Hva er eksos og hva kan måles

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SILLY OLD
FOOL
Profile-Comments.com

When diesel fuel burns in an engine, the resulting exhaust is made up of soot and gases representing thousands of different chemical substances. ***Diesel exhaust contains 20-100 times more particles than gasoline exhaust.***

The "top" gases which can cause health problems:

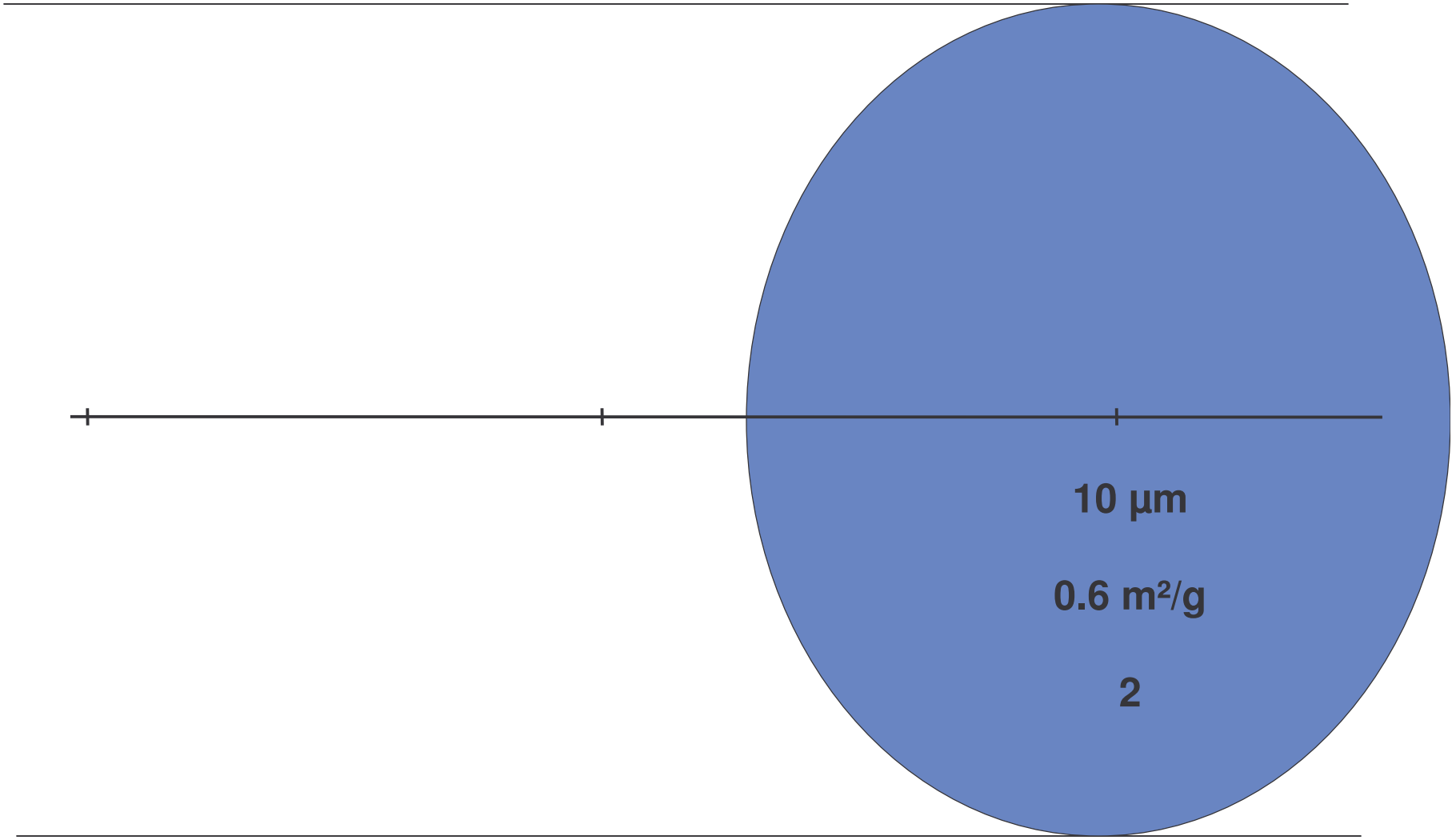
N_2O	Nitrous oxide	SO_2	Sulfur dioxide
NO_2	Nitrogen dioxide	H_2S	Hydrogen sulfide
C_6H_6	Benzen	CO	Carbon monoxide
CH_2O	Formaldehyde		

