The emerging case of nanopollutants in the aquatic environment: analytical challenges for the exposure assessment of silver and zinc oxide nanoparticles

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Nanotechnology trends

| Technology	2011	2012	2017	CAGR%* 2012-2017
Nanomaterials	14,072.9	15,924.8	32,327.5	18.6
Nanotools	6,032.8	4,763.5	11,416.9	19.1
Nanodevices	39.5	45.3	176.2	31.2
Total	20,145.2	20,733.6	48,920.6	18.7

*CAGR; compound annual growth rate. Adopted from BCC Research 2012

The structure of nano-tecnology market for 2010-2015

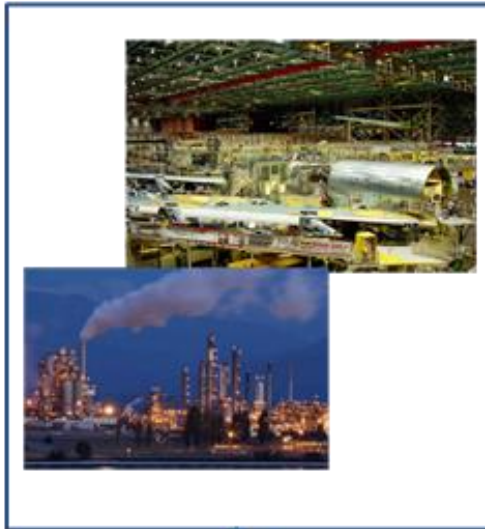| Position	Market share, %
Nano-materials	30-35
Semi-conductors	18-25
Data storage devices	15-20
Bio-technologies	9-14
Polymers	8-12
Electro-chemistry	3-5
Optics	2-4

