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Messing, Maria; Svensson, Christian; Schollin, A; Deppert, Knut; Mueller, BO.; Pagels, Joakim; Rissler, Jenny; Bohgard, Mats; Linse, Sara; Cedervall, Tommy

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LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

Protein interactions with the surface of gold nanoparticles: possible means of determining particle toxicity

M. E. Messing, C. R. Svensson¹, A. Schollin², K. Deppert, B. O. Meuller, J. Pagels¹,
J. Rissler¹, M. Bohgard¹, S. Linse², and T. Cedervall²

Solid State Physics, Lund University, 221 00 Lund, Sweden
(corresponding author: M. E. Messing, e-mail: maria.messing@ftf.lth.se)

¹ *Ergonomics and Aerosol Technology, Lund University, 221 00 Lund, Sweden*

² *Biochemistry and Structural Biology, Lund University, 221 00 Lund, Sweden*

With the increasing amount of products and applications found in our everyday life based on nanoparticles, the concerns about possible adverse health effects of nanoparticles are being discussed intensively [1]. One of the major routes of exposure to nanoparticles is by inhalation of particles from air, leading to deposition in the respiratory tract. Many properties of nanometer-sized materials are different compared to bulk materials, and the effect of nanoparticles on biological systems is far from fully understood.

In recent years the nanoparticle interaction with biomolecules has been identified as one of the key parameters to understanding nanoparticle toxicology [2]. When biomolecules bind to the nanoparticle surface a dynamic protein/biomolecule corona is created [3]. This protein corona is dependent on the surface chemical properties, as well as the size and morphology of the particles. The protein corona is “read” by the biological system and of great relevance for the biological effects of nanoparticles.

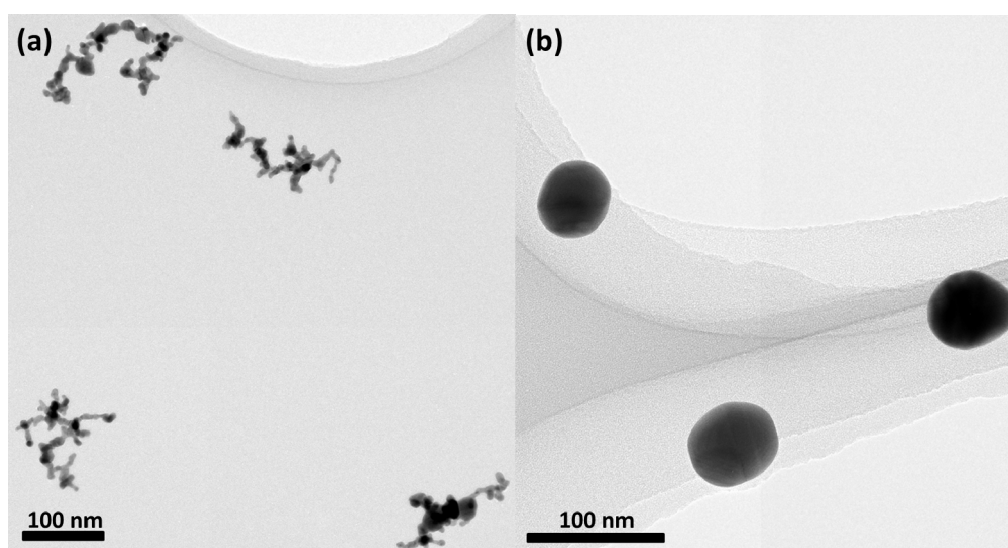


Figure 1. TEM micrographs of deposited (a) agglomerate and (b) compact gold nanoparticles.

In this work we present a method to investigate the composition of the biomolecule/protein corona formed on nanoparticles deposited into physiological fluids. Gold nanoparticles in the gas-phase were generated, and deposited, by aerosol methods [4] into bovine serum albumin (BSA), porcine serum, and porcine lung fluid. Particles with two different morphologies but the same mobility diameter, namely compact spherical particles and chainlike agglomerates (Figure 1), were generated and deposited. Before deposition the particles were thoroughly characterized on-line to determine their size, number concentration, and mass concentration [5]. Dynamic light scattering (DLS) was used to identify the particle-biomolecule complexes and the protein corona was investigated using sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE).

DLS data indicate that nanoparticle-biomolecule complexes did indeed form for gold particles deposited into BSA and furthermore that these complexes were stable over several days. Results from SDS-PAGE strongly indicate that the protein corona is different between agglomerates and compact spherical particles deposited into porcine blood plasma (Figure 2). The result also indicates that the corona is different between particles deposited into lung fluid and blood serum. These results clearly demonstrate the usefulness of the here described deposition method for investigating the protein corona and enhancing our knowledge of nanoparticle toxicity.

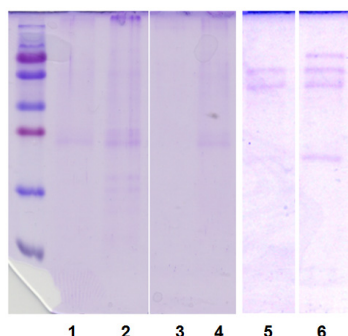


Figure 2. Results from SDS-PAGE for gold nanoparticles mixed with porcine blood. 1 and 2 show the corona signature for Au nanoparticles in full plasma and 10 times diluted, respectively. 3 and 4 show corona signature for agglomerates in full and 10 times diluted, respectively. Bands 5 and 6 show the background signature of 10 times diluted and full blood plasma.

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