3M™ Glass Bubbles
For Resin Systems

Do More with 3M™ Glass Bubbles

High-strength additives for reduced part weight, improved dimensional stability, enhanced processing – and much more.
3M ™ Glass Bubbles are high-strength, low-density hollow glass microspheres used in a wide range of thermoplastics, sheet/bulk-molded composites, structural foams and elastomers. 3M glass bubbles have long been relied upon as density reducing fillers, particularly in transportation applications. Now, these unique engineered additives give you even more ways to reduce weight, improve processing and boost productivity and profits.

Expand your design possibilities with 3M ™ Glass Bubbles

- Reduce weight in resin systems by 15% or more, while maintaining mechanical properties.
- Make more parts per hour by improving cycle time 15-25%. Parts with less mass cool faster - and require less energy to process.
- Improve dimensional stability, reduce shrinkage and warpage, and cut down on waste and reprocessing.
- Enhance surface appearance and deliver Class A paintable surfaces.
- Contribute to environmental sustainability through better fuel economy and a smaller carbon footprint throughout your product’s life cycle.

Made from soda-lime-borosilicate glass, 3M glass bubbles are chemically inert and water resistant. Their unique spherical shape also offers a variety of advantages over irregularly-shaped mineral fillers and glass fiber. 3M glass bubbles create a “ball-bearing” effect that can result in higher filler loading without the degree of flow issues encountered with other fillers. And, where thin-walling can create issues with part integrity, formulating with 3M glass bubbles can allow manufacturers to achieve weight reduction targets without altering part design.

3M glass bubbles are available in a broad range of sizes, densities and crush strengths, to help you achieve the ideal balance of properties for your application. And they can be optimized for use in existing formulations. Today, a new generation of high-strength 3M glass bubbles – including recently introduced 3M ™ Glass Bubbles iM16K for injection molding – are creating a wealth of new opportunities for lightweight plastics. Capable of surviving high-shear and pressure processes, 3M glass bubbles for resin systems can help you produce lighter parts with improved mechanical properties in less time – giving you the competitive edge.

The chart below shows properties of 3M glass bubbles commonly used in resin system applications.

<table>
<thead>
<tr>
<th>Product</th>
<th>Target Crush Strength (90% survival, psi)</th>
<th>True Density (g/cc)</th>
<th>Particle Size (microns, by volume)</th>
<th>Effective top size (&gt;95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distribution</td>
<td>10th%</td>
<td>50th%</td>
<td>90th%</td>
</tr>
<tr>
<td>K37</td>
<td>3,000</td>
<td>0.37</td>
<td>20</td>
<td>45</td>
</tr>
<tr>
<td>S38</td>
<td>4,000</td>
<td>0.38</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>S38HS</td>
<td>5,500</td>
<td>0.38</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>K42HS</td>
<td>7,500</td>
<td>0.42</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>S60</td>
<td>10,000</td>
<td>0.60</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>S60HS</td>
<td>18,000</td>
<td>0.60</td>
<td>11</td>
<td>30</td>
</tr>
<tr>
<td>iM16K</td>
<td>16,000</td>
<td>0.46</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>iM30K</td>
<td>28,000</td>
<td>0.60</td>
<td>9</td>
<td>16</td>
</tr>
</tbody>
</table>
The following chart represents the 3M™ Glass Bubbles product portfolio, arranged by their relative strengths and densities.

Following their initial development in the 1970s, improvements in glass bubble crush strength tended to be incremental (as shown by the black trend line), and were accompanied by corresponding increases in density.

In recent years, however, growing customer interest in glass bubbles as fillers for engineered thermoplastics has led to rapid advances in the technology (shown by the blue trend line). Today, we are able to increase glass bubble strength many times, without corresponding increases in density or bubble size.
Unlike irregularly-shaped fillers, 3M glass bubbles roll easily over one another. This helps increase volume loading capacity, reduce shrinkage, and lower resin demand. It can also help reduce warpage in many molded plastic parts.

Users of 3M™ Glass Bubbles are reporting significant process and product improvements, including:

- **Reduced part density** – significant reduction in some compounds
- **Improved dimensional stability** – helps you meet tight tolerances
- **Improved throughput** – for lower injection pressures and faster cooling
- **Increased filler loading** – for reduced resin demand, lower costs
- **Excellent thermal and electrical insulation properties**
- **Resistant to water, chemicals, UV radiation**
- **Smaller carbon footprints** – contributing to sustainability

**Dimensional Stability**

A leading resin compounder has found that the addition of 3M glass bubbles not only reduces the density of thermoplastic olefin parts, but also helps improve part stiffness and dimensional stability, while reducing shrinkage.

**Cost Reduction**

By using 3M glass bubble-filled polypropylene in place of talc-filled PC/ABS, a Korean automotive OEM reports a 50% cost reduction in producing finished core parts for instrument panels, as well as 16.8% less weight, use of original tooling and improved material flow.

**Sustainability**

A global polymer processing firm determined that use of a single interior aircraft component filled with 3M glass bubbles would reduce weight by more than 5 kg per aircraft – resulting in a savings of 1,000 liters of fuel per year. Extended to a fleet of 150 aircraft over a 15-year operating life, the total fuel savings would amount to approximately 2.25 million liters of fuel, along with a significant reduction in carbon emissions.

**Class A Surface Finish**

Because of their small size (16 micron average), 3M™ Glass Bubbles IM30K added to sheet molding compounds (SMC) are enabling a Midwest auto parts supplier to meet OEM Class A surface quality standards, while achieving significant density reduction targets. Unlike larger bubbles, which tend to leave surface voids when sanded, the IM30K bubbles produce a surface finish that can be sanded smooth, without visual defects.

