LAWSON SCIENTIFIC

Application Note

Nano-scopic Visualization

Introduction

The analysis of nanoparticles is a ubiquitous requirement in a broad range of industry sectors. Product performance and stability frequently depends on the ability to manufacture particle suspensions to fine tolerances without the presence of contaminants or aggregates. Foremost in such analyses is particle size and size distribution measurement for which a number of techniques are well established and commonly employed in routine quality control as well as in a research and development environment. For particles in the deeply sub-micro region however, only electron microscopy and dynamic light scattering are used frequently.

Both have drawbacks including capital and running costs, analysis turnaround time, and limited ability to resolve particle size distribution profiles. The HALO LM10 is a characterization tool specifically designed for visualisation of nanoparticles in liquids using only a conventional optical microscope (see figure 1).

Figure 1: HALO LM10™ nano particle Viewing Module

Methodology

The HALO system consists of HALO LM10™ viewing module, HALO 2.0 Analytical Software Suite, microscope and CCD camera. A sample is diluted in a suitable diluent, such as water, and 5ml is loaded into the HALO™ LM10™ for immediate viewing/analysis. The dedicated HALO™ 2.0 software suite allows the user to automatically count and size the nano-particles on an individual basis. Results are displayed as a graph of size against count of individual particles, overcoming the limitations inherent in other particle analysis systems generating only mean particle size data with limited distribution information.

Particle Size Distribution

Image analysis provides particle sizing through scattering intensity and through measurement of Brownian motion. Distributions from these two independent methodologies correlate well. These results come from measurement of individual particles, avoiding the averaging assumptions inherent from photon correlation spectroscopy.

One of the specific advantages offered by the technique described here is the ability to identify, track and analyse small particles even when they are present in heterogeneous samples containing high numbers of larger particles.

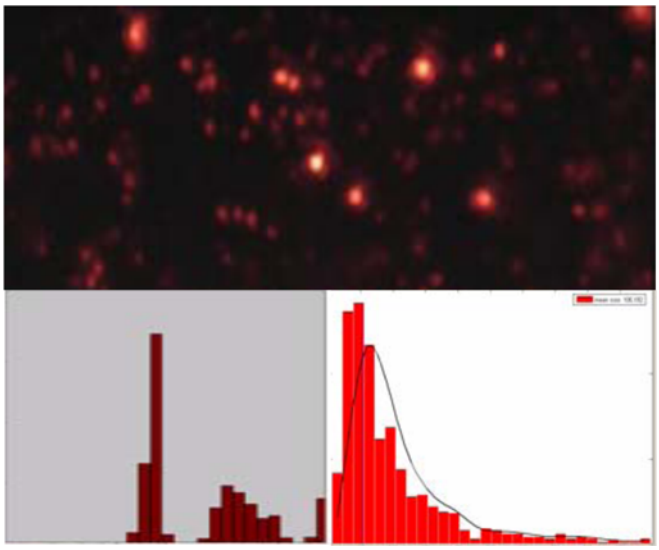


Figure 2: Particle size distributions obtained from a video (a) of a suspension of 100nm particles containing a low number of 200nm particles when analysed by: b) PCS and by c) the Halo Single Particle Tracking system.

Figure 2 shows a comparison between the results of a 5 second analysis of a suspension of 100nm polystyrene latex micro-spheres containing a low number of 200nm particles (Fig 2a). It can be seen that analysis by PCS generates a particle size distribution profile (Fig 2b) that, through the intensity bias of the technique, can over-estimate the concentration of larger particles present though this can be adjusted for. The Halo system also shows the presence of the 200nm particles (Fig 2c) but

which more accurately reflects their true concentration. Similarly, it should be noted that the Halo system allows the number of particles of any given size that were seen during the analysis to be counted directly representing an advantage over conventional PCS which cannot generate such information.

