Nutrafoods (2013) 12:111
DOI 10.1007/s13749-013-0036-4



# NanoSustain project

## *Successful completion of the EU FP7 project*

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The NanoSustain Project Coordinator, *Rudolf Reuther* (rudolf.reuter@enas-online.com), announced in his final newsletter of August the successful completion of the EU FP7 NanoSustain project, after three years of intensive research work, reporting and evaluation.

Although still under review by the European Commission, the final report was submitted in July 2013 including the second periodic report with an extensive description of the analytical and experimental work performed and results achieved, and the final project report summarising the dissemination and exploitation of the outcome of the project and how the project has fostered current efforts on nanosafety towards a more holistic assessment of the benefits and risks associated with engineered nanomaterials (EN).

The huge amount of brand new scientific data generated during the course of the project has provided new evidence and knowledge on how nanomaterials may interact and react with living systems and how strongly their behaviour depends on the particular physicochemical form and surface properties rather than on composition or concentration. The project focused on three nanoparticles ($TiO_2$, ZnO and multiwall carbon nanotube) produced worldwide in large quantities, in addition to nanocellulose, a relatively new compound derived from sustainable sources and with an enormous potential for future applications.

Overall results suggest and confirm the basic assumption that any human toxicity associated with nanoproperties or nanostructures may be masked or even eliminated when free nanoparticles become embedded, bound or incorporated in the solid matrix of a product or environmental substrate.

Concerning the ecotoxicity of nanoparticles, only nano-ZnO showed an acute and dose-related toxic response (against *Vibrio fischeri*), which corresponded well with the concentration of dissolved $Zn^{2+}$ ions, indicating that the observed toxicity may be ruled by the known dissolution of divalent $Zn^{2+}$ from the solid matrix rather than by nano-ZnO.

None of the tested pure nanomaterials showed any "nanospecific" toxicity. Dustiness tests performed to simulate routine handling of nanomaterials showed that nanoparticles are released from all tested products or composites irrespective of whether these products contained nanomaterials or not, and that the generated dust revealed either no toxicity (from carbon nanotubes containing epoxy resins) or a lower inflammatory response (from nano-$TiO_2$ containing paint) than the pure nanomaterials, which will limit any possible risks to human health. But the extent to which the as yet unknown release of nanomaterials from products into natural systems (water, soil) may give rise to indirect (environmental) exposure with possible adverse effects is still to be established.

Based on the comprehensive data generated on human and environmental hazard, exposure and possible risks, NanoSustain explored the suitability of current waste treatment technologies to safely handle nanomaterials at the end of their product life.

To sum up, a good level of degradability was observed and there was no ecotoxicity of paper containing nanocellulose, meaning that this organic nanomaterial may rapidly degrade and transform into harmless compounds when released in the environment.

Also, incineration has been tested as a final treatment option for carbon nanotubes (CNT) containing epoxy resins, where reuse or recycling or land-filling may not be a possible or safe disposal option.

This technology did not give rise to the release and emission of CNT particles in the combustion gas or their deposition in the resulting bottom ash but proved suitable to recover the energy contained in this particular nanoproduct.

Melting of coated glass released nanoparticles, but the number and mass concentration of emitted particles did not depend on whether coating was applied or not, or on the type of coating, i.e., whether nano-ZnO was added or not. In addition, leaching experiments showed that $Zn^{2+}$ is released in particular at low and high pH, low salinity and high DOC from both the nano- and micro-sized ZnO-coated glass, which may be particularly relevant in case these products end up in land-fills.

To obtain a more holistic view on the potential environmental impact of selected nanomaterials that may occur along their product chain, but also to identify new opportunities for a better environmental design, behaviour and sustainability at an early stage, life cycle analyses (LCA) were also realised for some applications: nanocellulose applied in various types of paper, nano-$TiO_2$ added to paint, nano-ZnO used in coated glass and CNT embedded in epoxy resins.

Four life-cycle phases were addressed, i.e., (1) the production of EN, (2) production of EN-containing products, (3) their use and (4) end-of-life recycling/disposal. The detailed results can be seen in the project homepage (www.nanosustain.eu), which will remain active and provide ongoing open access to follow up the continuous publication of all results achieved within the NanoSustain project.

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