Stability of silver nanoparticles (nAg) in aqueous solution: the role of particle size and water ionic strength

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Silver nanoparticles

Nanosilver (nAg)

- Amongst the most widely used ENP's ≈30% registered commercial nano-products
- Antimicrobial properties
- Antiseptic activity
- High electrical and thermal conductivity
- Chemical stability
- Catalytic activity

Applications:

- Microelectronics
- Inks
- Drug-delivery agents
- Biosensors
- Medical imaging
- Personal care products


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Nano Silver Ice
ICE PACK


iPod nano


Nano Silver
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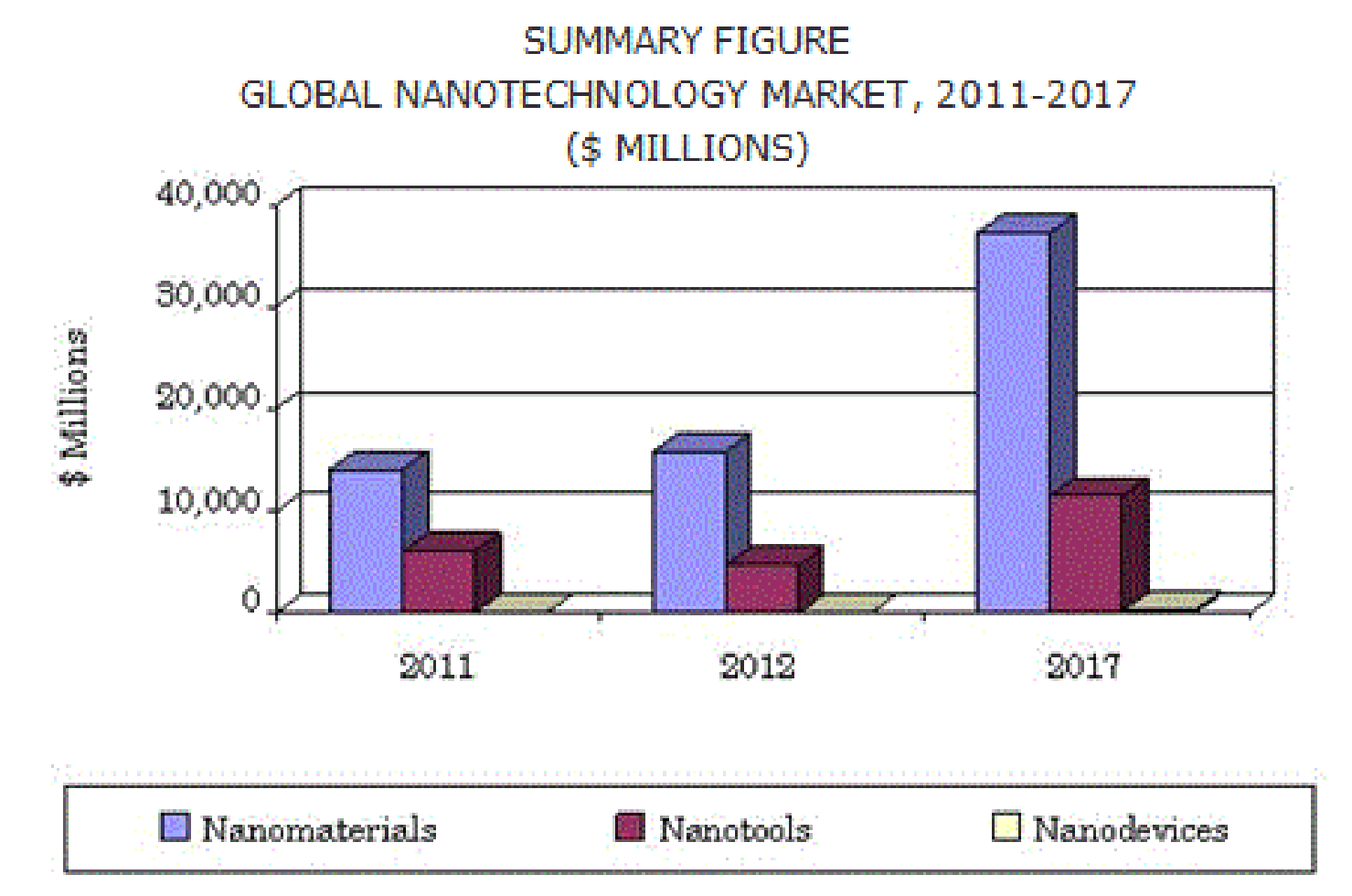
Ag

