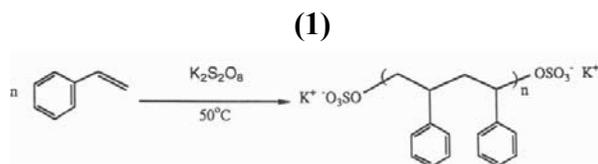


Product and Price Information

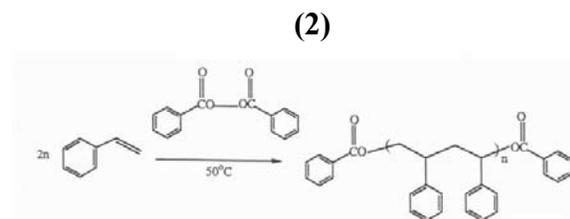
SPHERO™ Polystyrene Particles

The SPHERO™ polystyrene particles are prepared by conventional emulsion polymerization with styrene as the monomer and potassium persulfate or benzoyl peroxide as polymerization initiator. In general, microparticles less than 0.5 μm are prepared in one step followed by a cleaning step on mixed bed ion exchange resin to remove detergent and inorganic salts. Larger particles are prepared by step wise growing of smaller particles with the addition of styrene monomer and initiator without any additional detergent. The microparticles are cleaned by repeated centrifugation. Cleaned microparticles are resuspended in deionized water. Sodium azide (0.02%) is added as bacteriostatic. As a result, the SPHERO™ microparticles can be coated with proteins without further cleaning.

Microparticles made using potassium persulfate as initiator have sulfate groups on their surface. As a result, these particles are negatively charged and are hydrophilic, as shown in equation (1).



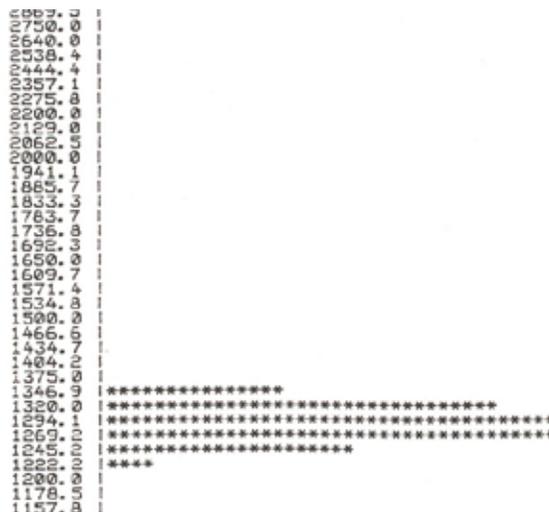
The SPHERO™ polystyrene particles greater than 3 μm are usually prepared using benzoyl peroxide as the initiator. These particles are relatively more hydrophobic, as shown in equation (2).



SPHERO™ polystyrene particles are composed of linear polystyrene without any cross-linking agent. These particles cannot tolerate organic solvents such as toluene, xylene, chloroform, methylene chloride, acetonitrile, dimethyl formamide or acetone. However, SPHERO™ polystyrene particles are stable in the presence of some water miscible solvents such as dimethyl sulfoxide and alcohols. Uniform size cross-linked polystyrene particles that are stable in the presence of organic solvents are also available.

Uniform SPHERO™ polystyrene particles are ideal for use in immunoassays such as latex agglutination, particle base enzyme immunoassays and fluorescence immunoassays. A tight size range of SPHERO™ polystyrene particles is maintained by monitoring size using a NICOMP Laser Particle Sizer (for particles greater than 3 μm) and a Scanning Electron Microscope for larger particles. Although the size measurements are accurate, these particles are not certified for use as calibration standard for size measurements or pore size analysis.

