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NIA Comment

on the publication
'In Vivo Skin Penetration of Quantum Dot Nanoparticles in the Murine Model: The Effect of UVR'
(Mortensen et al., *Nano Letters*; 2008; ASAP Web Release Date: 08-Aug-2008; (Letter) DOI: 10.1021/nl801323y)

The issue

A recently published study in a scientific journal examined the impact of UV-radiation (UVR) on nanoparticle skin penetration by using an *in vivo* semiconductor quantum dot nanoparticle (QD) model system on mice.

The study concluded that qualitatively higher levels of penetration were observable in the UVR exposed mice.

It is important to put the results and conclusions of this study into context and perspective.

The facts

- Sunscreens may contain a number of different organic and/or mineral UV-filters to create the sunscreen's 'sun protection factor' (SPF), which protects skin from effects of UVR:
    - Many studies have shown that the use of sunscreens reduces the occurrence and the development of skin and lips cancers, and herpes labial. [1, 2, 3]
    - Sunscreens protect DNA from deteriorations induced by ultra-violet radiations, reduce the appearance of modified squamous cells and the development of certain indices of the melanoma. [4, 5, 6, 7, 8]

Nanotechnology Industries Association

- Scientific studies have shown that the presence of mineral UV-filters significantly enhances the SPF-properties of a sunscreen, as well as increasing the durability of organic UV-filters, which may be present in sunscreen formulations. [9]

- The most common types of mineral UV-filters are TiO_2 and ZnO. Both materials are used in sunscreens in wide variety of different formulations, sizes, surface coatings and dopings, in order to make them waterproof and to improve their application characteristics. The authors of the study suggest that *'these coatings may alter their skin penetration characteristics.'*

- The study repeatedly refers to the application of TiO_2 and ZnO pigments in sunscreens, but in fact uses an *in vivo* skin model, which is not representative of the conditions encountered during the use of a sunscreen formulation.

- The study used semiconductor quantum dots (QDs) as model nanoparticles, in order to facilitate the imaging of the particles during the experiments. The authors acknowledge that *'this result does not directly address the issue of metal oxide NP penetration through UVR damaged skin'*, demonstrating that the study is not representative of commercial sunscreens. Indeed, a large number of other studies have demonstrated that mineral sunscreens DO NOT cross the skin barrier after topical application on either healthy or compromised skin. [10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23]

- The study suggests that qualitatively higher levels of QD penetration were observable in the UVR exposed mice. The conditions created in the investigation are designed to be the most "susceptible" to show an effect, since the specific quantum dots used in this paper (i.e. QDs 565) have been reported in another work on porcine skin *in vitro*. [24]

- In this study, the QDs are reported to penetrate to some extent through intact skin, as well as irradiated skin. It is important to point out that the stratum corneum of hairless mice is extremely thin and easily disrupted; the authors of the study acknowledge that *'the weaknesses in the stratum corneum [...] may contribute to increased stratum corneum penetration possibility.'*

- Numerous studies, including some conducted by government labs, have shown that sunscreen pigments are non-toxic and do not move around the body even when introduced subcutaneously and intravenously. [18, 22, 25, 26, 27]

- In conclusion, the following should be taken into consideration:

  - Skin barrier properties are lower in mice compared to humans, due to structural differences including thinner stratum corneum in mice.

  - The size of QDs reported in this paper (20-30 nm) corresponds to the hydrodynamic diameter, not the actual "physical" diameter (5 nm). In sunscreens, however, individual nanoparticles aggregate and agglomerate to form much larger units, which are typically > 100 nm.

  - The paper clarifies that, even after UV-irradiation, skin penetration was minute, with most of the QDs found in the hair follicles and skin folds as expected.

In summary, although the study provides insights into how UVR and nanoparticles might interact on the skin, its results can not be interpreted as applying to sunscreens that utilize TiO_2 and ZnO pigments in their formulations.

The Nanotechnology Industries Association

Formed in 2005 by a group of companies from a variety of industry sectors including healthcare, chemicals, automotive and consumer products, the Nanotechnology Industries Association (NIA) creates a clear single voice to represent the diverse industries in the multi-stakeholder debate on nanotechnologies.

The NIA provides a purely industry-led perspective, derived from the views of the collective membership and forms an interface with government, acting as a source for consultation on regulation and standards, communicating the benefits of nanotechnologies and interacting with the media to ensure an ongoing advancement and commercialisation of nanotechnologies.

For further information visit http://www.nanotechia.org or contact us on enquiries@nanotechia.org.

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Nanotechnology Industries Association

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