Adopted from Kovalev 2013

Total Products Listed
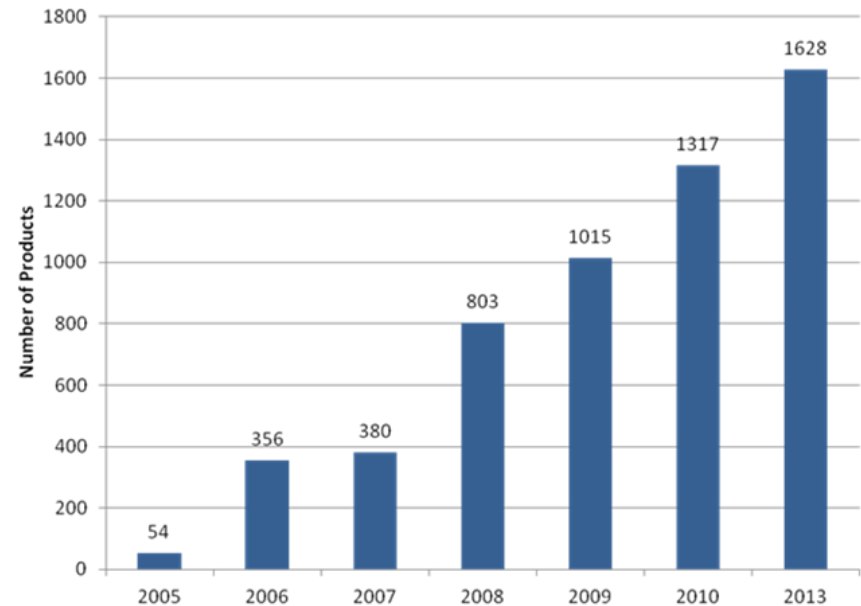
Adopted from Project on Emerging Technologies (WWICS)
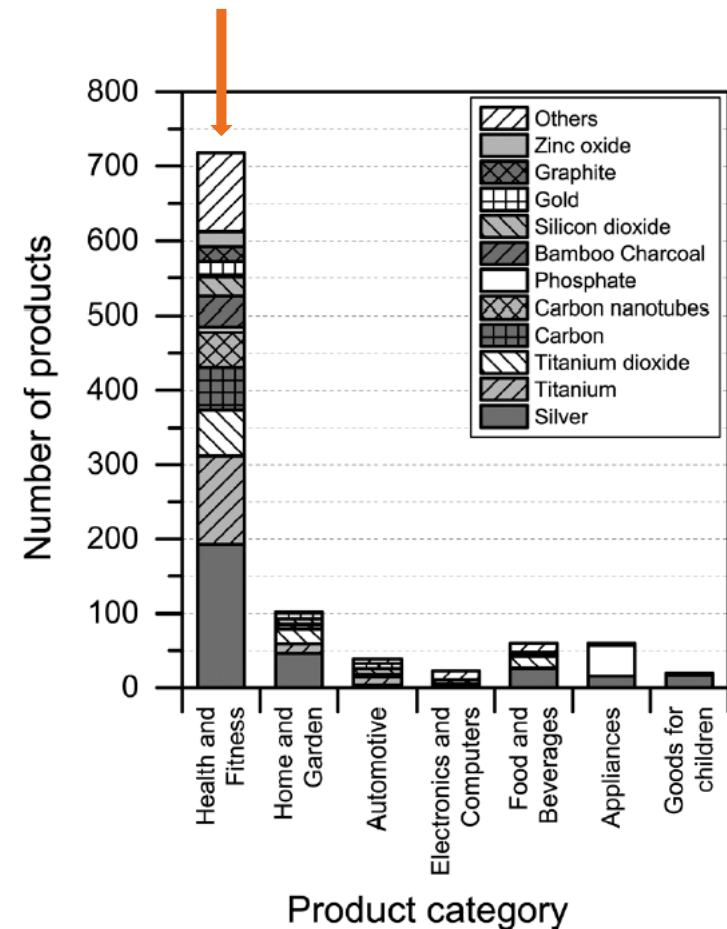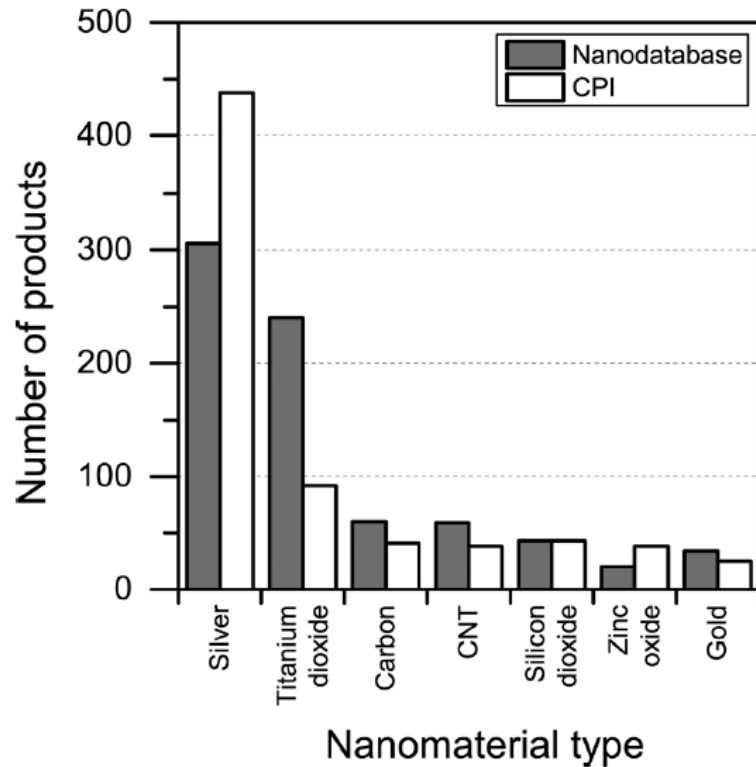
Production/fabrication

