WHY NANOPARTICLES IN THE ENVIRONMENT MAY BE A BIG DEAL

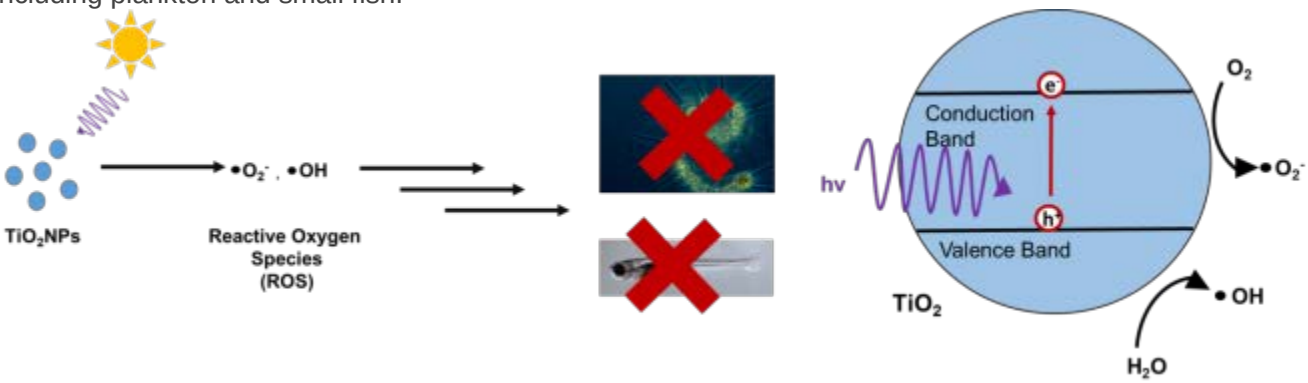
As an industrialized society, we already deal everyday with the consequences of man-made chemical contamination in our environment. These contaminants may be too subtle to easily see (BPA leaching into your personal water bottle, the proliferation of steroids and hormones in drinking water) or so obvious as to be impossible to ignore (the Cuyahoga River fire of 1967, the Gulf oil spill), but what is undeniable is the impact man-made chemical contaminants1 can have on human health and local environments. As society becomes more interested in reaping the potential benefits of nanotechnology, nanoparticle production will increase, the number of nanoparticle-enabled products will increase, and man-made nanoparticles will join more traditional man-made chemicals as environmental contaminants.

Some of the well-known effects of chemical contaminants in the environment. Eutrophication of a fresh water pond (due to excessive fertilizer runoff), sea birds suffering the effects of the Gulf oil spill, and industrial chemical pollution in a small river. Image sources: 1, 2, 3.

After nearly 50 years of detailed study, we know quite a bit about the effect of traditional chemical contaminants (pesticides, plasticizers, pharmaceuticals, etc.) on human or environmental health.[2] However, the possibility that man-made nanoparticles could soon join them in the environment raises new concerns, because nanoparticles may impact the health and stability of local ecosystems in ways that are difficult to predict. Today, we are drawing a distinction between man-made and naturally-occurring nanoparticles; when and where nanoparticles occur naturally, they may actually be an important part of the biological and geochemical processes that are essential for what we consider “normal” ecosystem function.

Just because some nanoparticles occur naturally doesn't mean that many man-made nanoparticles don't pose a serious environmental concern. Ironically, it is nanomaterials' unique size-dependent properties (which may allow us to unlock new and amazing innovations), that could also pose unforeseen problems if nanoparticles are unintentionally released into the environment. Like traditional chemical contaminants, some man-made nanoparticles may be directly toxic to microbes, plants, and animals. Silver nanoparticles, for instance (though they are not toxic to humans), dissolve in water and release silver ions (which are antibacterial). If silver nanoparticles are released into the environment, these types of concentrated silver ion releases could devastate local bacterial populations, with drastic consequences for the affected ecosystems.

There are also several types of nanomaterials that may be detrimental to the environment because they facilitate chemical reactions that can harm plankton, bacteria, and small animals. Many metal and metal oxide nanomaterials are excellent catalysts (materials that speed up the rate of different chemical reactions). If these catalytic nanomaterials are released into the environment, they can enable chemical reactions that generate toxic chemicals, such as free radicals or reactive oxygen species (aka ROSs). One of these nanomaterials is titanium dioxide (TiO2), which is an excellent photocatalyst (ultraviolet light exposure activates its catalytic properties). When illuminated by sunlight, titanium dioxide nanoparticles can catalyze chemical reactions that increase the concentrations of several ROSs (including hydroxide {●OH} or superoxide {●O2-} radicals) in natural waters.3 These reactive oxygen species are known to be harmful to many aquatic organisms, including plankton and small fish.



In addition to being directly toxic to organisms, nanoparticles can enable chemical reactions in the environment which produce toxic chemical compounds. Here titanium dioxide nanoparticles (a photocatalyst) facilitate the production of reactive oxygen species (ROS), chemicals which harm plankton and small fish species. Image adapted via 1, 2.

Source : http://sustainable-nano.com/2014/05/13/nano-contaminants-how-nanoparticles-get-into-the-environment/