Comment on "Sulfidation of Silver Nanoparticles: Natural Antidote to Their Toxicity"

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Levard et al.[1] reported that sulfidation of silver nanoparticles (Ag-NPs) works as a natural antidote to their toxicity. They found that reduction in the toxicity exerted in four diverse types of aquatic and terrestrial eukaryotic organisms is primarily associated with a postsulfidation decrease in Ag^+ concentration, which is due to the lower solubility of Ag_2S relative to elemental Ag (Ag^0). They also showed that the presence of chloride in the exposure medium for a given organism affects the toxicity outcomes by affecting Ag speciation. Transformation of metallic NPs to their sulfide forms (that is, sulfidation) commonly occurs as a part of the wastewater treatment processes.[2−6] As most NPs enter the environment as a part of wastewater treatment plant effluent, the work done by Levard et al.[1] is very interesting and important. We agree that the decreased Ag^+ level after sulfidation may play a role in toxicity reduction. However, the corresponding role presented in the work by Levard et al.[1] is likely to be overestimated.

Our point lies in the fact that although the magnitude of the dissolution rate of Ag-NPs is one order higher than that of Ag sulfide NPs, the dissolution ratio of Ag-NPs is still low. It was reported that the dissolution equilibrium of the initial Ag-NPs was reached after one month and only about 2% was dissociated.[7] This result is in agreement with that obtained by Levard et al.[1] (see Figure 2). Thus, the possible maximum concentration of Ag^+ dissociated from pristine Ag-NPs at the concentration of 2 mg/L (as indicated in Figure 4 with almost 100% lethality in *Caenorhabditis elegans* (*C. elegans*)) was no more than 0.04 mg/L. Meanwhile, the 50% growth inhibition dose (EC_{50}) and the minimum observed dose causing 100% lethality in *C. elegans* within 24 h of exposure to Ag^+ were 0.1 and 0.15 mg/L, respectively,[8] in which *C. elegans* were exposed to EPA medium, same as the condition used in Figure 4 of Levard et al.[1] As the possible maximum concentration of Ag^+ dissociated from Ag-NPs is less than half of EC_{50} and only one-fourth of the minimum concentration causing 100% lethality, the potential maximum concentration of dissociated Ag^+ alone is unlikely to cause almost 100% lethality in *C. elegans* (see Figure 4). Therefore, there must be another cause for the marked difference in toxicity between pristine Ag-NPs and Ag-NPs that have undergone partial sulfidation. Given the same logic, toxicity reduction due to the formation of AgCl(s) in the presence of chloride might also not be as important as described by Levard et al.[1]

The authors made an important contribution in understanding sulfidation-induced reduction of toxicity of Ag-NPs. However, based on our above rationale, the real mechanism underlying toxicity reduction of Ag-NPs through sulfidation remains unknown, and more work should be done to elucidate this. We sincerely hope that this comment can help toward a better understanding of this interesting topic.

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Notes

The authors declare no competing financial interest.

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