Technical Information

UNIFUSE®

redefining molded plastic

UNIFUSE: A Bird Dog Distributors Company
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TECHNICAL INFORMATION AND ARTICLES REGARDING UNIFUSE VIBRATIONAL MICROLAMINATION (VIM) PROCESS FOR MOLDING PLASTIC

Unifuse LLC is #1 for Custom Plastic Products.

We mold your finished plastic product by the patented UNIFUSE Vibrational Molding (VIM) process. The result is superior, stress-free strength that easily outlasts products molded by other processes. Our unique manufacturing process enables us to be highly responsive, providing prototypes, modification, and production—all with short lead times. The surprisingly low cost of mold fabrication and part production makes your special design affordable which, in turn makes us the best choice for your special project.

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UNIFUSE TECHNOLOGY GIVES YOU NEW OPPORTUNITIES!!

What UNIFUSE LLC does and the potential for you.

The patented technology of the UNIFUSE Vibrational Microlamination (VIM) process removes the typical limitations on engineers designing plastic products for industrial applications.

<u>Key advantages of the UNIFUSE process are:</u>

- Optimization of plastic tooling design
- Low tooling costs
- Easy tool modification for design changes
- High quality, stress-free, long life products
- Maximum cost effectiveness

WHAT CAN UNIFUSE LLC DO FOR YOU?

UNIFUSE provides you with:

- Lower tooling costs for new designs and mold fabrication
- Low cost product proofs with low cost "on the fly" modifications
- Strong, stress-free, long life polyethylene products
- The capability to mold tall, straight walled (no taper) containers
- In-molding embedment and reinforced sections
- Over 25 years of expertise in UNIFUSE molding

PROCESS COMPARISONS

YOUR REFERENCE GUIDE TO

VIBRATIONAL (VIM) MOLDING
VS.
INJECTION, ROTATIONAL, AND THERMOFORM MOLDING

UNIFUSE USES A TOTALLY DIFFERENT PROCESS FOR MOLDING THERMOPLASTIC MATERIALS.

THE UNIFUSE PROCESS MIGHT NOT SOLVE ALL PROBLEMS, BUT IT WILL PROBABLY SOLVE YOURS.

THE UNIFUSE TECHNOLOGY GIVES YOU NEW OPPORTUNITIES FOR UNIQUE DESIGNS AND SOLUTIONS.

Key points regarding the UNIFUSE process:

- **Patented technology**
- **Low cost tooling and setup**
- **The ability to modify molds as needed or desired**
- **Slow cooling for strength and stress-relieved plastic parts**
- **High quality, long lasting products**
- **Ideal for prototypes and production**
- **Makes it possible to maximize your efficiency and cost effectiveness**
- **Not always the lowest cost, but always the greatest value**

Process Comparison

Rotational vs. Vibrational Microlamination (VIM) Molding

I. CONCEPT:

Rotational Molding: Distributes material by rotation, which causes a wiping action while material is adhering to the mold surface.

VIM: Distributes material by vibration.

II. SPECIAL EQUIPMENT:

Rotational Molding: Has a "spider" which rotates the mold 360º in two directions. The part is made on the inside of a female mold. Heat is applied through the mold by placing it in an oven.

VIM: Needs no spider or 360° rotation. Heat is applied through the mold, which can be male, female, or a combination.

III. ENERGY:

Rotational Molding: Energy is applied by heating an oven (or a room). Substantial heat loss occurs when the oven is opened and closed to insert the mold and the "spider".

VIM: Energy is applied only to the mold, using an estimated 1/8 the energy as compared to rotational.

IV. MOLDS:

Rotational Molding: Molds are female, normally made of cast aluminum or fabricated steel. They are less expensive than injection molds, but generally cost $15,000 or more.

VIM: Molds are made from aircraft quality aluminum sheet, shaped and arc welded. The molds have considerably less mass resulting in in faster heating and cooling. Costs are estimated at 20% of rotational molds, generally starting at $3,000.

V. MATERIAL:

Rotational Molding: Normally uses polyethylene or polycarbonate.

VIM: Can use any rotational material but can also use acrylic, polypropylene, polystyrene, and some vinyl materials, and most other materials that have a constant melt temperature.

VI. CONTROLS:

Rotational Molding: Controls are the temperature of the oven and time.

VIM: Holds the mold temperature to +/- 2º, which allows for optimum control to enable the use of a variety of materials.

VII. INSERTS:

Rotational Molding: Does not allow for easy inserting.

VIM: Mold can be opened at any time to place inserts and fuse them to the molded product.

Process Comparison

Injection vs. Vibrational (VIM) Molding

I. PROCESS:

Injection Molding: Melts plastic and pressure injects it into a closed mold. Requires quick cooling to allow for part ejection, resulting in stressed plastic.

VIM: Distributes material by vibration. Cools the part slowly, resulting in a stress-free product.

II. MOLDS:

Injection Molding: Molds are machined steel, hardened and polished. They are expensive and due to the abrasion of flowing plastic they require maintenance.

VIM: Molds are made from aircraft quality aluminum sheet, shaped and arc welded. The molds have considerably less mass resulting in in faster heating and cooling. Costs are estimated at 20% of rotational molds, generally starting at $2,000.