Terminology: particle size fractions

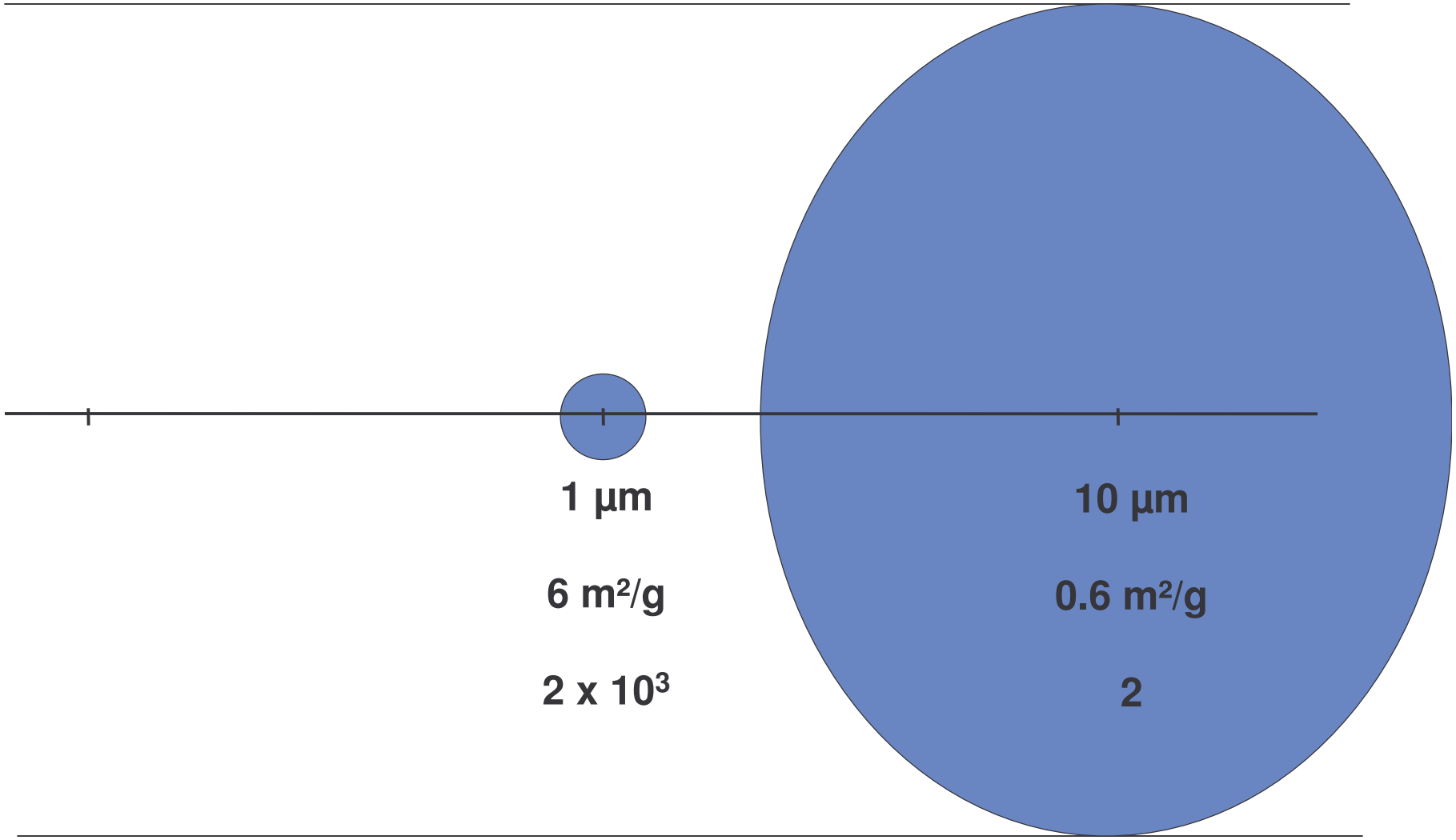
Environment	Workplace
TSP	inhalable
PM10	thoracic
PM2.5	respirable
PM1	
PM0.1	ultrafine