Histogram of SPHERO™ polystyrene particles from the NICOMP Laser Particle Sizer



```

SPHERO CARBOXYL POLYSTYRENE PARTICLES DE9.05-24-
  MEAN DIAM. = 1290.0  STD.DEV. = 30.8  (2 %)
  RESIDUAL = 0.0      FIT ERROR = 2.4  CH.#1 =
  FROM THE GAUSSIAN ANALYSIS, CHI SQR. = 0.7

CHANNEL WIDTH = 2.0E1 USEC
PRESCALE FACTOR = 3.0
TEMPERATURE = 20.00 DEGREES CENT.
VISCOSITY = 1.002 CENTIPOISE
INDEX OF REFRACTION = 1.330
SINE OF ANGLE/2 = .7070
LASER WAVELENGTH = 632.8 NANOMETERS
DELAYED BASELINE? Y
    
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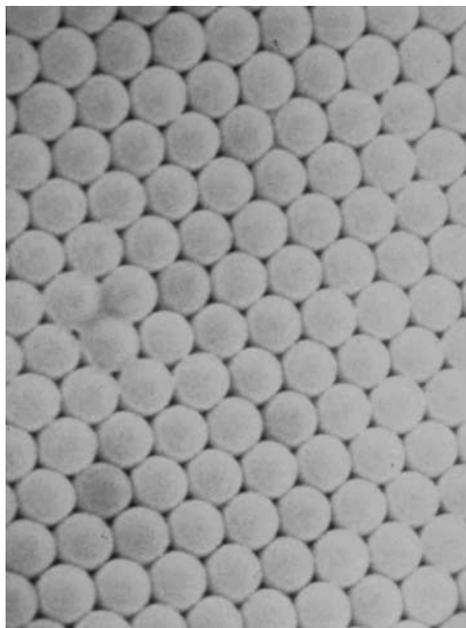
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SPHERO™ Polystyrene Particles

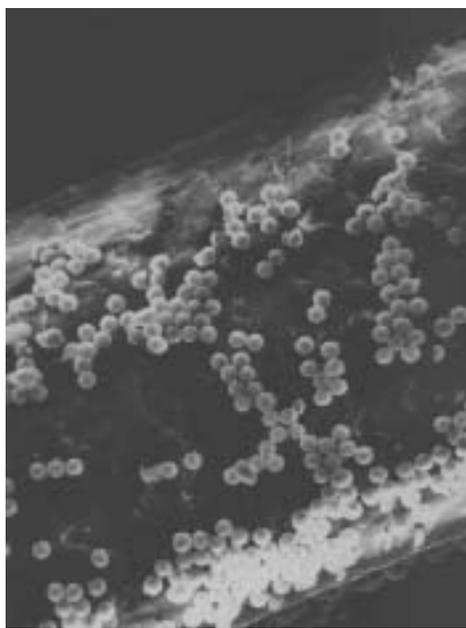
Particle Type and Surface	Size, μm	% w/v	Catalog No.	Unit
Polystyrene	0.05-0.1	5.0	PP-008-10	10 mL
			PP-008-100	100 mL
Polystyrene	0.2-0.3	5.0	PP-025-10	10 mL
			PP-025-100	100 mL
Polystyrene	0.4-0.6	5.0	PP-05-10	10 mL
			PP-05-100	100 mL
Polystyrene	0.7-0.9	5.0	PP-08-10	10 mL
			PP-08-100	100 mL
Polystyrene	1.0-1.4	5.0	PP-10-10	10 mL
			PP-10-100	100 mL
Polystyrene	1.5-1.9	5.0	PP-15-10	10 mL
			PP-15-100	100 mL
Polystyrene	2.0-2.4	5.0	PP-20-10	10 mL
			PP-20-100	100 mL
Polystyrene	2.5-2.9	5.0	PP-25-10	10 mL
			PP-25-100	100 mL
Polystyrene	3.0-3.4	5.0	PP-30-10	10 mL
			PP-30-100	100 mL
Polystyrene	3.5-3.9	5.0	PP-35-10	10 mL
			PP-35-100	100 mL
Polystyrene	4.0-4.4	5.0	PP-40-10	10 mL
			PP-40-100	100 mL
Polystyrene	4.5-4.9	5.0	PP-45-10	10 mL
			PP-45-100	100 mL
Polystyrene	5.0-5.9	5.0	PP-50-10	100 mL
			PP-50-100	10 mL
Polystyrene	6.0-8.0	5.0	PP-60-10	100 mL
			PP-60-100	10 mL
Polystyrene	8.0-12.9	2.5	PP-100-10	10 mL

Scanning Electron Microscope (SEM) photos of polystyrene particles are shown below to illustrate the uniformity of their size. (a) Single sheet of 0.8 μm polystyrene particles. (b) Face-centered-cubic packing of 0.86 μm particles. Theoretically, particles fill ~74% of the space regardless of their size. (c) 3.4 μm polystyrene particles on the surface of a human hair, which is about 100 μm in diameter.