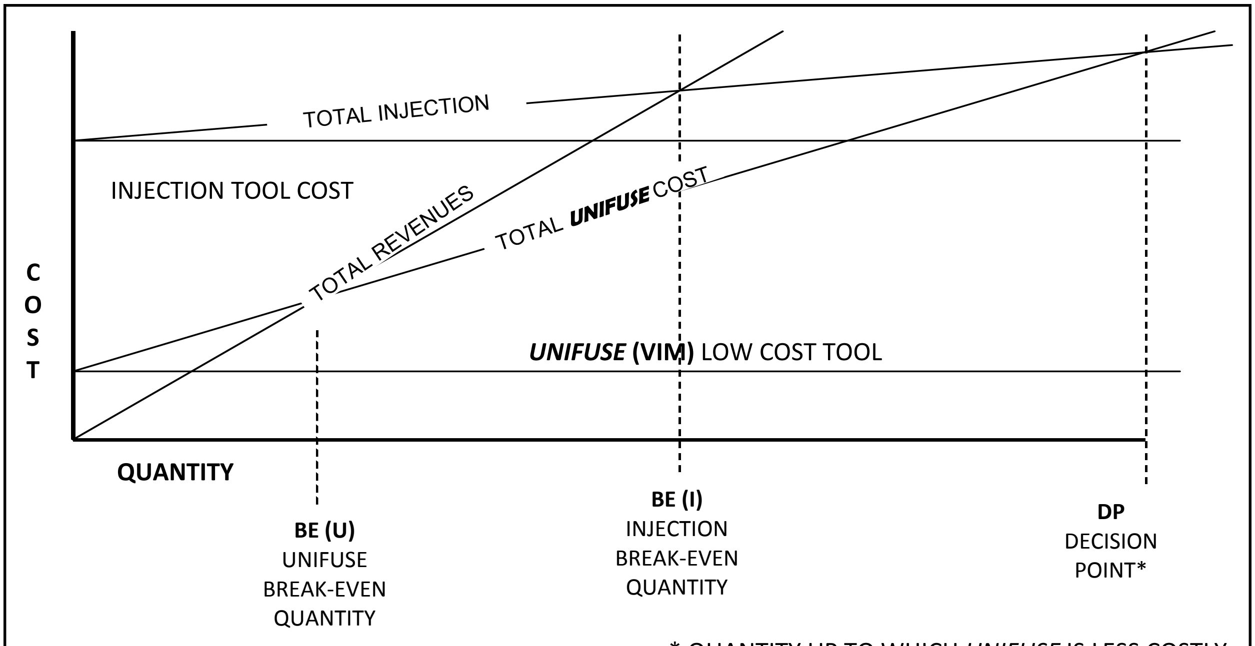
III. COST / QUANTITY COMPARISON:

This chart shows two superimposed break-even curves using UNIFUSE and injection tooling as the fixed costs. It shows the break-even quantity for each process and the decision point quantity up to which UNIFUSE costs less.

IV. PROCESS DECISION:

Injection Molding: High quantity of known design.

VIM: Low or medium quantity or in situations where the product design may change.



* QUANTITY UP TO WHICH *UNIFUSE* IS LESS COSTLY.

Process Comparison

Thermoforming vs. Vibrational (VIM) Molding

I. CONCEPT:

Thermoforming: Using extruded plastic sheets, thermoforming reheats the plastic and creates a vacuum which sucks the soft material into a wood or metal mold.

Uni-Forming: Using plastic particles and a low cost aluminum mold, UNI-FORMING fuses them using vibration and carefully controlled heat, into a finished product shape.

II. EQUIPMENT:

Thermoforming: Machines can be single or multiple station.

Uni-Forming: Machines can be single or multiple station. Molds are sequenced in such a way that they can be interchanged easily. This reduces the cost of setting up for low quantity production runs.

III. PART DESIGN:

Thermoforming: Ideal for thin gauge products. Parts must have draft or taper, as the material is stretched and will tear without draft. There is a depth limit to the parts, as the thickness is reduced at the bottom. Thus thicker than normal material is often required for processing.

Uni-Forming: Process uses plastic particles, eliminating extruding costs. The process is self-leveling, giving the same thickness throughout, often reducing the part weight. There is no depth limit, except for the machine's capacity. Uni-Forming can thus make parts of 24-inches or more.

IV. PROCESS DECISION

Thermoforming: Standard for thin forms and finished parts which use materials with embossed or gloss surfaces.

Uni-Forming: Used for high strength, no-draft parts, and where cost, quality, and/or space design limitations require this unique process.

PRODUCT ADVANTAGES

- Seamless, smooth, one-piece construction.
- UNIFUSE molded polyethylene material standard.
- Resistant to water, oil, most chemicals, and heat.
- Will not rot, rust, dent, chip, or crack.
- Steam—cleanable.
- Non-toxic, FDA approved material.
- Many colors available.
- Fire retardant and conductive materials available
- RFID components can be molded into the product.

(12) United States Patent
Fried et al.