Nano particles

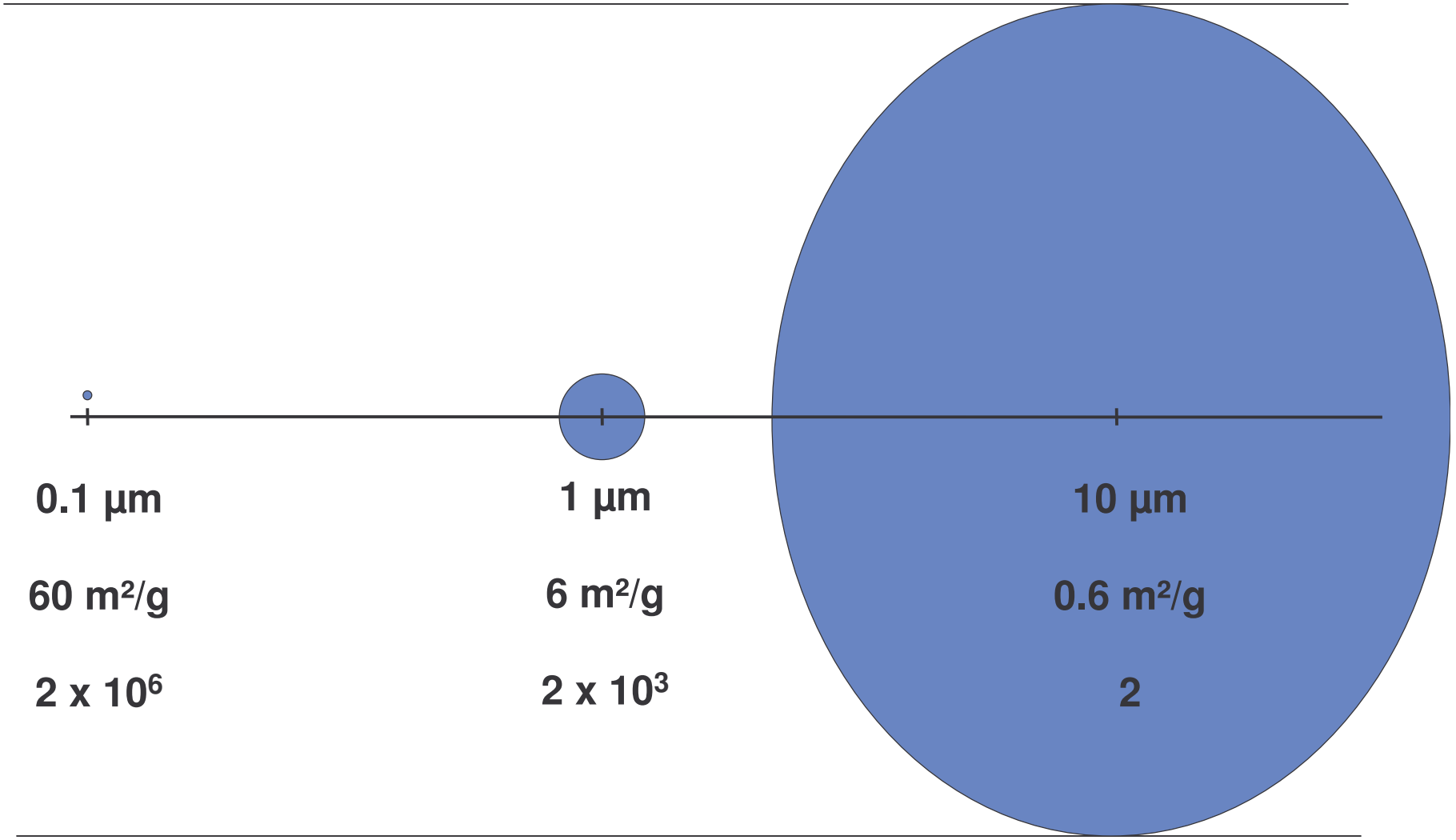
PM10



PM10, PM1

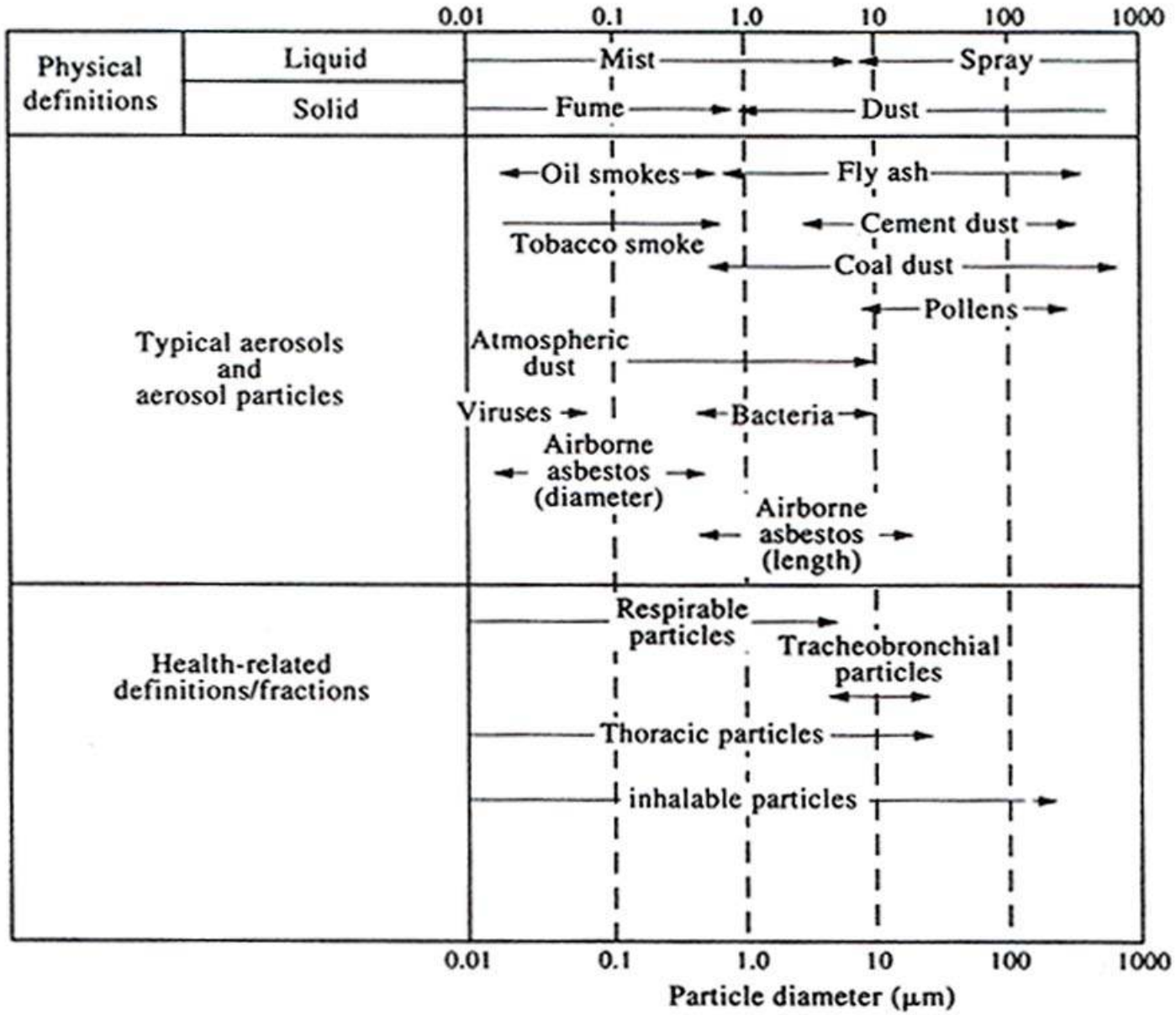


PM10, PM1, PM0.1 / ultra-fine

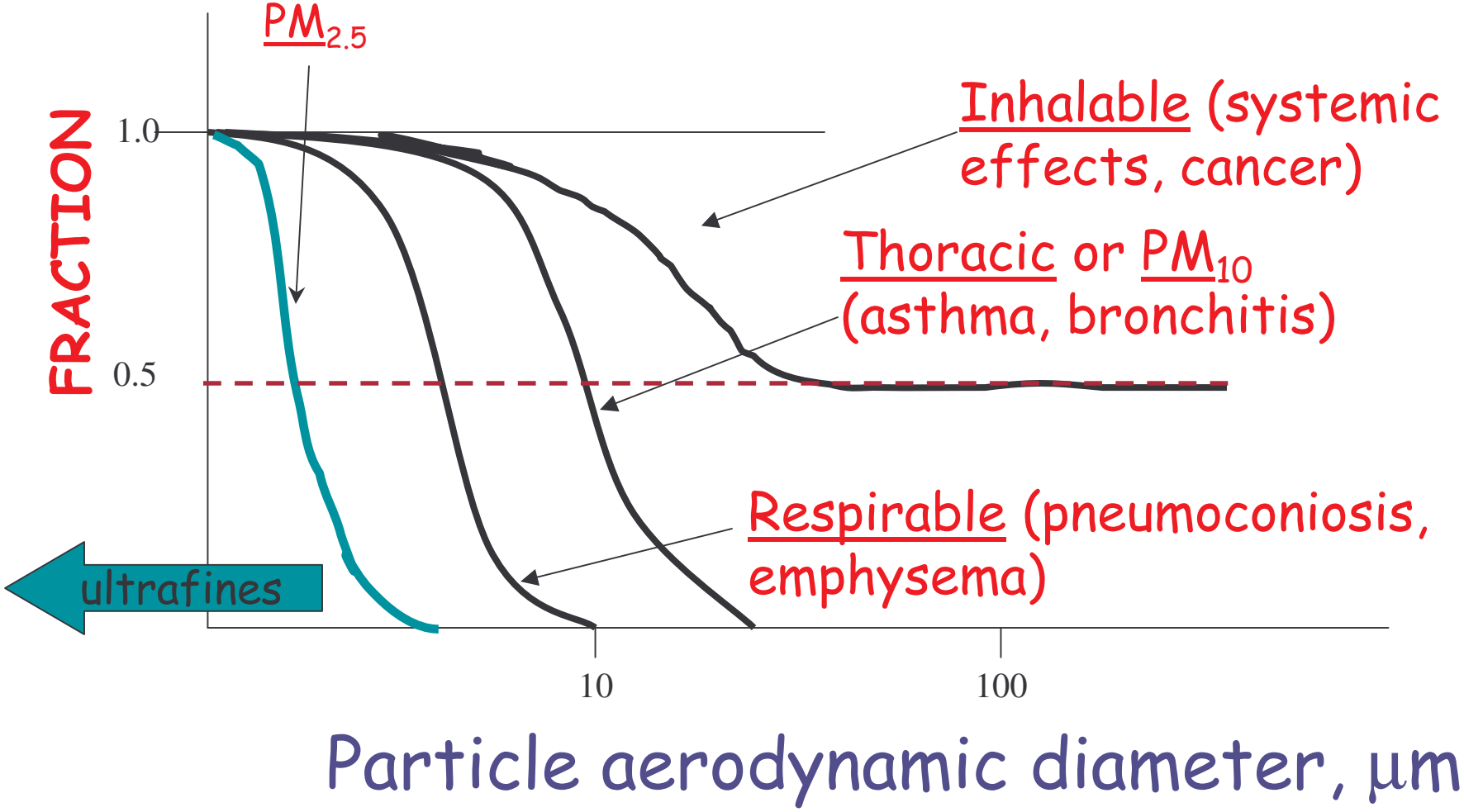


Ultra-fine, nano

0.01 µm	0.1 µm
