**Supplemental Table**

Supplemental Table 1. Toxicity of NPs to different organisms.

| NPs | Advertised particle size (nm) | TEM/SEM measured size (nm) | DLS (nm) | Zeta potential (mV) | Test species | Effects | Reference |
|---|---|---|---|---|---|---|---|
| $TiO_2$ | 25<br>100 | N/A | N/A | N/A | green algae *D. subspicatus* | $EC_{50}$ = 44 mg/L<br>$EC_{50}$ was beyond the tested range, > 50 mg/L | 1 |
| | 25-70 | N/A | N/A | N/A | algae *P. subcapitata* | $EC_{50}$ = 5.83 mg Ti/L | 2 |
| | 25-70 | N/A | N/A | N/A | *S. cerevisiae* S288C | not toxic even at 20000 mg/L | 3 |
| | N/A | 17-64 | N/A | N/A | *E. coli* | $LC_{50}$ (light) = 0.16 mg /L<br>$LC_{50}$ (dark) = 4.63 mg /L | 4 |
| | 27.5 | 14.2-64.6 | N/A | N/A | human lung epithelial cells | not cytotoxic at any concentration up to 100 µg/mL | 5 |
| | N/A | 91 | N/A | + 48.8 | in human peripheral blood lymphocytes4 or BEAS-2B/ IMR-90 cells | no significant induction of DNA damage based on the comet assay | 6 |
| | 25 | N/A | 371±323 | -18 ± 4.5 | *S. oneidensis* | no significant change in cell survival with increasing concentration | 7 |
| | < 25 | N/A | 185 ± 40 | N/A | waste activated sludge | doses up to no inhibitory effect at 150 mg/ g-TSS | 8 |
| | 50 | N/A | N/A | -21 | *B. subtilis*, *E. coli* and *P. fluorescens* | did not affect bacterial populations | 9 |
| | 66 | N/A | 330 | N/A | *B. subtilisand* | resulting in 75% growth reduction with 1000 ppm | 10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | *E. coli* | resulting in 72% growth reduction with 5000 ppm | |
| | | | | | *Vibrio fischeri* | $EC_{50}$ > 20000 mg/L | |
| | 25-70 | N/A | N/A | N/A | *Daphnia magna* | $LC_{50}$ ~ 20000 mg/L | 11 |
| | | | | | *Thamnocephalus platyurus* | $LC_{50}$ > 20000 mg/L | |
| | 25-70 | N/A | N/A | N/A | Pseudokirchneriella subcapitata | EC50 = 5.83 mg Ti/L | 2 |
| | 50-70 | N/A | N/A | N/A | algae *P. subcapitata* | $EC_{50}$ ~ 0.04 mg Zn/L | 2 |
| | | | | | *E. coli* | $EC_{50}$ = 115.7 mg/L | |
| | 50-70 | N/A | N/A | N/A | *B. subtilis* | $EC_{50}$ = 85.8 mg/L | 12 |
| | | | | | *S. aureus* | $EC_{50}$ >125 mg/L | |
| | 13 | N/A | N/A | N/A | *E. coli* | complete inhibition of *E. coli* growth at concentrations > 3.4mM | 13 |
| | | | | | *S. aureus* | growth of S. aureus was completely inhibited at concentrations > 1mM | |
| ZnO | 100 | N/A | N/A | N/A | Mouse macrophage (Ana-1) cell line | $IC_{50}$ = 35.26 mg/L | 14 |
| | 30 | N/A | N/A | N/A | Mouse macrophage (Ana-2) cell line | $IC_{50}$ = 32.43 mg/L | 13 |
| | 10-30 | N/A | N/A | N/A | Mouse macrophage (Ana-3) cell line | $IC_{50}$ = 24.84 mg/L | 13 |
| | 50-70 | N/A | N/A | N/A | *S. cerevisiae* S288C | $EC_{50}$ = 121–134 mg ZnO/L | 12 |
| | 150 | N/A | N/A | N/A | *S. agalactiae* | 0.12 M caused more than 95% inhibition of bacterial growth, $1.2 \times 10^{-3}$ M, a slight decrease in the number of bacteria colonies was detected | 15 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | *S. aureus* | $6 \times 10^{-4}$ M, a slight decrease in the number of bacteria colonies was detected | |