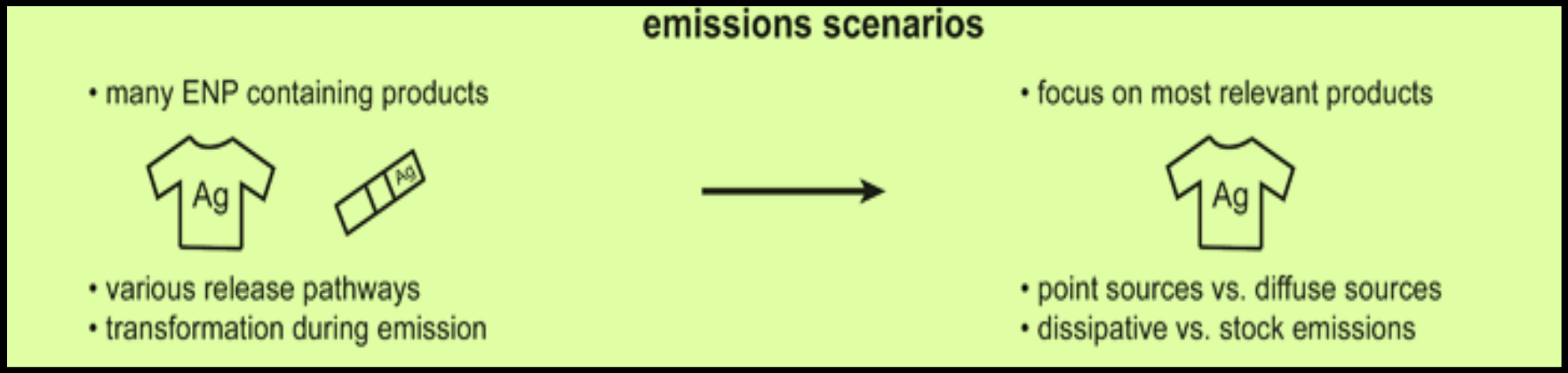
Trends



BCC Research. 2010

Implications

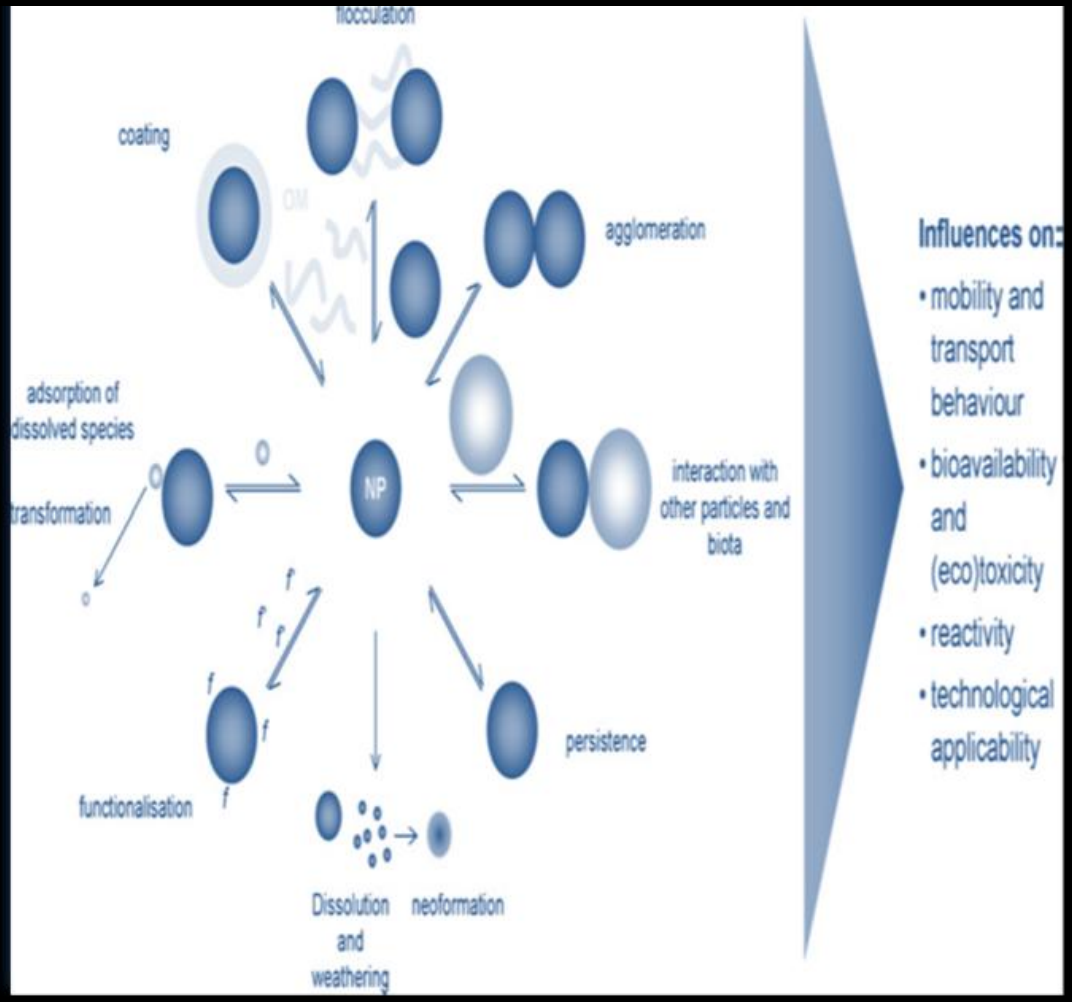
- Wide applications- potential release into environment,



