



Attn.: *Meir Efargan*  
**Quest Testing**  
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Phone: 917-277-7580

EMSL Order ID: 362500281  
Sample(s) Received: 1/21/2025  
Date of Reporting: 1/28/2025  
Date Printed: 1/28/2025  
Reported By: J. Liang

**- Laboratory Report -**

**Combustion-by-Products – NIOSH 5000  
(Black Carbon, Carbonized Material & Carbon Black)**

**Project: Fire Air Quality**

Procurement of Samples and Analytical Overview:

The samples for analysis (two air cassettes with pre weighed PVC filters) arrived at EMSL Analytical (Cinnaminson, NJ) on January 21, 2025. The package arrived in satisfactory condition with no evidence of damage to the contents. The data reported herein has been obtained using the following equipment and methodologies.

Methods & Equipment:

Conditioning Chamber  
Microbalance (0.002mg sensitivity)

NIOSH 5000

*Common Origin: Combustion by-product, fires, candles, etc.*

Black Carbon (Soot): a randomly formed particulate of carbon, commonly with a spherical to pseudo-spherical (aciniform) morphology. It is a by-product of uncontrolled combustion.

Carbonized Material/ Char: a solid decomposition product of natural or synthetic origin that maintains, at least in part, its original form.

Ash: Residue left after complete carbonization of the material. It does not maintain its original form.

Charcoal: a term for char obtained from wood, peat, coal or other organic material.

*Common Origin: Industry, Manufacturing*

Carbon Black (Furnace, Lamp, Acetylene Black): an industrially manufactured spherical, carbon material with sizes below 1um. Produced for varying uses such as paint pigment, copier toner and automobile tires.

Analyzed by:

Jiawei Liang  
Laboratory Technician

January 28, 2025

Date

Reviewed/Approved by:

Eugenia Mirica, Ph.D.  
Laboratory Director

January 28, 2025

Date



**EMSL Analytical, Inc.**

200 Route 130 North, Cinnaminson, NJ 08077  
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Results:

Sample ID	EMSL Sample ID	Description	Volume (liters)	Concentration (mg/m3)	LOQ (mg/m3)
#1	362500281-0001	Apartment-4-R	138	0.413	0.014
#2	362500281-0002	Apartment-4-F & Hallway	154	0.162	0.013

The presence of any other particulate material in the air sampled interferes with the analysis.

The OSHA, NIOSH, ACGIH exposure limits for carbon black is 3.5 mg/m<sup>3</sup> (see NIOSH 5000 method).



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Descriptions & Definitions:

None Detected (ND) denotes the absence of an analyte in the subsample analyzed.

Limit of Detection (LOD): The minimum concentration that can be theoretically achieved for a given analytical procedure in the absence of matrix or sample processing effects. Particle analysis is limited to a single occurrence of an analyte particle in the sub-sample analyzed.

Limit of Quantitation (LOQ): The minimum concentration of an analyte that can be measured within specified limits of precision and accuracy during routine laboratory operating conditions

Concentrations for bulk samples are derived from Visual Area Estimation (VAE) unless otherwise noted. Air sample concentrations are calculated to particles per unit volume.

VAE technique estimates the relative projected area of a certain type of particulate from a mixture of particulate by comparison to data derived from analysis of calibration materials having similar texture and particulate content. Due to bi-dimensional nature of the measurements, in some cases the particle thickness could affect the results.

Black Carbon (Soot): a randomly formed particulate of carbon, commonly with a spherical to pseudo-spherical (aciniform) morphology. It is a by-product of uncontrolled combustion.

Carbonized Material/ Char: a solid decomposition product of natural or synthetic origin that maintains, at least in part, its original form.

Ash: Residue left after complete carbonization of the material. It does not maintain its original form. Wood ash contains calcium carbonate as its major component. It also contains potash, phosphate; there are trace elements of iron, manganese, zinc, copper and some heavy metals. The concentrations vary depending on the combustion temperature and wood type.

Carbonized material (char and ash) are analyzed using optical microscopy (epi-reflected and polarized light microscopy). The samples are analyzed for traits such as color, size, morphology, evidence of cellular morphology.

Black Carbon is identified based on particle morphology as determined by TEM and elemental composition as determined by EDX.

Typically, all the particles that are extracted from the as-received sampling media are considered as part of the sample when deriving the concentrations. Therefore, due to regular environmental dust accumulation, the concentrations of the combustion by-products present in a certain area will diminish in time even if no remediation/cleaning were involved



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### Black Carbon Analysis

In recent years, there has been an increasing number of complaints relating to the sudden and unexpected appearance of soot-like material observed in homes and commercial buildings. These stains may form on carpets, walls, plastic objects and other materials, and have been noted around ventilation grilles and electrical outlets. The culprit for this “ghosting” phenomenon is the formation of Black Carbon. EMSL Analytical, Inc. has extensive experience in confirming the presence and identifying the source of Black Carbon.

