Nanostrukturierte Materialien: Gesundheit, Exposition, Materialeigenschaften

AP3: Detection of SiO_2 and Ag Nanoparticles in the Lung

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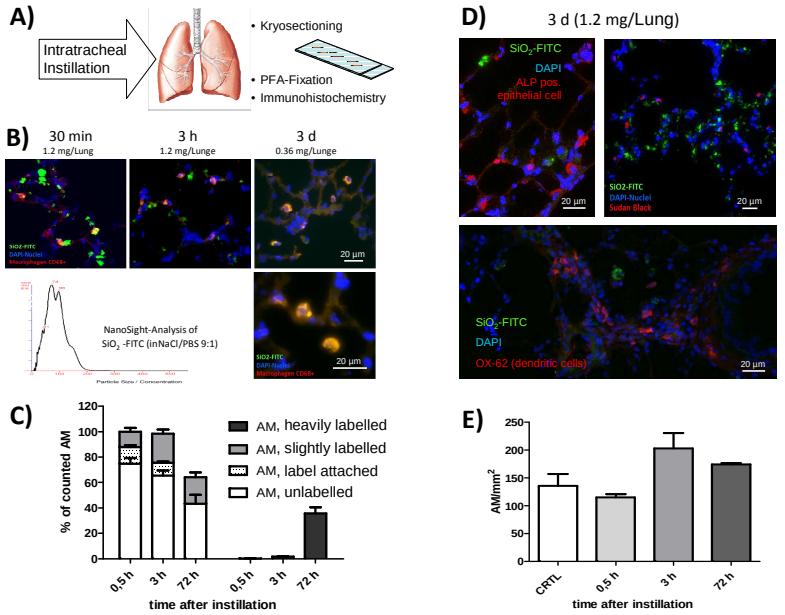
The localization of industrially relevant nanoparticles (NP) composed of silica, silver (Ag) or zirconium oxide (ZrO_2), as well as surface modified modifications thereof, is mandatory for our understanding of the bioactivity of NP within lung tissue. In this paper several labelling and detection strategies were employed to detect NP in the lung.

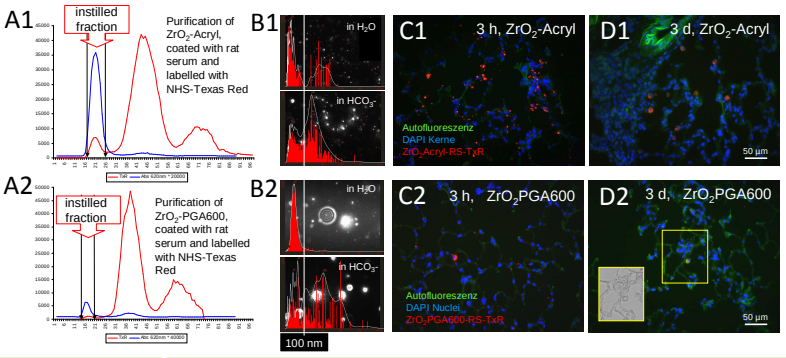
1) SiO_2-FITC NP: Biokinetics and Distribution in Lung Tissue

- Fluorescent SiO_2-FITC NP were administered to rat lungs via intratracheal instillation (ITI). Kryosections were analyzed by fluorescence microscopy after 0.5 - 72 hrs (1A).
- Particles were administered as a nanosuspension (NanoSight Measurement, 1B). After 30 min fluorescent NP agglomerates were found in lung alveolae. After 3 days fluorescent particles appeared nearly exclusively in alveolar macrophages (AM, CD68 positive) (1B-1C). Number of AM slightly increased over time (1E).
- Alkaline phosphatase (ALP) positive epithelial cells, lipid containing type-2 cells (Sudan Black stain), and dendritic cells (Ox62 positive) remained unlabelled (1D).



2) Serum-Coated ZrO_2-NP: Biokinetics and Lung Distribution

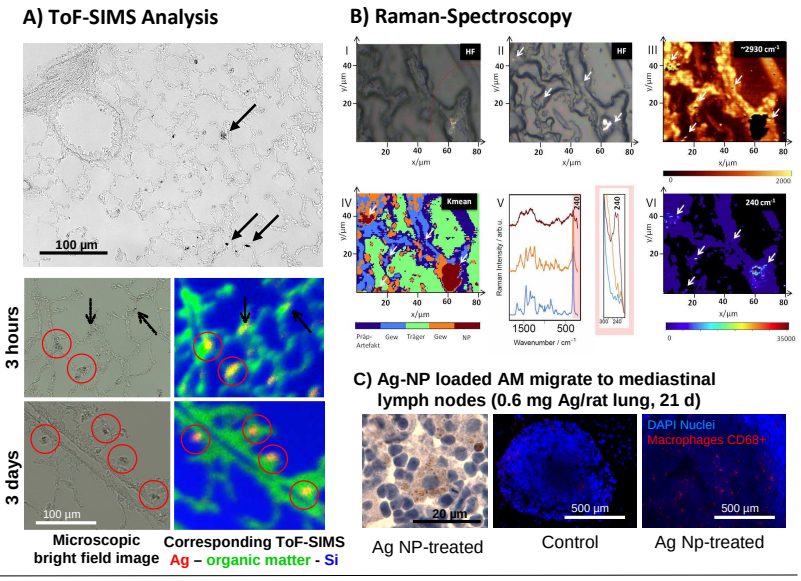
- ZrO_2 NP (modified by acrylic or PEG moieties) were coated with rat serum proteins, labelled with TexasRed-NHS, purified by gel filtration and eluted into a HCO_3^- buffer suitable for instillation (2A).
- NanoSight analyses confirmed that particles labelled this way contained a major nano-sized fraction (2B).
- Tissue distribution analysis of rat lungs showed agglomerated red fluorescent label in alveolae after 3 h; the label was concentrated in AM after 3d (2C).
- Labelling efficacy of ZrO_2-PGA600 (2A2-2D2) was considerably weaker than ZrO_2-Acryl (2A1-2D1) due to low protein binding (see also results of APQ).



3) Ag-NP in Lung and Lymph Nodes

- Ag-NP instilled in rat lungs can be seen as dark grains in AM on sections of lung parenchyma (3A, arrows).
- Selected regions of air-dried lung sections were subjected to ToF-SIMS analysis for the first time. ToF-SIMS confirmed scattered Ag-NP after 3h and a concentration of Ag-NP in AM-like structures (3A, red circles).
- Largely concentrated Ag-NP were also detected by Raman spectroscopy using the 240 cm^{-1} band and a K-mean cluster analysis (3B).
- Ag-NP were also observed in large macrophages migrated to mediastinal lymph nodes (MLN). A far higher number of macrophages was found in MLN of animals treated with Ag-NP (0.6 mg/lung) (3C).

Starting with well dispersed suspensions of SiO_2, ZrO_2, or Ag nanoparticles instilled into the rat lung, the vast majority of particles was gathered within alveolar macrophages after 3 days. Apparently, this early biokinetic behavior is neither influenced by particle coating with acrylic or PEG moieties nor by pre-coating with serum proteins.



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