| N/A | 19 ± 7 | N/A | -2.9 ± 0.3 | *E. coli* | the bacterial mortality at ZnO NPs concentration of 50 mg/L are 40% in Tap water, 20% in Xixi River and West Lake, and 10% in Qiantang River | 16 |
| N/A | 47-106 | N/A | N/A | *E. coli* | $LC_{50}$ (light) = 0.048 mg/L<br>$LC_{50}$ (dark) = 0.13 mg/L | 4 |
| 25 | N/A | N/A | N/A | human myeloblastic leukemia cells (HL60)<br>normal peripheral blood mononuclear cells (PBMCs) | $CC_{50}$ = 52.80 µg/mL,<br>$CC_{50}$ = 741.82 µg/mL | 17 |
| 42 | N/A | 111±44 | - 6.14 | human umbilical vein endothelial cells (HUVECs) | decreased the cellular viability to about 40% of the control at 240 µM | 18 |
| <100 | N/A | 140 ± 20 | N/A | waste activated sludge | inhibitory effect with its dosages increased | 8 |
| 20 | N/A | N/A | -5 | *B. subtilis*, *E. coli* and *P. fluorescens* | 100% mortality | 9 |
| 67 | N/A | 480 | N/A | *B. subtilis*<br>*E. coli* | 90% growth reduction at 10 ppm<br>48% growth reduction at 1000 ppm | 10 |
| 50-70 | N/A | N/A | N/A | *Vibrio fischeri*<br>*Daphnia magna*<br>*Thamnocephalus platyurus* | $EC_{50}$ = 1.9 ± 0.2 mg/L<br>$LC_{50}$ = 3.2 ± 1.3 mg/L<br>$LC_{50}$ = 0.18 ± 0.03 mg/L | 11 |
| 50-70 | N/A | N/A | N/A | Pseudokirchneriella subcapitata | $EC_{50}$ ~ 0.04 mg Zn/L | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20 | 20.3 ± 1.9 | 27.0 ± 10.8 | - 47.1 ± 1.9 | RAW 264.7 | $EC_{20}$ = 7 mg/L | |
| | | | | | L929 cells | $EC_{20}$ = 2.8 mg/L | |
| | 80 | 79.8 ± 5.1 | 79 ± 25.2 | - 49.7 ± 1.8 | RAW 264.7 | $EC_{20}$ = 38 mg/L | 19 |
| | | | | | L929 cells | $EC_{20}$ = 17 mg/L | |
| | 110 | 112.6 ± 7.8 | 111.6 ± 29.9 | - 54.5 ± 1.8 | RAW 264.7 | $EC_{20}$ = 100 mg/L | |
| | | | | | L929 cells | $EC_{20}$ > 12 mg/L | |
| | 40 | 46 ± 21 | N/A | -13.6 | human mesenchymal stem cells (hMSCs) | DNA damage after 1, 3, and 24 h at 0.1 mg/L | 20 |
| | 15 | N/A | N/A | N/A | rat liver derived cell line (BRL 3A) | $EC_{50}$ = 24 ± 7.25 mg/L | 21 |
| | 100 | | | | | $EC_{50}$ = 19±5.2 mg/L | |
| | less than 10 | N/A | N/A | N/A | human hepatoma cells | $IC_{50}$ = 3.38 ± 0.55 µg/mL | 22 |
| Ag | N/A | 50 ± 20 | 85 | -30 | Human mesenchymal stem cells | 57% growth reduction for 20 µg/mL, and 100% growth reduction for 25 µg/mL | 23 |
| | 9-21 | N/A | N/A | N/A | Nitrifying Bacteria | $EC_{50}$ = 0.14 mg/L | 24 |
| | 7-10 | N/A | N/A | N/A | human hepatoma cell line, HepG2 | cytotoxicity at higher doses (>1.0 mg/L) | 25 |
| | 10-20 | N/A | N/A | N/A | ammonia-oxidizing bacteria | ammoxidation inhibition by nano-Ag was dependant on the level of concentration | 26 |
| | N/A | 57 ± 20 | 143 ± 9 | −44.7 ± 1.6 | Natural Estuarine Plankton Community | the growth rates of both phytoplankton and bacterioplankton populations were significantly reduced by Ag NPs at concentrations of ≥ 500 µg/L | 27 |
| | 25 | N/A | 76.65±5.73 | - 4.76±0.19 | HEK293T cell | $IC_{50}$ = 30 µg/mL | 28 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | N/A | 54.3±5.3 | 101.9±3.3 | - 9.9±0.4 | the HaCaT cell | $LD_{50}$ = 54.3 μg/mL | 29 |
| | 100 | N/A | N/A | -37.3 | the human LoVo cell line | the 100 nm nanoparticles exerted indirect effects via serine/threonine protein kinase (PAK), mitogen-activated protein kinase (MAPK), and phosphatase 2A pathways, | 30 |