(10) Patent No.: US 6,589,470 B2
(45) Date of Patent: Jul. 8, 2003

(54) **PROCESS FOR PRODUCING MOLDED PLASTIC ARTICLES**

(76) Inventors: **Robert P. Fried**, R.R. 1, Box 93, Staatsburg, NY (US) 12580; **Bernard Rottman**, 155A N. Quaker La., Staatsburg, NY (US) 12580

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **May 11, 2001**

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Related U.S. Application Data

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(52) **U.S. Cl.** **264/443**; 264/71; 264/72; 264/102; 264/302; 264/310; 425/384; 425/403; 425/434; 425/435; 425/457

(58) **Field of Search** .... 264/443, 301, 264/302, 309, 310, 311, DIG. 60, 71, 72, 101–102; 425/434, 435, 403, 384, 457

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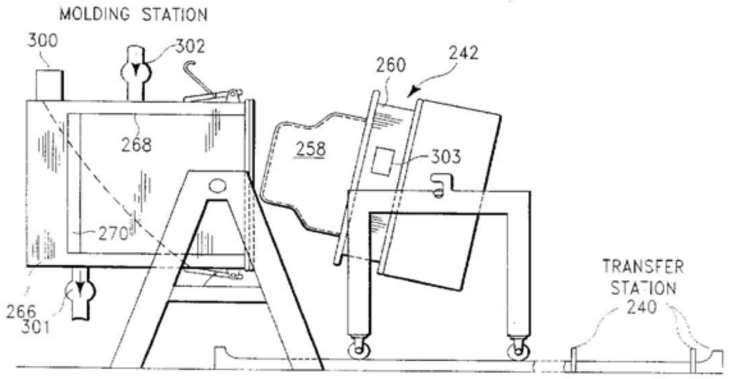
(57) **ABSTRACT**

A process for forming molded articles from particulate thermoplastic material, the process comprising:

(a) providing a track having a plurality of process stations,
(b) providing a mold assembly comprising a base, at least one hollow mold upstanding from the base, and guide means on the base for moving the mold assembly on the track,
(c) preheating the mold assembly at a preheat station on the track,
(d) moving the mold assembly from the preheat station to a transfer station on the track,
(e) transferring the mold assembly from the transfer station to a molding station,
(f) forming the molded articles by fusing particulate material to the at least one mold at the molding station,
(g) transferring the mold assembly with the molded articles thereon from the molding station back to the transfer station,
(h) moving the mold assembly from the transfer station to a cooling station on the track,
(i) moving the mold assembly from the cooling station to an unloading station on the track,
(j) removing the molded articles from the at least one mold at the unloading station, and
(k) moving the mold assembly from the unloading station to the preheat station.

7 Claims, 15 Drawing Sheets



Molding process micro-laminates thermoplastics

Stress lines are eliminated; resultant products are strong

David J. Bak, East Coast Editor

Staatsburg, NY -- A thermoplastic molding process that utilizes plastic particles in the plastic (not molten) state is being used to make large, stress-free products. Developed by B&R Specialties, Inc., the "Unifuse" process is a sequential particle buildup of plastic over a single surface mold. A combination of heat and vibration fuses the material. The result is plastic structure of uniform thickness with no inherent stress or degradation of basic polymer strength. Final products, therefore, are highly resistant to impact and cracking.

Normally, thermoplastic materials are molded by injection, extrusion or thermoforming. In injection or extrusion molding the plastic is melted, shot through a nozzle, and cooled. The cooling process, however, seldom occurs evenly throughout the product, so the finished product has built-in stress lines. With thermoforming, sheet plastic is heated so it will flow, then it is stretched either in a die or by vacuum. This stretching process also results in stress in final product.

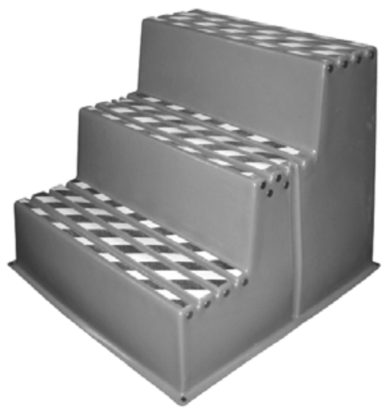
Because the "Unifuse" process uses a method referred to as "vibrational microlamination", the problem of stress in the end product is avoided. What happens is this. A mold of prepolished aircraft-quality aluminum is cut to shape on a duplicator with a plasma cutter on the follower bead. This process allows the shape to be outlined with no material degradation or torch spatter. The mold is then formed and heliarc welded.

Once formed, the mold is moved into a sealed chamber which serves as a controlled environment for the molding process. The process can be done under pressure, ambient conditions or under a vacuum. The plastic particles are sequentially applied to the mold and subjected to heat and vibration. The vibration provides a compacting and self-leveling effect while the even distribution of heat aids in building a uniform wall thickness. The build up of plastic molecules on the mold, one layer after another, results in the final end product.

Wall thickness of 1/16 to ½ inch can be achieved by varying the molding temperature and the length of time the mold is in the chamber. Higher temperatures and longer molding times result in thicker parts. After the desired wall thickness is attained, the mold is removed form the chamber and the cooling cycle begins. Cooling time is controlled to avoid stress buildup.

Besides no inherent stress, benefits of the molding process are that large parts (up to 1 by 5 by 5 ft) are easily made and tooling costs are low. Most engineered thermoplastics can be used, including PE, PP, PC, and PVC. Parts with zero draft can be molded, undercuts are feasible, and structural inserts can be added during the process. The finished surface on the mold side will be as good as the mold surface itself, while the other side can be varied from smooth to embossed.

For additional details, contact Robert Fried, B&R Specialties, Inc., 9G Center, Staatsburg, NY 12580. (845) 889-4000.



ADDING VALUE:
BEING THERE WHEN YOU'RE NEEDED

MHDA members have to do more than just specify equipment. Being there with ideas when the customer calls can lead to long-term relationships.

by Clyde E. Witt, senior editor

Each year *Material Handling Engineering*'s editors select a Material Handling Equipment Dealer Association (MHEDA) member for our Value Added Award. This year's winner, Werres Corporation, Rockville, Maryland, exemplifies how a dealer can work closely with a customer to rebuild a more efficient process in the wake of a damaging fire.

