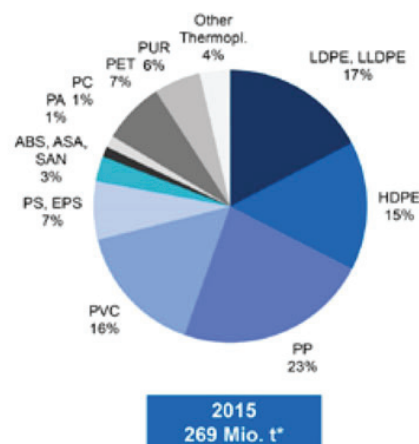
LSE Polyolefin Plastics

Today, LSE polyolefin plastics have replaced steel as the primary material of choice for durable goods. But keep in mind most safety standards were written during the time period when pressure sensitive adhesive labels were being applied to steel and other high surface energy materials.

One reason for the switch from steel to LSE polyolefin plastics was the reduction of manufacturing parts needed for final assembly of products. Hundreds of steel parts were reduced to a small handful of polyethylene parts which allowed manufacturers and OEM’s to eliminate secondary operations and lower the cost of manufacturing and products significantly. In addition, Industrial Designers and Engineers have chosen these plastics, specifically, for their ability to stand up against chemicals, harsh environments and heavy impacts while lasting 3 years or more, the normal life expectancy for most durable goods products. As manu-

World Plastics Materials Demand 2015 by Types

PlasticsEurope
Association of Plastics Manufacturers



- Polyolefins account for more than 55% of global Plastics Materials demand.
- PVC is the second largest resin type following Polyolefins.
- Standard Plastics (Polyolefins, PVC, PS & EPS, PET) account for approx. 85% of the total demand.

facturers and OEM's in the Automotive industry strive for safer and more fuel-efficient cars, using LSE polyolefin plastics is also becoming more and more prevalent as it's estimated that a 10% reduction in a vehicles weight equates to a 5-7% increase in fuel economy. Features such as lowering interior noise and vibrations in vehicle manufacturing only adds to the many other benefits of using LSE polyolefins plastics.

In 2015, LSE Polyolefin plastics such as LDPE, LLDPE, HDPE & Polypropylene made up roughly 55% of global plastics demand for both durable goods and packaging products. Who knows what that figure is today?

In 2018, global production of polypropylene hit 55.9 million metric tons at a value of \$97.4 billion U.S. Dollars and is poised to grow at a rate of 5.84% annually. Polyethylene production hit 99.6 million metric tons at a value of \$164 billion U.S. Dollars and is poised to grow at a rate of 3.78% annually!

Steel, Aluminum and Glass Part 2

Durable goods manufacturers and OEM's looking to label LSE polyolefin plastics permanently can do a quick Google search for "permanent labels for LSE polyolefin" that will land a list of label suppliers that market and sell special formulated adhesives and label constructions that will supposedly bond and adhere permanently to LSE polyolefin plastics.

Based on the marketing language used, anyone looking for a permanent solution would be led to believe that viable chemical and environmental testing had in fact been conducted on labels applied to LSE polyolefin test panels verifying permanence.

As durable goods converted from metals to LSE polyolefin plastics during the mid 1990's, safety labeling standards had already been in place for quite some time. Because adhesive based labeling fell within the same general testing scope as coatings, paints and adhesives, using steel, aluminum and glass panels for standardized testing was established with no real reason to change. Previously existing safety standards reference testing guidelines as the criteria to follow. Below are a few ASTM testing guidelines for adhesion.

1. ASTM D903 - 98 Peel or Stripping Strength of Adhesive Bonds
2. ASTM D6252 – 98 Standard Test Method for Peel Adhesion of Pressure-Sensitive Label Stocks at 90° Angle.
3. ASTM D6862-11 Standard Test Method for 90° Peel Resistance of Adhesives
4. ASTM D3330 / D3330M – 2004 Test Method for 180° Peel Adhesion of Pressure-Sensitive Tape
(Ref: ASTM A666 Preparation of Steel)

Today, the only testing conducted on actual LSE polyolefin panels Industrial Designers and Engineers will see for labels marketed for use on LSE polyolefin durable goods is "Peel Adhesion." This portion of data sheets shows pressure sensitive adhesive labels applied to various substrates and then peeled by an apparatus after a prescribed dwell time, usually 24, 48 and 72 hours. The results are then measured and recorded.

