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Identification of urban aerosol origin trough laser light scattering and SEM-EDS analysis

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Abstract

Pollution with suspended particles/aerosols are of major concern in the entire Balkan peninsula, especially PM10 (and lower) fraction exceeding the allowable limits. Timisoara city, the second largest city in Romania is not an exception, today being in the infringement procedures enforced by EU Commission. To overcome the problem and find solution it is necessary to understand the aerosols origin. Several samples were taken and the morphological and compositional analysis of bulk particles were performed by using scanning electron microscopy equipped with an energy dispersive X-ray spectrometer (SEM/EDX) for total suspended particles TSP. Samples were collected through standard method described by ISO 4222. In parallel with total suspended and sediment particles the particle size distribution was analyzed by means of light scattering techniques, in 15 channels from 300 nm to 20 µm equivalent particle diameter.

1. Introduction

Air pollution is a major concern for all nations, with a higher or lower development level. The rapid increase of the industry sector and urban development had generated substantial quantities of substances and poisonous materials, which are, mostly evacuated in the atmosphere. The human society was not willing to recognize that the environment has only a limited capacity to process all this waste, without major changes. As a consequence we are able to observe malfunctions in the health degree, deterioration of flora and fauna,

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materials, buildings, in parallel with the loss of natural resources. Each of us is a polluter but also a victim of pollution. (Apascaritei et al., 2009)

In the past decades Europe citizens become aware of air pollution harmful effect on health and realized the need to reduce air pollution. Numerous researches are conducted across Europe, most of them using traditional HIA (health impact assessment) methods to evaluate the impact of air pollution on health. For example, an extensive study was performed in 25 European cities and found that a decrease to 10 μg/m3 of long term exposure to PM2.5 fine particles could add up to 22 months of life expectancy for persons 30 years of age or older. (Pascal et al., 2013)

The atmospheric particles of interest are emitted both from natural and anthropogenic sources and have various size and chemical compositions, depending on their characteristics (chemical, mixing state) pose significant impact on human health and surrounding climate.

In the present, a significant importance is given to the characterization of individual atmospheric particles, physical and chemical. A detailed characterization of individual atmospheric particles provide important information's about particles sources, formation, transport of chemical species, and many studies have been conducted on characterization of individual atmospheric particles. Scanning electron microscopy equipped with energy-dispersed X-ray analyser (SEM/EDX) is commonly used for single particle study It provides useful information on the morphology, elemental composition and particle density of aerosols and also gives us a better insight about the origin of particles that whether emitted from anthropogenic or the natural processes. (Pachauri et al., 2013)

In this context, the present paper represents the first attempt to characterize bulk particles – and not individual particles in this phase – collected as TSP fraction in Timisoara environment. The elemental composition of individual particles would be more useful then bulk, however, as this is the first SED-EMS analysis conducted to characterize Timisoara aerosols/particles, this approach was selected.

2. Method

The sampling site was located in Timisoara, in a residential, central located area. The city is crossed by several important traffic routes (main one from Serbia to Hungary) as the city has no ring roads. Two methods were used to collect the samples. One was the standard gravimetric method for PM10, in accordance with EN12341:2002; and one for particle deposition rate and concentration, in accordance with ISO/DIS 4222.2 standard. In addition, for particle size distribution and concentration one GRIMM 1108 Optical Particle Counter was deployed on daily basis, in-situ monitoring (excepting night hours).

For the total particle deposition rate a solution with known copper sulfate concentration was used to avoid bacteria and microorganism growth. The equation 1 was used to determine the TSP (deposited) concentration of the sample, in accordance with ISO/DIS 4222.2

$$C_{TSP} = \frac{(m - m_1)}{S} \quad \left[\frac{g}{m^2 \cdot period}\right] \tag{1}$$

where: m is deposited particles mass, in grams; C_{TSP} is deposited particles concentration; m_1 – copper sulfate mass, in grams and S is the area of collecting vessel.

Fig. 1. TSP collection setup. 1 – bird protection; 2 – collecting vessel; 3 – stack; 4 – ground; and view of the collecting site location.

TSP sample was analyzed at National Institute for Research and Development in Electrochemistry and Condensed Matter, Timisoara, with INSPECT S / EDAX GENESIS XM2i SEM-EDS system. The EDS analysis was carried out for only one sample. The sample comes from a LVS3 system with PM10 impactor and quartz fiber filter.

3. Results

In figures 2 to 5 some results are presented. In Fig. 2 a sample of PM10 to PM1 fraction concentrations in ambient air is presented. In Fig. 3, the number of particles in the sample is given, while in Fig. 4 and 5 the results of SEM-EDS analysis of a single sample collected on quartz fibre filter (PM10 impactor) is given.