- Via: washing effluent, spillage, leachates from solid waste

- Depending water chemistry & NPs properties

- Different transformations:



Delay and Frimmel. 2012. *Anal. Bioanal. Chem.*402: 583–592.

-Dissolution,

-Agglomeration,

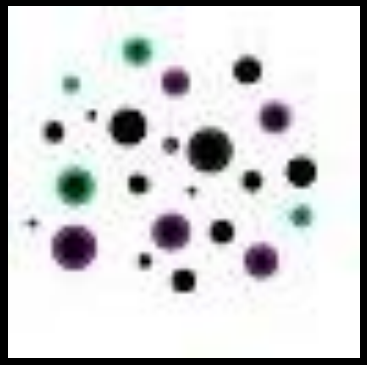
-Production of ROS,

-Adsorption of dissolved species,

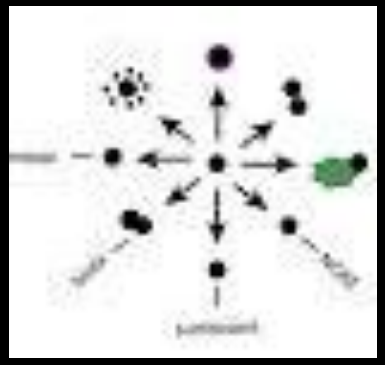
-Association of nAg with cell membranes

-Functionalization

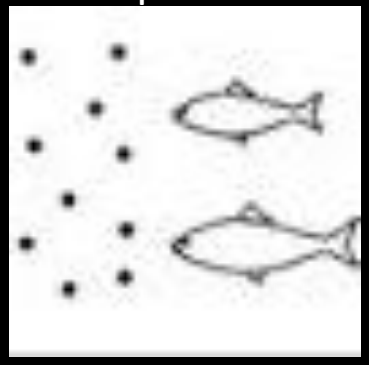
NPs



Fate



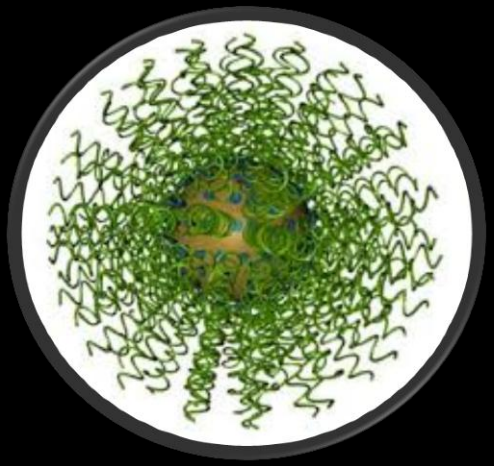
Exposure



- Toxicity towards aquatic micro-organisms & higher aquatic plants

- Indefinite- toxicity towards aquatic biota due: particulate, ionic form or both