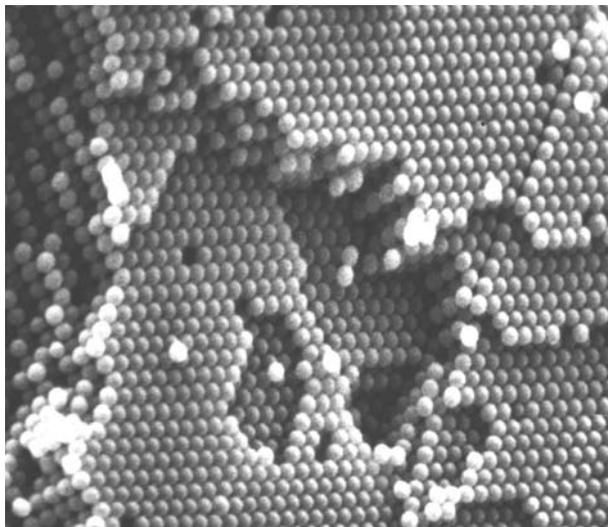
(A)



(C)



(B)



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SPHERO™ Functionalized Polystyrene Particles

There are several ways to prepare particles with functionalized surface. As mentioned previously, if potassium persulfate is used as an initiator for polymerization the surface of the particles will consist of sulfate groups. Similarly, other functional groups can be introduced on the surface of the particles by using other functionalized initiators. The surface functional groups can also be introduced by chemical modification of the existing surface functional groups by using functionalized monomer either during the particle formation step or during the final coating step.

Most of the **SPHERO™** functionalized polystyrene particles are prepared by coating a thin layer of functionalized polymer onto the surface of plain particles. As a result, all of the functional groups are on the surface of the particles. The functional groups are attached to the surface of the particles by alkyl chains of two to eight carbons in length depending upon the type of functionalized monomer used. The number of functional groups on the surface can be adjusted by varying the amount of functionalized monomer used for coating. The 0.8 μm **SPHERO™** carboxyl polystyrene particles typically contain about 50 $\mu\text{eq/g}$ of carboxyl groups on the surface of the particles. In addition, the 0.8 μm **SPHERO™** amino polystyrene particles typically contain about 15~20 $\mu\text{eq/g}$ of amino groups on the surface of the particles. These two types of the functionalized particles are very useful for covalent coupling of proteins, antibodies or antigens to the surface of the microparticles using water soluble carbodiimide methods. Other types of functionalized particles such as epoxy, hydroxyl, sulfate and dimethylamino particles offer different surface charges on the particles. These particles are used to manipulate the orientation of the coated material by passive adsorption.

In general, polyclonal antibodies can be coated to polystyrene particles by passive adsorption. According to our experience, the optimal amount of antibody to particles ratio is ~100 μg of antibody per mL of 0.5% w/v (5 mg solid per mL) of 0.8 μm polystyrene. Since the total surface area of the particles is inversely proportional to the diameter of the particles, the amount of antibody to particles ratio needs to be adjusted accordingly. If needed, the proteins or other Ligand can also be coated to carboxyl or amino polystyrene using water soluble carbodiimide as the coupling agent. Please refer to Sphero TECHNICAL NOTES-1 (STN-1) pages for more information on particle coating.

