EDITORIAL

Nanotechnology under the skin

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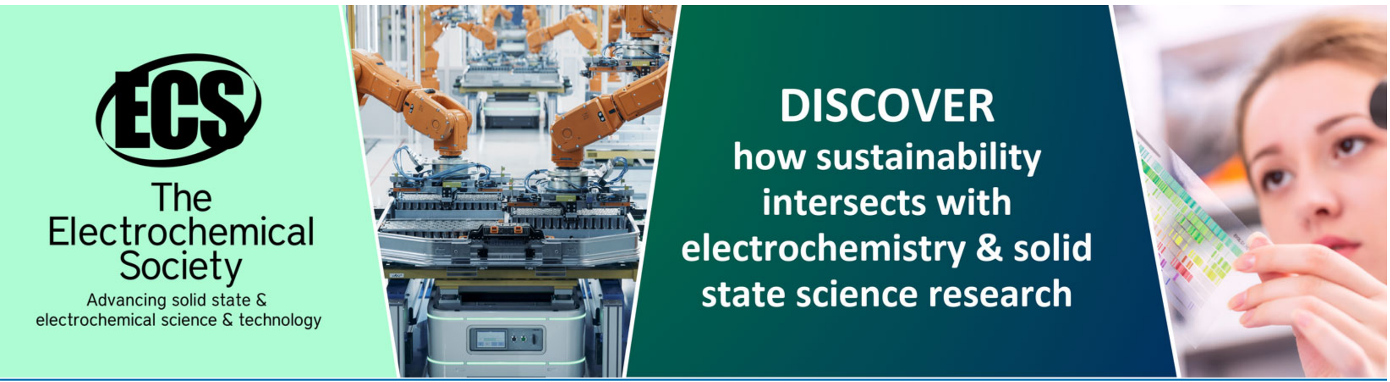

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EDITORIAL

Nanotechnology under the skin

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Concerns over health and ecological implications as living organisms are increasingly exposed to nanoparticles are constantly raised. Yet the use of nanoscale structures in technology and medicine has already infiltrated daily life in countless ways. from cosmetics and sun cream to mobile phones. The potential of nanotechnology in medicine is particularly difficult to ignore and ranges from cancer treatment to immune system activation [1]. The reduced dimensions of nanostructures lend them to targeted diagnostic and therapeutic practices that enable treatment with greater accuracy and less discomfort. Striking a balance between over caution and recklessness can be tricky, and provides an additional drive to investigate and learn more about the science of the nanoscale.

Alongside investigations to exploit nanoparticles in medicine and technology, there have been a substantial number of studies to investigate the possible effects on our health, as well as some studies on the environmental ramifications. Researchers in the US have investigated the effects on aquatic life of ZnO nanoparticles, which may pollute lakes and rivers through accidental release during fabrication or as wash out from consumer materials [2]. The study is focused on zebrafish during early development. Zhu *et al* observe that while there may be evidence that Zn^{2+} ions and ZnO nanoparticles have toxic effects on zebrafish embryos, these effects are apparently mitigated by a type of sediment formulated from the nanoparticles.

The positive contribution of nanotechnology in cancer treatment is an area of particularly high research activity at present. Although traditional chemotherapeutic agents can be effective against the growth of cancerous cells, they can have a detrimental effect on the immune system, which is critical in combating cancer. Researchers in China studied the behaviour of $C_{60}(OH)_{20}$ nanoparticles *in vivo* and found that they play important roles in the anti-tumour process by activating the immune system [3].

As Shiri Weinstein and Dan Peer in Israel explain, manipulation of RNA interference is also a growing field of medical research with huge potential [4]. RNA interference medicine exploits the natural cellular mechanism for the regulation of gene expression, allowing highly specific therapy to target molecules that elude other techniques either because they lack ligand binding domains or are too similar to other crucial molecules in the body. Delivery of RNAi medicine requires nanocarriers that are well characterized, easily functionalized and biocompatible, can evade the immune system, have a low rate of aggregation in order to avoid toxic accumulation in the body, are small enough to penetrate target tissues but not too small to avoid renal clearance, and accumulate in the target cells over other cells (or tissues), among other desired attributes.

Carbon nanotubes [5], the wonder structures of modern nanoscience and technology, have unsurprisingly attracted a great deal of interest in medical research. Their cage-like structure and low cytotoxicity has inspired research into using them for drug delivery. Researchers in China conjugated single-walled carbon nanotubes with integrin avβ3 mAb as a specific targeting component, aimed at integrin avβ3-positive cancer cells [6]. Wallace and Samson in the UK have used coarse-grained molecular dynamics calculations to study the adsorption mechanism of bilayer-forming lipids and detergents on carbon nanotubes, which is particularly important since lipid-coated carbon nanotubes are likely to be less disruptive to cell membranes [7]. The toxicity of carbon nanotubes has been the topic of much investigation, not only with a view to their medical applications [8], but also in view of the possible inhalation of carbon nanotubes used in the electronics or computing industry should they become airbourne [9].

Despite such concerns, carbon nanotubes continue to attract interest for the promise they hold for aiding medical treatments. In this issue, researchers in Brazil analyse the impact of multi-walled carbon nanotubes on the immune system in terms of the activation of macrophages, the proliferation of antigen-specific and nonspecific T lymphocytes, the production of cytokines, and the induction of an antibody response to ovalbumin [1]. Their work demonstrates the important immunostimulatory effect of carbon nanotubes.

Reports on the potential of nanoparticles to be the bane or boon of our future world span a colourful spectrum. Like microorganisms that can be critical to life processes and fatal too, there is no doubt a little yin–yang in the role of nanoparticles in our future. Perhaps one of the exciting elements in nanomedical research is the possibility of putting materials with potentially harmful characteristics to use for healing. The results of scientific endeavour at the nanoscale continue to progress our understanding, allowing us to maximise the potential of nanotechnology within informed restrictions. Where knowledge lays the boundaries, a little imagination adds wings, and the current state of research in nanomedicine seems well set to take flight.

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