- Understanding- Fate and behavior



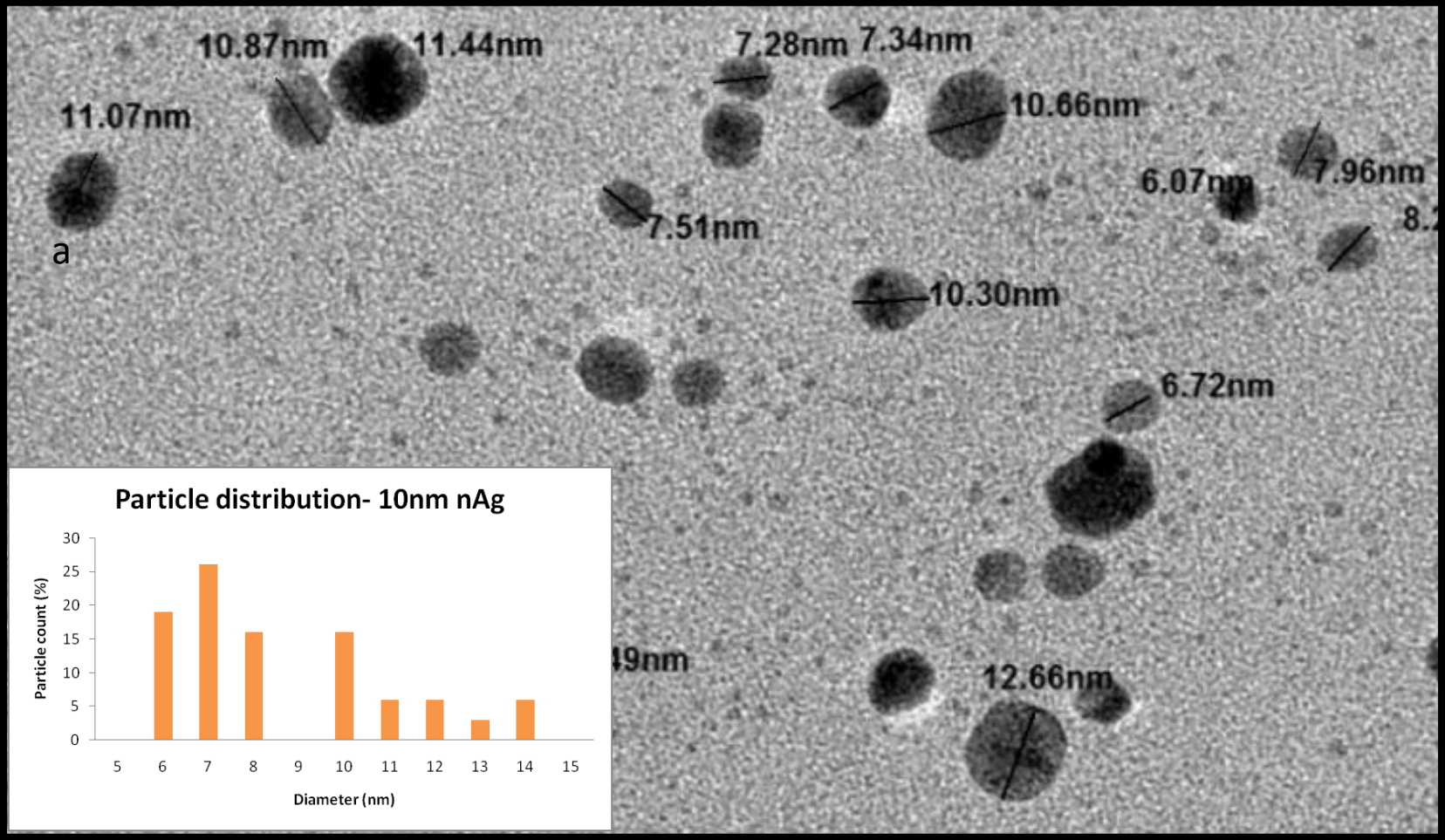
Study method

- Study the stability of silver nanoparticles; how dissolution and agglomeration dynamics are influenced by;
- Size (10nm & 40nm)
- Water ionic strength, in (50% & 100%)IS Hoagland's medium.