1991 did not begin well for the Standard Fusee Corporation, Easton, Maryland. A January fire at this highway safety flare manufacturing plant wiped out the building known as Factory #2, a principal production facility. Damage was limited to that building. No one was in the building at the time. They were able to transfer production to other locations and never missed a customer's order. But they faced some touch rebuilding decisions.

Mike Cottingham, vice president, says they took this "opportunity" to create a more efficient material handling process.

"We didn't want to just replicate our former system," Cottingham says. "We wanted to reduce costs through more efficient production and material handling. We also wanted to take advantage of a lot of new knowledge about ergonomics."

To help them with this project they contacted Werres Corporation and Ed Sistek, the material handling specialist who worked with Standard about 10 years previously following another fire.

Fulfilling the customer's needs

Sistek says that solving what some might consider a minor problem in the system proved to be the key, or driver, for much of what would follow.

"Going in we knew we had a challenge with the way they moved the product," he says. "Previously they had used a corrugated tote with a masonite bottom. Both parties knew the corrugated container was a problem."

The solution was a plastic tote.

"We had stringent requirements," says Sistek. "Since the basic production unit is gross lots, we had to have a tote that could carry specific numbers of different length flares.

"We went to a custom molder, **B&R Specialties, Inc., Staatsburg, NY.** Through an evolutionary process involving all parties, they created totes that would carry the designated number of flares and fit the conveyor requirements."

The totes are Unifuse molded polyethylene containers. They're designed to handle the rigors of several production processes, including a drying process.

Once the design of the tote was determined, a conveyor system (using equipment from Rapistan Demag and ACSI) was designed and built.

A PLASTIC MOLDING PROCESS FOR 'IMPOSSIBLE' PARTS

DONALD R. DREGER
Staff Editor

ONE OF the most unusual plastics-molding processes developed recently converts thermoplastic pellets or powders to finished parts without going through a melting phase. The method, called Unifuse, is a proprietary process of B&R Specialties, Inc., Staatsburg, NY. Through a combination of heat and vibration, the process is said to produce parts of practically any size, with superior strength and integrity, from any thermoplastic material. In addition, the special techniques involved in the process produce parts without stresses or flow patterns and without subjecting the plastic to thermal degradation.

The Unifuse process, generically called vibrational microlamination (VIM), has been commercial for about four years and has been used principally for molding relatively large components such as bins, hopper, tanks, racks, hoods, and trays from polyethylene, polypropylene, and polyvinylidene fluoride. The process can also mold parts that are impractical, even impossible, by conventional molding methods - for example, cylindrical parts several feet long, with uniform wall thickness and with no draft

The Process

The VIM process uses a single-surface mold, either male or female, mounted on a frame or platen. The heated mold is placed in an environmentally controlled chamber, and warm thermoplastic material in pellet or powder form is fed rapidly onto the mold. Processing temperature is considerably below that used in extruding or injection molding but is sufficient to cause the plastic particles to fuse under the additional influence of vibrational energy. Temperature control is critical because the resins must not reach the molten state. This control is particularly important with crystalline materials, whose softening and melting temperatures are close together.

When the desired thickness is reached, the mold is removed from the chamber, another mold goes in, and the finished part is removed from the first mold after a brief cooling, usually by cold air or water.

Composites: The nature of the VIM process enables a broad range of composite components to be made by simply removing the mold and its plastic coating from the chamber, placing or spraying a reinforcement or other embedment on it, and laminates include woven fabric or strands of aramin (Kevlar), glass, or carbon fiber; conductive shields or screens of metal for RF shielding; or structural embedments of steel or aluminum for stiffening or fastening purposes.

Shorter fibers of glass, carbon, or other materials also can be incorporated into molded parts. These materials can be applied, either in layers or along with the resin pellets or powder, to form a fiber-reinforced structure in a single operation. These fibers are distributed in a random fashion, not aligned as they would be in an injection molding, thus providing a molding with uniform strength in all directions.

Tooling: Because the VIM process is done at atmospheric pressure, molds are lightweight and much less expensive than those required for injection molding. Most molds are fabricated by welding aircraft-quality sheet aluminum and can be produced in a matter of days. Mold surfaces must be mirror-smooth so that parts can be demolded easily. For female molds, where part release is not a problem (since the part shrinks away from the mold during cooling), electrode forming of a nickel shell, backed up with a glass-fiber-reinforced layer, is an acceptable mold-making technique.