Black Carbon is a fine-grained solid residue that results from incomplete combustion of hydrocarbons. Common sources of Black Carbon that can cause residential or commercial property damage include candles, fuels such as oil, propane and natural gas used in gas appliances and gas log fireplaces, firewood burned in a fireplace or a wood-burning stove. Even printer cartridges can produce a manufactured Carbon Black that is nearly identical to Black Carbon (Soot).

Black Carbon particles may appear as individual spherical particles or as grape-like conglomerates. The diameter of the individual particles generally varies between 10nm to 70nm (see Figures 1 and 2). Considering the size and the specific morphology of Black Carbon particulate, the analysis for identification of Black Carbon is best performed by electron microscopy ensuring the appropriate magnification range for imaging. Transmission Electron Microscopy can easily achieve a magnification of 100,000x, which is more than sufficient to observe individual particles. Even the best light microscopes can only achieve 1,000x magnification. At a magnification of 1000x observations are limited to particles no smaller than 300nm. This is roughly the size of the smallest bacteria. Black Carbon particles are generally one order of magnitude smaller.

However, the majority of nano-size particles, such as iron oxides, titanium dioxide or aluminum oxide have the same morphology. For example, titanium dioxide (TiO<sub>2</sub>) is a common interference due to its spherical morphology and its expansive use in food, commercial and pharmaceutical products. Therefore, the particles elemental composition should also be determined by energy dispersive x-ray analysis to verify if the material sampled is actually Black Carbon.

At EMSL Analytical, Inc. **identification** of Black Carbon is performed using Transmission Electron Microscopy (TEM) in conjunction with Energy Dispersive X-Ray Analysis (EDX). Sample collection for airborne Black Carbon should be performed according to the NIOSH 5000 method. Dust “wipe” sampling can be performed with 1 square inch alcohol wipes such as those used to cleanse your arm before a shot with a hypodermic needle. These can be found at nearly any pharmacy. For analysis, the dust samples are sonicated in alcohol and the resulting suspension is used for drop-mounting the particles onto formvar-coated copper grids. The concentration of Black Carbon is derived by Visual Area Estimation Technique. This technique estimates the relative projected area of a certain type of particulate from a mixture of particulates by comparison to data derived from analysis of calibration materials having similar texture and particulate content. Due to two-dimensional nature of the measurements, in some cases the particle thickness could affect the results.

Identifying the origin of combustion product formation can help to eliminate potential sources. At EMSL Analytical, Inc., the identification of the **source** of Black Carbon is performed using Transmission Electron Microscopy (TEM) in conjunction with Attenuated Total Reflection - Fourier Transform Infrared Spectroscopy (ATR-FTIR) and Gas Chromatography/ Mass Spectrometry (GC/MS). The analysis is based upon the different particle sizes and the presence of selected functional groups in the samples that distinguish sources such as paraffin residue from candles or fuel oil from oil heaters.



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Figure #1: Black Carbon (Soot) from an oil heater that had been dispersed through a residential home compared to manufactured Carbon Black used as a pigment.

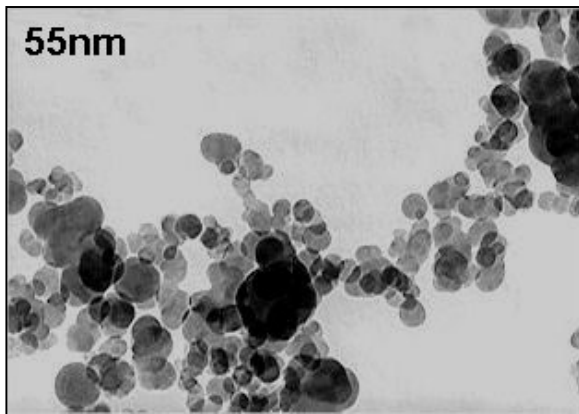


Fig 1A: 100,000x magnification of Black Carbon (Soot). Particle sizes range from 30 to 70nm.

