# Gold and Silver Coated Nano Particles

## Characterising coating thickness for nano-scale drug delivery

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There is much research currently being carried out regarding the therapeutic benefits of using coated metal particles as nano-scale drug delivery systems. The use of nano-delivery systems to target tumours during chemotherapy is receiving particular attention namely due to their ability to efficiently penetrate tumours and eliminate them in a single treatment. Higher drug doses are able to be delivered to tumours due to the increased number of pores found in the blood vessels supplying them. This allows the nano-scale drug to enter and accumulate easily; making the drug more effective and reducing the side effects associated with systematic chemotherapy.

The coated nano-particles utilised as drug delivery vehicles are typically gold and silver based. It has always been difficult to characterise these coated particles and see the difference in size between the coated and uncoated core material using traditional light scattering techniques for particle sizing. Using the technique of Differential Centrifugal Sedimentation (DCS), peaks in particle size distributions for both the coated and uncoated particles can easily be separated and resolved; making this technique an ideal characterisation tool, enabling coating thickness to be measured and the coating process monitored.

When the core metal particle is coated, its bulk density is very much reduced and hence the coated particles will sediment slower than the core material when injected into the same solvent gradient in the rotating disc. Using the same density value as the core material in the instrument software causes the peak for the coated material to appear at a smaller particle size since it has taken these particles longer to sediment and pass the light source detector. Initially, the particle size peak of the coated material appears oddly positioned but can simply be corrected by recalculating data using the correct density for that coated material.

The following charts show particle size distributions measured on a gold core with and without polymer coating material. The shell thickness of the coating was calculated to be 3.5nm. This example shows two clearly resolved peaks, one at 13.2nm for the gold core particles and another at 10.8nm for the polymer coated gold particles. The DCS technique can be used to follow their reaction to completion, gain better understanding of the coating process and easily determine when the gold core has been fully coated.

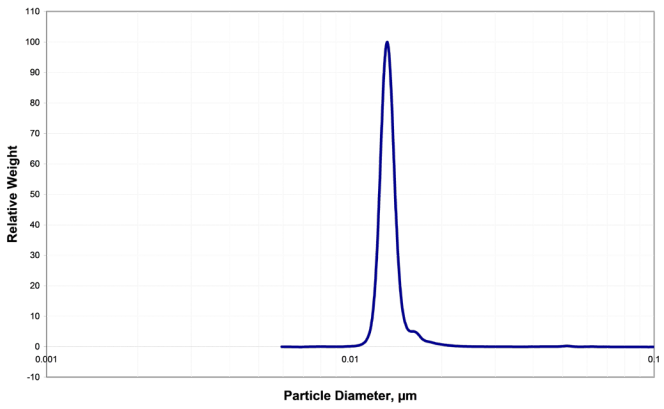


**Fig.1**

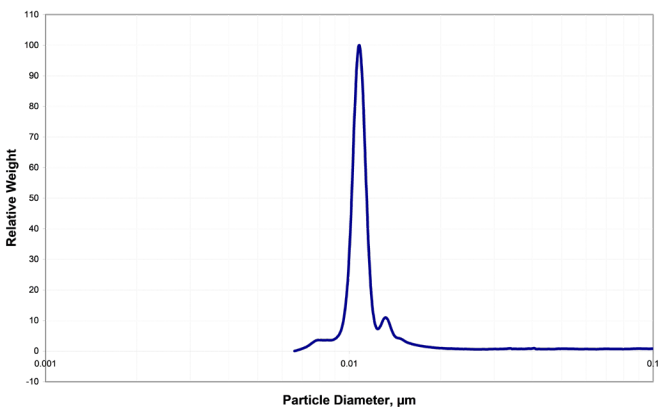


**Fig.2**

The main benefit of the DCS technique is that due to the density difference both peaks can be clearly resolved for core and coated metal particles and positions of their mean particle size, together with the density of the core and coating material can be actually used to accurately calculate the thickness of the coating/shell applied. No other commonly used particle sizing technique is able to achieve this since they are unable to resolve the two peaks. For example, with light scattering methods only a single broad peak would be seen that would have a maximum peak size indicative of the average of the mixture of core and coated particles sizes.

**An Introduction to Differential Centrifugal Sedimentation**

Differential Centrifugal Sedimentation (DCS) is an innovative, yet simple technique that has been 'reborn' in recent years. Previous limitations and difficulties with the technique of sedimentation have been overcome with advances in technology and some smart thinking regarding instrumentation and disc design. DCS is now a powerful tool in measuring nano particle size distributions down to around 3nm.


**Fig.3**

With the unique ability to resolve very close multi-modal particle distributions, even within 2%, and to distinguish extremely small shifts and changes in particle size, DCS is once more becoming a valuable particle characterisation tool. The term 'high resolution' is a commonly used expression in the world of particle sizing, however DCS really does achieve unparalleled resolution as can be seen when used in characterisation of nano particle coatings covered earlier in this article. Practical range of the technique is from around 3nm right up to 80micron (exact range will be dependent on density), however the real benefits over and above more traditional so-called nano particle sizing techniques are generally noticed below around 300nm.

These days, DCS has become fast, very simple to use, is highly accurate and reproducible. It can measure up to 40 samples on the same 'run', does 'speed ramping' for measurement of broad distributions in a single sample, and can even measure 'buoyant' or 'neutral density' particles (i.e. particles having a lower density to the medium in which they are dispersed). Due to the high resolution achievable DCS is ideal for resolving aggregates and agglomerates and to observe tiny relative shifts in peaks and tails of particle size distributions. It may also be used to measure absolute particle size too; however density of particle material must be known. It can even be used for quantitative measurements if optical property (refractive index) of the particulate is known. Number or weight distributions can also be easily calculated and displayed.

**Want to find out more?**

To learn more about high-resolution particle size characterisation using the UHR CPS Disc Centrifuge visit **analytik.co.uk/cps** (UK and Ireland) or visit **cpsinstruments.eu**.