SPHERO™ Carboxyl Polystyrene

Particle Type and Surface	Size, μm	% w/v	Catalog No.	Unit
Carboxyl-polystyrene	0.05-0.1	2.5	CP-008-20	20 mL
			CP-008-200	200 mL
Carboxyl-polystyrene	0.2-0.3	5.0	CP-025-10	10 mL
			CP-025-100	100 mL
Carboxyl-polystyrene	0.4-0.6	5.0	CP-05-10	10 mL
			CP-05-100	100 mL
Carboxyl-polystyrene	0.7-0.9	5.0	CP-08-10	10 mL
			CP-08-100	100 mL
Carboxyl-polystyrene	1.0-1.4	5.0	CP-10-10	10 mL
			CP-10-100	100 mL
Carboxyl-polystyrene	1.5-1.9	5.0	CP-15-10	10 mL
			CP-15-100	100 mL
Carboxyl-polystyrene	2.0-2.4	5.0	CP-20-10	10 mL
			CP-20-100	100 mL
Carboxyl-polystyrene	2.5-2.9	5.0	CP-25-10	10 mL
			CP-25-100	100 mL
Carboxyl-polystyrene	3.0-3.4	5.0	CP-30-10	10 mL
			CP-30-100	100 mL
Carboxyl-polystyrene	3.5-3.9	5.0	CP-35-10	10 mL
			CP-35-100	100 mL
Carboxyl-polystyrene	4.0-4.4	5.0	CP-40-10	10 mL
			CP-40-100	100 mL
Carboxyl-polystyrene	4.5-4.9	5.0	CP-45-10	10 mL
			CP-45-100	100 mL
Carboxyl-polystyrene	5.0-5.9	5.0	CP-50-10	10 mL
			CP-50-100	100 mL
Carboxyl-polystyrene	6.0-8.0	5.0	CP-60-10	10 mL
			CP-60-100	100 mL

The washing of polystyrene particles to remove unbound proteins or ligands during coating is accomplished by centrifugation or cross flow filtration for particles with size of 0.4 μm or larger. For smaller size particles gel filtration or other means of washing should be used. The choice of particle size and type is dependent upon the intended application. For example, particles with size of 0.4 to 2.0 μm are suitable for latex agglutination assay, solid phase enzyme immunoassay or solid phase fluorescence immunoassay, while particles with size of 2.0 μm or larger are preferred for flow cytometry applications.

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SPHERO™ Amino Polystyrene

Particle Type and Surface	Size, μm	% w/v	Catalog No.	Unit
Amino-polystyrene	0.2-0.3	2.5	AP-025-10	10 mL
			AP-025-100	100 mL
Amino-polystyrene	0.4-0.6	5.0	AP-05-10	10 mL
Amino-polystyrene	0.7-0.9	5.0	AP-08-10	10 mL
			AP-08-100	100 mL
Amino-polystyrene	1.0-1.4	5.0	AP-10-10	10 mL
			AP-10-100	100 mL
Amino-polystyrene	2.0-2.49	5.0	AP-20-10	10 mL
			AP-20-100	100 mL
Amino-polystyrene	2.5-2.9	5.0	AP-25-10	10 mL
			AP-25-100	100 mL
Amino-polystyrene	3.0-3.4	5.0	AP-30-10	10 mL
			AP-30-100	100 mL
Amino-polystyrene	3.5-3.9	5.0	AP-35-10	10 mL
			AP-35-100	100 mL
Amino-polystyrene	6.0-8.0	5.0	AP-60-10	10 mL
			AP-60-100	100 mL
Amino-polystyrene	8.0-12.9	1.0	AP-100-10	10 mL

SPHERO™ Dimethylamino Polystyrene

Particle Type and Surface	Size, μm	% w/v	Catalog No.	Unit
Dimethylamino-polystyrene	0.7-0.9	5.0	DP-08-10	10 mL
			DP-08-100	100 mL

SPHERO™ Hydroxy Polystyrene

Particle Type and Surface	Size, μm	% w/v	Catalog No.	Unit
Hydroxy-polystyrene	0.7-0.9	5.0	HP-08-10	10 mL
			HP-08-100	100 mL

