AEC-NASA TECH BRIEF

Method Accurately Measures Mean Particle Diameters of Monodisperse Polystyrene Latexes

The problem:

To perform a primary calibration of particle sizes of monodisperse polystyrene latexes in a manner more accurate than calibration by electron microscopy to provide size standards for electronic particle counters.

Diameter measurements obtained by electron microscopy are distorted, producing diameter values larger than actual particle diameters. The particles soften and flatten out in the electron beam. Collodion gratings (for calibration of the electron microscope during preparation of mounts) are also distorted.

The solution:

A photomicrographic method for accurately determining arithmetic average (mean) particle diameters. Many diameters are measured simultaneously by measuring row lengths of the particles arranged in a two-dimensional triangular array at a glass–oil interface.

Several factors leading to particle size distortion are prevented. No distortion due to attractive forces between the particles occurs since the particles do not aggregate in the oil. No distortion due to attraction of surface tension forces between the particles and the glass surface occurs since the particles are easily dislodged from the glass interface by gentle rotation of the coverslip. The particles are not softened and flattened, since an electron beam is not used.

The data are then corrected for geometric distortion. Cracks in a particle array are easily detected by comparing mean diameters determined along different directions in the array.

How it's done:

Approximately 5 ml of polystyrene latex is mixed with a drop of immersion oil on a microscope slide. The slide is examined by phase microscopy. When a single layered (two-dimensional) triangular array is found, the photographic magnification is determined by calibration of the microscopy with a calibrated machine screw and two collodion replica gratings. The array is photographed at the largest magnification; fine grained 35-mm film is used. The positive print is measured with a vernier caliper.

The following statistics are then determined from the array:

1. $\bar{x}$ (apparent mean particle diameter)
2. $CV_{\bar{x}}$ (coefficient of variation for apparent particle diameter)
3. $\Delta\bar{x}$ (computed overestimate of particle diameter)
4. D (corrected mean diameter)

D is determined either from a weighted average of D values for each array or from the least squares value of $\bar{x}$ by using the mean value of CV weighted over all the latex arrays to determine $\Delta\bar{x}$ ($D = \bar{x} - \Delta\bar{x}$). The least squares method is preferred because independent error in numerical determination of the array coefficient is explicitly included.

Notes:

1. Monodisperse polystyrene latexes are the only accurate secondary standards available for calibration of electronic counters that are used to measure micron-size particles.
2. The photomicrographic method is applicable to particles in two-dimensional arrays of three-dimensional lattices.
3. Photographs taken 1 year after formation of arrays showed no apparent changes in the arrays. The particles had not further aggregated or clumped in the oil.
4. Additional details are contained in *Ultrafine Particles*, Editor in Chief: W. E. Kuhn, New York, Wiley 1963

(continued overleaf)

5. Inquiries concerning this innovation may be directed to:

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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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