

Measuring polydispersity of bowl-shaped particles

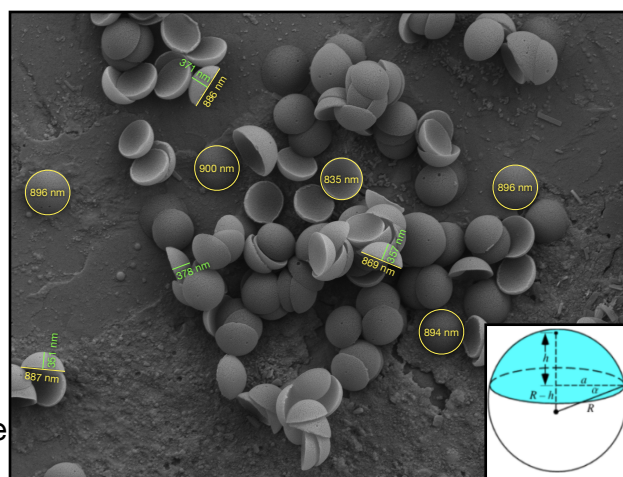
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Summary

In an effort to quantitatively compare the size polydispersity of particles made using a scaled-up 1 L batch with a smaller and more typical 5 mL batch, we used micrographs acquired using a scanning electron microscope (SEM) to manually measure particle dimensions. On the right is one such micrograph, from our scaled-up 1 L batch, with the dimensions of a few particles drawn as an example. The particle shape was modeled as a spherical cap of base radius a and height h , as shown in the figure's inset.

Of course, this method has inherent limitations such as pixel-biasing and being limited to measuring only particles that are preferentially oriented with the imaging plane, like the examples shown here.

Despite these limitations, by measuring a reasonably representative large enough quantity of particles in this way, we have produced an estimate of their mean size (base radius and height), and polydispersity index (PDI), which is defined as the standard deviation of the particle radii distribution divided by the mean particle radius. For the scaled-up batch of particles, we were able to precisely measure 229 particle radii (a) and the heights (h) of 33, while for the smaller 5 mL batch we measured 211 particle radii and 33 of their heights. We compared these dimensions and their resulting PDI to the corresponding measurements of the seed particles, polystyrene (PS) microspheres, that the bowl-shaped particles were fabricated from.



Measuring dispersity of bowl-shaped particles.

SEM micrograph of polystyrene bowl-shaped particles, with demonstrative outlines of diameter (yellow) and height (green) measurements. Inset: schematic of particle geometry and dimensions. The Zeiss Merlin FESEM used in this study was acquired through the support of the NSF under Award Number DMR-0923251.

Results

Small (5 mL) batch: based on 211 particle radii and 33 particle heights, we measure a PDI of 0.048 and 0.061, respectively. The mean particle diameter is 2.0 μm with a mean height of 676 nm. The seed particles, polystyrene microspheres from Thermo Scientific™, from which these particles were fabricated are quoted to have a PDI of ≤ 0.030 and a mean diameter of 1 μm .

Electronic Supplementary Information (ESI) for *Soft Matter*

Large (1 L) batch: based on 229 particle radii and 33 particle heights, we measure a PDI of 0.065 and 0.088, respectively. The mean particle diameter is 881 nm with a mean height of 375 nm. The seed particles, polystyrene microspheres synthesized in our lab, from which these particles were fabricated have a PDI of ≤ 0.066 and a mean diameter of 560 nm, as measured by dynamic light scattering (Zetasizer Nano ZS, Malvern Instruments).

Batch size	Mean diameter (μm)	Diameter PDI	Median diameter (μm)	Mean height (μm)	Median height (μm)	Height PDI
5 mL "small"	2.01	0.048	2.00	0.68	0.68	0.061
1 L "large"	0.88	0.065	0.87	0.38	0.37	0.088