SPHERO™ Sulfonate Polystyrene

Particle Type and Surface	Size, μm	% w/v	Catalog No.	Unit
Sulfonate-polystyrene	0.7-0.9	5.0	SP-08-10	10 mL
			SP-08-100	100 mL

SPHERO™ Epoxy Polystyrene

Particle Type and Surface	Size, μm	% w/v	Catalog No.	Unit
Epoxy-polystyrene	3.0-3.4	5.0	EPX-30-5	5 mL
Epoxy-polystyrene	5.0-5.9	5.0	EPX-50-5	5 mL
Epoxy-polystyrene	7.0-7.9	5.0	EPX-70-5	5 mL
Epoxy-polystyrene	18.0-22.9	2.5	EPX-200-5	5 mL

3. SPHERO™ Cross-linked Polystyrene Particles

Particle Type and Surface	Size, μm	% w/v	Catalog No.	Unit
Polystyrene, Cross-linked, non-uniform shape	0.4-0.6	5.0	PPX-05-10	10 mL
Polystyrene, Cross-linked, non-uniform shape	0.7-0.9	5.0	PPX-08-10	100 mL
Polystyrene, Cross-linked, non-uniform shape	1.0-1.4	5.0	PPX-10-10	10 mL
Polystyrene, Cross-linked, non-uniform shape	2.0-2.4	5.0	PPX-20-10	10 mL
Polystyrene, Cross-linked, non-uniform shape	2.5-2.9	5.0	PPX-25-10	10 mL
Polystyrene, Cross-linked	5.0-5.9	5.0	PPX-50-10	10 mL
Polystyrene, Cross-linked	8.0-12.9	2.5	PPX-100-10	10 mL
Polystyrene, Cross-linked	13.0-17.9	2.5	PPX-150-10	10 mL
Polystyrene, Cross-linked	24.0-30.0	2.5	PPX-250-10	10 mL
Polystyrene, Cross-linked, Research Grade	38.0-44.0	5.0	PPX-400-10	10 mL
Polystyrene, Cross-linked, Research Grade	53.0-62.0	5.0	PPX-600-10	10 mL
Polystyrene, Cross-linked, Research Grade	90.0-105.0	5.0	PPX-1000-10	10 mL
Polystyrene, Cross-linked, Research Grade,	125.0-149.0	5.0	PPX-1400-10	10 mL
Polystyrene, Cross-linked, Research Grade	212.0-249.0	5.0	PPX-2200-10	10 mL

Spherotech offers a wide range of cross-linked polystyrene particles. Both non-uniform and uniform shape cross-linked polystyrene particles are manufactured at Spherotech. The low cost non-uniform particles are useful when particle shape does not matter. These non-uniform cross-linked polystyrene particles are stable in the presence of organic solvents.

If perfect spherical monosized polymer particles are needed Spherotech also has cross-linked polystyrene particles that are uniform in size and shape. However, these particles are not stable in the presence of organic solvents.

SPHERO™ Functionalized Cross-linked Polystyrene

Particle Type and Surface	Size, μm	% w/v	Catalog No.	Unit
Carboxyl-polystyrene, Cross-linked	3.0-3.4	5.0	CPX-30-10	10 mL
Carboxyl-polystyrene, Cross-linked	5.0-5.9	2.5	CPX-50-10	10 mL
Carboxyl-polystyrene, Cross-linked	6.0-7.9	2.5	CPX-60-10	10 mL
Carboxyl-polystyrene, Cross-linked	8.0-12.9	2.5	CPX-100-10	10 mL
Carboxyl-polystyrene, Cross-linked	13.0-17.9	2.5	CPX-150-10	10 mL
Amino-polystyrene, Cross-linked	2.0-2.9	1.0	APX-20-10	10 mL
Amino-polystyrene, Cross-linked	3.0-3.4	2.5	APX-30-10	10 mL
Amino-polystyrene, Cross-linked	6.0-6.9	2.5	APX-60-10	10 mL

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