Cambridge Polymer Group, INC.
Consultation, Testing, and Instrumentation for Polymeric Materials

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# Application note for swelling microsphere measurements

To estimate the swelling rates and final swelling ratio of extremely small polymeric samples (such as microspheres), CPG has developed a device capable of tracking dimensional changes on the microscale following introduction of a solvent. The difficulties associated with tracking dynamic dimensional changes in neutrally buoyant particles is non-trivial, but has been elegantly solved at CPG. Figure 1 shows a polydisperse image of dry microspheres.

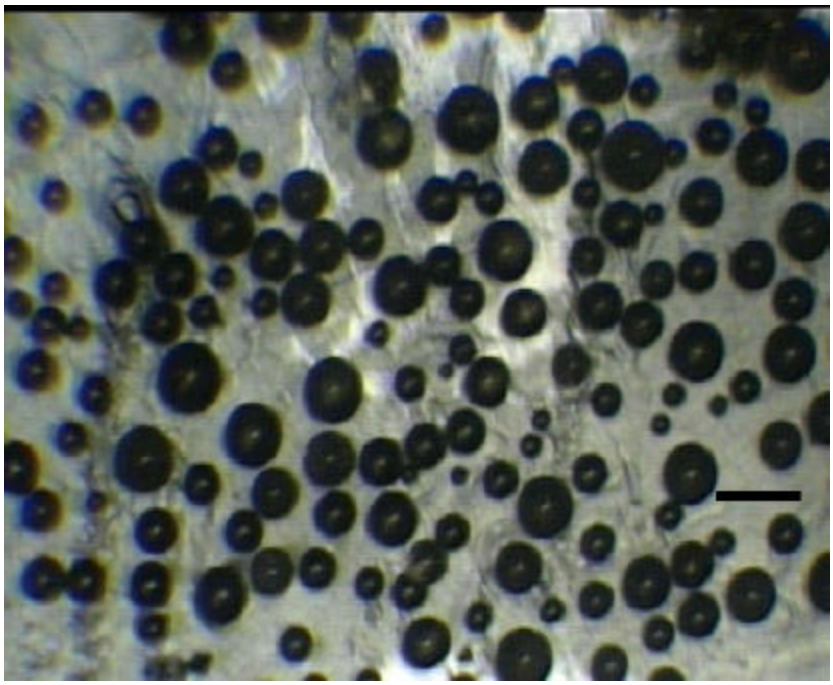

**Figure 1:** A dry sample of polydisperse spherical beads 40 to 180 microns in diameter. Bar is 200 microns

To measure the swell-ratio of these spheres during and after solvation, the samples are placed into a device that allows video microscope access and solvent entry while preserving the view of the particles (Figure 2). A microscope video camera is used to track the swelling dynamics following addition of solvent to the chamber.

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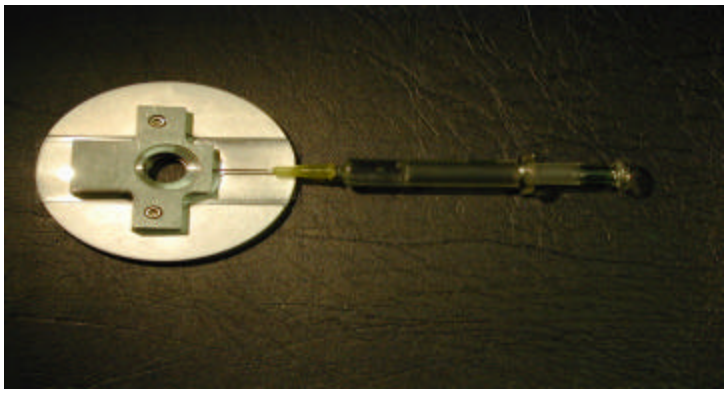

**Figure 2:** Swelling ratio chamber allows microscope access and rapid solvent changes

Swell ratio calculation: Frames from the beginning of the video sequence (prior to the addition of the solvent) and at the end of the swelling procedure can be extracted and imported to a suitable image processing program where precise measurements of the initial and final bead diameters can be made (See Figures 3 and 4).