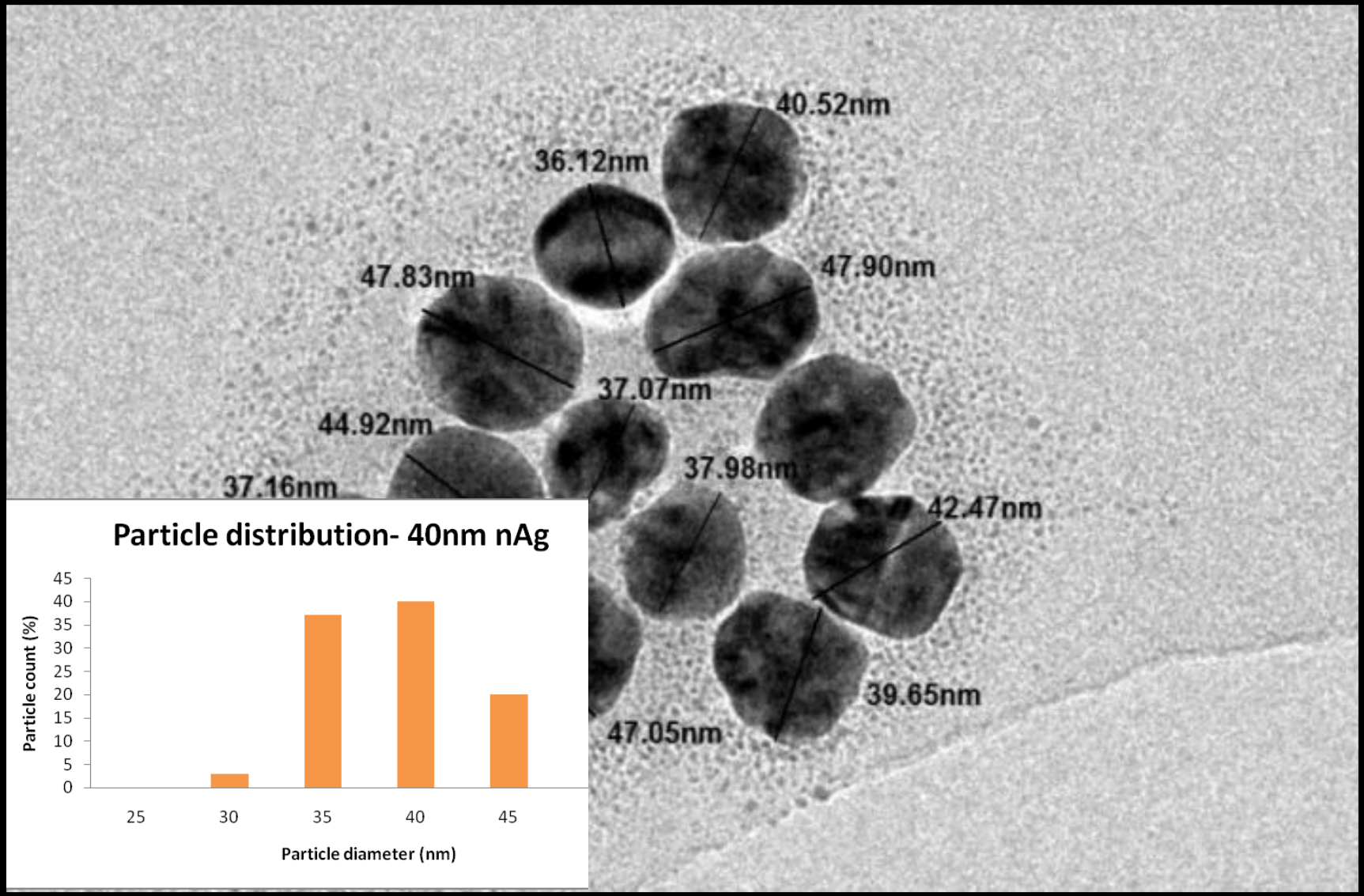
- **Hoagland's medium is:**
- Nutrient culture method of growing/preserving plants without soil;
- 100% IS: contain 1.6g powder per 1.0 L water

Silver nanoparticles

Citrate-nAg, purchased and characterized with TEM:



TEM image of silver nanoparticles average 10nm and size distribution histogram.



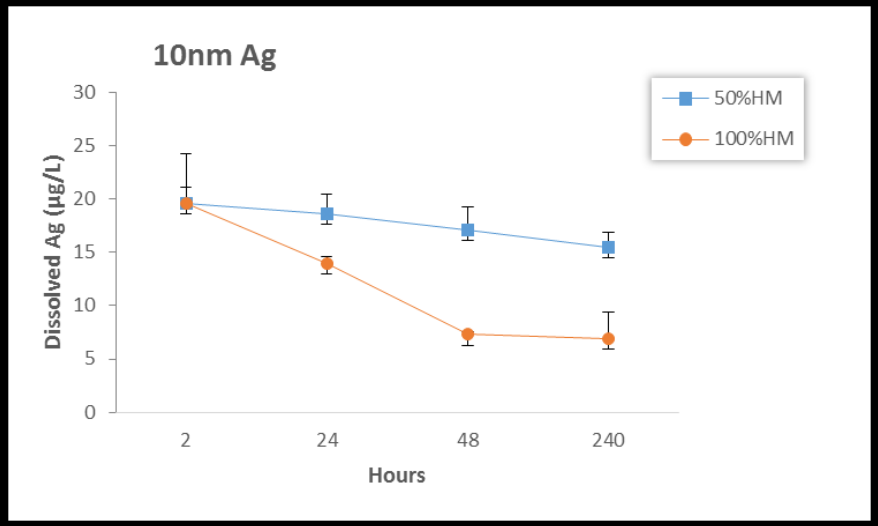
TEM image of silver nanoparticles; average 40nm and size distribution histogram.