Mold cost can range from a few hundred dollars for small parts to as much as $5,000 for a more complex mold as large as 5

How the processes compare

	VIM	Injection Solid	Injection Str foam	Thermo-forming	Blow molding	Rotational molding
Production quantity						
Low (100-1,000)	Yes	No	No	Yes	No	Yes
Med)1,000-20,000)	Yes	Sometimes	Yes	Yes	Sometimes	Sometimes
High (2,000 +)	Yes	Yes	Yes	Yes	Yes	No
Tooling Cost	Low	High	High	Low	High	Moderate
Materials						
Polyolefins	Yes	Yes	Yes	Limited	Limited	Limited
Engineering Thermoplastics	Yes	Yes	Yes	Limited	Limited	Limited
Part weight (lb)	To 180	Under 10	To 100	To 40	To 20	To 200
Part shape	Open one side	Broad range	Broad range	Open one side	Closed hollow	Open or closed hollow
Design						
Draft required	No	Yes	Yes	Yes	No	Sometimes
Wall thickness (in.)	0.005 to 1.0	To $^3/_8$	$^1/_8$ to $^3/_8$	Varies	Varies	To $^3/_8$
Corner angles	Can be square	Can be square	Can be square	Needs radius	Needs radius	Needs radius
Ribs possible	Yes	Yes	Yes	Yes	No	Yes
Inserts possible	Yes	Yes	Yes	No	No	Some
Stress	Low	High	Low	High	High	Low
Tolerances (in.)	± 0.005 mold side	±0.005 or closer	±0.010 or closer	±0.015	±0.005	±0.032

example, a mold costing about $100,000 for a low-pressure structural-foam part weighing about 100 lb.

Design

The VIM process can handle parts of any size, but those under about one-half pound probably are made more economically by other processes unless quantities are too small to amortize tooling costs. Parts must be open on one side so they can be removed from the mold. Two or more moldings can be fused together to form closed, hollow structures.

Wall thickness is uniform and can be varied, even on the same tooling, from about 0.005 in. to as much as 1 in., based on the time in the molding chamber and the feed rate. Most parts are made with wall thicknesses ranging from $^1/_8$ to $^3/_8$ in. At the other end of the scale, containers have been molded as large as 4 x 4 x 10 ft. Part-to-part uniformity can be held on a 3-lb part, for example, to ± 1 oz.

Because a single-surface mold is used, molded parts are smooth on the mold side and textured or matte on the other surface. Degree of the texture can be controlled somewhat, however. For example, a smoother surface can be produced by using powder instead of pellets or a resin with a higher melt index. Another method for creating a smoother surface involves applying heart and external ironing to the molded part.

When necessary, the VIM process can be used to produce parts without draft. One such part now being molded is a straight-sided, closed cylinder 48 in. long. The part is ejected from its mold pneumatically. Air is introduced at the closed end of the mold at a rate to keep the part moving off the mold as both members cool, but not so fast as to tear the part or collapse the mold. Other examples include straight-sided electronic enclosures for such products a generator housings and chain-hoist chain boxes.

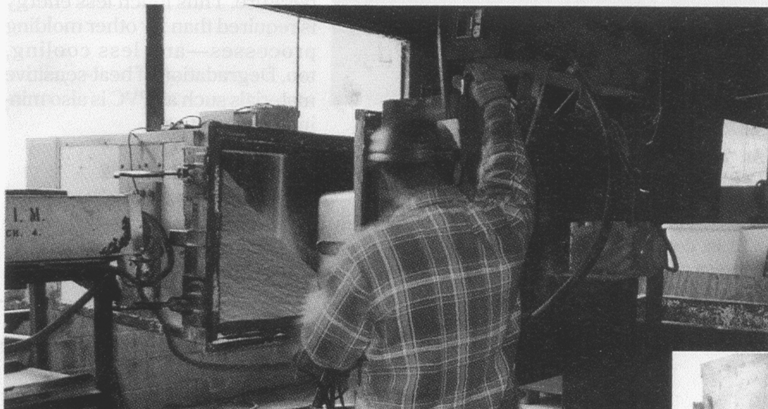
An important advantage offered by the vibrational microlamination process is the stress-free nature of molded parts. Another is the lack of property degradation involved because of the low temperatures and the slow cooling rates used.

Materials

Most VIM parts have been molded in polyolefin resins and many others in polycarbonate, polysulfone, polyvinylidene fluoride, and polyphenylene sulfide. Vinyl resins are difficult to mold because their molecules are described as being "ragged" and they require pressure to keep them together. The problem can be overcome to some degree, however, by the addition of a plasticizer. Another difficult resin, insofar as the VIM process is concerned, is ultrahigh-molecular-weight polyethylene which, because of its high viscosity, also requires pressure to be molded.

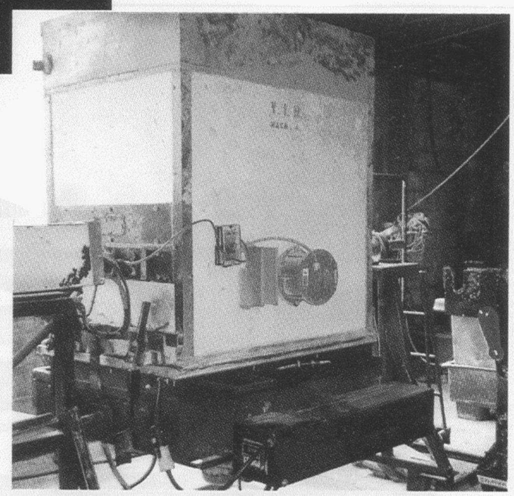
Low-Stress Molding Process Makes 'Impossible' Parts

Want to make a large part with thick and thin walls, deep draws, zero draft, undercuts, low stresses, or embedded reinforcements? Vibration molding easily handles such challenges, even when no other thermoplastic process will. And if you do have a choice of methods, vibration molding will probably beat the other process's economics and lead times for low- to medium-volume jobs (50 to 10,000 units). If it sounds too good to be true, ask Robert Fried and Bernard Rottman. They are the inventors of the patented process (called Unifuse or VIM) and are partners in B&R Specialties, Inc., Staatsburg, N.Y., the successor to Now Corp., which introduced VIM in 1977.

