# Ivy Nanoparticles for Sunscreen UV Protection and Cosmetic Applications

Mingjun Zhang, Quanshui Li, Lijin Xia, Zhili Zhang, Mingjun Zhang
Department of Mechanical, Aerospace and Biomedical Engineering, University of Tennessee, Knoxville TN

**Statement of Purpose:** Sunscreen is to protect exposed skins by absorbing or reflecting the ultraviolet solar light. The ultraviolet ranges to be blocked have been categorized by UV-A (320-400 nm) and UV-B (280-320nm)(*1*). The ingredients in the sunscreen creams usually contain organic compounds, inorganic particles and organic particles. The organic compounds, such as oxybenzone, absorb the ultraviolet light. The inorganic particles, such as ZnO and $TiO_2$(*2*), reflect, absorb and scatter the solar light. Furthermore, the organic particles, such as Methylene bis-benzotriazolyl tetramethylbutylphenol, can also reflect, absorb and scatter the solar light. For sunscreen protection, there are some disadvantages in the inorganic materials. For example, $TiO_2$ has reported on the low hazard potential to human skin(*3*). It also has some chemical oxidation to induce DNA (*4-5*) and RNA damage (*6*). There is a clear need to use organic nanoparticles for sunscreen to reduce the potential health concerns. We propose using ivy nanoparticles.

**Methods:** The organic nanoparticles secreted by ivy have been observed for surface affixing (*7-8*). Following a similar procedure (*9*), solutions were prepared by immerging the ivy rootlets into water. Most of the solutions were dialyzed with dd$H_2$O through a cellulose membrane (Sigma-Aldrich, D9277) to filter out all chemicals less than 12,500 Daltons. Then the dialyzed solution was further filtered using millipore membrane (220 nm Nylon filters). Half of this solution was filtered again with 20 nm filters. Atomic Force Microscopy (AFM), high-performance liquid chromatography (HPLC), Dynamic Light Scattering (DLS) and absorption spectroscopy have been conducted to characterize the optical properties of the organic nanoparticles secreted by Ivy.

**Results:** From the dynamic light scattering experiments, the organic nanoparticles only exist in the solution filtered by 220nm millipore membrane while nanoparticles have been completely filtered out by 20nm membrane. So the differences between them are due to the absorption of the organic nanoparticles. As shown in the Figure 1, the absorption configurations of the sample show strong ultraviolet and weak visible absorption, and the sharp absorption edge from the ultraviolet to the visible range. It will be a great advantage in sunscreen for blocking the ultraviolet light and allowing high visible transparence.

The absorption spectra of ZnO and $TiO_2$ are shown and normalized to their own absorbance at the wavelength of 280nm. Comparing with the behaviors of ZnO and $TiO_2$ nanoparticle solutions, the organic nanoparticles have obvious advantage, which is the sharper decreasing near to the visible range. The concentrations of TiO2 and ZnO in the commercial sunscreens can be greater than 5%. The organic nanoparticles with such high concentrations have resulted in the strong scattering and absorption. It is better than the pure chemical compounds. Another important feature of the organic nanoparticles from the plants is their low hazard to human skin and cells.

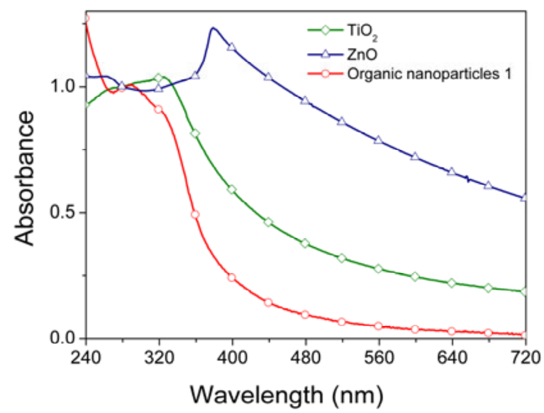


Figure 1. The absorption spectra comparison of the organic nanoparticles with ZnO and $TiO_2$ nanoparticles. Each curve is normalized with their own absorbance at the wavelength of 280 nm.

**Conclusions:** The organic nanoparticles from the plant ivy and their optical properties have been characterized. The ultraviolet absorption properties of the organic nanoparticles have been recorded experimentally, which have strong ultraviolet and weak visible absorption and a sharp absorption edge. These properties will be useful for the ultraviolet protection. The simulations about organic nanoparticles for their sunscreen application have given the results of the most effective extinction sizes in the ultraviolet range. In addition, the adhesive ivy nanoparticles will help comsmetic products stay longer on skins, which is a great benefit for skin nutrition absorption.

**References:**

1. F. P. Gasparro, M. Mitchnick, J. F. Nash, *Photochemistry and Photobiology* **68**, 243 (Sep, 1998).
2. G. P. Dransfield, *Radiation Protection Dosimetry* **91**, 271 (2000).
3. D. B. Warheit *et al.*, *Toxicology Letters* **171**, 99 (Jul, 2007).
4. R. Dunford *et al.*, *Febs Letters* **418**, 87 (1997).
5. K. Hirakawa, M. Mori, M. Yoshida, S. Oikawa, S. Kawanishi, *Free Radical Research* **38**, 439 (2004).
6. W. G. Wamer, J. J. Yin, R. R. Wei, *Free Radical Biology and Medicine* **23**, 851 (1997).
7. M. Zhang, M. Z. Liu, H. Prest, S. Fischer, *Nano Lett.* **8**, 1277 (May, 2008).
8. M. Zhang, M. Z. Liu, S. Bewick, Z. Y. Suo, *J. Biomed. Nanotechnol.* **5**, 294 (Jun, 2009).
9. L. Xia *et al. J. Biomed. Nanotechnol, submitted.*