Usage/application

Waste/disposal

ENVIRONMENT

Prediction of environmental health implications

RISK = EXPOSURE + HAZARD

- SOURCES

- FATE and TRANSPORT

- QUANTITY

- FREQUENCY

- DURATION

Nano-enabled products: Europe and USA (CPI)
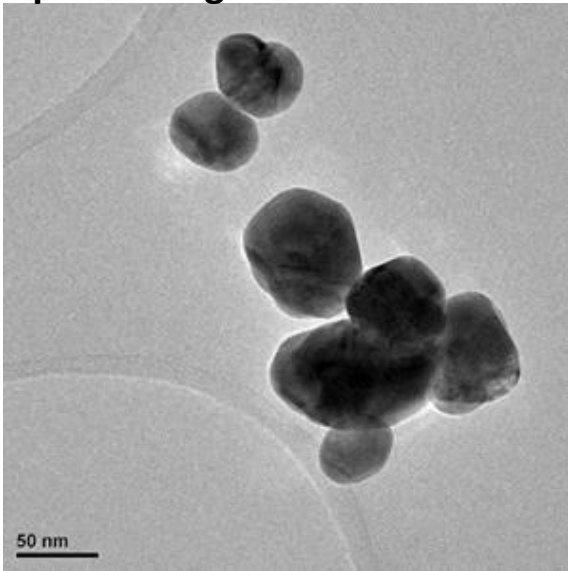

Hansen *et al.* 2016. *Environ. Sci.: nano* 3

Hoagland's Medium (HM)

Exposure water	HM50	HM100
Ca (mg/L)	74	157
Mg (mg/L)	20.25	42.5
$CaCO_3$ (mg/L)	550.25	268.5
pH	6	6