The second portion of data sheets is more crucial to actual durability and permanency of pressure sensitive labeling but veers from the application method mentioned above. Instead of various substrates, labels are applied to only stainless steel, aluminum or glass and then exposed to chemical and environmental inputs for a prescribed period. The test does not include application of the label to other surfaces of interest like LSE polyolefin plastics for which the label is marketed for in the first place.

Fact Check

The National Association of Graphic and Product Identification Manufacturers Industry Standards and Practices Manual for Product Identification states, "it is important to identify the substrate to which a PSA (Pressure Sensitive Label) will be applied. Is it plastic, i.e., high or low density polyethylene, polypropylene,

polycarbonate etc., or is it metal? Is it painted, lacquered or coated in any way? PSA's exhibit different bonding characteristics on different surfaces."

3 Facts about PSA's:

1. PSA suppliers are marketing and selling PSA's as "permanent" for use on LSE polyolefin durable goods. Thus, they've identified and marketed the substrates to which their PSA's will be applied to as referenced above.
2. Data sheets that display and market conclusive information about "permanent" PSA labels for use on LSE polyolefin durable goods, provide no data on chemical and environmental testing conducted on LSE polyolefin plastics as there's no formal testing requirement to do so.
3. Days, weeks, months and years of real world exposures to chemicals, UV and other environmental inputs proves that PSA labels neither bond nor adhere permanently to LSE polyolefin durable goods over extended periods of time.

Fine print disclaimers for "Product Performance and Suitability" are usually found at the bottom of data sheets. Such language proves the 3 facts about PSAs shown above, placing the burden of discovery on manufacturers and OEMs.

PSA Label Supplier Example

"All of the descriptive information, the typical performance data, and recommendations for the use of said products shall be used only as a guide and do not reflect the specification or specification range for any particular property of the product. Furnishing such information is merely an attempt to assist you after you have indicated your contemplated use and shall in no event constitute a warranty of any kind by said company. All purchasers of said products shall be responsible for independently determining the suitability of the material for the purpose for which it is purchased. No distributor, salesman, or representative of said company is authorized to give any warranty, guaranty, or make any representation in addition or contrary to the above."

ML/IMD Printed Inserts

In-Mold Labels (IML) and In Mold Decorating (IMD) came into the spotlight in early 2000 when engineers began using them for durable goods products in the injection molding industry. Robotics and automation are the driving force behind IML's and IMD's being used today. IML and IMD printed inserts are constructed of a treated semi-compatible layer which is then printed with screen, rotogravure, offset or digital inks. A final clearcoat or laminated polymer over layer finishes the construction. Although they are considered permanent in many applications, even IML/IMD printed inserts have their limitations when used in conjunction with LSE polyolefin substrates. On page 9 of Fall 2010 SPE Injection Molding Division's newsletter, it was stated that "The most appropriate sheet or film materials for printed inserts are those with higher surface energy that will allow stronger and more consistent ink bonding. These include polycarbonate, PET, acrylic, ABS, PVC, and PS. However, success with some lower surface energy materials, as well as those that are self-lubricating, is limited due to interfilm adhesion issues. With proper pretreatment, PP and PE have also been successfully used in the in mold process."

With the expanding use of LSE polyolefins by manufacturers and OEM's as their material of choice for durable goods within industries such as automotive, durable goods, food, beverage, supply chain, agriculture, medical, outdoor power equipment, recreational sports, powersports, waste, recycling and sanitary, it's crucial that chemical and environmental testing be conducted on labels attached to actual LSE polyolefin panels and data

collected, whether PSA, IML/IMD or any other type, particularly when it comes to the extent of permanent safety/warning labeling that must either meet or exceed the standards that regulate them. This will ensure a future of safety and warning labeling that provides customers proper use instructions and hazards associated with the durable goods products they buy while simultaneously keeping manufacturers and OEM's free from litigious risk for the life-use

Why Polyfuze?

