Characterisation of protein-nanoparticle conjugates

Hsiao-Chi Chuang [1,2], Tzu-Tao Chen [2], Tim Jones [3], Kelly BéruBé [4], Chii-Lan Lin [1,2], Tsun-Jen Cheng [5]

[1]School of Respiratory Therapy, College of Medicine, Taipei Medical University, Taipei, Taiwan
[2]Division of Pulmonary Medicine, Department of Internal Medicine, Shuang Ho Hospital, Taipei Medical University, Taipei, Taiwan
[3]School of Biosciences, Cardiff University, Cardiff, Wales, CF10 3AX, UK
[4]School of Earth Sciences, Cardiff University, Cardiff, Wales, CF10 3AT, UK
[5]Institute of Occupational Medicine and Industrial Hygiene, College of Public Health, National Taiwan University, Taipei, Taiwan

Background

Depending on the nature of the nanoparticles, reactive oxygen species may be generated, thus disturbing the oxidative balance in the lung environment. The toxicity of the particle may be mitigated by components of the epithelial lining fluid, such as antioxidants. The presence of protein in the lining fluid could also resolve the biological effects of particle exposure. However, the mechanisms of protein-particle interaction remain unclear.

Objective

The objective of this study was to characterise the interactions of proteins with carbon nanoparticles. To achieve this objective, the physicochemical characteristics of carbon black and carbon nanotubes were assessed, as were their zeta potential, hydrodynamic diameters, structural properties, elemental characteristics and aggregation status.

Results and Conclusions

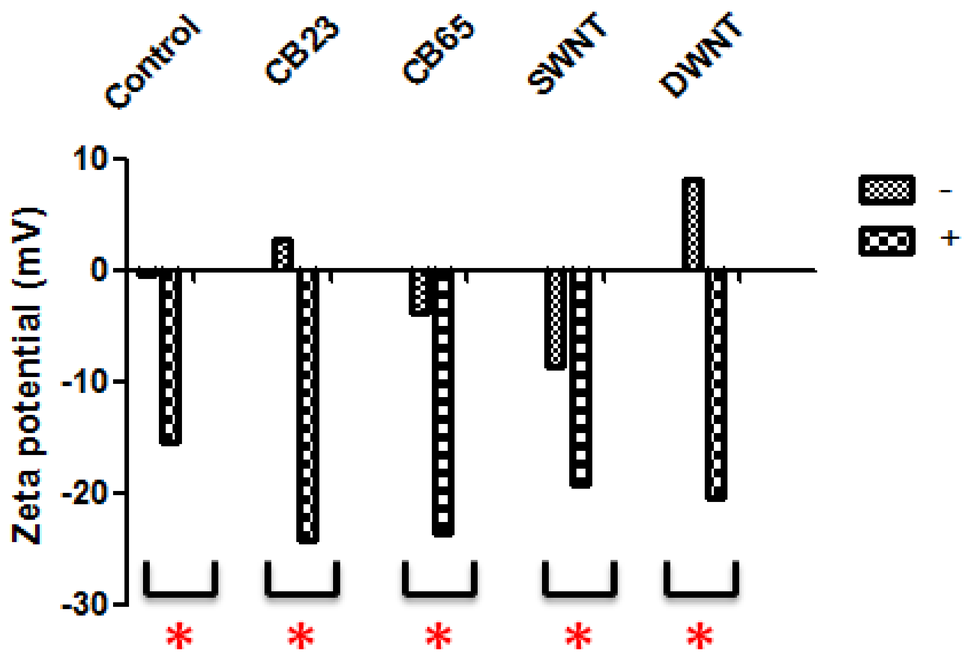

Figure 1. Nanoparticles were used to investigate the interactions between bovine serum albumin (BSA) and particles, including carbon black, which has an average diameter of 23 nm (CB23) or 65 nm (CB65); single-walled nanotubes (SWNTs), which have an average diameter of 1−2 nm (500 nm in length); and double-walled nanotubes (DWNTs), which have an average diameter of 5 nm (5−15 μm in length). The zeta potentials values of CB23, CB65, SWNTs and DWNTs were significantly decreased after the addition of BSA ($p<0.05$).

