

## Editorial

# The challenges of green nanotechnology

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### Summary

Nanomaterials have great impacts on life sciences; however, these advanced materials may induce inadvertent consequences. Thus, this editorial will highlight the futuristic challenges in green nanotechnology.



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The knowledge about the behaviour of nanomaterials and the advancements in nanotechnology have clearly evidenced the advantages of the use of a high surface to mass ratio in heterogeneous reactions and discovered the tremendous capabilities of so small materials that are suitable to act at the molecular scale.

On moving from the microlevel to the nanolevel, we have found innovative applications for old materials and it has also opened the search for new nanomaterials. Thus, nowadays there is a tremendous amount of research with potential applications in different industrial and analytical fields, as well as clinical application for diagnosis, treatment of illnesses and drug delivery. Because of that, the search for the biocompatible and toxin-free nanomaterials is mandatory to move from the bench to the real world and the safe use of these materials in nanomedicine.

On the other hand, there is a social responsibility concerning the production and use of nanomaterials and their potential environmental deleterious effects. Think on the fact that the generalized use of nanomaterials could create a new generation of nanopollutants different from those provided by suspended macro or micro particles with many common aspects with those regarding volatile compounds and vapours. The uncontrolled emission of nanoparticles containing cadmium and other heavy metals, as core materials, together with the use of toxic compounds, as capping materials, could contribute to enhance the mobility of dangerous products in the environment and create a new type of pollutants with a high reactive capabilities and small associated sizes suitable to move from the treated materials to the air and water and to pass through the cell membranes. To evaluate all the aforementioned unknown processes, we need to increase our knowledge about the transport

and availability of materials under study together with the evaluation of aspects regarding synergistic and antagonistic characteristics of the nanomaterials employed in our laboratories.

It is true that in many cases, we are at the beginning of the story and that the tremendous possibilities offered by the new nanomaterials cannot be easily complemented, with a deep knowledge on their potential side effects. However, this last aspect is our own concern as both scientists and citizens, and it would be dramatic to generalize the use of our basic studies and to move from the academic level to the industrial and applied use without making a correct evaluation of the potential risks.

In order to do not stop and do not slow down our research, and to move safely from the bench to the real world, it could be a good starting point to work on nanomaterials with an intrinsic absence of toxic components; thus moving to a green nanotechnology, well focused on materials and methods free from deleterious environmental side effects and potential risks for operators and in such a frame, we must think on the sustainability of our research effort, focusing on natural original nanomaterials and soft techniques which, besides reducing the risks, could improve the economic opportunities of application of our studies.

In short, it seems important, from my point of view, to think about the toxic nature of some of the core components of materials used nowadays at the laboratory scale and on the molecules employed for the modification of innocuous materials, like silicon, carbonaceous or noble metal nanoparticles, in order to assure their biocompatibility and absence of side effects on natural media and biota, together with a conscientious exploration of the possibilities offered by natural products, in order to be used as raw materials

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for the development of our nanodevices.

The challenge of a sustainable nanotechnology is not only an ethical concern but also offering a way for the enlargement of applications of our studies because, nothing that starts with wrong toxic materials could be suitable to produce correct results of a general applicability at clinical or industrial scale. Hence, we must be careful in our research, taking into account its potential dangerous aspects in order to improve the safety also in our own laboratories and future applications, thus moving from the consideration of simple practical and successful results to their complementarity with environmental effects. The aforementioned considerations must also concern the

publication of works in this field and thus, in the published works, authors must consider safety aspects regarding the materials to be used together with an environmental evaluation of the methodologies proposed in an eco-scale. All these efforts, be sure, will contribute to improve the safe use of our work and enhance the applicability of our research.

#### **Ethical issues**

There is none to be declared.

#### **Competing interests**

The author declares no conflict of interests.