In 1983, Michael Stevenson began the company Mold In Graphic Systems® (MIGS®) after spending 8 years of development inventing the world's first and only Mold In Graphic® label to replace failing pressure sensitive adhesive labels used in rotationally molded LSE polyolefin plastics.

Over 30 years and thousands of customers later, MIGS supplies 100% LSE polyolefin compatible labels that permanently meld Brand names, logos and safety/warning information directly into rotomolded kayaks, coolers, traffic bollards and thousands of other products used throughout the world.

In 2012, as an offshoot of Mold In Graphic Systems® Brand, Polyfuze® Graphics Corporation was created to supply 100% LSE polyolefin compatible labels to manufacturers and OEM's within the injection molding industry. Polyfuze labels are tailored to permanently meld Brand names, logos, and safety/warning information directly into LSE polyolefin plastic durable goods until their end of life use. This claim is backed by testing conducted on Polyfuze labels applied to LSE polyolefin plastic panels (Test Data Reports available upon request) and guaranteed by Polyfuze's Lifetime Guarantee. Polyfuze has also invented its VersaFlex system allowing application of the same permanent LSE polyolefin compatible labels to injection, blow, thermoformed & rotomolded LSE polyolefin durable goods.

When end of life comes to an LSE polyolefin durable good and it's time to recycle, Polyfuze® labels are 100% recyclable, just like the LSE polyolefin plastics they're seamlessly fused to.

Polyfuze Has Three Goals To Accomplish:

Goal #1. Securing your trust and belief in our labeling products & service.

Polyfuzes permanent Brand and Logo labels will give you a ROI on your Brand Image for the durable goods you produce until their end of life. Something no other label supplier provides, we back Polyfuze labels with a lifetime guarantee.

Goal #2. Polyfuze permanent Safety/Warning labels serve a threefold purpose you and your customers can trust in.

1. First purpose is keeping consumers safe and informed when using LSE polyolefin durable goods until the products end-of-life.
2. Keeping manufacturers and OEM's of LSE polyolefin durable goods safe from litigious risk caused by label failures.
3. Helping manufacturers and OEM's comply with their labeling market codes and regulations to meet actual "permanent" criteria written within safety label standards.

Goal #3. We call this our selfish goal.

Being your partner of choice when it comes to providing your LSE polyolefin plastic labeling needs.

For more information, please contact Jason Brownell at jasonbrownell@polyfuze.com

September 26th, 2019

Conference Call

.....
Respectfully Submitted by Secretary Joseph Lawrence
October 16th, 2019

Welcome & Opening Remarks – Rick Puglielli, Division Chair

Chair Rick Puglielli called the meeting to order at 8:00 AM EST and welcomed all attendees to the Fall 2019 IMD Board Meeting. Secretary Joseph Lawrence called roll at 8:05 AM (EDT).

Roll Call – Joseph Lawrence, Secretary

Present via WebEx & MML/Teleconference:

Brad Johnson, Joseph Lawrence (Secretary), Erik Foltz, Tom Giovannetti, Pete Grelle, Edwin Tam, Adam Kramschuster, Angela Rodenburgh, David Kusuma, Susan Montgomery (Councilor), Lynzie Nebel, Sriraj Patel, Ray McKee, David Okonski (ANTEC 2020 TPC), Rick Puglielli (Chair), Hoa Pham, Tom Turng and Saeed Farahani

The participation of the official IMD Board Members constituted a quorum.

Absent were:

Alex Beaumont, Vikram Bhargava, Kishore Mehta, Srikanth Pilla, Jeremy Dworshak, Chad Ulven and Jim Wenskus

Approval of the March 17th, 2019 Meeting Minutes

The meeting minutes from the IMD Board Meeting of March 17th, 2019 were presented and approved.

Motion: Pete Grelle made a motion to approve the meeting minutes as presented, Edwin Tam seconded, and the motion passed at 8:12 AM (EDT).

Chair, Rick Puglielli went through the action items. David Okonski requested for a volunteer from IMD to partner with Detroit section for Auto Epcon.

