



ENGINEERED GLASS MATERIALS DIVISION Spheriglass® Solid Glass Microspheres

High Performance Solid Glass Polymer Additives

TECHNICAL AND ECONOMIC ADVANTAGES can result from the inclusion of Spheriglass® solid glass spheres as a performance additive for thermoplastic and thermosetting resin systems. Their multiple benefits, including enhanced processing and reduced manufacturing costs are outlined below.

Glass spheres are smooth, hard and offer excellent chemical resistance and low oil absorption. These and other characteristics enable the spheres to be used in a wide range of applications in the transportation, automotive, chemical, electronic, industrial, and engineering industries, where they can substantially reduce reject rates in production.

Potters Industries is the world's leading supplier of glass spheres and has a Research and Development Laboratory to provide applications, engineering and technical assistance.

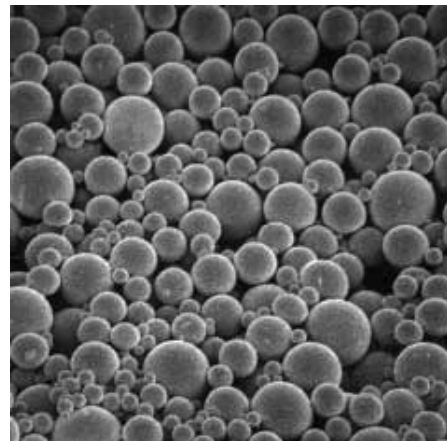
Multi Benefits of Spheres:

PROCESS

- Solid smooth shape
- lowest surface to volume ratio
- high loading capacity
- improved lubricity
- low resin mix viscosity
- excellent mold flow
- uniform dispersion

PRODUCT

- Improve surface hardness, toughness and durability
- improved abrasion and scratch resistance
- low uniform shrinkage
- low warpage



- high flexural modulus
- increased surface hardness
- better stress distribution
- Enables high loading levels
- Excellent chemical resistance

Improved Flow Properties

Spheres lower the viscosity of most resin mix systems, acting as miniature internal ball bearings to improve flow. When used in combination with fibers or other particle shapes, mold flow is improved, thus reducing product defects, and potentially improving production rates.

Low Shrinkage and Warpage

High loadings of glass spheres add significantly to the dimensional stability of finished products by reducing shrinkage and improving part flatness.

Better Molded Parts

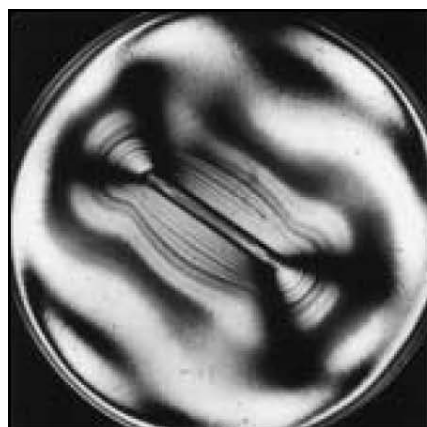
Glass spheres produce superior finished product characteristics in many resin systems. High loadings can increase flexural modulus, increase surface hardness and improve stress distribution.

High Resin Displacement

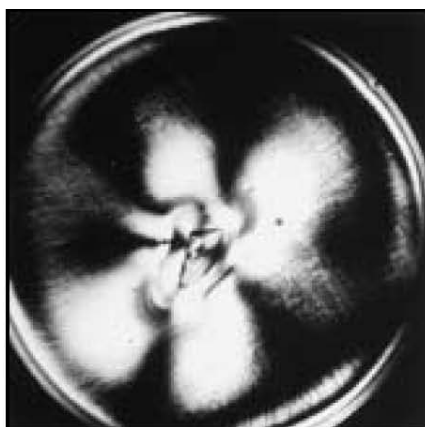
The precise geometry of Spherglass spheres allows them to disperse evenly, pack closely, and wet out easily in the compound, permitting very high filler loadings.

