

CHARACTERIZATION OF ROAD SIDE PARTICULATE MATTER OF DELHI REGION

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Abstract

Elemental composition with their surface morphology of particulate matter in PM_{2.5 - 10} at high traffic zones of Delhi region was studied. The surface morphology of particulate matter was done by scanning electron microscope and elemental distribution was done by selected area EDS. SEM micrographs clearly show that the composition of particulate matter is very complex with layered / branched structure. It was also observed that the particulate material collected on PTFE membrane is largely branched aggregates, crystalline or mixture of inorganic micro or nano crystals. Elemental composition of the particulate matter shows the presence of C, O, Na, Mg, Al, Si, S, Cl, K, Ca, Mn, Fe, Ni, Zn and Pb.

Key words Particulate matter, SEM, EDS, Traffic, Road side PM

Introduction

Air born particulate matter or aerosols, which are mixture of solid and liquid particles, have considerable variation in terms of their chemical composition and size. Aerosols may be primary in nature, which means they are emitted directly from sources such as road traffic or blown dust and they may also be secondary, in that they are formed in the atmosphere through chemical processes.

The chemical composition is an important factor that needs to be addressed whenever particulate matter pollution is concerned. A major contribution to PM pollution in urban areas is believed to be attributed to traffic, especially to emissions from diesel engines are formed at high temperature in the engine, in exhaust pipe or immediately after emission to the atmosphere.

The composition of atmospheric particulate matter is an important factor in component deposition, cloud albedo and cloud condensation nuclei, source apportionment & its origin etc (Charlson et al,1987; Lukac, 1994; Facchini et al., 1999; Horvath, 2003; Nho – kim et al., 2004; Kocifaj and Horvath, 2005), in the impact of aerosols on human health (Chan and Lippmann, 1980; Braunfahrlander et al., 1992; Dockery and pope, 1994; Pope et al., 1995; Berico et al., 1997; Horvath, 1996), and in visibility (Horvath et al., 1997; Tsai et al., 2003). Therefore, understanding the physical and chemical characterization of atmospheric aerosol or particulate matter is very crucial.

Airborne particles are important carriers of metals, certain of which possess toxic properties and commonly are present in excess of natural levels. In urban areas, road traffic is recognized as an important source of both particles and certain metals. Therefore, it would be of great importance to do elemental analysis with its morphological study of particulate material.

Experimental

Site selection & Sampling

Heavy traffic zones were selected for the collection of PM material using dust monitor. Heavy traffic zone chosen for this study was Ashram Chowk, CRR I main Gate, CP. All these samples were collected on PTFE membrane in dust monitor from GRIMM ENVIRON check # 1165, Environment dust station with its met system. This system is placed 3m apart on the roof of buildings about 10 – 15 m above the ground, set at an air flow rate of 1.2 L/min and fitted with 47mm diameter PTFE membrane. The sampling period was 24 hours continuously for 7 days on each site separately.

Morphological Analysis

At the end of each sample period the PTFE membrane paper was weighed on an analytical balance and cut into the small piece of about 10mm x 10mm. The samples membranes of 10 x10mm were mounted on the specimen stubs and given a thin coating of gold for making them conducting to the electron beam. Thereafter the samples were transferred to electron microscope chamber for the purpose of microstructure and compositional analysis. The samples were thoroughly scanned and pictures were recorded at suitable areas for surface structure examination. The elemental composition examination was carried out at number of regions and spectra recorded to ascertain the presence of elements and their composition in the samples. Sample from traffic zones of Delhi is designated as Sample 1. Sample is designated as Sample 2. Model LEO 440 PC based digital SEM along with Oxford – Link ISIS – 300 EDS system is used for this purpose.

Results & Discussion

Chemical and morphological characterization of particulate matter is very important while one wants to get details about the origin and its chemistry in the atmospheric environment. Although It is very tedious work to characterize particulate matter on the basis of SEM and EDS method because it is very complex mixture of different species like material from combustion of fuel, brake pads along with inorganic and / or organic materials.

