

Material Properties of Polystyrene and Poly(methyl methacrylate) (PMMA) Microspheres

All of our polystyrene and PMMA (poly(methyl methacrylate)) microspheres are solid, non-porous polymer bead products. We do not empirically evaluate physical properties of our polymer beads, but we anticipate that many of the values associated with these properties are similar to those values reported in the scientific literature for the bulk polymers. A list of material properties for bulk general purpose polystyrene and PMMA from the literature and other internet sources may be found below:

ELECTRICAL PROPERTIES:

-dielectric constant (ϵ)

polystyrene (amorphous): 2.49-2.55 at 1kHz (curve flat to 1GHz)*
 PMMA: 3.6 at 50Hz, 25°C; 3.0 at 1KHz, 25°C; 2.6 at 1MHz, 25°C; 2.57 at 30GHz, 25°C; 2.59 at 138 GHz, 25°C*

-dielectric strength

polystyrene: (ASTM D 149): 19.7-22.7 MV/m; 500-575 Volts/mil; 19.7-22.7 kV/mm**
 PMMA: 17.7-60 kV/mm*****

-electrical conductivity

polystyrene: 10^{-16} S/m*****
 PMMA: n/a

-resistivity [unit = Ohm cm]

polystyrene: $10^{20} - 10^{22}$; * volume resistivity (ASTM D 257): 1.0×10^{17} **
 PMMA: $>10^{15}$; $10^{14} - 10^{15}$ *****

THERMODYNAMIC PROPERTIES:

-coefficient of thermal expansion [unit = K^{-1}]

polystyrene: linear: $6-8 \times 10^{-5}$ (<T); volume: $1.7-2.1 \times 10^{-4}$ (<T^Δg), $5.1-6.0 \times 10^{-4}$ (>T^Δg)*
 PMMA: linear: 7×10^{-5} (0-50°C); volume: 2.6×10^{-4} (<T), 2.25 - 2.72 $\times 10^{-4}$ (<T^Δ), $5.6 - 5.8 \times 10^{-4}$ (>T^Δ)*

-density [unit = g/cm³]

polystyrene (amorphous): 1.04 – 1.065*
 PMMA: 1.195 (0°C); 1.190 (20°C); 1.188 (25°C); 1.150 (T_g)*

-glass transition temperature (T_g)

polystyrene: 80-90°C*
 PMMA: 377-378 K (104-105 °C)*

-heat capacity [C_p; unit = kJ kg⁻¹ K⁻¹]

polystyrene: 1.185 (1.139) at 0°C; 1.256 (1.394) at 50°C; 1.838 (1.821) at 100°C*
 PMMA: 0.585 at -173°C; 0.878 at -100°C; 1.255 at 0°C; 1.42 (1.47) at 25°C; 1.72 (2.02) at 100°C; 2.05 (2.76) at 120°C; 2.38 (3.35) at 180°C; 4.69 (2.35) at 240°C; 10.55 (2.50) at 300°C*

-heat of combustion

polystyrene: -4.33 x 103 kJ mol⁻¹*
 PMMA: -26,200 kJ kg⁻¹*

-heat of fusion

polystyrene: 8.37 +/- 0.08 kJ mol⁻¹*
 PMMA: n/a

-heat of polymerization

polystyrene: -69.9 - -67.4 kJ mol⁻¹*
 PMMA: -57.8 kJ mol⁻¹*

-heat of solution

polystyrene: -3.60 kJ mol⁻¹*
 PMMA: n/a

-melting point (T_m)

polystyrene: 240°C (250°C)*
 PMMA: 130°C*****

-thermal conductivity [unit = W m⁻¹ K⁻¹]

polystyrene: 0.105 at 0°C; 0.116 at 50°C; 0.128 at 100°C; * 0.144; ** 0.999 BTU (in/hrft²F)**
 PMMA: 0.193 at 0-50°C*

OPTICAL PROPERTIES:

