

Bio Nanoparticle Sizing

Analysing growth in real-time with the CPS Disc Centrifuge

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Micro-organisms have the capability to carry out many useful metabolic functions. One recently identified capability, which has the possibility to revolutionise the way in which we make nanoparticles, is via bio-manufacturing, where bacteria offer a supporting surface on which to grow nanoparticles and also the means by which the nanoparticle growth is achieved, 'bottom up', under bio-control, using enzymatic reactions.

Electron Microscopy (EM) is very useful for visualising what has been made by the bacteria, but by its very nature EM can only provide retrospective 'snapshots' of dried cells in a vacuum. An EM of a cell 'decorated' with palladium (Fig1 A) or gold (Fig1 B) nanoparticles shows that the metallic particles are approximately the same size, but we cannot tell if the electron opaque deposits on the cell surface are agglomerations of small particles or simply larger particles grown from individual small seeds.

For applications in catalysis, for example in hydrogenations ('Bio-Pd(0)')¹, oxidations ('Bio-Au(0)')² or fuel cells ('Bio-Pt(0)')³, the nanoparticle size is critical. First tests using the disc centrifuge have indicated that small inter-batch variations in the nanoparticle population are revealed (Fig. 2) that could have an effect on the activity of the preparation.

The disc centrifuge is vital to help us to visualise these small differences in preparations, which look identical by electron microscopy. Are these differences due to small unknown differences in the metabolism of the nanoparticle-synthesising cells or to one batch simply being slightly more active and becoming 'overgrown' during the incubation period? Unlike other methods, the disc centrifuge analysis is very rapid so that it is possible to take samples in real-time during nanoparticle growth. This means that we can follow the progression of the size distribution and also be able to know the right time to harvest for a particular bacterial cell type, nanoparticle and desired application.

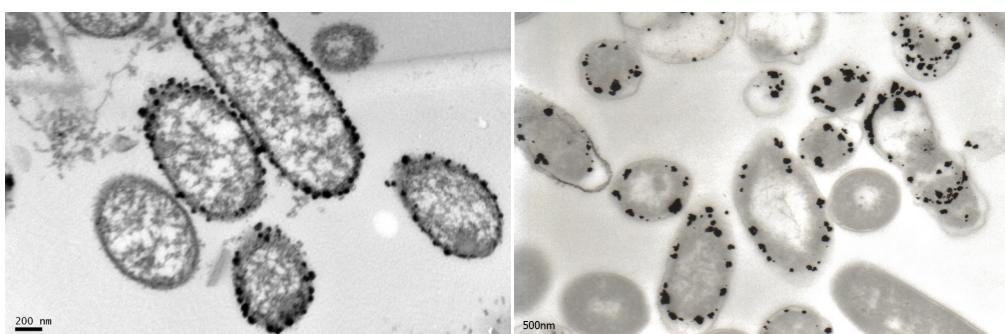


Fig.1 - TEM micrographs of *E. coli* cells treated with (A) palladium (II) and (B) gold (III) salts showing electron opaque metallic nanoparticles on the cell surface.

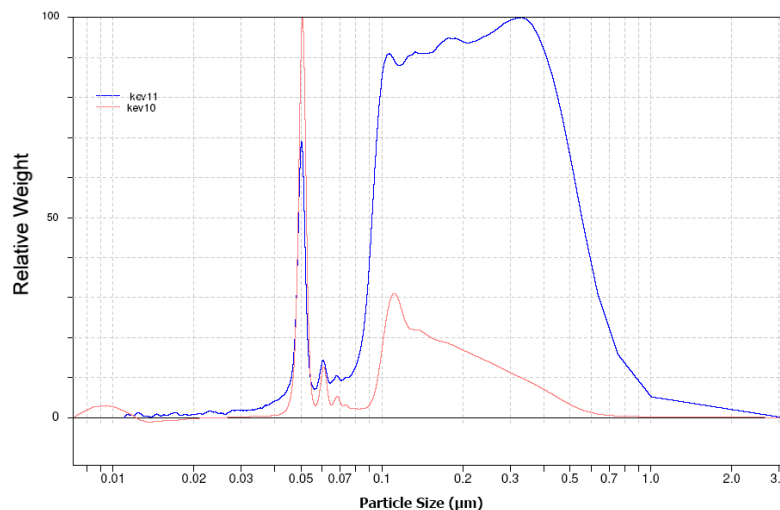


Fig.2 - Size distributions of nanoparticles made by a two bacterial cultures carrying metallic nanoparticles that appear to be identical by electron microscopy.
Note differences (arrowed).

References:

1. Novel supported Pd hydrogenation bionanocatalyst for hybrid homogeneous/heterogeneous catalysis. N. J. Creamer, I. P. Mikheenko, P. Yong, K. Deplanche, D. Sanyahumbi, J. Wood, K. Pollmann, M. Merroun, S. Selenska-Pobell and L. E. Macaskie (2007), *Catal. Today*, 128(1-2), 80-87.
2. Biorecovery of gold from jewellery wastes by *Desulfovibrio desulfuricans* and *Escherichia coli* and biomanufacture of active Au-nanomaterial. K. Deplanche, G. A. Attard and L. E. Macaskie (2007), *Adv. Mater. Res.*, 20-21, 647-650.
3. From bio-mineralisation to fuel cells: biomanufacture of Pt and Pd nanocrystals for fuel cell electrode catalyst. P. Yong, M. Paterson-Beedle, I. P. Mikheenko and L. E. Macaskie (2007), *Biotechnol. Lett.*, 29(4), 539-544.

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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.