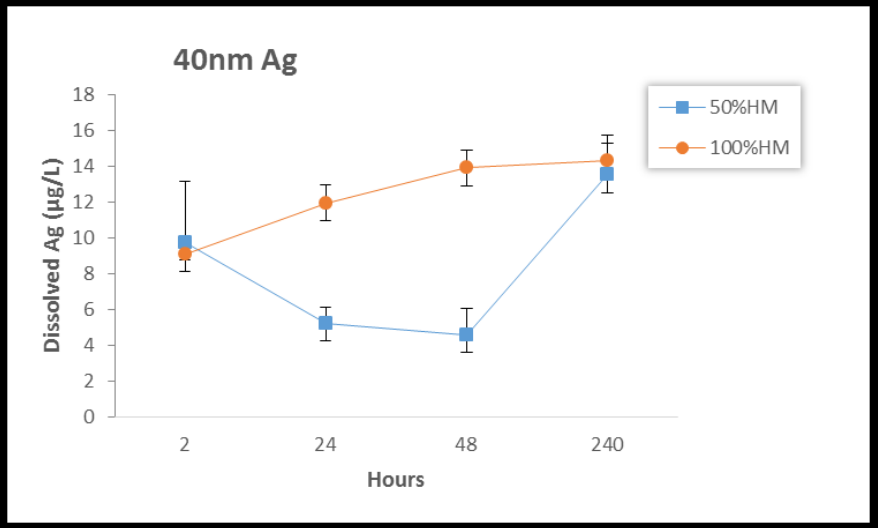
Ag^{+} Release Experiment

- Hoagland's medium (HM) of 50% and 100% strength's
- Dosed with Ag suspensions to achieve 100µg/L
- Performed separately, for both 10nm and 40nm exposure samples
- Placed in incubator equipped with shaker-25^{o}C
- Period of 10 days
- Centrifugal ultrafiltration
- ICP-MS: dissolution dynamics
- TEM, NTA and zetasiser: agglomeration dynamics

Results

ICP-MS



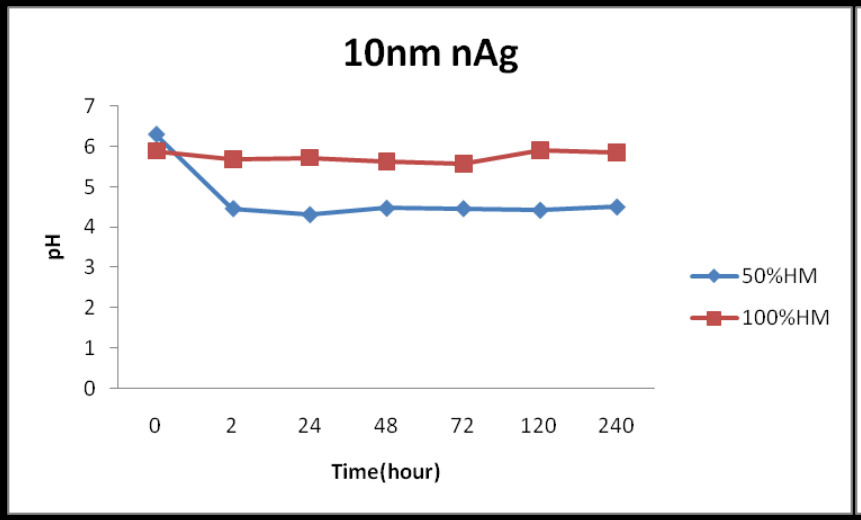


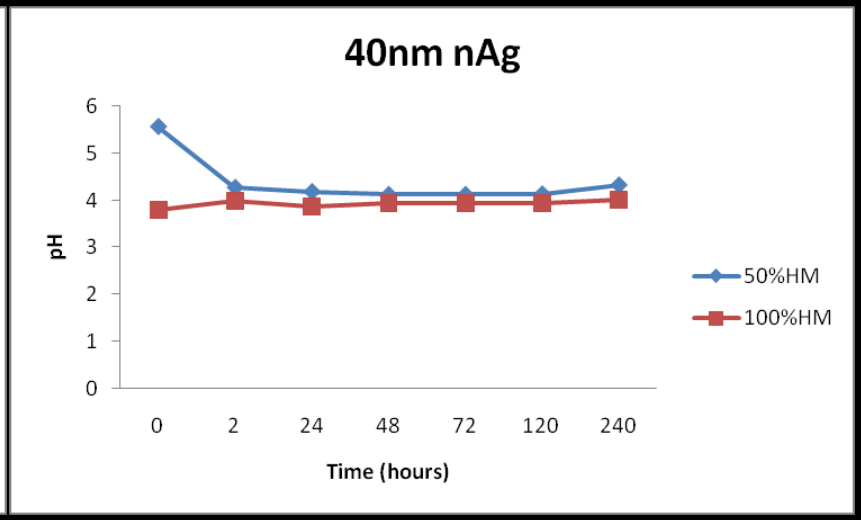
The dissolution kinetics of silver nanoparticles for 10 days: 10nm Ag and 40nm Ag