**Weight Reduction**

A U.S.-based plastics molder has achieved weight reductions of up to 32% in sheet molded compounds for automotive and non-automotive panels without compromising product quality. By using 3M glass bubbles in the resin matrix, this molder also reported excellent performance compared to alternative fillers such as carbon fiber, organic fillers, nano-particles, and nanometer particles.

**Reduced Production Time**

A U.S.-based developer of injection molding compounds indicates that the use of 3M glass bubbles can cut cycle times as much as 20%, primarily because the reduced mass results in faster cooling from the melt. Additionally, parts with less mass require less torque to process, resulting in additional productivity benefits.

**Expanded Design Possibilities**

A global manufacturer of elastomer-based products used 3M glass bubbles to make PVC boots that are light enough to float. The glass bubbles provided a 17% weight reduction, thermal insulation and increased buoyancy for improved comfort in industrial fishing applications.
Customer-pleasing Possibilities

Because of their unique ability to reduce density, increase filler loading, improve dimensional stability and other useful properties, 3M™ Glass Bubbles are finding utility in a growing number of plastics and rubber applications. To learn how 3M glass bubbles could help improve your product’s performance, contact your 3M representative.
3M offers a family of high-strength, low-density glass bubbles optimized to withstand the rigors of compounding and injection molding. The new iM Series offers excellent survivability at the high pressures encountered in typical plastics processing operations.

For higher pressure applications, 3M™ Glass Bubbles iM30K have a strength of 28,000 psi at a 0.60 g/cc density and a particle size of 16 microns. For lower pressure applications where a lower density could be beneficial, 3M™ Glass Bubbles iM16K feature a strength of 16,000 psi at a 0.46 g/cc density and a particle size of 20 microns. This optimal balance of strength and density gives you the design flexibility to create lighter, more uniform parts from ABS, acetal, nylon and other engineered thermoplastics.

These additives are designed to reduce density without compromising the modulus, strength or dimensional stability of thermoplastics. Formulating with 3M glass bubbles can reduce shrinkage and warpage, cutting down on scrap rates and reprocessing. Because of their ability to significantly reduce resin use, high-strength 3M glass bubbles can also enable a number of other important process improvements. Lower-density materials require less torque to process and can reduce wear on tooling and secondary operations. Glass bubble-filled systems also cool faster, reducing cycle time and increasing throughput – helping processors reduce their overall part costs while improving productivity.

Achieving the perfect balance

3M™ Glass Bubbles iM16K
Withstands molding and extrusion pressures up to 16,000 psi - at just 0.46 g/cc density

The newest member of 3M’s high-strength glass bubble portfolio, 3M Glass Bubbles iM16K, is changing the way the plastics industry uses lightweight fillers. This injection molding grade of glass bubbles is optimized to reduce the density of filled plastics without compromising strength or other physical properties.

Glass bubbles iM16K are strong enough to survive harsh injection molding and compounding processes, yet have a specific density of only 0.46 g/cc – enabling weight reductions of 15% or more in many polypropylene-filled systems, and 18% or more in nylon glass fiber-filled parts. With this ideal balance of strength and density, and a small particle size, glass bubbles iM16K are engineered to help you do more!

Effect of 3M™ Glass Bubbles on Weight Reduction

<table>
<thead>
<tr>
<th>Wt% Glass Bubbles Loading</th>
<th>% Weight Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.40</td>
</tr>
<tr>
<td>5</td>
<td>1.36</td>
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<tr>
<td>10</td>
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<td>15</td>
<td>1.28</td>
</tr>
<tr>
<td>20</td>
<td>1.24</td>
</tr>
</tbody>
</table>

Effect of Surface Treatment on Mechanical Properties

*All data, with the exception of elongation, have been normalized for the base virgin resin to equal 100%.
3M™ Glass Bubbles are a high performance alternative to conventional fillers in the production of sheet molding compounds (SMC), bulk molding compounds (BMC) and other thermoset plastics.

For over 25 years, 3M glass bubbles have proven their ability to reduce the density of parts such as doors, fenders, acoustic covers and sunroof shades, while maintaining a desirable balance of physical properties.

Potential Savings with 3M™ Glass Bubbles

These sample calculations show how 3M glass bubbles can be used to produce a lighter weight automotive component for approximately the same manufacturing cost as a standard SMC formulation:

A new way of calculating SMC formulations

Traditionally, most SMC formulations specify the proportions of their ingredients as weight fractions, or parts per hundred of resin. This can present problems when replacing calcium carbonate with lightweight, high-performance fillers such as 3M glass bubbles.

A pound of 3M glass bubbles,* for instance, takes up almost 7 times as much space as a pound of calcium carbonate. If you were simply to substitute an equal weight of glass bubbles for the calcium carbonate in a formulation, the volume ratio of all other ingredients would be reduced substantially.

Formulating by volume fraction instead of weight allows the proper balance of resin, filler and reinforcement, so parts can be made lighter – while still maintaining an acceptable balance of physical properties.

* At a true density of 0.37 g/cc.
Additional Information

3M™ Glass Bubbles are supported by global sales, technical and customer service resources, with fully-staffed technical service laboratories in the U.S., Europe, Japan, Latin America and Southeast Asia. Users benefit from 3M’s broad technology base and continuing attention to product development, performance, safety and environmental issues.

For additional technical information on 3M glass bubbles in the United States, call 3M Advanced Materials Division, 800-367-8905.

For other 3M global offices, and information on additional 3M products, visit our web site at: www.3M.com/engineeredadditives.

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