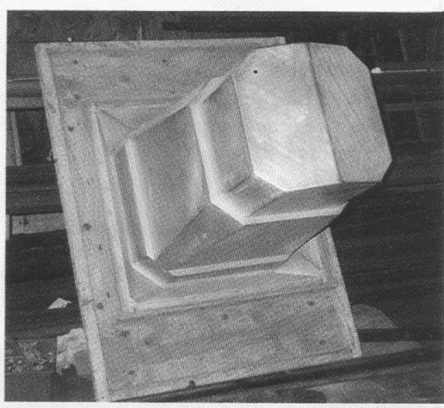


The process, which is available for licensing, has evolved considerably since then. Recent developments include use of post-consumer recycle, multilayer parts, foam/solid sandwiches, and embedding of metal fasteners, metal screens for EMI/RFI shielding, or Kevlar fabrics for structural reinforcement.

Above: Operator pushes mold on a trolley to mate with material reservoir filled with powdered resin.



Right: VIM machine turns mold and reservoir upright so that resin covers the mold. Electrically heated mold is vibrated to fuse a layer of material. Afterward, the mold assembly is rotated 180° and vibrated some more to shake off unfused resin before demolding.



Left: Molds are fabricated of aircraft-quality aluminum sheet and mounted on wood-and-steel bases.

Maximum part size has increased dramatically—to 9 x 5 x 6 ft. Perhaps most important are increases in productivity. The first dual-mold machine, which has just been put into service, reportedly matches the output of an industrial thermoformer. A four-mold system now in development will double output again.

In two decades, VIM has established credibility with customers such as Pratt & Whitney, General Electric, and IBM, for which B&R makes material-handling trays. Also, auto makers use intricate dunnage made by VIM, and hospitals use VIM-molded medical-waste carts. B&R builds around 20 new molds a month and consumes close to 1 million lb/yr of resin in making VIM parts. B&R has one licensee in Israel that uses a variant of the process to make ballistic armor with reinforcing inserts. In the U.S., the only other current user of VIM is C.R. Daniels, Inc., Ellicott City, Md., which molds tote boxes and bins.

TREATS PLASTIC GENTLY

The VIM process uses a single mold surface fabricated out of sheet aluminum and mounted on a wood-and-steel base. Molds can be male, female,

VIBRATION MOLDING

or a combination of both. The tool is enclosed in a box of wood or other material so that the molding surface can be entirely covered with loose plastic powder or granules. The mold is then heated with electricity or gas and vibrated mechanically so that plastic fuses all over its surface in what is basically a sintering process. Fusion takes place only at the mold surface, and part thickness is determined by the length of time the mold is in contact with the material. After fusion, the mold is inverted and excess resin is shaken off the part. Heat and vibration continue for a time to smooth out the non-mold surface. The mold is then cooled by an air blower, and the part is demolded. There is generally no waste to trim.

An "impossible" part made by VIM: LLDPE carrier for auto suspension components (shown with tooling inserts in place) has 10 cavities of 9-in. diam. x 21 in. deep, with less than 1/8 in. between cavities.

Parts are said to be molded with extremely low stress and no flow orientation because no shearing or pressure are applied to the material. Parts are also allowed to cool slowly on the mold at ambient temperature, with only a fan blowing over them.

Fried notes that the molding temperature is right around the glass-transition point of the material, but below its melting temperature. Thus much less energy is required than for other molding processes—and less cooling, too. Degradation of heat-sensitive materials such as PVC is also minimized, Fried says.

WIDE DESIGN FREEDOM

The process is said to allow broad latitude in part design and material composition. Large parts are no more difficult or time-consuming to mold than small ones. The largest part made to date is a prototype of a 4-cu-yd (800-gal) LLDPE waste bin that measures 65 x 48 x 48 in. and weighs 185 lb. (The largest waste bin ever injection molded is 2 cu yd or 400 gal.)

Part thickness can be from 0.015 to 1.25 in. Thickness can be selectively increased by raising the temperature of certain areas of the mold.

Multi-layered structures are produced by fusing additional layers of different materials over the first. A layer of recycled resin can be sandwiched between virgin layers, or a foam layer (made with a chemical blowing agent) can be placed between solid layers. Reinforcing fabrics can also be placed between layers, even on selected areas of the part.

Because VIM does not pass the material over a screw or through an orifice, heavily contaminated regrinds can be used—for example, chopped wire scrap containing 8% metal.

Multiple small molds—not necessarily identical—can be processed simultaneously. Because resin will not fuse on the wood sections of the molds, the parts do not need to be trimmed apart. Holes can be molded into parts by placing a PTFE insert on the mold surface (no resin will fuse on the insert). Metal inserts can be embedded in parts by first injection molding resin around the base of the insert and then placing the insert into a pocket in the freshly molded VIM part while it is still hot.

Although B&R most often uses LLDPE, other suitable materials include HDPE, PP, nylon, polycarbonate, and acetal. Rotomolding-grade materials in powder or 0.020-in. micropellet form work well, as does reground flake. Standard-size pellets can also be used, Fried says, but they leave a rougher surface on the non-mold side of the part.

The process produces only one molded surface, which is smooth enough to suit medical applications that require rigorous washing. The non-mold surface is usually fairly smooth, as well, and it can be improved if necessary by light application of a flame torch.

