Is the Shape of Air Particulate Matter Important? A study on the Interactions of the Two Shapes of Titanium Dioxide Nanoparticles with a Model of Pulmonary Surfactant

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Air quality indices are measured based on the concentration and size of the particles. But should the shape of these particles be considered as well? Upon inhalation, Air Particulate Matter with a size of less than or equal to 2.5μm (PM2.5) can reach the deepest areas of the respiratory system called alveolar region where the gas exchange with blood circulation happens. In this zone, the walls of almost 500 million tiny alveoli sacs are lined with a tiny layer of fluid which causes a high surface tension and instability in this large air-liquid interface. However, thanks to the lung surfactant, there is no collapse of this region in a healthy human. Therefore, the first barrier that PM2.5 encounter before reaching the blood circulation is the interface covered by a monolayer of lung surfactant molecules. The purpose of this research is to study the interfacial properties of these monolayers interacted with titanium (IV) oxide nanoparticles with two different shapes, spherical and irregular ones, and with the same average size of 20 nm. Dipalmitoyl phosphatidylcholine (DPPC) as one of the main constituents of the pulmonary surfactant was used as the synthetic model. Using Profile Analysis Tensiometry (PAT) as an automatic set-up working based on Young-Laplace equation, we measured the interfacial tension and surface dilatational viscoelasticity in the pendant drop mode. The temperature was constant at 37°C. Four different amplitudes, 1%, 2%, 5%, and 10%, for the volume change of drops were used. Moreover, various frequencies, 0.1, 0.125, 0.25, and 0.5 Hz, were applied as the representative of the breathing cycle at different ages for a healthy human. The dependence of the interfacial and mechanical properties of the bespoke monolayers on the shape of the nanoparticles can be considered as an important factor for the environmental authorities.