Sebastian Kuehr, Kuria Ndungu, Anastasia Georgantzopoulou

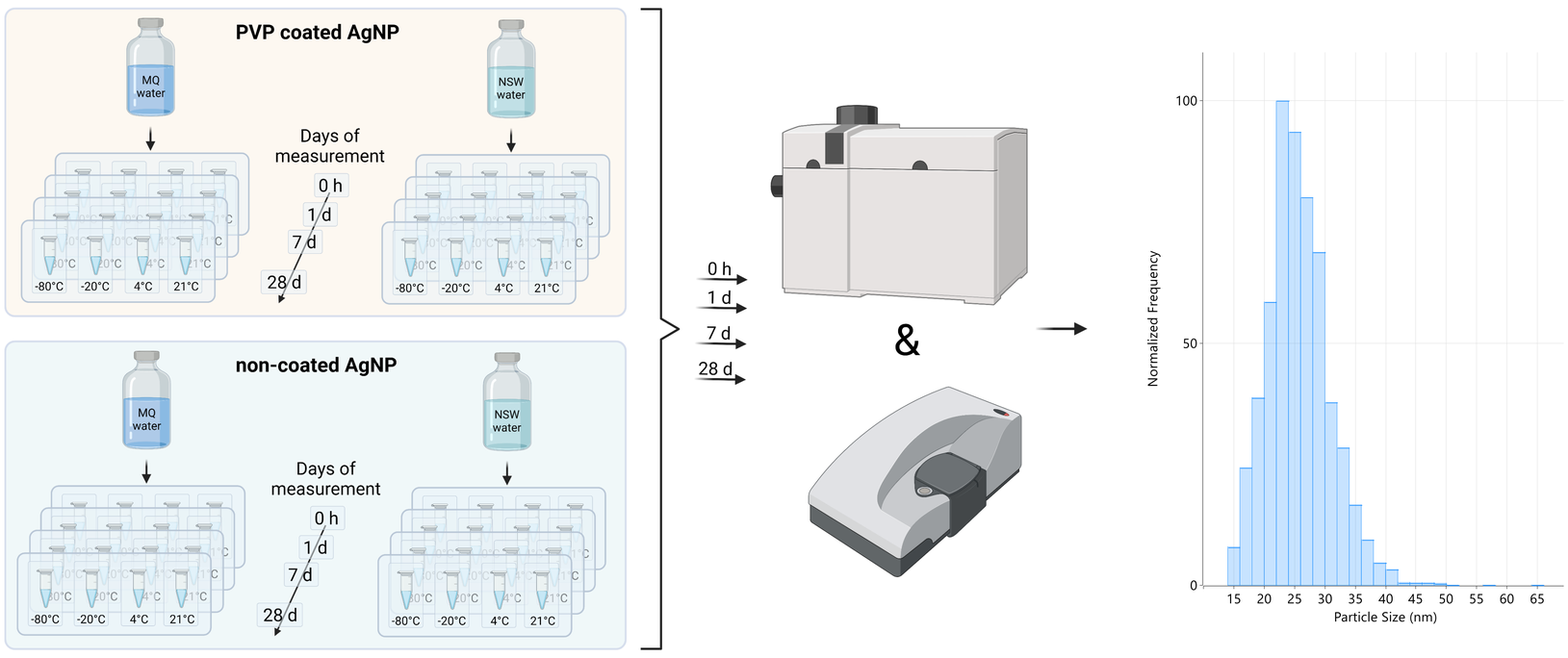
Impact of Storage Conditions on Silver Nanoparticle Stability for Toxicity Studies Using spICP-MS

Objective

Single particle Inductively Coupled Plasma - Mass Spectrometry (spICP-MS) is increasingly being used in fate and toxicity studies for the detection, characterization and quantification of nanoparticles (NP). Samples from exposure-studies are usually preserved for varying lengths of time and temperatures prior to analysis which can alter the NP characteristics and affect data interpretation. However, to date, there is little systematic data on how sample storage conditions impact the characteristics of NP in aqueous samples (e.g. increased dissolution or aggregation).

In this study we investigated the impact of storage temperature and media type on the quality of non-coated and PVP-coated silver nanoparticles (AgNP) suspensions. PVP coated AgNP represent well dispersed particles often used in ecotoxicological studies while non-coated AgNP represent AgNP as they are expected to be found in environmental samples. In addition, AgNP suspensions were prepared in both MQ water and filtered natural seawater (NSW). Filtered natural seawater represents a more environmentally realistic media regarding ionic-strength and is suitable for spICP-MS analysis without further extraction steps that can alter the NP characteristics.

Methods



I. Stock suspensions of PVP coated and non-coated AgNP were prepared, in MQ water and NSW, at a concentration of 200 µg Ag/L. The suspensions were divided into subsamples for the 4 sampling points: 0 h, 1 d, 7 d and 28 d of storage and the 4 tested storage temperatures: - 80, - 20, 4 and 21 °C (5 replicates per condition).