| | 20 | | | -57.5 | | the 20 nm nanoparticles induced direct effects on cellular stress, including generation of reactive oxygen species and protein carbonylation. | |
| | 10<br>50<br>100 | N/A | N/A | N/A | MC3T3-E1 cells | 10 nm AgNPs induced more apoptotic cells than the larger particles (i.e., 50 and 100 nm). | 31 |
| CuO | 30 | N/A | N/A | N/A | algae *P. subcapitata* | $EC_{50}$= 0.71 mg Cu/L | 2 |
| | 20-30 | N/A | N/A | N/A | *E. coli*<br>*B. subtilis*<br>*S. aureus* | $EC_{50}$ = 28.6 mg/L<br>$EC_{50}$ = 61.1 mg/L<br>$EC_{50}$ = 65.9 mg/L | 12 |
| | 30 | N/A | N/A | N/A | *S. cerevisiae* S288C | $EC_{50}$ = 13.4 mg/L | 3 |
| | 30 | N/A | 192.5 | N/A | *E. coli* biosensor | the formation of superoxide anions, hydrogen peroxide and single-stranded DNA already at very low sub-toxic levels (0.1 mg Cu/L) | 32 |
| | N/A | 92 ± 12 | N/A | N/A | activated sludge | The sludge flocs were unstable after exposure to CuO NPs (50 mg/L) | 33 |
| | N/A | 17-45 | N/A | N/A | *E. coli* | $LC_{50}$ (light) = 1.68 mg/L<br>$LC_{50}$ (dark) = 58.3 mg/L | 4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 30 | N/A | 194 ± 16.9 | 31.9 ± 7.31 | Yeast *S. cerevisiae* BY4741 | $IC_{50}$ = 4.8 mg/L in DI<br>$IC_{50}$ = 643 mg/L in YPD | 34 |
| | 30 | N/A | N/A | N/A | *Vibrio fischeri* | $EC_{50}$ = 79 ± 27 mg/L | 11 |
| | | | | | *Daphnia magna* | $LC_{50}$ = 3.2 ± 1.6 mg/L | |
| | | | | | *Thamnocephalus platyurus* | $LC_{50}$ = 2.1 ± 0.5 mg/L | |
| | 30 | N/A | N/A | N/A | Pseudokirchneriella subcapitata | $EC_{50}$ = 0.71 mg Cu/L | 2 |
| NiO | 10 - 20 | N/A | N/A | N/A | *E. coli* | $EC_{50}$ = 160.2 mg/L | 12 |
| | | | | | *B. subtilis* | $EC_{50}$ = 121.9 mg/L | |
| | | | | | *S. aureus* | $EC_{50}$ = 121.1 mg/L | |
| $Sb_2O_3$ | 90 - 210 | N/A | N/A | N/A | *E. coli* Bacillus subtilis, and Streptococcus aureus | EC50= 265.5，144.7，324 mg L−1 | 12 |
| $MoO_3$ | 150<br>30 | N/A | N/A | N/A | rat liver derived cell line (BRL 3A) | $EC_{50}$ = 174.68 ± 26 mg/L<br>$EC_{50}$ = 171.58 ± 25 mg/L | 21 |
| | N/A | 400nm long, 100 - 200 nm wide | N/A | N/A | iMCF-7 | $IC_{50}$ = 275 µg/mL | 35 |
| $CeO_2$ | 7 | N/A | 15 | N/A | | DNA damage | 36 |
| | N/A | 20 ± 3 | N/A | N/A | | cell membrane damage | 37 |
| | less than 25 | N/A | N/A | N/A | anaerobic granule | a reduction of 15 - 19% for the flocculent sludge at the dosage of 5, 50 and 150 mg $CeO_2$ NPs/g-VSS | 38 |
| | | | | | flocculent sludge | a reduction of 35% for the granular sludge at 150 mg $CeO_2$ NPs/g-VSS. | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | N/A | 10 - 20 | N/A | N/A | freshwater alga (*P. subcapitata*) | $EC_{50}$ = 10.3 ± 1.7 mg/L | 39 |
| | 7 | N/A | N/A | N/A | *E. coli* | lethal | 40 |
| | 33 | N/A | 125 ± 38 | − 6.64 | human umbilical vein endothelial cells (HUVECs) | $CeO_2$ NPs did not show toxic effects even with doubling of tested dosage to 480 µM | 18 |
| Au | 10 - 20 | N/A | N/A | N/A | ammonia-oxidizing bacteria | no significant effect on ammoxidation | 26 |