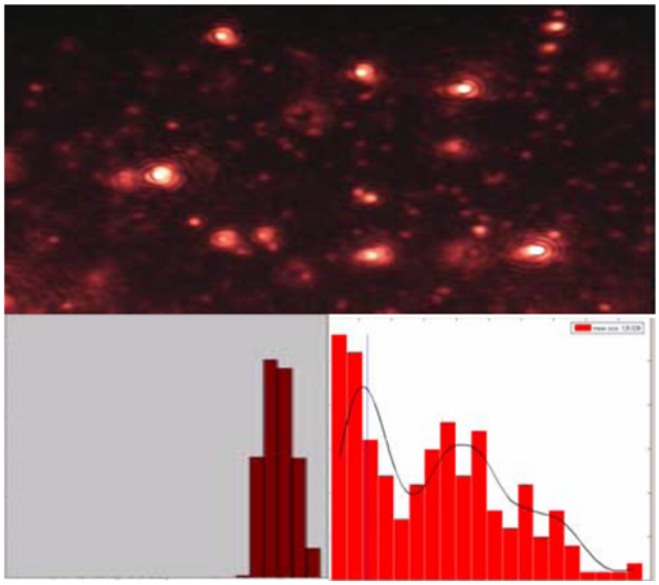
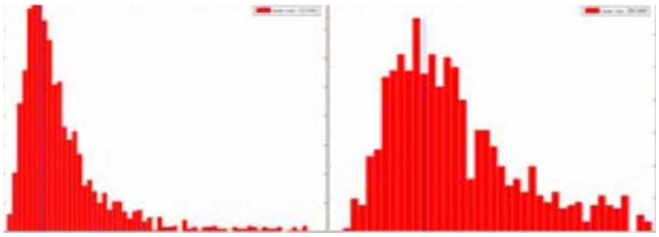


Figure 3: Particle size distributions obtained from a video (a) of a suspension of 100nm particles containing several larger 400nm particles when analysed by: b) PCS and by c) the Halo Single Particle Tracking system

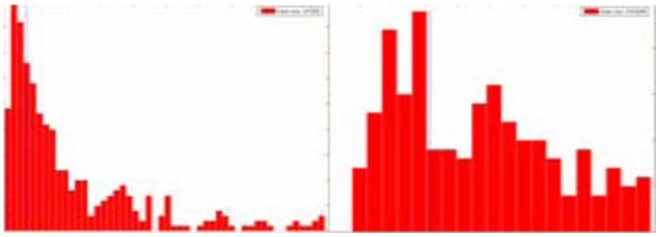
In figure 3 can be seen the benefit of being able to analyse particles for size by Brownian motion but without relying on an intensity weighted average of a large ensemble of particles as per PCS. In this case a suspension of 100nm particles was spiked with a low number of 400nm particles and analysed conventionally by PCS and for 5 seconds by Halo. While the peak associated with the 400nm particles is less well defined in Halo (Fig 3c) as a consequence of the short analysis time and more complex scattering profile of the larger particles (as can be seen in the video still of the suspension (Fig 3a)), the signal generated by PCS from the larger particles effectively obscures that generated by the smaller particles leading to loss of data relating to the smaller particle peak (as marked in Fig 3b).

Examples

Examples of materials analysed by this method include; viruses (adenovirus, herpes, λ phage), a wide range of pigments in inks and paints (e.g. TiO_2), ferritin molecules, metal oxides (in magnetic storage media), precursor chemicals for wafer fabrication, multi-walled carbon nanotubes, fuel additives (ZnO_2), cosmetics and healthcare products (cream and shampoo formulations), foodstuffs (microemulsions), ceramics, quantum dots and polymers and colloids of many different types.



Purple paint pigment 8nm Ag colloid



λ phage CsCl purified Fabric conditioner

Conclusion

HALO provides a new view of the nano-world. The single particle tracking analysis system described allows deeply sub-micron particles to be individually visualised (but not imaged) in liquids and from which high resolution particle size distribution profiles can be obtained.

References

All data and images are taken from:

- B. Carr, T. Diaper and E. Barrett, RSC, PSA 2005, UK, NanoParticle Tracking Analysis - The Halo™ system.
- NANOSIGHT LIMITED, (2005) Product specification and usage, www.nanosight.co.uk

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