General Product Information						
Product	Particle Size Distribution*			Bulk Density* (lbs/cu. ft.) ASTM D-3101-78		Oil Absorption* (g oil/100g. spheres) ASTM D-1483
	Mean Value (microns)	Range (microns)	US Mesh Size	Untapped	Tapped	
A-GLASS						
1922	-	150 – 250	60 – 100	91	98	18
2024	-	106 – 212	70 – 140	91	98	18
2429	70 – 100	53 – 106	140 – 270	91	98	18
2530	60 – 70	45 – 90	170 – 325	91	98	18
3000	30 – 50	-	- 325	90	99	18
5000	7 – 10	-	-	80	101	20
E-GLASS						
3000E	30 – 50	-	- 325	82	100	19

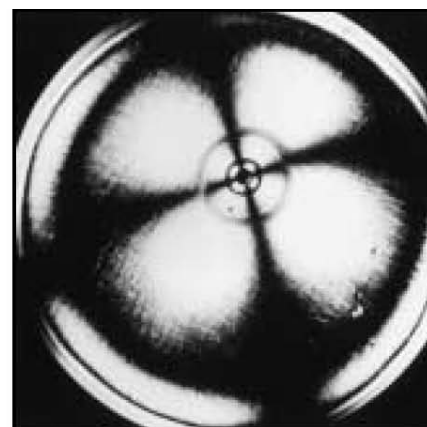
*Typical Values



FIBER



IRREGULAR PARTICLE



GLASS SPHERE

Dimensional Stability

Better stress distribution is achieved from the use of a spherically shaped particle. This behavior is illustrated above showing the stress patterns in cured epoxy resins compounded with the three different classes of substances commonly mixed into plastics: fibers, irregular particles and spheres. With glass spheres, the stress pattern is regular and predictable, showing less localized stress concentrations.

A molded part can shrink in any of its three dimensions. Glass fiber-filled parts, owing to the directional orientation of the fibers, normally have different shrinkage rates for different directions. Shrinkage measured along the length of the fiber is very low; across the fiber it is usually quite high. Therefore, the dimensional stability of glass fiber-filled parts is partially dependent on the flow of material into the mold. The non-directional orientation of spheres produces a more uniform shrinkage rate throughout the part and the isotropic nature of spheres results in more predictable manufacturing quality.

Coupling Agent Coatings

Spherglass solid glass spheres are incorporated into most thermoplastic and thermosetting resin systems as an inorganic reinforcement. When coated Spherglass additives are used, processing and resin composite performance are enhanced, while overall manufacturing costs are reduced. Spherglass solid glass spheres are available with coupling agents CP-01, CP-02, and CP-03; each designed for optimum performance in specific resin systems. The coupling agents are applied in molecular layers to obtain maximum interfacial bonding between spheres and resin.

Recommended Coupling Agents

Thermoplastic Resin Systems	
Acrylics	CP-01
Acetal	CP-02, CP-03
Acrylonitrile Butadiene Styrene	CP-01
Cellulosics	CP-02, CP-03
Fluoroplastics	CP-26
Ionomer	CP-02, CP-03
Nylon	CP-03
PBT/PET	CP-02, CP-03
Polycarbonate	CP-02, CP-03
Polyethylene	CP-01
Polyimide	CP-03
Polymethyl Methacrylate	CP-01
Polyphenylene Oxide	CP-03
Polypropylene	CP-03
Polystyrene	CP-01
Polysulfone	CP-03
Polyvinyl Chloride	CP-03
Styrene Acrylonitrile	CP-01
Thermosetting Resin Systems	
Epoxy	CP-02, CP-03
Melamine	CP-02, CP-03
Phenolic	CP-03
Polyester, unsaturated	CP-01
Silicone	CP-01
Urea	CP-03
Urethane	CP-03
Vinyl Ester	CP-01