600 m^2/g	60 m^2/g
2×10^9	2×10^6

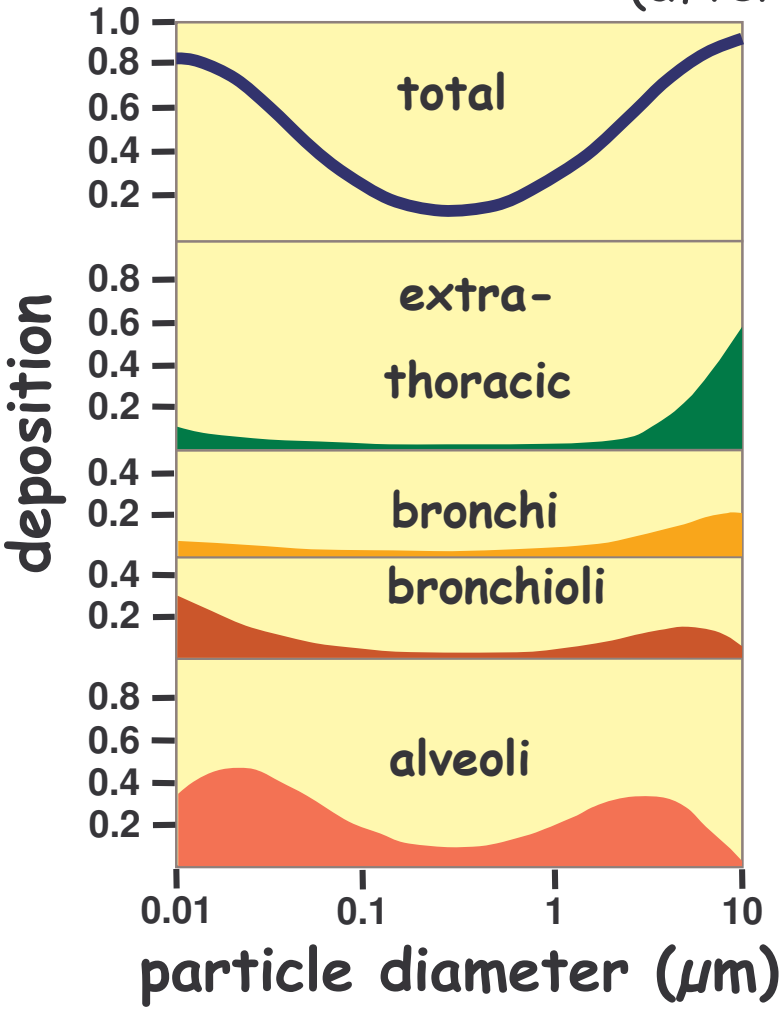

0.01
0.1
1.0
10
100
1000
Physical definitions
Liquid
Solid
Mist
Spray
Fume
Dust
Typical aerosols and aerosol particles
Oil smokes
Fly ash
Cement dust