-optical dispersion ($\eta_f - \eta_c$)

polystyrene: 1.92×10^{-2} ($\lambda = 486.1\text{nm}$, $\lambda = 656.3\text{nm}$)*
 PMMA: n/a

-NMR spectrum

polystyrene: peaks [ppm] at 3.0, 3.5 (aromatic), 8.4 (CH₂)*
 PMMA: n/a

-refractive index

polystyrene: $n_D = 1.59 - 1.60$ ($\lambda = 589.3\text{nm}$)*; 1.617 ($\lambda = 436.8\text{nm}$), 1.606 ($\lambda = 486.1\text{nm}$), 1.592 ($\lambda = 587.6\text{nm}$), 1.587 ($\lambda = 632.8\text{nm}$), 1.582 ($\lambda = 703\text{nm}$), 1.577 ($\lambda = 833\text{nm}$), 1.576 ($\lambda = 879\text{nm}$), 1.572 ($\lambda = 1052\text{nm}$)**
 PMMA: $n_D = 1.492$ ($\lambda = 589\text{nm}$); $n_g = 1.494$ ($\lambda = 546\text{nm}$); $n_g = 1.502$ ($\lambda = 436\text{nm}$)*; 1.502 ($\lambda = 436.8\text{nm}$), 1.497 ($\lambda = 486.1\text{nm}$), 1.491 ($\lambda = 587.6\text{nm}$), 1.489 ($\lambda = 632.8\text{nm}$), 1.486 ($\lambda = 703\text{nm}$), 1.484 ($\lambda = 833\text{nm}$), 1.483 ($\lambda = 879\text{nm}$), 1.481 ($\lambda = 1052\text{nm}$)**

-UV spectrum (in vacuo)

polystyrene: absorption bands at 260nm, 194nm, and 80nm*
 PMMA: n/a

MECHANICAL PROPERTIES:

-coefficient of friction

polystyrene: 0.515 (20-80°C); 0.744 (100°C); >2 (120°C); 0.25 (100°C), 2.65 (110-120°C)*; 0.35 – 0.45*****
 PMMA: 0.54*****

-Compressibility [unit = MPa⁻¹]

polystyrene: 220×10^{-6} *
 PMMA: 245×10^{-6} (T = 20°C); 290×10^{-6} (T = 60°C); 355×10^{-6} (T = 100°C); 390×10^{-6} (T = 109.3°C); 500×10^{-6} (T = 119.8°C); 530×10^{-6} (T = 129.7°C); 585×10^{-6} (T = 139.3°C)*

-compressive modulus [unit = MPa]

polystyrene: 3000 (unoriented)*
 PMMA: n/a

-compressive strength

polystyrene: 83 MPa, 12,000 psi, 845 kg/cm³**
 PMMA: 83 - 124 MPa*****

-elasticity modulus

polystyrene: n/a
 PMMA: 3300 MPa (25°C)*

-hardness

polystyrene: n/a
 PMMA: 0.41 GPA****

-Poisson's ratio

polystyrene: 0.325 – 0.33*

PMMA: 0.34 – 0.4****

-shear modulus

polystyrene: 700-800 MPa*****

PMMA: 1700 MPa (dynamic, 25°C, 10Hz)*

-tensile strength

polystyrene: 32-60 MPa*****

PMMA: 48–76 MPa*****

-Young's modulus (tensile modulus)

polystyrene: 3200-3400 MPa (unoriented)*; 3000-3500 MPa*****

PMMA: 5.0 GPa****; 1800 – 3100 MPa*****

CHEMICAL PROPERTIES:**-solubility parameter (δ [J/m³]^{1/2} * 10⁻³)**

polystyrene: 17.4 – 21.1*

PMMA: 17.4 – 27.2*

-solubility parameter (δ [cal/cm³]^{1/2})

polystyrene: 8.5 – 10.3*

PMMA: 8.5 – 13.3*

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