River water - unfiltered

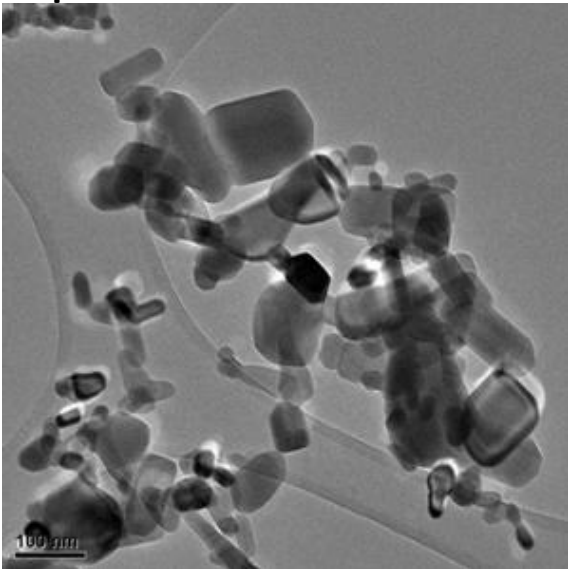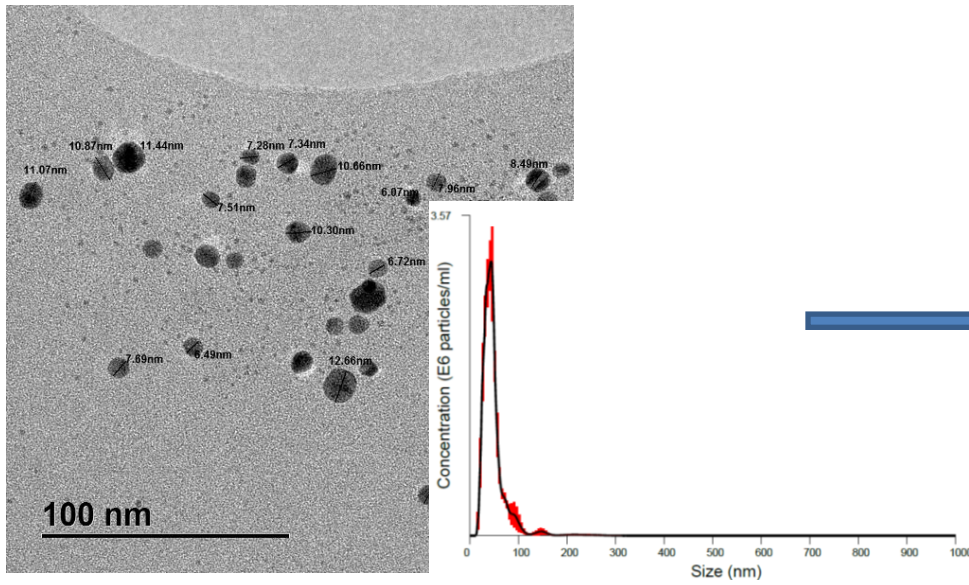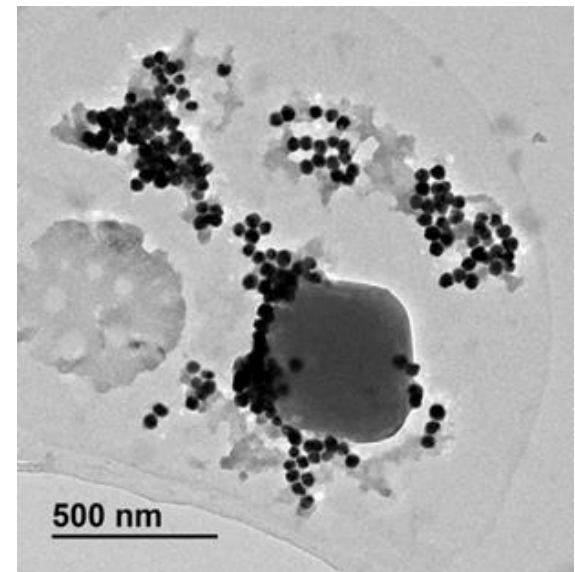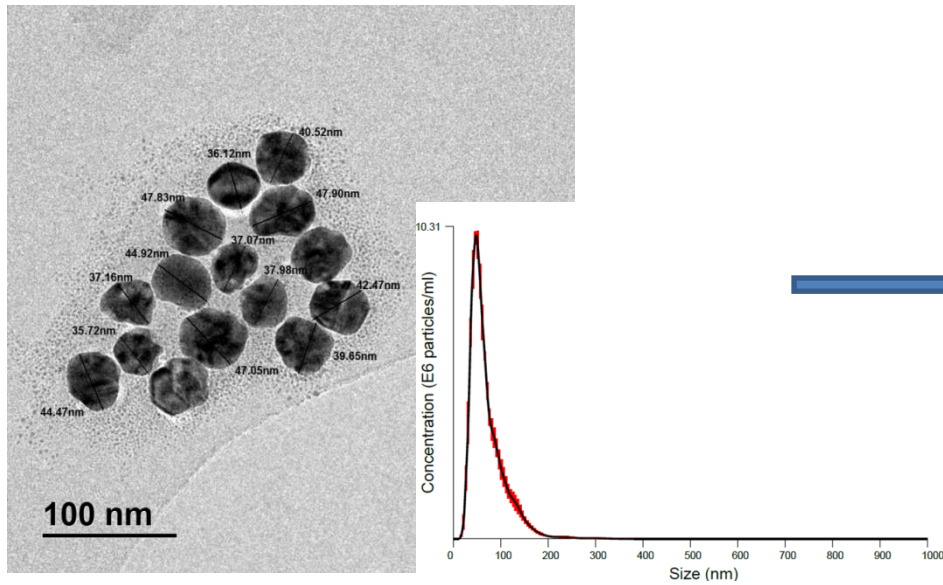| Parameter	Value (stdev.)
pH	7.05-7.54 (0.15)
DOC	3.2-3.77 (0.17) mg/L
Ag	<0.005 mg/L
Na^+	13 mg/L
Ca^{2+}	10.67 (0.47) mg/L
Mg^{2+}	7.93 (0.05) mg/L
SO_4^{2-}	7.97 (0.17) mg/L
Cl^-	0.02 (0.005) mg/L