VIM can mold many shapes that are difficult or impossible for other processes. Zero-draft capability is one example. A rectangular LLDPE bin liner made for Eastman Kodak measures 44 x 38 in. and 30 in. deep and has zero draft. Ejecting a zero-draft part from a male mold is no problem: Compressed air at only 2 psi is blown under the part as it cools. "The part just walks off the mold," Fried declares.

Parts with multiple deep draws are another case of "impossible" shapes that VIM handles with ease. One example is a special carrier for automobile suspension parts. The LLDPE carrier has 10 pockets of 9-in. diam. and 21 in. deep, with less than $^1/_8$-in. separation between the pockets. Fried doubts that any other method could produce this part.

Slow cooling on the mold helps VIM hold close tolerances. On large parts, such as a 54-in.-long medical-waste cart with a tight-fitting lid, VIM consistently holds $\pm^1/_{32}$ in. across the part, Fried claims.

Although they're sintered without pressure, VIM parts are strong: An LLDPE tray made for Pillsbury holds a 250-lb bag of cheese. The $^3/_{16}$-in.-thick tray is designed for stacking five high.

ATTRACTIVE ECONOMICS

Low-cost tooling is a major strength of the VIM process. Pinhole-free, aircraft-quality aluminum sheet must be used to prevent parts from sticking. Molds can cost as little as $150 or up to a few thousand dollars for the most complex multicavity tools. Most can be built in less than a week. The mold for the 29-cu-ft Kodak bin liner cost well under $1000 and was built in less than a day, Fried says. The largest VIM mold ever built—for the 4-cu-yd waste bin—took three weeks to build and cost $58,000 (versus an estimated $2-3 million for a comparable injection mold).

VIM parts, regardless of size, generally take 15-20 min to mold. Multiple cavities or multiple small molds ganged together can increase productivity. It's also very easy to change molds: They're simply lifted off the trolley.

B&R's newest machine shuttles two molds in and out of a central molding station, so that one mold is cooling while the other is making parts, effectively doubling the output. Fried says the Pillsbury cheese tray will be molded in four-cavity molds with two molds ganged together. The shuttle machine will thus produce eight parts every 15-20 min, which is reportedly competitive with thermoforming cycle times. The machine is more automated than earlier versions: It requires an operator's attention for just 5 minutes twice an hour to unload parts. For further productivity gains, B&R is planning to build a four-station system that could be of either linear or rotary design.

Fried says a licensee could get started in VIM with an investment of $100,000 to $500,000, depending on project scope and machine size, plus a 5% royalty payment. B&R would supply the equipment components for the customer to assemble on site. (CIRCLE 18)

—Matthew H. Naitove

Technical Applications—UNIFUSE (VIM) Molding

MATERIAL HANDLING	Baskets, bins, booths, boxes, bulk containers, cabinets, carts, cases, dollies, flow racks, hoppers, liners, lockers, pallets, pans, protectors, racks, security containers, storage systems, tanks, trailers, trucks
MEDICAL & ENVIRONMENTAL	Trash, recycling containers, divided containers, medical waste carts, environmental enclosures, oxygen tank holders, special medical and environmental containers
HI-TECH: **Chemical** **Electronics**	 Anti-corrosive containers and tanks, sinks, pans, trays, funnels Containers, circuit board boxes, carriers, cases, storage cabinets, storage racks, carousel containers, carousel work stations, kit carts, security carts, work racks, shock protectors, acoustical absorbers, conductive protection, anti-static protection, mobile rack covers
OEM	Designed to your specifications

MATERIAL OPTIONS

UNIFUSE molding gives you broader material options. Typical material properties are listed below.

	D792 Specific Gravity*	D638 Tensile Strength (psi)*	D638 Tensile Modulus (by 10k psi)*	D790 Flexural Modulus (by 10k psi)*	D256 Impact Strength Izod*	Maximum Continuous Use Temp. (F)
LLDPE	0.92—0.96	2000—5000	0.4—1.8	1.6	0.2—2.3	180 deg.
POLYPROPYLENE	0.89—0.91	3900	1—2.25	1—6.5	1.6	230 deg.
POLYCARBONATE	1.19—1.25	350	3.3	3.3	2.4—17	220 deg.
PVDF	1.09—1.11	2700—7400	1.9—2.1	1.7—2.6	3—10.3	280 deg.
ACRYLIC	1.17—1.20	8000—11000	3.5—5	2.8—5	0.2—2.3	170—200 deg
POLYSULFONE	1.24	10200	3.6	3.8	1.3	300—345 deg.

*Nominal ratings only, which may vary with different applications—must be checked for your specific application.

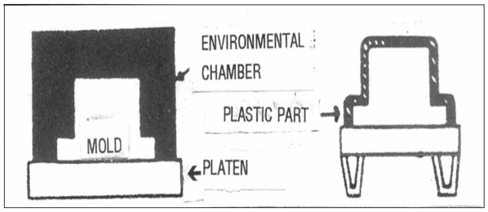
Process Comparison—Quick View

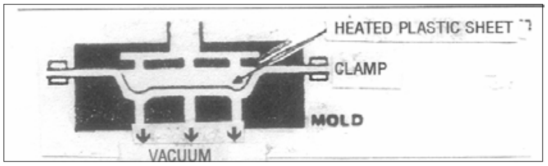
UNIFUSE (VIM) Molding Compared to Other Thermoplastic Processes

	VIM	Injection	Extrusion	Thermo-forming	Blow	Rotational
Mold Cost	**LOW**	High	Medium	Medium	High	Medium
Melt Plastic	**NO**	Yes	Yes	No	Yes	No
Pressure	**LOW**	High	High	Vacuum	High	Low
Stress Free	**YES**	No	No	No	No	Yes
Inserts/Additives	**YES**	Some	No	No	No	Yes

UNIFUSE (VIM) VIBRATIONAL MOLDING PROCESS

The UNIFUSE VIM process (vibrational microlamination) utilizes a single surface mold, carefully controlled heat, and vibration to fuse thermoplastics into a mold shape. Parts can be large, tooling costs are low, and the process can mold inserts, grooves, laminates, etc. UNIFUSE (VIM) is the #1 method for custom designs and special projects.