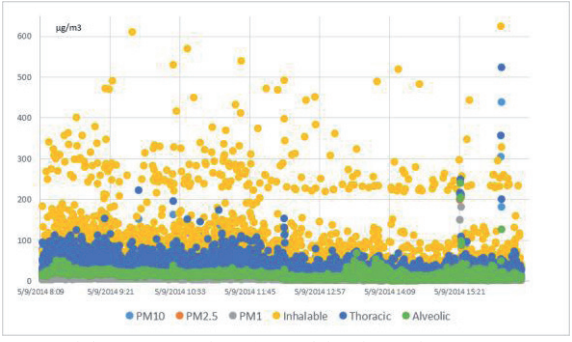

Fig. 2. Particles concentrations (several fractions), frequency 6 seconds.

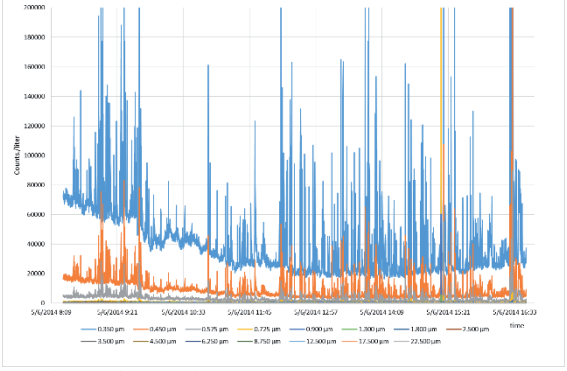

Fig. 3. Particles number (15 sizes from 300 nm to 20 µm), frequency 6 seconds.

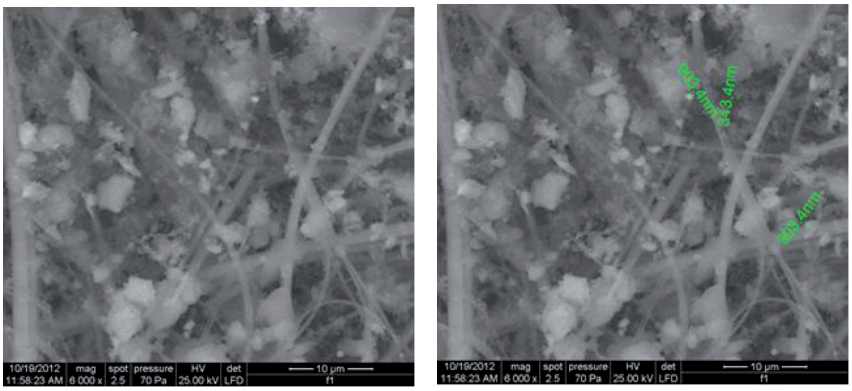

Fig. 4. Sample analysis with SEM.

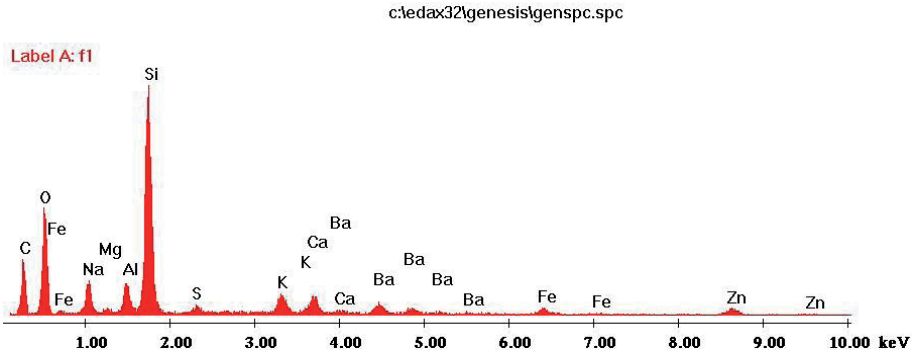

Fig. 5. Sample analysis with EDS.

4. Conclusions

The elemental composition of atmospheric particles were investigated with an SEM-EDX system. The morphological characteristics of the particles were done in 15 sizes, from 300 nm to 20 µm with a GRIMM 1108 Optical Particle Counter.

The results are only the first steps taken to analyse the Timisoara environmental particles, and as only one sample was analysed on SEM-EDX the results are far from being conclusive.

However, analysing the graphs is easy to observe that the number of particle under 1 µm is significant and that EDS results showing various minerals and metals in particle composition lead to the desire to extend the research.

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