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Urban particulate matter and human health: a case study from Casale Monferrato (Italy).

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Urbanization and increasing anthropogenic activities (e.g. transport, industry, and fossil fuel use) contribute to increase particulate matter (PM) concentrations in urban environments. Humans are exposed to PM mainly by inhalation, and the ultrafine fraction of PM can pass the brain-blood barrier and accumulate into the brain. This study applies material science characterization techniques, such as optical fluorescence, electron microscopy and magnetic susceptibility to characterize urban PM from Casale Monferrato (Italy), and biosimulant approaches such as pre- and post- interaction studies exploiting simulated brain tissues to assess the possible transformations of exogenous nanoparticles (NPs) in a biochemical environment.

Samples were collected from 14 locations in Casale Monferrato, being representative of five urban land-use types (commercial, industrial, mixed, park, and residential). Investigation of pre-interaction samples were conducted using PXRD, SEM-EDXS, fluorescence optical microscope, and magnetic susceptibility analyses.

PXRD pattern of all land-use type samples detected the presence of different crystalline phases. The dimensional distribution measured on SEM images showed particles with an average diameter of ~12.295 µm. The main heavy metal detected through EDXS investigations is Fe. Fluorescence optical microscopy acquisitions identified fluorescent particles in all samples. Magnetic analyses showed magnetic susceptibility values that range from 0.986 10^{-6} m^3/kg (park) to 4.690 10^{-6} m^3/kg (mixed).

Preliminary results showed that a significant concentration of the analyzed urban PM could be inhaled, and a fraction of it could even accumulate into the brain. To investigate the possible transformations of NPs due to the exposition to the brain environment, dissolution experiments with simulated brain tissue were done. To simulate human brain conditions, 1% agarose hydrogel simulated tissues were synthesized. The simulated tissues were exposed to <100 nm NPs (previously sieved from the starting samples) for 168 hours, after which the NPs were extracted and analyzed. NPs in post-interaction samples were characterized identically to those in pre-interaction samples.

HR S/TEM-EDXS with Dual-EELS and 4D-STEM techniques were used to detect crystallography, chemical composition, bulk and surface alterations, and electromagnetic fields of single NPs both pre- and post-interaction.