Financial Report – Ray McKee, Treasurer of IMD

Ray McKee presented the financial report and mentioned that there was a balance of ~\$39,000 remaining in the account. The ANTEC reception budget was \$15,000.

Councilor Report – Susan Montgomery, Councilor

Susan shared the financial summary from headquarters. For 2018, SPE had a net positive operational results, but showed an overall deficit due to lower than expected investment results. January 2019 results were better than budget and SPE is projecting a loss for 2019. She also presented changes in election timing and by laws. In addition, she mentioned a name change of Sustainability Division to Plastics Recycling Division.

There was a discussion on Pinnacle Award. Edwin Tam suggested to setup a Pinnacle Committee. This will be discussed in the next board meeting.

Technical Director Report/TPC update – Pete Grelle, Technical Director

Pete Grelle presented the various upcoming meetings. David Okonski is the TPC for ANTEC 2020. Edwin Tam spoke about the various changes in ANTEC for 2020. There will be no joint sessions and no matrix meeting. Pat Ferry will decide on the sessions from SPE and the TPC will be providing the technical content.

Pete mentioned that the paper reviews will be scheduled in the Detroit area. There was a discussion about IMTECH in November 2020. Susan discussed the various locations available in the Cleveland area.

Membership Report – Erik Foltz, Membership Chair

Erik Foltz presented the updates on membership. He mentioned that he shared the new member welcome letter draft to the IMD board members. The letter draft was discussed. Erik mentioned that he is planning to send the welcome letters via email to new IMD members.

Sponsorship Committee update – Sriraj Patel

Sriraj Patel presented ideas and suggested changes to the sponsorship tiers for the IMD reception during ANTEC 2020. This year's budget is ~\$20,000 for the IMD reception. Different ways to attract more sponsors for the IMD networking reception was discussed.

Committee Chair Appointments – Rick Puglielli

IMD committee appointments were discussed by Chair, Rick Puglielli. Rick went through each of the committees and confirmed the chair appointments. Rick appointed Angela Rodenburgh as the chair of the communications committee.

Motion: Rick Puglielli made a motion to appoint Angela Rodenburgh as the chair of the communications committee, Edwin Tam seconded, and the motion passed at 10:48 AM (EDT).

Discussion happened on each committees. The committee chairs are responsible to add members on each committee as needed. Volunteers interested in joining membership committee should contact Erik Foltz. The sponsorship committee is 'ad hoc' until changed in bylaws. Angela presented ways to increase sponsorship opportunities.

Action item: Adam Kramschuster to develop a marketing contract.

Adjournment – Rick Puglielli, Chair

Motion: Rick made a motion to adjourn the meeting. Pete Grelle seconded, and the motion passed. The meeting was adjourned at 12:05 AM (EDT).

The next meeting will held on January 17th 2020 at the Tupperware headquarters in Orlando, Florida. An agenda will be provided by Rick in early January.



INJECTION MOLDING

Top Reasons to Join SPE and its Injection Molding Division

Networking within the Plastics Industry

The Injection Molding Division (IMD) boasts the largest membership of all divisions within SPE. Joining the IMD allows you access to over 20,000+ members within your industry.

The Chain

SPE's very own community forum provides tools for you to share information, ask for help, discuss problems, exchange lessons learned, search for information, or simply stay connected with other SPE members.

Online Technical Library

Downloadable technical papers on every key topic in plastics.

PLASTICS INSIGHT

Bringing you weekly focused content from thousands of sources, covering product, research, trends, and more.

SPE PRO-Plastics Research Online

RSS Feed of the latest in plastics research.

Free subscription to "Plastics Engineering Magazine"

Awards and Scholarships for Students/Young Professionals

The Injection Molding Division is helping promote the plastics industry to students and young professionals, by offering scholastic and travel scholarships to students interested in the plastics industry.

SPE Conferences and Webinars

Discounts on 40+ SPE Conferences around the world. Bringing you in-depth information on materials, processes or industries to help you gain knowledge and expand your professional network.

Jobs in the Industry

Resources for job seekers. Post your resume free!

Visit www.4spe.org to join today.

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Reception Chair and
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Chair Historian**

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Engineer-Of-The-Year Award

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