II. The samples were analyzed by spICP-MS after dilution to a final concentration of 50 ng Ag/L. At the beginning (0 h) and the end of incubation, undiluted replicates were also analyzed by Dynamic Light Scattering (DLS) for the hydrodynamic diameter and Z-potential measurement.

Fig. 1: Schematic overview of the experiment to investigate the impact of storage conditions over different time periods on the characteristics of different AgNP suspensions by using spICP-MS and DLS.

Results

- Ag concentrations based on the particle fraction were more stable at lower temperatures (Fig. 2).
- NSW AgNP suspension undergoes stronger losses in the particle fraction in NSW compared to MQ.
- No impact of the storage temperature on the calculated mean particles size or hydrodynamic diameter was observed (Fig. 3).
- Non-coated AgNP were more vulnerable for decreases in particle size.

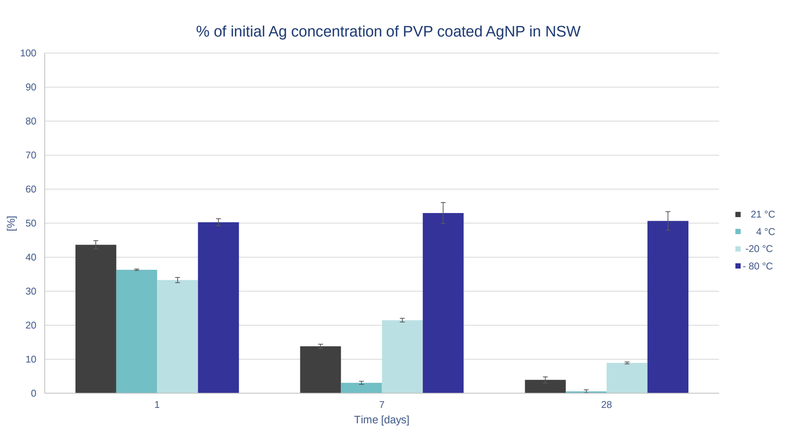


Fig. 2: Percentage of the initial Ag concentration (based on the particle fraction) measured in the NSW suspension of PVP – coated AgNP after different storage durations.

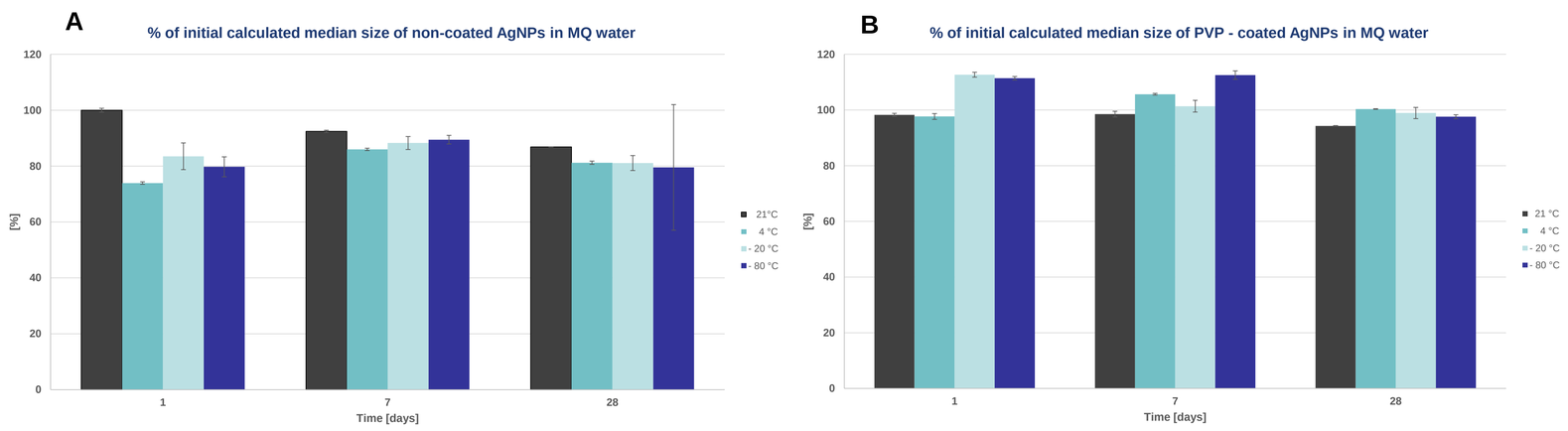


Fig. 3: Percentage of the initial calculated median particle size of non-coated AgNP (A) and PVP-coated AgNP (B) in MQ suspensions determined by spICP-MS after different storage durations.

Conclusion

- Regardless of the type of AgNP (coated or non-coated), aqueous samples should be stored at low temperatures (-20 or -80 °C) to preserve the original NP characteristic during storage.
- Long storage periods for non-coated samples containing non-coated AgNP should be avoided.

Norwegian Institute for Water Research

Contact info:
Norwegian Institute for Water Research (NIVA)
Økernveien, N-0579 Oslo, Norway
Email: sek@niva.no

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