Sample	Ca (mg/l)	Mg (mg/l)	$CaCO_3$ (mg/l)
10nm+50%HM	81	23	297
10nm+100%HM	147	42	540
40nm+50%HM	73	20	265
40nm+100%HM	152	44	568

Results conti.

pH

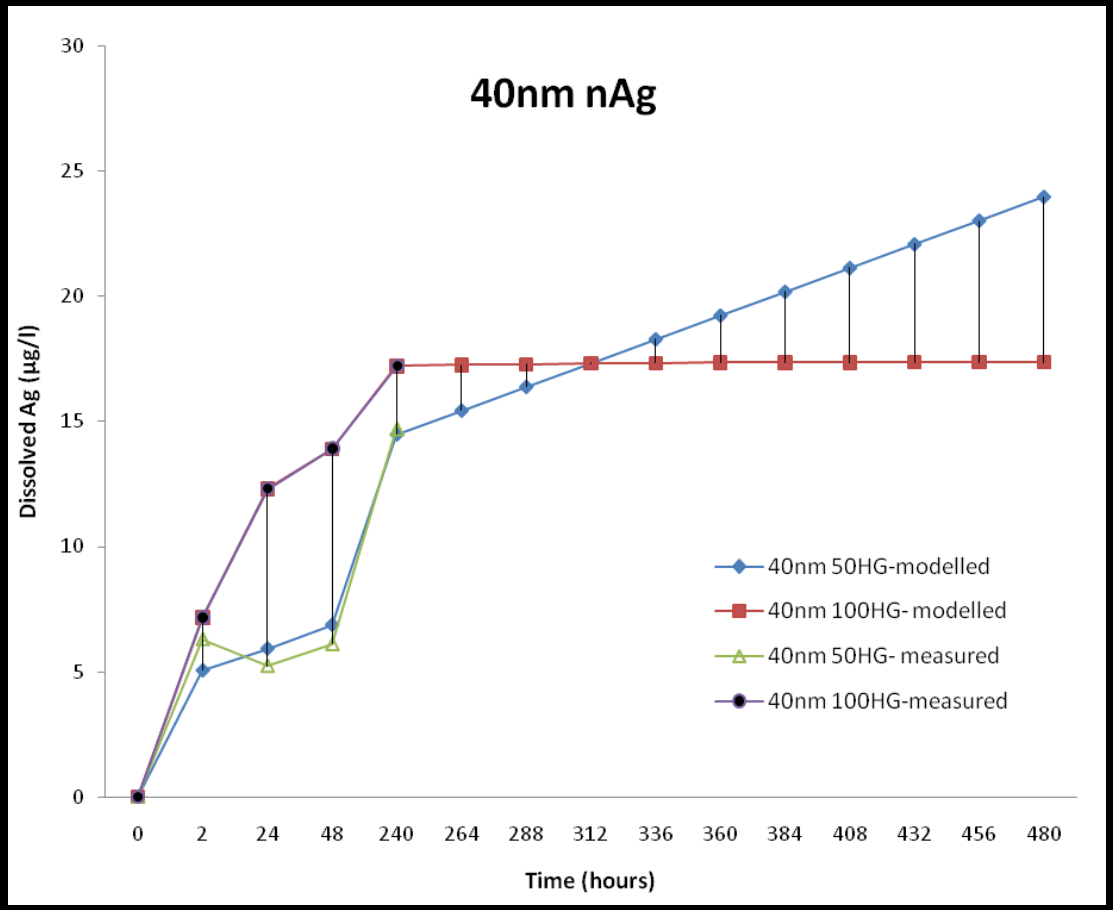




- Observed lower pH in 40nm exposures and higher pH levels in 10nm exposures
- 10nm nAg in 50% HM had lower pH, as well as the 40nm nAg in 100% HM
- Indicate that Ag^{+} release may be influenced pH

Results conti.

