Joining forces

Risk assessment and life-cycle assessment provide complementary information on the impact of a technology on the environment. We present diverging opinions on how to integrate the two approaches to best evaluate the environmental impact of engineered nanomaterials.

Those who have attended a popular lecture on nanotechnology will be familiar with the moment in which the presenter asks how many people in the audience already own some nanomaterials. The presenter won't really wait for an answer and within a few seconds will reach into a pocket and extract a smartphone declaring "probably all of you". It is indeed true that most people do not realize how diffuse the use of nanotechnology already is and how likely it is that it will rise steadily in the coming years. Aside from in electronics, engineered nanomaterials are already used in a variety of products like cosmetics and food packaging, and are likely to become integral parts of photovoltaics and energy storage devices.

With such widespread potential use, the implications for the environment must be carefully evaluated to ensure that nanotechnology-enabled products are properly regulated. It is essential to assess the extent to which engineered nanomaterials could be harmful for the environment and for humans, and this is usually achieved through a procedure known as risk assessment (RA). More generally, the environment will also be affected by the synthesis, usage and disposal of nanomaterials, for example in terms of energy consumed or CO_2 emitted. This holistic view of environmental impact can be obtained from a process known as life-cycle assessment (LCA).

In this issue we publish three Perspectives about the possibility of integrating RA and LCA to assess nanomaterials, either by refining the methods, for example incorporating RA elements into LCA, or more simply by combining the results of the two approaches applied independently. Jeroen Guinée and co-authors (page 727) provide a detailed overview of the principles behind the two procedures. Using silver nanoparticles incorporated into socks for antibacterial effects as an example they explain the different views that the two approaches provide. In one case (RA) the potential hazard of releasing silver nanoparticles into the environment. In the other case (LCA) information like the difference in energy used and CO_2 emitted by producing, washing and disposing of socks with and without silver nanoparticles. The authors also outline four schools of thoughts on the integration of the two procedures, and encourage cooperation between experts in the two fields to guarantee that the most complete environmental assessment is performed while the technology is developed, rather than afterwards.

In their Perspective, Guido Sonnemann and co-authors (page 734) advocate the integration of the two approaches directly at a methodological stage, with the purpose of providing regulators with the most complete information. The authors outline three levels of integration, suggesting that the lowest integration level, known as site generic, requires little effort to be achieved and could provide guidance for the development of environmentally benign nanomaterials from early stages.

It seems clear that the lack of complete data about the environmental effect of nanomaterials will remain a challenge for the foreseeable future, but action to regulate nanomaterials has to proceed anyway.

The opposite view is provided by Igor Linkov and co-authors (page 740), who propose that the fundamental differences in the conditions and assumptions as well as in the purpose of the two methods make their integration unpractical. The authors believe that a more pragmatic approach is to apply the two methods in parallel and then combine the results.

Although we cannot conclude at this stage whether integrating methods or results will provide the best outcome, is clear that a combination of some sort is desirable for a complete evaluation. It also seems clear that the lack of complete data about the environmental effect of nanomaterials, both in terms of toxicity and of environmental impact more generally, will remain a challenge for the foreseeable future, but action to regulate nanomaterials has to proceed anyway.

LEE MARTIN/ALAMY STOCK PHOTO

Are socks with silver nanoparticles better or worse for the environment than socks without?

The necessity for stronger initiatives to regulate nanomaterials is expressed in two other articles in this issue. In his Commentary Steffen Foss Hansen (page 714) proposes a framework to regulate nanomaterials that involves registration, evaluation, authorization and categorization. It is difficult to predict whether it will be possible to implement such a framework or any variation of it. But the attempt to create a comprehensive procedure that aims at keeping into account the complexity of nanomaterials' structures and properties is an important step that should be applauded.

Finally Finbarr Murphy and co-authors (page 717) present the field of nanotechnology from an insurance point of view. The extent to which it is necessary to implement insurance policies specific to nanomaterials is not something often considered by academia or industry. However, as the authors of the Commentary explain, the lack of clarity on risks associated specifically to the nanoscale could be seriously detrimental to the development of the nanotechnology-enabled products, and this can only be avoided by more-effective communications between the insurance sectors and researchers. ❐