



## Ion beam analysis of urban aerosol micro and nanoparticles compared with environmentally related children diseases in two Polish towns

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### Abstract

Urban aerosol particles were collected in two Polish towns—Legnica and Starachowice, and characterised with mass spectrometry methods. Bulk analysis of particulate matter collected on quartz fibre filters was performed using spark source mass spectrometry (SSMS). Analysis of chosen elements revealed the differences in total concentrations in the towns. We found in Legnica more: Sr—5 times with respect to Starachowice, Se, As—3 times, Cl, V, Y, Mo—2 times, Cr, Fe, Ni, Cu, Rb i Pb—less than 2 times. In Starachowice we found more: Ti—40 times, Zn—5 times, Mn—2 times, Br, Co i Zr—less than 2 times. Another technique—secondary ion mass spectrometry (SIMS) allowed us to perform depth profile analysis of collected particles on aluminium plates of cascade impactor. The SIMS results showed “core-shell” structure of particles dependent on their grain size in the range of 300 nm to 15 μm. The shell layer was enriched in Cr, Cu and Pb.

The results were compared with the medical study of the prevalence of environmentally related children diseases observed in these two cities. Questionnaire studies and allergic skin prick tests were performed according to the protocol of International Study of Asthma and Allergies in Childhood (ISAAC). An epidemiological study performed on Legnica and Starachowice children shows statistically similar results besides the compositional and morphological differences of particles suspended in the air of the two towns.

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**Keywords:** Aerosol particles; Depth profile analysis; SIMS; Core-shell structure; Environmentally related children diseases

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## 1. Introduction

Aerosol pollution of atmosphere in industrial areas is supposed to introduce grave effects on human health [1]. A large body of evidence suggests that allergic respiratory diseases are related to air pollution. The main objective of the project was to study the relationship between suspended aerosol micro- and nanoparticles in two different Polish towns of similar size and prevalence of environmentally related children diseases. The towns under comparison were Legnica in Western Poland, an industrial town located near copper plants, and Starachowice located in Central Poland, regarded recently as a town with very low environmental pollution. The particular aim of this project was to analyse the morphology and structure of the particles and check how the particle surfaces differ from their cores and what toxic materials are being carried on their surfaces.

## 2. Methods

Aerosol samples were collected over 24 h time periods from rooftop sites in Legnica and Starachowice with quartz-fibre filter collectors, Burkard spore traps and 9-stage cascade impactors [2]. Bulk analysis of particles collected on quartz filters was performed with spark source mass spectrometry (SSMS) using a magnetic sector analyser. Morphology and structure of particles collected on impactor plates were tested by secondary ion mass spectrometry (SIMS) depth profile analysis using SAJW-05 apparatus, equipped with a 06-350E physical electronics ion gun, a sample rotation manipulator and a QMA-410 Balzers 16 mm quadrupole analyser.

The epidemiological study comprised the representative samples of 9–11 year old children from Legnica and Starachowice. Questionnaire studies and allergic skin prick tests were performed according to the protocol of International Study of Asthma and Allergies in Childhood (ISAAC) [3].

## 3. Results

Collected particulate material was compared for the two towns. Grain size distribution of particles in both towns were similar, showing that sub-micrometer particles were the majority of the suspended mass. PM10 (Particulate Matter 10  $\mu\text{m}$  in diameter and smaller) contamination levels are also similar. However, the bulk composition of collected particulate samples in these two towns shows different contents of 20 chosen elements (Fig. 1). We found 13 elements of higher concentration in Legnica and

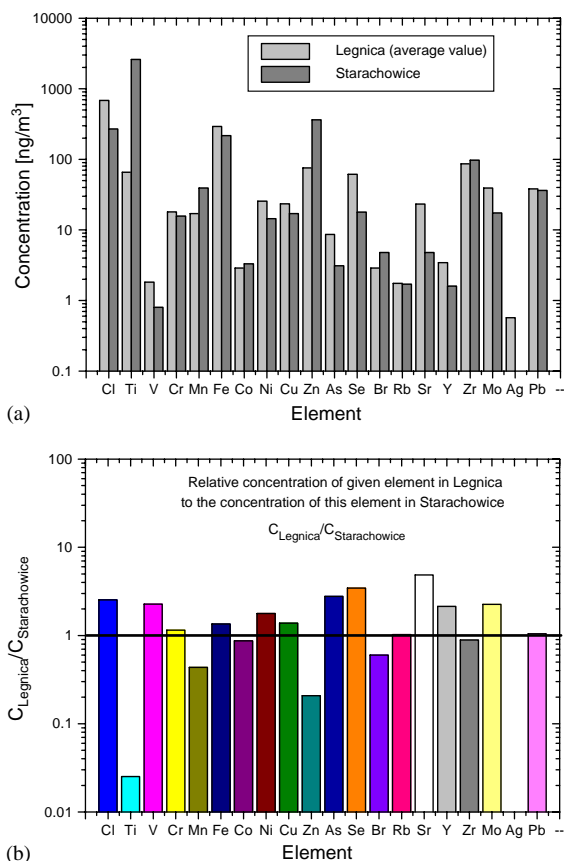


Fig. 1. a, b. Bulk concentration of 20 elements in PM10 particles collected from the air in Legnica (average values of 7 measurements) and Starachowice (single measurement). The values obtained from spark source mass spectrometry (SSMS) analysis are shown in  $\text{ng/m}^3$  (a) Comparison of the concentrations is shown in (b) Values above “1” indicate higher concentration in Legnica, while the values below “1” higher concentration in Starachowice.

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