Integrated assessment of organic and inorganic atmospheric pollutants in museums: A case study of Rubens' House in Antwerp, Belgium.

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Many researchers, conservators and curators recognize that atmospheric pollution is one of the major threats to works of art. In principle all atmospheric particles, when deposited onto art objects, can be considered harmful due to their potential to cause deterioration. Moreover, like sulphur oxide, particulate matter, under proper conditions, can induce and aggravate surface damage particularly in serving as centres for moisture condensation and adsorption of gaseous pollutants. Characterization of particulate matter, and inorganic and organic gases could therefore elucidate the range of compounds found in the ambient air inside and outside museums and could contribute significantly to future prevention of deterioration of artefacts. This approach to active conservation requires both elemental and molecular characterisation of indoor and outdoor aerosols and gases. Due to the complexity of air pollution, a combination of different techniques was crucial to access the indoor atmosphere. Particles and gases were collected at the Rubens' House Museum in Antwerp, Belgium, where a unique exhibit of this famous 17th century artist's paintings and living quarters are to be seen. The collected aerosol samples were analysed by electron-probe microanalysis, including facilities for low-Z element determination (low-Z EPMA) and by energy-dispersive X-ray fluorescence, to investigate the elemental composition of individual particles as a function of their size and of bulk samples, respectively. In order to explore the chemical, physical and structural information of individual particles, a new approach for transferring micrometer-sized particles between different sample holders has been developed using manipulators, allowing a combination of micro-Raman and low-Z EPMA on the same particle.

Sulphur dioxide and nitrogen dioxide collected onto passive samplers were analyzed with ion chromatography (IC), while ozone was analyzed with UV/VIS-spectrophotometry. To achieve an acceptable base-line resolution for the detection of acetic and formic acids by IC, a custom type column was used. Benzene, toluene, ethylbenzene and xylenes (BTEX), also chemiadsorbed onto passive samplers were analyzed by gas chromatography-mass spectrometry (GC-MS). Besides passive sampling, a simple and efficient method using solid-phase micro-extraction (SPME) and gas chromatography – ion trap mass spectrometry (GC-ITMS) was established for the determination of acetic acid in museum atmospheres as well as in other environments with low air fluxes.

Results are interpreted separately and as a whole with the specific aim of identifying compounds that could contribute to the chemical reactions taking place on the surfaces of these artefacts, causing degradation of the objects.