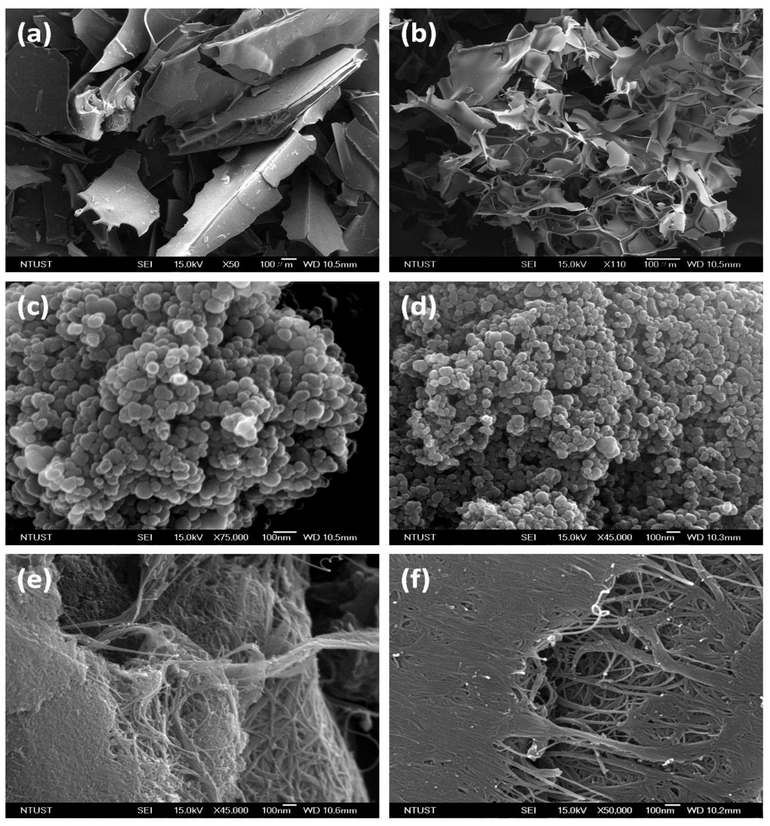

Figure 2. The amorphous morphology of crystalline BSA and lyophilised crystalline BSA was observed (a and b). There were no significant differences in morphology between the particle samples and the protein-particle conjugates: CB23 and CB65 (c and d) and SWNTs and DWNTs (e and f).

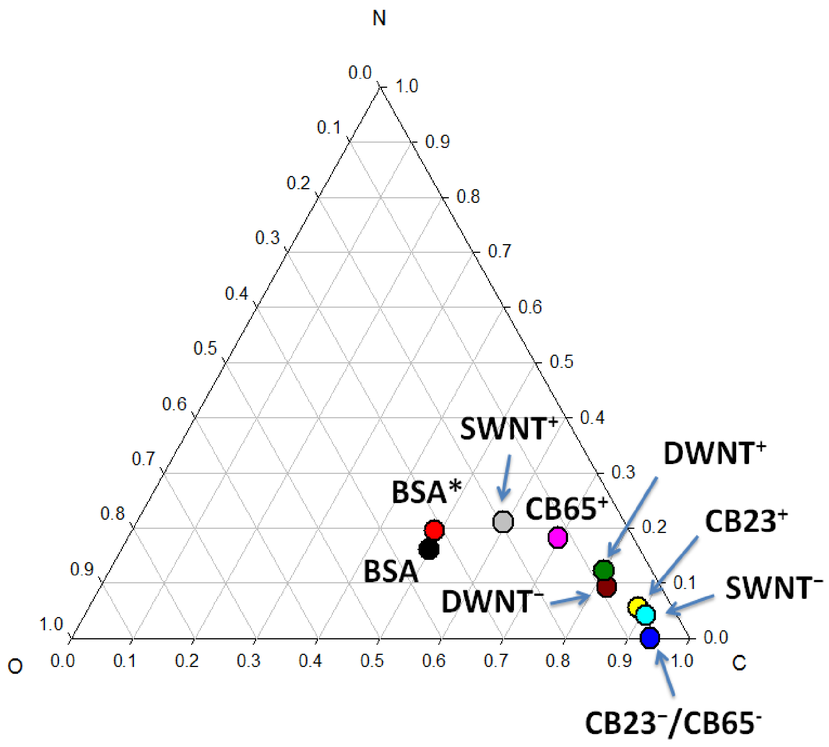

Figure 3. The C-O-N ratios of the particles and protein-particle conjugates revealed that the O-N ratios were increased in the particles after the addition of BSA.

The most plausible mechanism of protein-particle conjugate formation is that the proteins were coated on the particle surface by "surface forces" to form a thin protein layer coated by particles. With regard to human health, the present study revealed that these carbon-based nanoparticles can react with proteins after inhalation and could associate with modification of the lung proteins.

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Taiwan CardioPulmonary Research (T-CPR) group