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How can I get accurate particle size measurements when I have mixtures of large and small nanoparticles?

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Nanoparticles are used in diverse applications that include food packaging, drug delivery, stain-repellent fabrics, and sunscreens. It is important to be able to accurately measure the sizes of these particles because in many cases, the sizes and their distribution affect the behavior of the nanoscale particles. When a population of small particles exists in a population of larger particles, the light scattering techniques that are typically used to determine particle size often produce incorrect measurements. Frequently, the presence of a few large particles can scatter too much light, hiding the presence of the small particles.

When you have multiple nanosize particle populations, you need a better measurement technique. The Agilent 7010 Particle Size Spectrophotometer is based on UV-visible absorption rather than light scattering, and it delivers accurate results for these complex samples.

Correct determination of multiple sets of particle sizes

Suspensions of gold nanoparticles (colloidal gold) provide an interesting test case. These suspensions were used in ancient times to produce red stained-glass windows, and gold nanoparticles are currently being explored for a variety of uses, from medical applications to coloring of wool fibers. The size of the gold nanoparticles affects the properties, so you need to be able to measure the particle sizes accurately, even when there are multimodal size distributions.

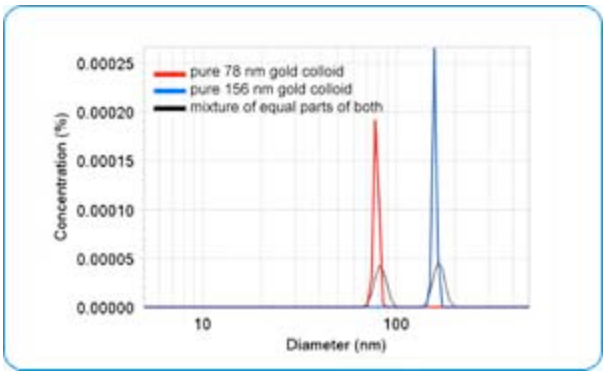

Figure 1. The Agilent 7010 accurately measures size and concentration of this bimodal distribution of particle sizes. (Click here to see this image larger.)

To show how the Agilent 7010 meets this challenge, we measured colloidal gold of nominal 80 nm diameter and nominal 150 nm diameter. First, we measured these colloids separately with the Agilent 7010. The 80 nm colloidal gold was measured to be 78 nm in diameter at a concentration of 0.000322% by volume (red line, **Figure 1**) and the 150 nm colloid was determined to be 156 nm in diameter at a concentration of 0.000344% (blue line, **Figure 1**).

These colloids were then mixed in a 1:1 ratio by volume. The black line in Figure 1 shows the particle size distribution of the mixture of the two dispersions of gold standards. The spectral fitting algorithm clearly broadens the peaks in the case of the mixture, as compared with the measurements of monodisperse particles. However, the particle size measurement correctly shows the nearly 1:1 relationship in concentration of the two peaks. In fact, integration of the peaks reveals that the relative concentration of the two modes is 48% 78 nm and 52% 156 nm gold – exactly the expected ratio.

The concentration of the mixed sample was measured as 0.000331% – a difference of less than 1% from the expected value. So in addition to the detection of the two size populations, the instrument correctly determined the relative amounts of the two modes and the correct total particle concentration on a volume percent basis.

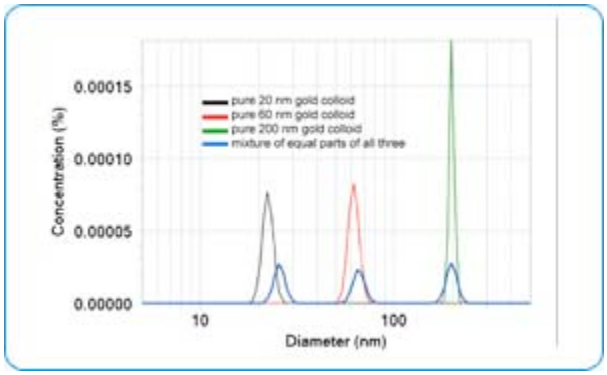

Figure 2. The Agilent 7010 also provides accurate results for this trimodal distribution of particle sizes. (Click here to see this image larger.)

For more challenging applications, the Agilent 7010 has the capability to detect more than two size populations. **Figure 2** shows in blue the particle size distribution for a mixture of equal parts monodisperse 20 nm, 60 nm, and 200 nm gold particles. For comparison, the particle size distributions for 20 nm gold alone (black), 60 nm gold alone (red), and 200 nm gold alone (green) are also shown.

Measure multiple size populations with confidence

The Agilent 7010, using its built-in UV-visible spectrophotometer, offers distinct advantages over existing techniques for critical size measurements of nanoscale particles. As shown in a recent Application Note, the Agilent 7010 can measure bimodal particle size distributions with a size difference as close as 1:1.5 while maintaining accuracy in both the size of the particles *and* the relative concentrations of the modes. It can detect secondary populations when they are as low in concentration as 5% by volume.

If you are faced with the challenge of measuring nanoparticles that have a mixture of sizes, consider the Agilent 7010. Visit our product page to review more information about the technology used in this instrument.