Pulmonary toxicity of boron nitride nanomaterials: a comparison between two-dimensional sheets and nanotubes of similar composition and purity

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Background: Boron nitride (BN) nanomaterials have recently drawn a lot of interest in the material community owing to interesting properties. Nevertheless, their biosafety has yet to be confirmed in vivo. Herein, we investigated the biological impact and clearance of two-dimensional hexagonal boron nitride nanosheets (hBN) and boron nitride nanotubes (BNNT) of similar purity in mouse lungs.
Methods: Mice were exposed by single pharyngeal aspiration to 30 µg of either hBN or BNNTs. At days 1, 7, and 28, bronchoalveolar lavage (BAL) fluids and lungs were collected. The pulmonary adverse effects were evaluated (immune response, histopathology, tissue remodelling, genotoxicity) and put in perspective with materials' accumulation, distribution and clearance from the lungs.
Results: hBN did not cause any significant immune response or lung damages in the exposed mice, despite the presence of materials confirmed by Raman spectroscopy. Moreover, hBN nanosheets were found in alveolar phagocytes, resulting in an efficient clearance from the lungs over time. Conversely, BNNTs caused a strong and chronic inflammatory response, characterized by a sustained inflammation up to 28 days after exposure, as well as the activation of both the innate and adaptive immunity. These responses could be ascribed to the poor clearance from the lungs and the high aspect ratio of BNNTs. Additionally, we observed granulomatous structures as well as fibrosis. However, we did not observe significant DNA damages after performing global lung analysis. Further analysis is ongoing to check if significant DNA damages could occur in the inflammatory areas of the lung.
Conclusion: Despite a similar chemical composition and purity, we demonstrate the safer toxicological profile of BN nanosheets in comparison to BN nanotubes. We also reveal the strong similarities in the lung response to BNNTs and multi-walled carbon nanotubes (MWCNTs), highlighting that the high aspect ratio is a major driver of pulmonary response to nanomaterials.