powder AgNPs in DI water

in test- Hoagland's medium

50 nm

2 µm

58.92nm 58.26nm 40.62nm
51.72nm 44.14nm
46.41nm
39.38nm 49.60nm
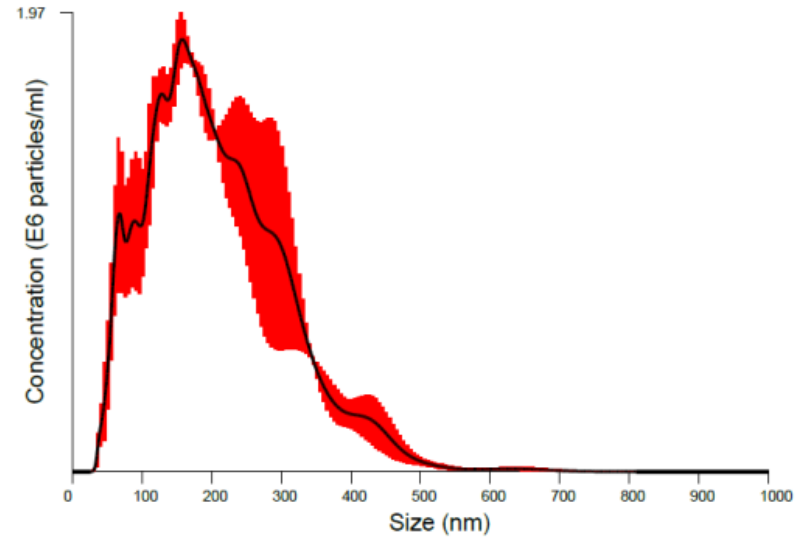35.42nm
50.67nm 45.62nm
74.65nm 57.11nm

200 nm
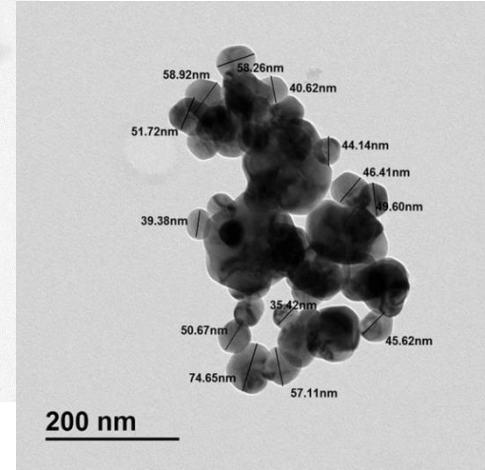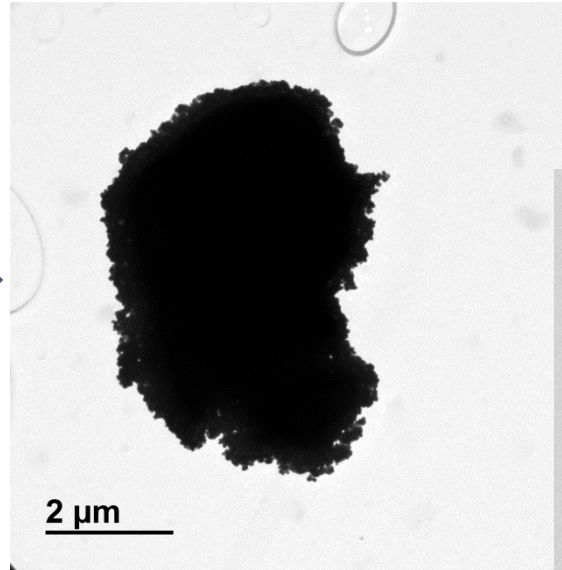
powder ZnONPs in DI water