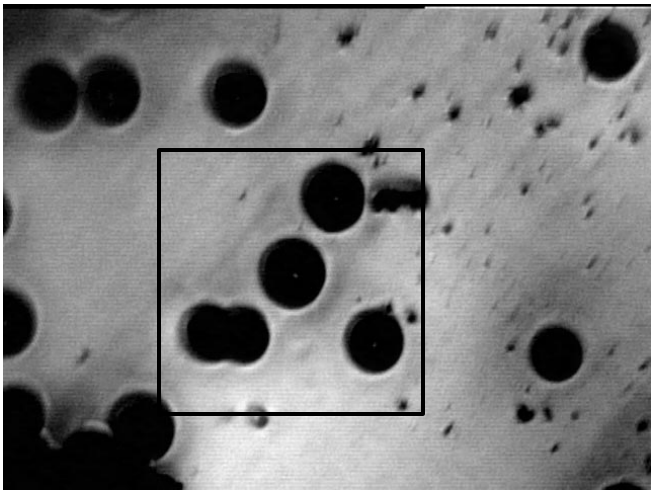

**Figure 3.** Microspheres prior to swelling. Box is a typical region for examination

 

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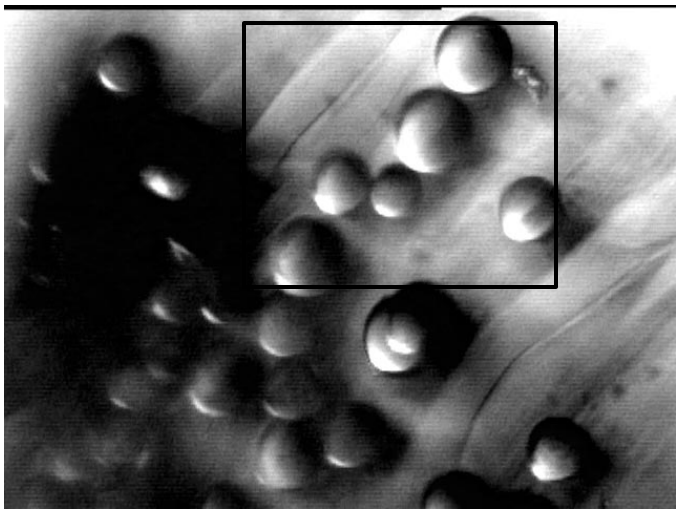

**Figure 4**. Microspheres at the end of the swelling experiment. The beads are now swollen maximally as indicated by the cessation of swelling shown by video.

The swelling ratio $q$ can be calculated by dividing the final swollen diameter cubed by the initial diameter cubed, or

$$q = \left( \frac{D_f}{D_0} \right)^3$$

Using video capture software and image processing, it is possible to capture the dynamics of the swelling response of the beads (Figure 5).

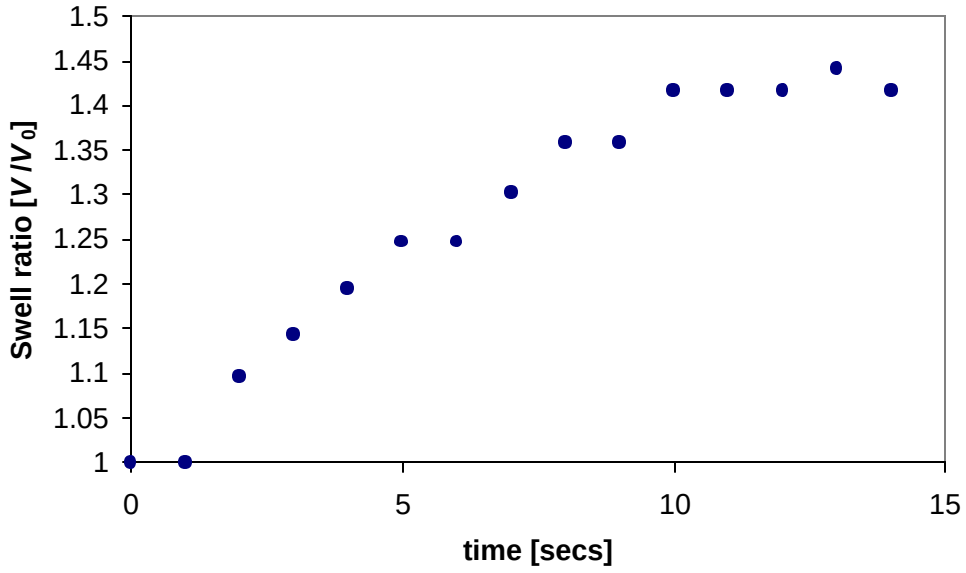


**Figure 5**: Dynamic swell ratio of microspheres as a function of exposure time to solvent.

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Applications of Swelling System

The swelling behavior of polymeric microspheres is of interest to a variety of industries. In drug release systems, the swelling kinetics can dictate the rate of drug release, dependent on pH, ionic strength of solution, or solution temperature. Swelling behavior is useful for examining materials used in superabsorbancy research , with both aqueous and organic solvents.

 