Letter to The Editor

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Where are Nanomaterials going? The Necessity of Safe Disposal of Nanowastes

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Nanotechnology is going to change our life, and nanomaterials (NMs) are growing fast, and their release to the environment became inevitable. Despite the policies and protocols that are established for safe disposal of nanomaterial containing wastes of laboratories and industries, there is still a lack of specific standards to address safe disposal of different NMs (1), as well as safe handling and appropriate personal protection for those who are at the first exposure line (2). NMs may leach to the environment by human or operational errors, imprudence, or lack of supervision. The most effective and common way to dispose NMs is incineration, however, it is also accompanied by risk of NMs transformation and creating new hazards (3). There is also the probability that the temperature of combustion chamber is lower than the nanostructure degradation point, leading to incomplete destruction (4).

In addition, we cannot predict the fate of NMs which are tested i*n vivo*, in lab animals. The administered NMs may be excreted through animal feces or urine. This is beside the nanomedicines or cosmetic products that are used by humans. It has been shown that even small changes in environmental or biological factors to which NMs are exposed can affect their fate (5).

On the other hand, there could not be any control on the NMs in consumer household products. The NMs used in these products most likely will find their way to the environment at the end of the product's life, or even before that. Silver nanoparticles (NPs) for example have been shown to be washed out from commercially available sock fabrics into the sewage network (6). This may contaminate groundwater or directly affect agricultural lands irrigated by sewage. Moreover, the overflow of sewer is a common problem, discharging contaminated wastewater to receiving waters (7). Predicted environmental concentrations calculated by simulated models showed accumulation of common NPs up to 21 $ng.L^{-1}$ in surface waters, 4 $\mu g\ L^{-1}$ in sewage treatment effluents, and 89 $\mu g.kg^{-1}$ in sludge-treated soil (8). High concentrations of TiO_2 NPs (up to 100 $\mu g\ L^{-1}$) were found in surface waters contaminated by sewer overflows (7). It seems that the "terrestrial ecosystems are expected to be an ultimate sink for a large portion of NPs" (9). Contamination of soil and water sources rightfully raises concerns about ultimate effects on ecosystem, food chain, and human health. A 56-day exposure of earthworms to gold NP containing soil showed that the presence of NPs in worms' food affect their reproduction (9).

However, most studies on NMs safety regard the relatively high doses for short duration of exposure to biological systems. Our knowledge about long-term exposure of living organisms to low doses of NMs is limited and non-conclusive. Therefore, we do not know yet what would be the real effects of NMs release to the environment, both on humans and ecosystem. To ensure ecological and human health safety, undoubtedly, assessment and awareness of the risks of long-term exposure to NMs and biological

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consequences of wandering NMs is a necessity.

It may also be necessary to reconsider the disposal protocols and specify the most efficient method for each type of NMs rather than incineration. Oxidation filtration, incorporation into silica, and bioremediation by specific microorganisms are other disposal and neutralizing strategies that their efficiency should be evaluated for each kind of nanowaste (10). However, not all the NMs need to be destroyed. Iron oxide NPs for example which can be easily removed from the waste by a magnet, can be reused as iron supplements in culture media of some microorganisms or plant tissues (10). Perhaps it is the time to develop efficient methods to recover and recycle NMs at the end of nanoproducts' life.

References

1. Faunce T, Kolodziejczyk B. Nanowaste: Need for disposal and recycling standards. G20 Insights, Policy Era: Agenda. 2017;2030.

2. Seal S, Karn B. Safety aspects of nanotechnology based activity. *Safety Sci*. 2014;63:217-25.

3. Holder AL, Vejerano EP, Zhou X, Marr LC. Nanomaterial disposal by incineration. E*nviron. Sci.: Processes Impacts*. 2013;15(9):1652-64.

4. Ghania Ounoughene, Olivier Le Bihan, Carine Chivas-Joly, Claire Longuet, Bruno Debray, et al.. Thermal disposal of waste containing nano-objects : first investigations on a methodology for risk management. 5. International Conference Nanosafe "Health and safety issues related to nanomaterials for a socially responsible approach", Nov 2016, Grenoble, France. pp.245. (ineris-01854347)

5. Hashemi F, Hormozi-Nezhad MR, Corbo C, Farvadi F, Shokrgozar MA, Mehrjoo M, et al. Laser irradiation affects the biological identity and cellular uptake of plasmonic nanoparticles. *Nanoscale.* 2019;11(13):5974-81.

6. Benn TM, Westerhoff P. Nanoparticle silver released into water from commercially available sock fabrics. *Environ Sci Technol.* 2008;42(11):4133-9.

7. Loosli F, Wang J, Rothenberg S, Bizimis M, Winkler C, Borovinskaya O, et al. Sewage spills are a major source of titanium dioxide engineered (nano)-particle release into the environment. *Environ Sci Nano*. 2019;6(3):763-77.

8. Gottschalk F, Sonderer T, Scholz RW, Nowack B. Modeled environmental concentrations of engineered nanomaterials (TiO2, ZnO, Ag, CNT, fullerenes) for different regions. *Environ Sci Technol.* 2009;43(24):9216-22.

9. Unrine JM, Hunyadi SE, Tsyusko OV, Rao W, Shoults-Wilson WA, Bertsch PM. Evidence for bioavailability of Au nanoparticles from soil and biodistribution within earthworms (Eisenia fetida). *Environ Sci Technol*. 2010;44(21):8308-13.

10. Raee MJ, Ebrahiminezhad A, Gholami A, Ghoshoon MB, Ghasemi Y. Magnetic immobilization of recombinant E. coli producing extracellular asparaginase: an effective way to intensify downstream process. *Sep Sci Technol*. 2018;53(9):1397-404.