in test- Hoagland's medium

100 nm

200 nm

58.37nm 38.01nm
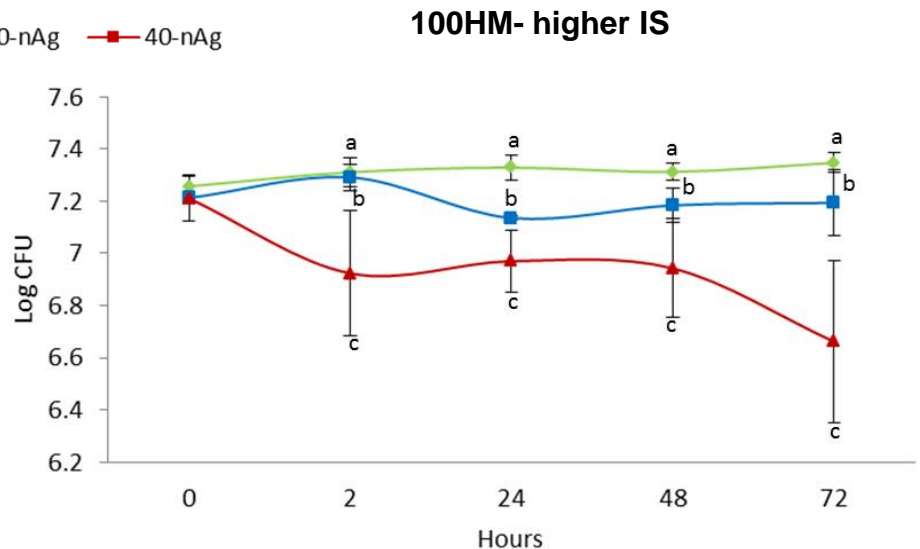25.43nm
37.15nm
29.08nm
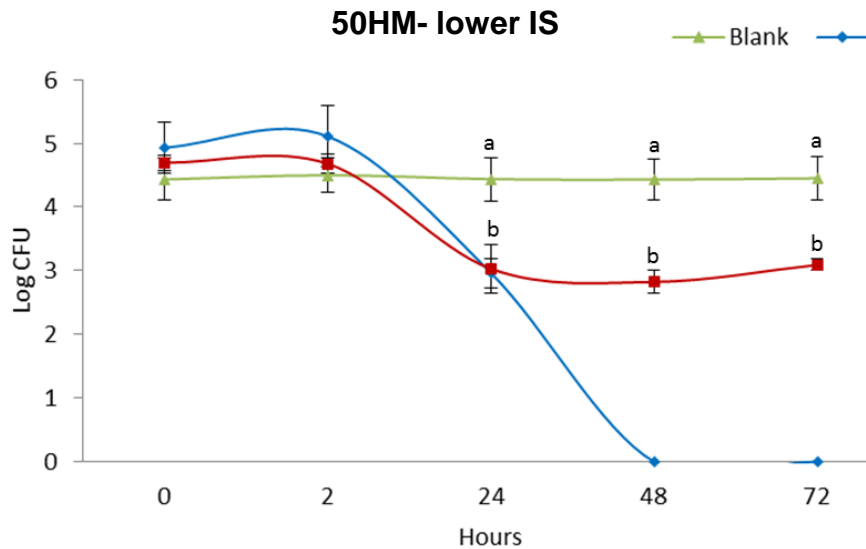127.86nm 88.49nm
29.81nm
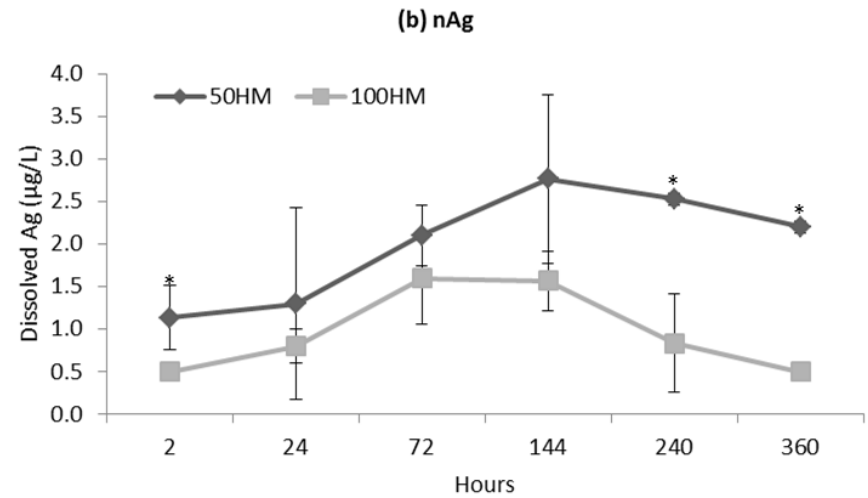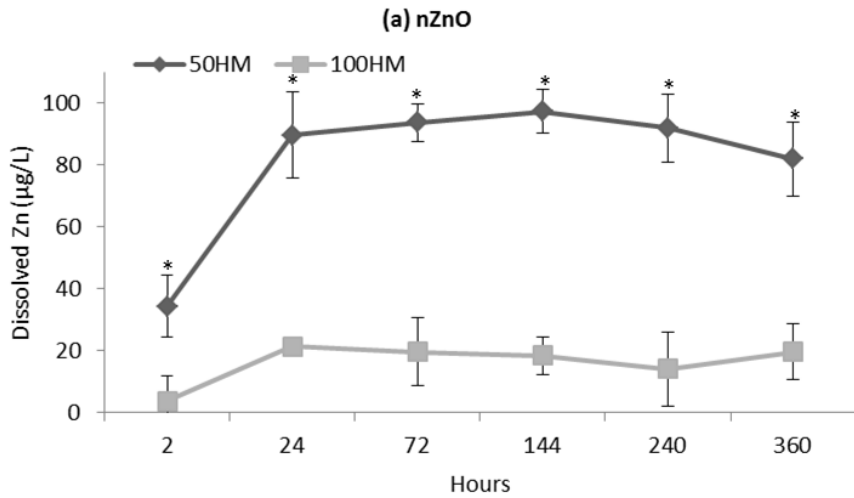58.60nm 48.97nm
34.15nm
63.21nm