Modell results:



MINTEK Modell

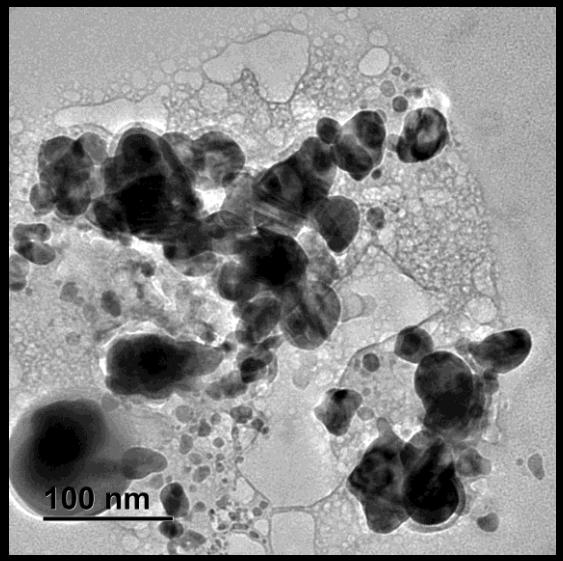
Result conti.

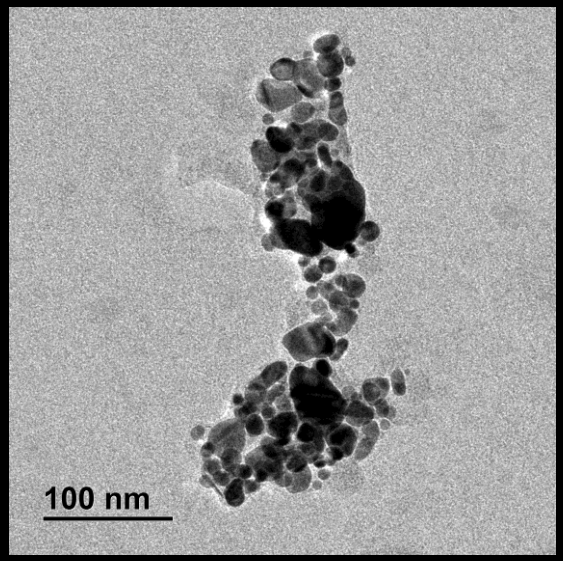
TEM: 10nm nAg

2hr

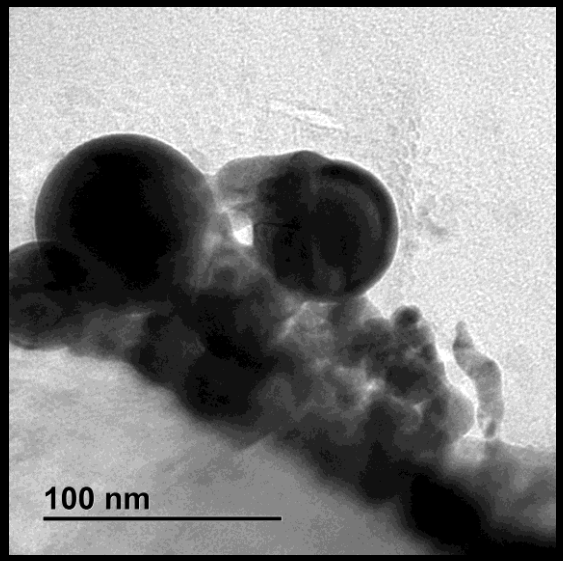
72hr

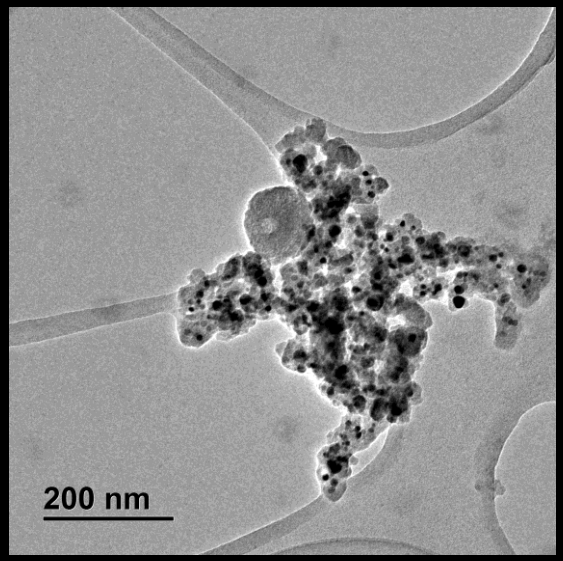
50%HM





100%HM





Conclusion

- 10nm Ag : Size dependant dissolution rates
  : Dissolution influenced by media strength
  : pH influenced by Ag^{+} concentration in 50% HM

- 40nm Ag : Higher dissolution rates on 10^{th} day
  : Dissolution was higher in 100%HM-effect low pH
  : More stable compared to 10nm Ag

Acknowledgements

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