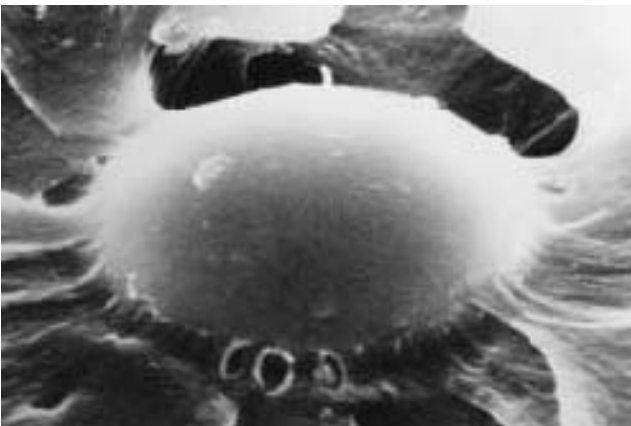
The following chart illustrates the improved properties of coated glass sphere filled Nylon 6/6 compounds.

Coupling Agents Improve Properties		Nylon 6/6		
		Unfilled	Solid Glass Spheres (40% by wt.)	
			3000 Uncoated	3000 CP-03 Coated
Flexural Strength (psi)	Dry	14300	14200	19000
	Wet ²	8900	8700	12100
Flexural Modulus (psi x 10 ⁵)	Dry	3.2	4.9	5.4
	Wet ²	1.7	2.7	3.1
Tensile Strength (psi)	Dry	9400	7100	11100
	Wet ²	8000	5500	9400
Heat Deflection Temp.		75	127	126

¹ The Nylon 6/6 used was "Zytel" 101 (Dupont)

² Sample conditioned for 16 hours in water at 50°C prior to testing wet physicals.

SPHERES with coating



SPHERES Uncoated



PROPERTIES OF A AND E GLASS

TYPICAL VALUES	A-GLASS Soda-Lime	E-GLASS Boro-Silicate
Physical:		
Specific Gravity	2.5	2.54
Refractive Index	1.51	1.55
Free Iron Content, % max	0.1	0.1
Mechanical:		
Young's Modulus, 10 ⁶ psi	10.0	10.5
Rigidity Modulus, 10 ⁶ psi	4.3	
Hardness (Moh)	6.0	6.5
Coefficient of Friction	0.9-1.0	1.0
Electrical:		
Dielectric Constant, 22°C, 10 ⁶ Hz	6.9	5.8
Loss Tangent, 22°C 10 ⁶ Hz	0.0085	0.0010
Vol. Resistivity, 25°C, ohm-cm	6.5 x 10 ¹²	10 ¹³ -10 ¹⁶
Thermal:		
Softening Point, °C	704	846
Expansion Coefficient, in/in/°C X 10 ⁻⁷	90	28
Thermal Conductivity (cal/(sec)(cm ²)(°C/cm) at 500°C)	0.0036	
Composition %:		
	A-Glass	E-Glass
SiO ₂ *	72.5	52.5
Na ₂ O	13.7	0.3
CaO	9.8	22.5
MgO	3.3	1.2
Al ₂ O ₃	0.4	14.5
FeO/Fe ₂ O ₃	0.2	0.2
K ₂ O	0.1	0.2
B ₂ O ₃	0.0	8.6

* No measurable free crystalline silica content as tested by ASTM C-169

Hydrolytic Leach Resistance**:

Leachate pH	9.4	8.5
Leach Conductivity, (mmho/cm)	101.0	45.0
Leach Concentrations, (mg/cc)		
Total Alkali	25.7	3.6
Calcium	18.1	20.4
Boron	Trace	18.7
Silica	5.4	1.1

** One hour boil under reflux with deionized water

Packaging

Spheriglass® Solid Glass Microspheres are available in paper bags with plastic liners, bulk bags and various bulk shipping modes. Details of packaging options are available as a separate document. Samples in sufficient quantity for testing are available on request.

Other Product Range:

Spherichel® Light Weight Hollow Glass Microspheres
 Q-CEL® Ultra-Light Weight Hollow Microspheres
 Conduct-O-Fil® Conductive Particles

Safety Information

Material Safety Data Sheets (MSDS) can be supplied on request.

For further information about our range of Solid and Hollow Microspheres, please contact us:

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