

Composition Of Aerosols From The Shelter Of The Chernobyl Power Plant

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INTRODUCTION

At present, the direct radiation exposure to the environment from the 4th block of the Chernobyl plant has been reduced significantly due to radioactive decay. However, the molten fuel material within the concrete shelter, the so-called “Sarcophagus”, is continuously releasing atmospheric aerosols, mostly due to the crystallization of the amorphous lava-like materials, fastened by its radioactivity and the repelling of these micro-crystals due to electric charging of the surface layer of the lava because of the alpha-radioactivity. These aerosols might at present constitute the major hazard from Chernobyl, not only locally but also over distances of many hundreds of km. Analysis of the aerosols can give important information to research and forecast of substance properties and state of materials containing the nuclear fuel.

EXPERIMENTS AND RESULTS

The main goal of the investigation was to study the indoor aerosol composition from a place located close to the nuclear reactor of the 4th block of the Chernobyl power station. Aerosols were collected from a room with nuclear fuel lava. Aerosol for subsequent single particle analysis were collected by Berner cascade impactor, which enables the sampling of size-segregated particles, depending on their aerodynamic diameter. The cut-off diameters of the used impaction stages with numbers 3, 4, 5, 6, 7 were 0.25, 0.5, 1.0, 2.0, 4.0 μm , respectively.

Molecular analysis of the samples was provided by a micro-Raman spectrometer (Renishaw in via, GB) with laser excitation at 785 nm. Samples were scanned using the Synchronscan mode from 100 to 3600 cm^{-1} , at a spectral resolution of 2 cm^{-1} .

As an example, Fig.1 represents a white light image of different single particle types deposited on the silver substrate of stage 4 of the Berner impactor. Moreover typical Raman spectra for rod-like single objects and agglomerates of round particles are presented.

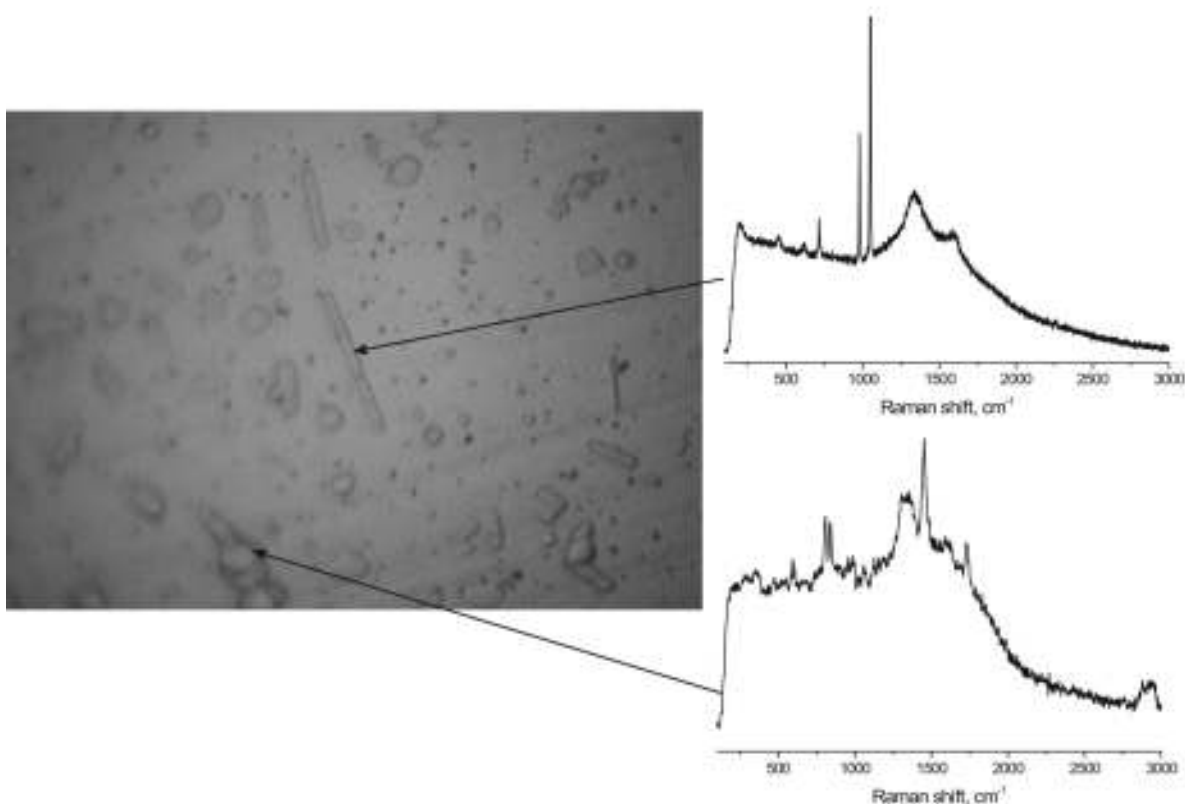


FIGURE 1. White light image of the single particles (with magnification of 1000) on a silver substrate and their Raman spectra.

Rod-like objects were detected on all stages, they had a thickness of 1 μm and a length of 5–50 μm . Raman spectra of these single objects show bands typical for ferro-axinite (at 716, 981 and 430 cm^{-1}), cerussite (at 1056 and 1380 cm^{-1}) and baryte (at 987 and 455 cm^{-1}).

In general, for part of the particles with a diameter of 3–5 μm , the Raman spectra consist of two strong bands, which are assigned to uranium rich particles at 811 cm^{-1} (vibrations of U_3O_8) and 833 cm^{-1} (vibrations of UO_3). Weak bands at 2880 cm^{-1} (symmetric vibrations of CH_2) and 2940 cm^{-1} (asymmetric vibrations of CH_2) are typical for organic components. Raman spectra of more than half of the analyzed particles consist of bands assigned to organic substances with strong bands typical for haematite (at 411 and 1321 cm^{-1}) and chalcocite (1588 cm^{-1}).

ACKNOWLEDGMENTS

The present work was realized in the frame of the international scientific cooperation Project **UA – BOF 2007** No 2837, funded by the University of Antwerp (UA) in the frame of the Special Research Fund (BOF UA).

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