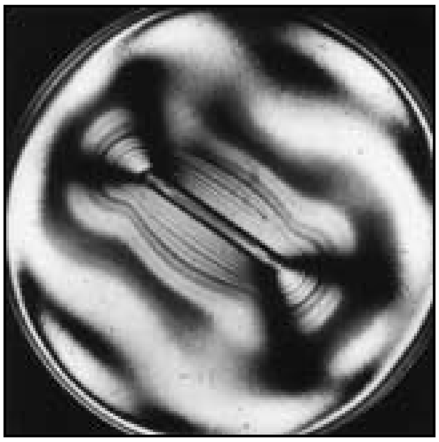
SPHERIGLASS®

SOLID GLASS SPHERES

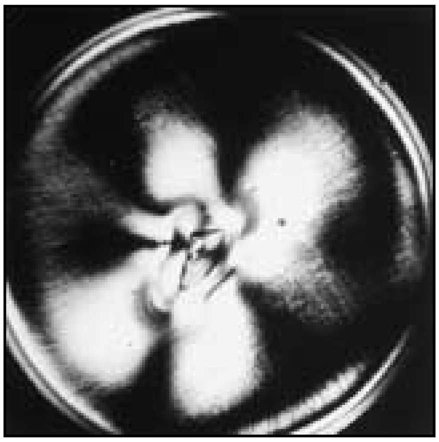
General Product Information

Product	Particle Size Distribution*		Bulk Density* (lbs/cu. ft.) ASTM D-3101-78		Oil Absorption* (g oil/100g. spheres) ASTM D-1483
	Microtrac Particle Size Analyzer Mean Value	Mass. % Retained US Mesh Size	Untapped	Tapped	
A-GLASS					
1922		150-250	91	98	18
2024		106-212	91	98	18
2429	70-100		91	98	18
2530	60-70		91	98	18
3000	30-50		80	99	18
E-GLASS					
3000E	30-50		82	101	17
*Typical Values					

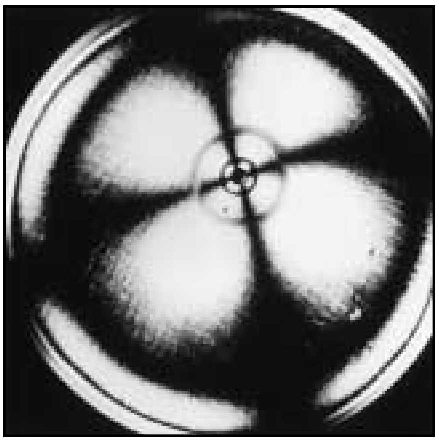
FIBER



IRREGULAR PARTICLE



GLASS SPHERE



Birefringence patterns show stress patterns in resin surrounding different shapes of filler particles. Note uniform stress patterns around 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

Spheriglass solid glass spheres are incorporated into most thermoplastic and thermosetting resin systems as an inorganic reinforcement. When coated Spheriglass additives are used, processing and resin composite performance are enhanced, while overall manufacturing costs are reduced. Spheriglass solid glass spheres are available with coatings containing specially and formulated coupling agents CP-01, CP-02, 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

Resin	Coating
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

Alkyd	CP-01
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

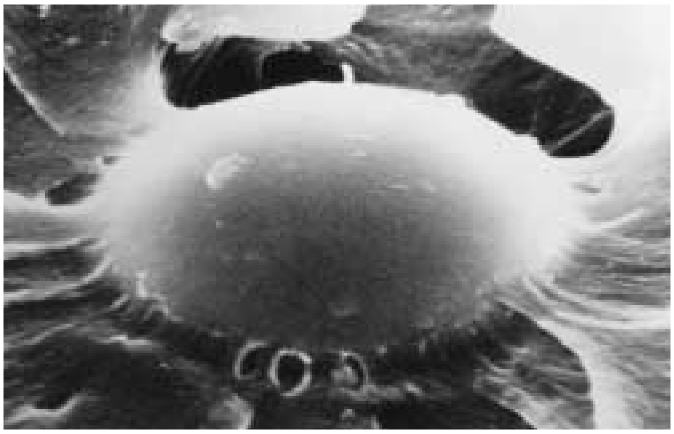
The following chart illustrates the improved properties of coated glass sphere filled Nylon 6/6 compounds.

Coupling Agents Improve Properties

		Nylon 6/6[1]		
		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. (°C at 264 psi)		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.

COATED SPHERES



UNCOATED SPHERES

Properties of A & 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	6.5×10^{12}	10^{13}-10^{16}
Thermal:		
Softening Point, °C	704	846
Expansion Coefficient, in/in/°CX10^{-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_2O	13.7	0.3
CaO	9.8	22.5
MgO	3.3	1.2
$A1_2O_3$	0.4	14.5
FeO/Fe_2O_3	0.2	0.2
K_2O	0.1	0.2
B_2O_3	0.0	8.6

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

Hydrolytic Leach Resistance:**	A-GLASS	E-GLASS
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

Safety Considerations

Studies from both government and industry sources have shown that the glass used in Potters spheres is non-toxic. No specific hazards exist with regard to ingestion, inhalation or contact. Material Safety Data Sheets are available on request.

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