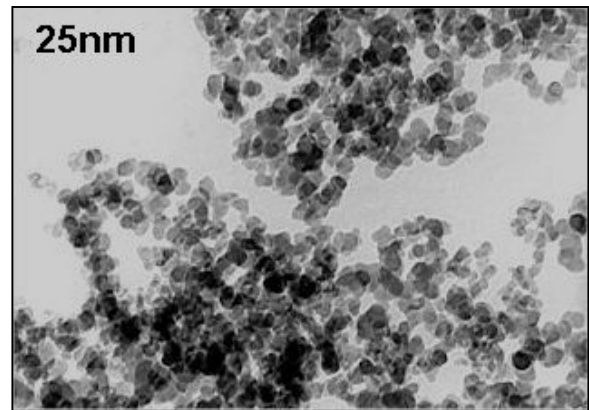


Fig 1B: 100,000x magnification of manufactured Carbon Black. Average particle size 25nm.

Figure #2: Carbon Black from standard copy machine that had been dispersed through a commercial building.

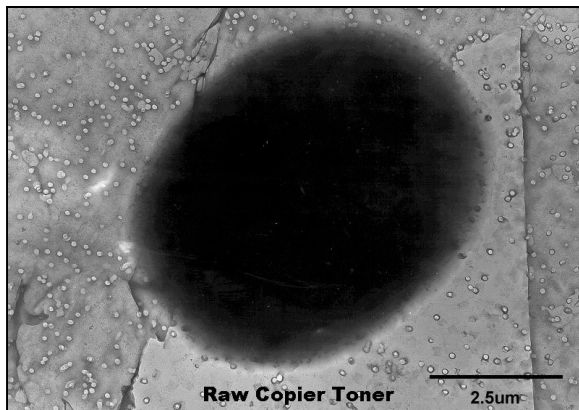


Fig 2A: ~1000x magnification. Copier toner from a standard copy machine. The image is similar to the appearance observed with a light microscope.

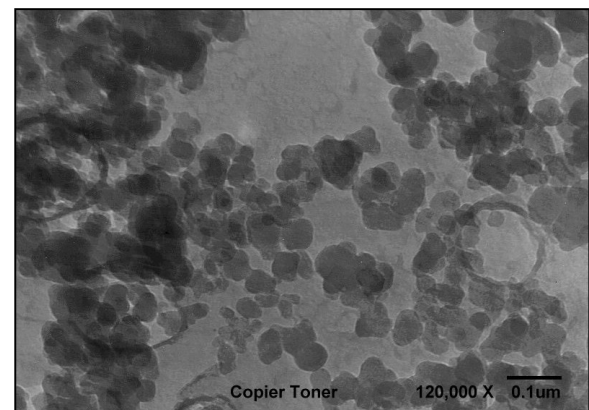


Fig 2B: 120,000x magnification. Upon increasing the magnification the individual Carbon Black particles can be observed verifying the globule in figure 2A as actually manufactured Carbon Black.



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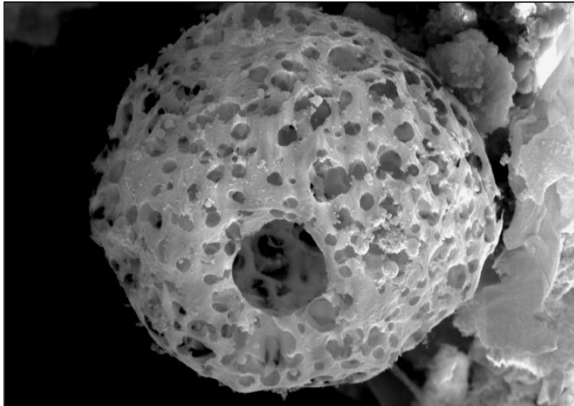


Figure 3a: 10,000x SEM image of a char spheroid.



Fig 3b: PLM image of Char originating from wildfires.

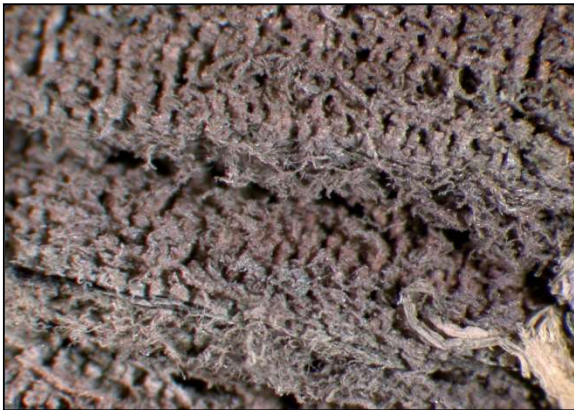


Figure 3c: RLM image of Char showing the original structure.

