The nature of Nanoparticles

Raewyn Turner 2016

Everything about nanoparticles varies: Colour, size, weight, personality, style, movement; what they’re attracted to, what they like, and what they desire.

They may be red, yellow, grey, blue, several colours. Humans can’t see them but by a trick of dark-field microscopy, they can be seen like beautiful stars in a starry sky in all their glorious colours. They can be ‘seen’ by other microscopes too, by touch ( the SEM or TEM needle touches them and makes an impression of their shape).

When they’re first dusted from their container into water or the product they’re intended for, they’re pristine. They’re born metal and from chemical reactions and heat are separated from their origins as tiny but powerful particles.

They love to attach to microorganisms, environmental surfaces, to get into plants, into soil and to be in water, but don’t like sea water.

At 1mm to 200mm or sometimes larger, they start out as themselves but quickly take on behaviours depending on where they are and who they’re with. From then on what they do and how they act is determined by where they are in the world, what they cling to, or what clings to them and what they may encounter.

If they cluster around others like themselves they slow down; but if coated with citrate they don’t huddle together, they can move off freely in which case they’ll have exclusion zones that make them look like each is circled by an inner-tyre tube. The tube can sometimes pop and they’ll get caught up with the soil, weeds, molecules or other particles and get stuck to them. A tyre tube with mesh is stronger and lasts much longer and is harder to deflate. But usually when they’re in any environment they’ll cling to anything they like: soil, particles, because they’re so sticky.

Nanoparticles and other particles are usually negatively charged. Pesticides find nanoparticles particularly attractive and won’t leave them alone, dancing day and night, touching them and generally making pests of themselves—hitching a ride on their back, using them as their wheels, until the nano sticks to root, soil or leaves and finds a home within plant or is consumed by crustaceans, worms, other c-elegans and fish.

They don’t change their shape and unlike molecules they’re not flexible and the carbon nanotubes are extremely strong. Triangles, squares, dots they care about which surface they want to stick to. They’ll roll, flip or drift towards the surface they like, but once there they won’t come to equilibrium with a surface, they refuse to obey the laws of thermodynamics like other molecules do. They’ll cling to algae, giving nothing of themselves but sticking onto its surface and become locked into the flesh of plants.

The gold nanoparticle rewards the plant’s roots by bringing along extra particle sweets that make the plant grow voluptuous and ripe; others lodge in the gills, gut, brains of fish and c-elegans worms and cause deformities. Cerium enters the plant and eats the light within its leaves to make itself so decreasing the plants photosynthesis.

Different sizes of gold nanos reveal themselves as a range of beautiful colours in water, carbon nanotubes conduct tiny electrical signals and mix with conductive plastics, and copper nanos will absorb and re-emit xrays into patterns.

As small as wavelengths of light, nanoparticles are on the verge of quantum effects—are they here or there? Are they communicating with each other instantaneously?

After the media hype and promise that nanoparticles and their properties would be harnessed to create self-assembling robots, the expectations have been trampled underfoot and have an odour similar to the reeds that died from toxic exposure to low concentrations of gold nanoparticles. There are no nanorobots and we seem to now be at a period of disappointment; not only that we don’t yet understand their behavior.

They’ve existed longer than anyone on this earth. Unlike chemicals that reach a steady state that we can understand thermodynamically, nanoparticles are kinetic. They’re a verb rather than a noun and involve time.

They are in part defined by their intrinsic properties ie gold, silver, copper, iron, plastic but its charge depends on its environment, who its absorbed or been absorbed by ( eg C02) what it cosies up to, whether its free floating; these factors determine its extrinsic properties; irreversible, the nanoparticle won’t let go of the macromolecule that determines its extrinsic properties. These won’t dissolve over time, they’ll exist for a very long time. Occasionally the nanoparticle is used to deliver a nutrient or a toxic package in which case the bonds will unravel like the cut string around a gift.

Placed as they are between molecules and atoms, and gross materiality, their function will be understood enough over the next few years to enable both implication and application. Each nanoparticle will have been observed sufficient to determine its values, predict its behavior and know what it cares about and what it will cling to.