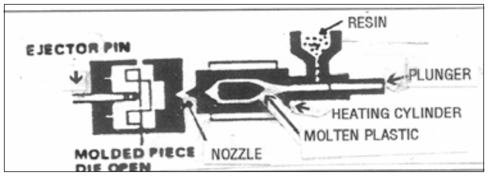


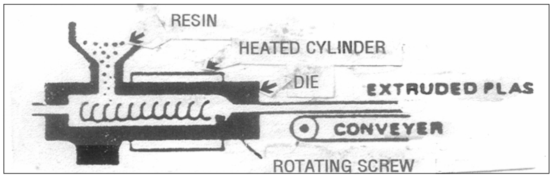
THERMOFORMING

Heated and softened plastic sheet is shaped to the contours of a mold by air pressure, vacuum, and/or mechanical means. When cool, the plastic retains the mold shape.

INJECTION MOLDING

A plunger pushes resin through the heated cylinder. The plastic, softened to a fluid, is forced into a cold, closed mold. Cooled and in a solid state, the piece is ejected and the cycle is rapidly repeated.



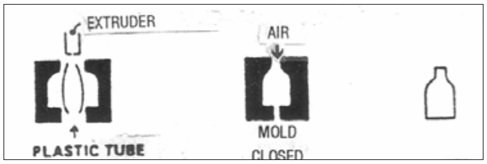


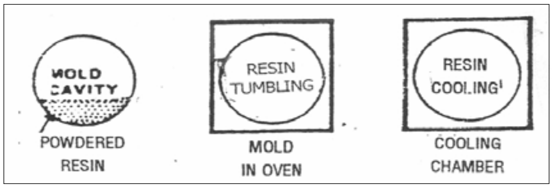
EXTRUSION MOLDING

Continuous sheeting film, profile shapes, and coatings on wire and cable are made by this process. A mechanical screw revolving in a heated chamber forces the molten plastic through a die of the desired shape.

BLOW MOLDING

This process is used to make hollow products such as bottles. A thick walled tube is extruded into an open split mold. The mold is closed and air blown into the tube causes the plastic to expand against the mold.





ROTATIONAL MOLDING

Hollow, one-piece parts, often very large, are made by this method. A mold, containing a measured amount of resin is rotated simultaneously about two axis within a large oven. The tumbling resin gradually melt and fuses to form an evenly distributed layer on the internal surface.

Features & Benefits of the Unifuse Molding Process

UNIFUSE MOLDED PLASTIC

Unifuse containers are heavy duty industrial type units that are weatherproof, chemical-proof, have high strength and are highly resistant to impact and cracking. Unifuse products in the field, and under constant use, have been tested for over 20 years without failure.

HIGH STRENGTH

The strength of Unifuse containers is due to our unique molding process. This starts with powder, not molten plastic, that is fused under heat and vibration and cooled slowly and evenly so that inherent stress is avoided. The results are containers that do not crack under intended use. In addition, Unifuse molding can make thick or heavy duty sections without product distortion.

CRACK RESISTANT

Thermoplastic materials (polyethylene, polypropylene, etc.) consist of long chain molecules which inherently have good strength and flexibility. They are excellent for container use. The Unifuse process molds these materials with no degradation to the basic polymer strength.

HOW OTHER METHODS FALL SHORT

Thermoplastic materials are normally molded by injection or extrusion in which plastic is melted, shot through a nozzle and then cooled. The cooling process does not occur evenly throughout so that the resulting product has inherent stress in its finished form.

Thermoforming can also be used which heats sheet plastic so it flows and then stretches it either in a die or by vacuum. This stretching process also results in inherent stress in the product. Containers made by these methods have a tendency to crack or break in use (i.e. garbage containers in cold weather).

LONG LIFE

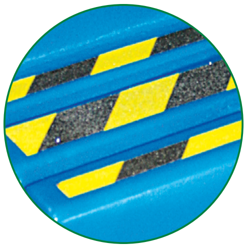
Containers made by Unifuse take advantage of our patented molding process to produce containers with superb crack resistance and better strengths to outlast other brands on the market.

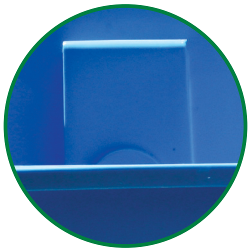
BEST VALUE

High quality, custom plastic containers with high strength and crack resistance meeting your expectations throughout their service-life which makes Unifuse products **THE BEST VALUE** available!

Custom Projects with Low-Cost Tooling and Quick Turnaround!

Call us with your requirements. | 276.926.6464





"Besides no inherent stress, benefits of the [Unifuse] molding process are that large parts are easily made and tooling costs are low."

— David J. Bak, East Coast Editor
Design News

UNIFUSE
redefining molded plastic

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