200 nm
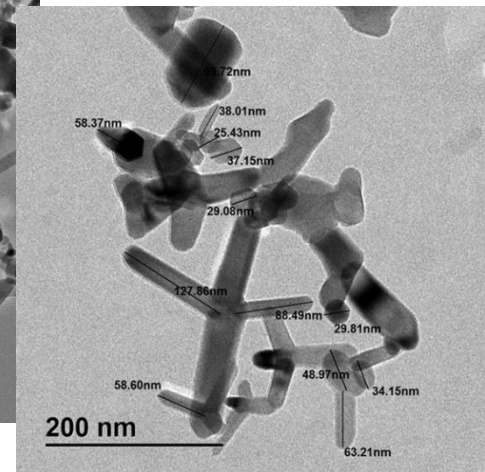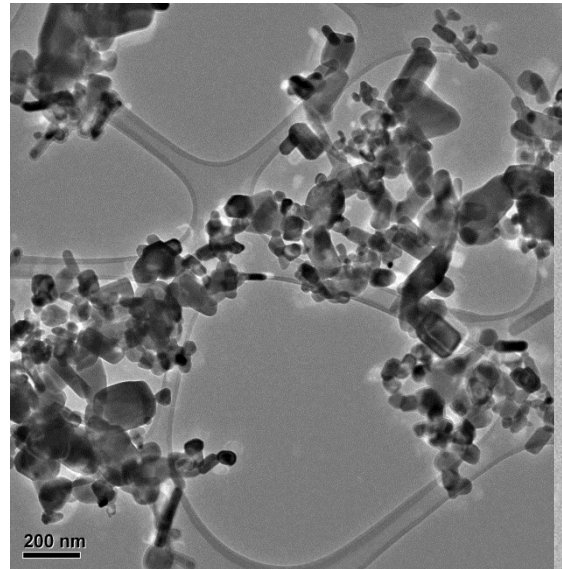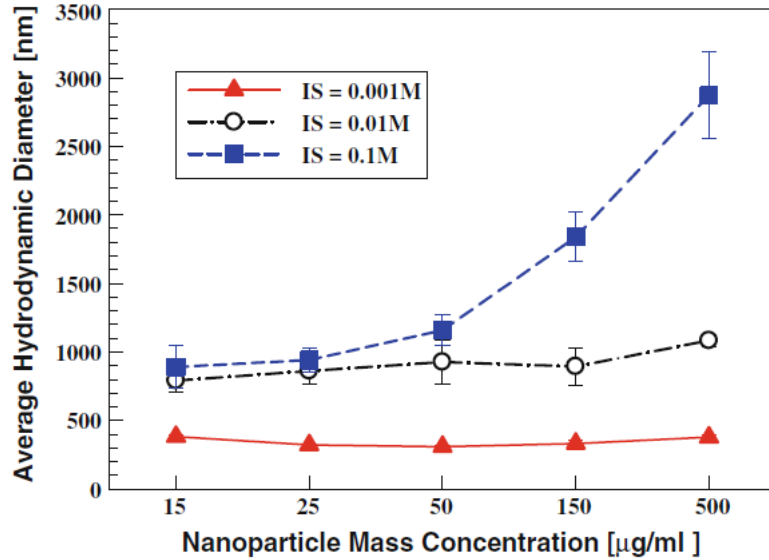
10 and 40 nm cit AgNPs in DI water

