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PATROLS
Advanced Tools for NanoSafety Testing

UNIVERSITY OF TRIESTE

"Silver nanoparticles 300K characterization in biological compartments for high and low exposure range"

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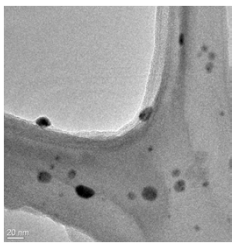
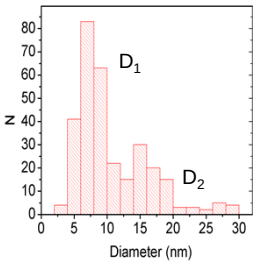
Project summary – Silver nanoparticles are well know for their very promising antibacterial properties, that are influenced by their size and silver ions amount realised in the environment or human media. Aggregation and dissolution ability of silver are the main driving forces that determine final antibacterial outcome. Nevertheless, concentration range can change size and ions release. All these contributes have to be evaluated for a full nanoparticles characterization within medium. For this reasons, the aim of this work is to characterize PATROLS Ag 300K NPs at high and low exposure concentration in water and in RPMI media, trying to mimic the behaviour at short and the long term exposure.

Size:





Ag NM 300K (Fraunhofer)

TEM Measurement:
$<D_1>$=7.3 nm
SD= 1.87 nm;

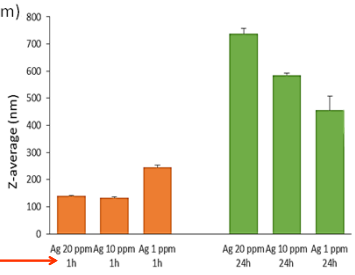
$<D_2>$=16.0 nm
SD= 2.8 nm

DLS Measurement: Comparison between MilliQ water and RPMI media.
Useful for high concentration range (20, 10 and 1 ppm)

Stock 256 ppm	DLS Size (nm)
Ag 300K in MilliQ water + 0.05% BSA 1h	123 ± 2

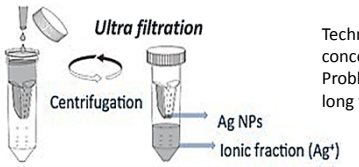
Exposure time: 1h and 24 h

Medium: RPMI



Dissolution:

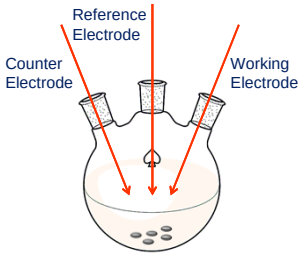
Ultra Filtration/ICP-OES



BENCHMARKING TECHNIQUE STATIC DISSOLUTION (ICP-OES)

Technique useful for high exposure range of concentration (20, 10 and 1 ppm).
Problem for low concentration range, that is used for long term exposure (20, 10 and 1 ppb).

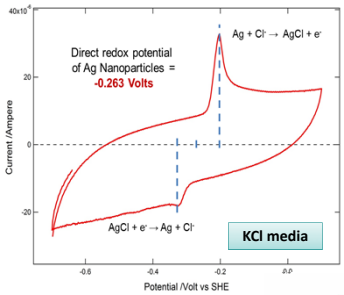
Electrochemical Measurements Setup

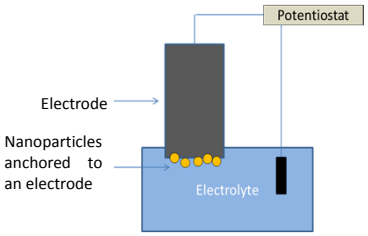


Check of the Ag behaviour in medium:
depending on medium composition, aggregation and precipitation can occur. This electrochemical technique could easy check the presence of solved Ag^+ ions in water, but completely lost the signal in chloride rich medium. For this reason it could be a promising setup for a first check of the nanoparticles behaviour in medium for high concentration range (ppm range).

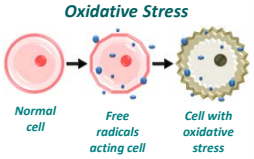
Redox Activity:

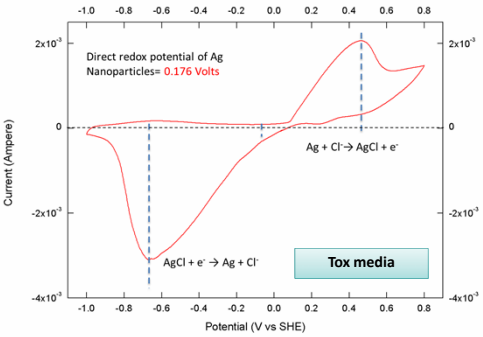
It says if a NP is redox active or not. Sweeping the voltage applied to an electrode loaded with nanoparticles gives the redox levels of the nanoparticle.





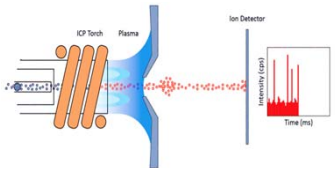
We used this method to investigate the electrochemical behavior of nanoparticles and calculate their direct redox potential in exposure media (tox media).

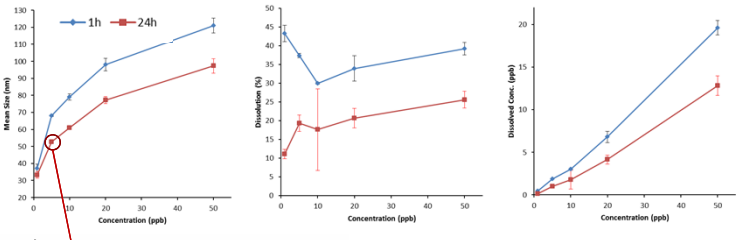


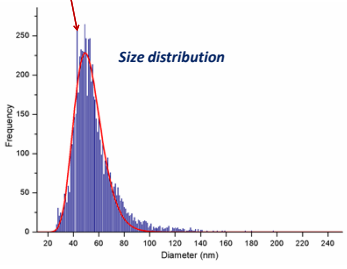


Single Particle ICP-MS:

Collected info:
- Dissolved fraction (ppb)
- NPs Dimension (nm)
- NPs Number (part/mL)







Analyzing data of size of Ag NM 300K, one important result is that, the estimated NPs size decreases, as expected, by decreasing concentration, approaching TEM size (< 20nnm) for very low concentration (below 5ppb). If we look to dissolution both expressed as percentage over sample nominal concentration or as total Ag+ concentration we observe for all media that under this very low range of concentration, samples follow a dissolution of first order and did not reach the solubility limit.

Finally, if we compare trend after 1h and 24h of exposure we observe that after 24h there is a decrease of particle size corresponding to a decrease of dissolution, this apparently contrasting behavior can be explained considering a re-nucleation phenomenon that most likely occur during the 24h of exposure.

Collected at USC (Smart State Center for Environmental Nanoscience and Risk-CENR, Arnold School of Public Health, University of South Carolina, Columbia, South Carolina, USA) facilities using SP-ICP-MS Perkin Elmer NexION 350D.

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