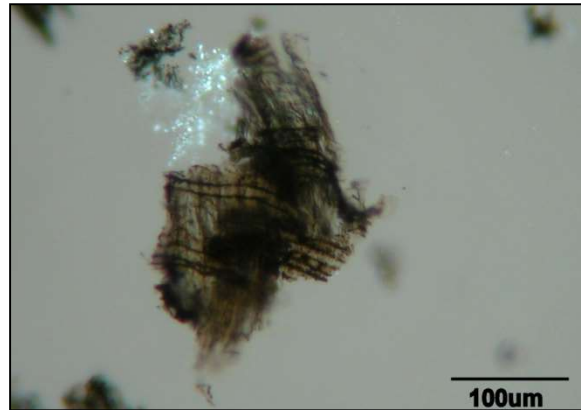


Fig 3d: PLM image of Char showing the intact structure of the original wood.

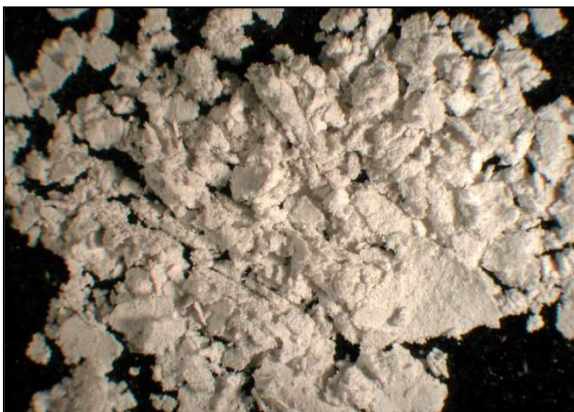


Fig 4a: RLM image of Ash showing no discernable structure.

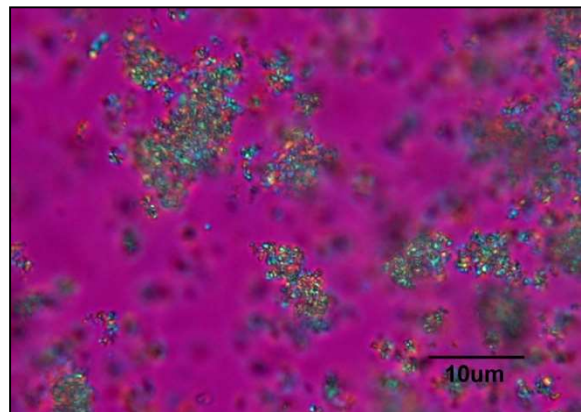


Figure 4b: PLM image of Ash showing the fine grain size and no evidence of the original structure.



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**Important Terms, Conditions, and Limitations:**

**Sample Retention:** Samples analyzed by EMSL will be retained for 60 days after analysis date. Storage beyond this period is available for a fee with written request prior to the initial 30 day period. Samples containing hazardous/toxic substances which require special handling may be returned to the client immediately. EMSL reserves the right to charge a sample disposal or return shipping fee.

**Change Orders and Cancellation:** All changes in the scope of work or turnaround time requested by the client after sample acceptance must be made in writing and confirmed in writing by EMSL. If requested changes result in a change in cost the client must accept payment responsibility. In the event work is cancelled by a client, EMSL will complete work in progress and invoice for work completed to the point of cancellation notice. EMSL is not responsible for holding times that are exceeded due to such changes.

**Warranty:** EMSL warrants to its clients that all services provided hereunder shall be performed in accordance with established and recognized analytical testing procedures, when available. The foregoing express warranty is exclusive and is given in lieu of all other warranties, expressed or implied. EMSL disclaims any other warranties, express or implied, including a warranty of fitness for particular purpose and warranty of merchantability.

**Limits of Liability:** In no event shall EMSL be liable for indirect, special, consequential, or incidental damages, including, but not limited to, damages for loss of profit or goodwill regardless of the negligence (either sole or concurrent) of EMSL and whether EMSL has been informed of the possibility of such damages, arising out of or in connection with EMSL's services thereunder or the delivery, use, reliance upon or interpretation of test results by client or any third party. We accept no legal responsibility for the purposes for which the client uses the test results. EMSL will not be held responsible for the improper selection of sampling devices even if we supply the device to the user. The user of the sampling device has the sole responsibility to select the proper sampler and sampling conditions to ensure that a valid sample is taken for analysis. Any resampling performed will be at the sole discretion of EMSL, the cost of which shall be limited to the reasonable value of the original sample delivery group (SDG) samples. In no event shall EMSL be liable to a client or any third party, whether based upon theories of tort, contract or any other legal or equitable theory, in excess of the amount paid to EMSL by client thereunder.

The data and other information contained in this report, as well as any accompanying documents, represent only the samples analyzed. They are reported upon the condition that they are not to be reproduced wholly or in part for advertising or other purposes without the written approval from the laboratory.