Morphological characterization of individual PM is tedious job. So, it is essential that PM images from specific sources and PM generated by different, specific conditions be available for reference and comparison, especially in identifying complex mixtures of ambient air PM. Ambient air PM is a complex mixture of carbonaceous clusters, aggregates of carbonaceous matter and inorganic crystals, and clusters and complex aggregates of inorganic crystals, (micro- and nanocrystals, some as small as 1 nm in diameter) [Murr,L. et al 2003].

SEM Micrograph of Particulate matter

Morphology of particulate material collected on PTFE membrane filter paper from the traffic hot spots of Delhi region is shown in Fig 1a & b. In this micrograph one can see the complex material compose of various micro / nano metallic clusters along with some fibrous structure. That fibrous structure might be due to brake pad linings or that could be due to only incomplete combustion of fuel at high temperature. It is clearly evident the complexity of particulate matter it may consist of various micro or nano metallic, organic or inorganic clusters.

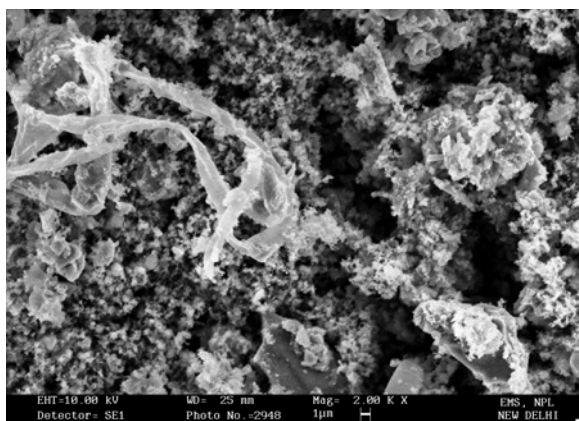


Fig 1a SEM Micrograph of traffic hot spot of Delhi

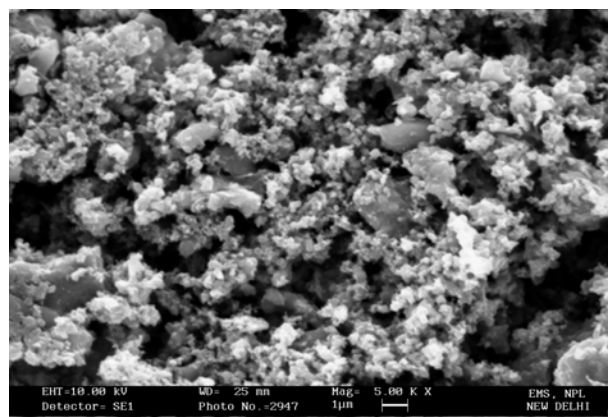


Fig 1b SEM Micrograph of traffic hot spot of Delhi

Energy Disperse spectroscopy

The compositional analysis of these samples was estimated at various places of micrograph. Various elements like C, O, F, Na, Mg, Al, Si, S, Cl, K, Ca, Mn, Fe, Ni, Zn, Pb were analyzed. Although F, Mn, Ni and Zn were not detected by this technique. These results are summarized in Table 1 with their percentage by weight.

Table 1 Percentage of various elements of particulate matter by EDS

S.No.	Elements	Sample 1 % by wt
1	C	37 - 38
2	O	30 – 31
3	F	ND
4	Na	0.68 – 0.72
5	Mg	0.82 – 0.88
6	Al	2.82 – 3.20
7	Si	8.25 – 8.50
8	S	3.20 – 8.50
9	Cl	0.85 – 1.20
10	K	3.00 – 3.50
11	Ca	3.50 – 4.15
12	Mn	ND
13	Fe	4.65 – 5.25
14	Ni	ND
15	Zn	ND
16	Pb	1.05 – 1.10

Conclusion

Elemental and morphological characterization of particulate is very important in regard to get information about its origin etc. It was observed in the samples collected from heavy traffic zones of Delhi that particulate may contain the complex material compose of various micro / nano metallic clusters along with some fibrous structure. That fibrous structure might be due to brake pad linings or that could be due to only incomplete combustion of fuel at high temperature. . Elemental composition of the particulate matter shows the presence of C, O, Na, Mg, Al, Si, S, Cl, K, Ca, Fe, and Pb. This is our preliminary study of morphological and elemental study of particulate matter collected from traffic hot spots of Delhi region. Further work in this direction is in progress.

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