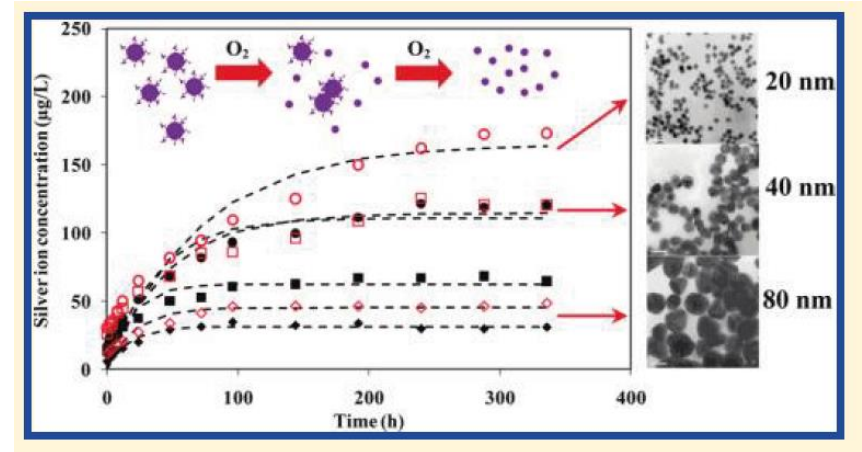**10 nm AgNPs in 0.45 μm filtered river water**

The influence of environmental parameters on behaviour and hazard

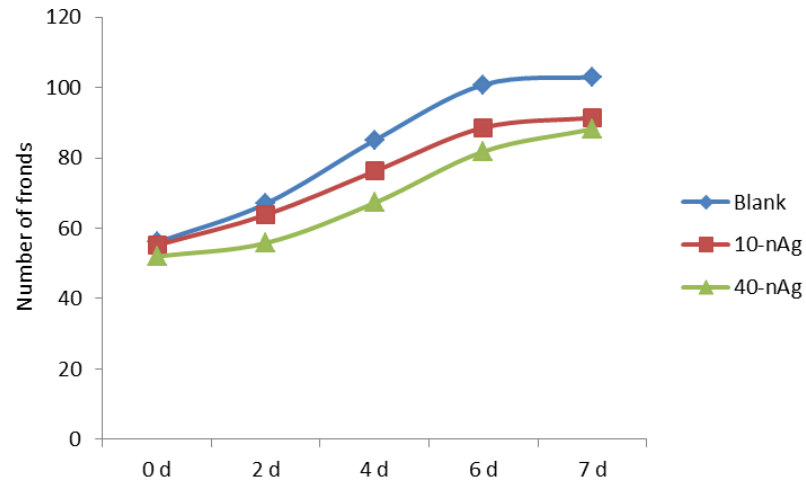# Size transformation- ionic strength influence

Suttiponparnit *et al.* 2011. *Nanoscale Res Lett.*, 6:27

Zhang *et al.* 2011. *Environ. Sci. Technol. 45*

Exposure assessment – multi-parametric approach
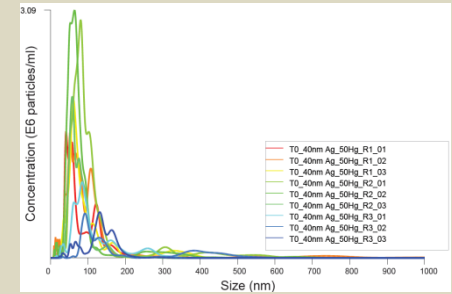

Dissolution

Ultracentifugation

HNO$_3$ preservation
ICP-MS

Agglomeration

Concentration (particles/mL)

Surface charge potential

Location specific risk assessment of nano-enabled products/processes

- Source identification

- Categorization and prioritization for the exposure of water resources

- Tiered exposure assessment of identified priority products/processes

- Integrate environmental data of the locality

- Link exposure and hazard

- Estimate risks: trade offs

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Acknowledgements

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