| Gold nanorods | N/A | 18 × 40 | N/A | N/A | in HeLa cells | less toxicity | 41 |
| $Co_3O_4$ | N/A | 51-132 | N/A | N/A | *E. coli* | $LC_{50}$ (light) = 35.06 mg/L<br>$LC_{50}$ (dark) = 55.56 mg/L | 4 |
| graphene oxide (GO) | N/A | The lateral length and thickness of GO were approximately 0.5−5 µm and 0.8−1.2 nm | 295 - 825 | N/A | *Chlorella vulgaris* | did not show significant differences compared with the control at 10 mg/L GO | 42 |
| carboxyl single-walled carbon nanotubes (C-SWCNT) | N/A | The outer diameter, inner diameter and length of C-SWCNT were approximately 1−2 nm, 0.8− 1.6, and 0.5−3 µm, | 396 - 712 | | | with 0.8−28.3% inhibition at 97 h | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SWCNT | N/A | an average outer diameter of 1.2 nm, lengths in the range of 10 to 20 µm | N/A | N/A | *E. coli* cell growth and biofilm formation | biofilms in aquatic systems can potentially recover from the toxic effects of SWNTs after long exposure times (48 h) | 43 |
| | N/A | >150 nm long | N/A | N/A | RAW 264.7, a macrophage-like cell line. | single-walled carbon nanotubes, and amorphous silica resulted in a lower toxicity | 44 |
| Silica | | 10 | 27.2 | -37.2 | | | |
| | N/A | N/A | N/A | N/A | in A549 (a human lung cell line) | no differences in the induction of pulmonary inflammation and lactate dehydrogenase | 45 |
| $SiO_2$ | 10–20 | N/A | 110 ± 40 | N/A | waste activated sludge | no inhibitory effect | 8 |
| porous $SiO_2$ | N/A | 25±4 | N/A | -16.94 | Immune Cells | do not influence mast cell viability | 46 |
| nonporous $SiO_2$ | | 11±5 | | -13.58 | | cell viability drops significantly to 72% | |
| $SiO_2$ | 20 | N/A | N/A | +35 | *B. subtilis* | killed 40% of *B. subtilis* | 9 |
| | | | | | *E. coli* | killed 58% of *E. coli* | |
| | | | | | *P. fluorescens* | killed 70% of *P. fluorescens* | |
| $SiO_2$ | 14 | N/A | 205 | N/A | *B. subtilis*<br>*E. coli* | least toxic | 10 |
| $Fe_3O_4$ | 30<br>70 | N/A | N/A | N/A | rat liver derived cell line (BRL 3A) | $EC_{50}$ > 250 mg/L | 21 |
| Al | 103 | N/A | N/A | N/A | rat liver derived cell line (BRL 3A) | $EC_{50}$ > 250 mg/L | 21 |
| $Al_2O_3$ | 60 | N/A | N/A | + 30 | *B. subtilis* | a mortality rate of 57% to *B. subtilis* | 9 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | *E. coli* | a mortality rate of 36% to *E. coli* | |
| | | | | | *P. fluorescens* | a mortality rate of 70% to *P. fuorescens* | |
| | < 50 | N/A | 130 ± 30 | N/A | waste activated sludge | no inhibitory effect | 8 |
| | N/A | 10-70 | 62-65 nm and 78-88 nm | N/A | *B. licheniformis* | 17% decrease in cell viability at 1μg/mL | 48 |
| $Fe_2O_3$ | 29 | 30-60 | 1580 | -17.3 | the A549 Cell Line | low toxicity was observed | 47 |
| $Fe_3O_4$ | 29-30 | 20-40 | < 200 | 1.8 | the A549 Cell Line | no toxicity was observed | 47 |
| carbon | < 30 | 20-40 | 210 | 6.9 | the A549 Cell Line | no toxicity was observed | 47 |
| carbon nanotubes | 110-170×（5-9×10^3） | 100-200×（3-7×10^3） | 300×（69×10^3） | -45.4 | the A549 Cell Line | a nonsignificant increase in nonviable cells | 47 |

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