Tobacco smoke
Coal dust
Pollens
Atmospheric dust
Viruses
Bacteria
Airborne asbestos (diameter)
Airborne asbestos (length)
Health-related definitions/fractions
Respirable particles
Tracheobronchial particles
Thoracic particles
inhalable particles
Particle diameter (μm)

CONVENTIONS FOR AEROSOL EXPOSURE ASSESSMENT AND STANDARDS

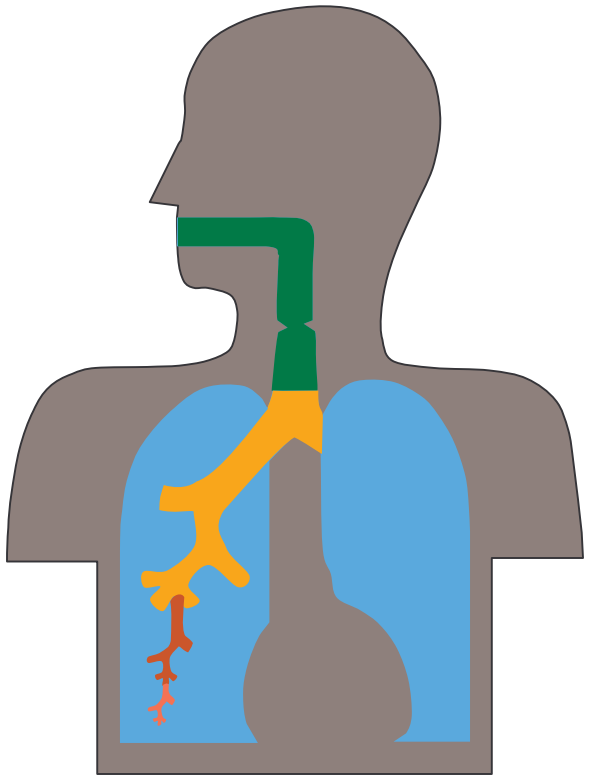


Particle Deposition

(after Kreyling, 2004)



ICRP 66 (1994), MPP Dep (2000)

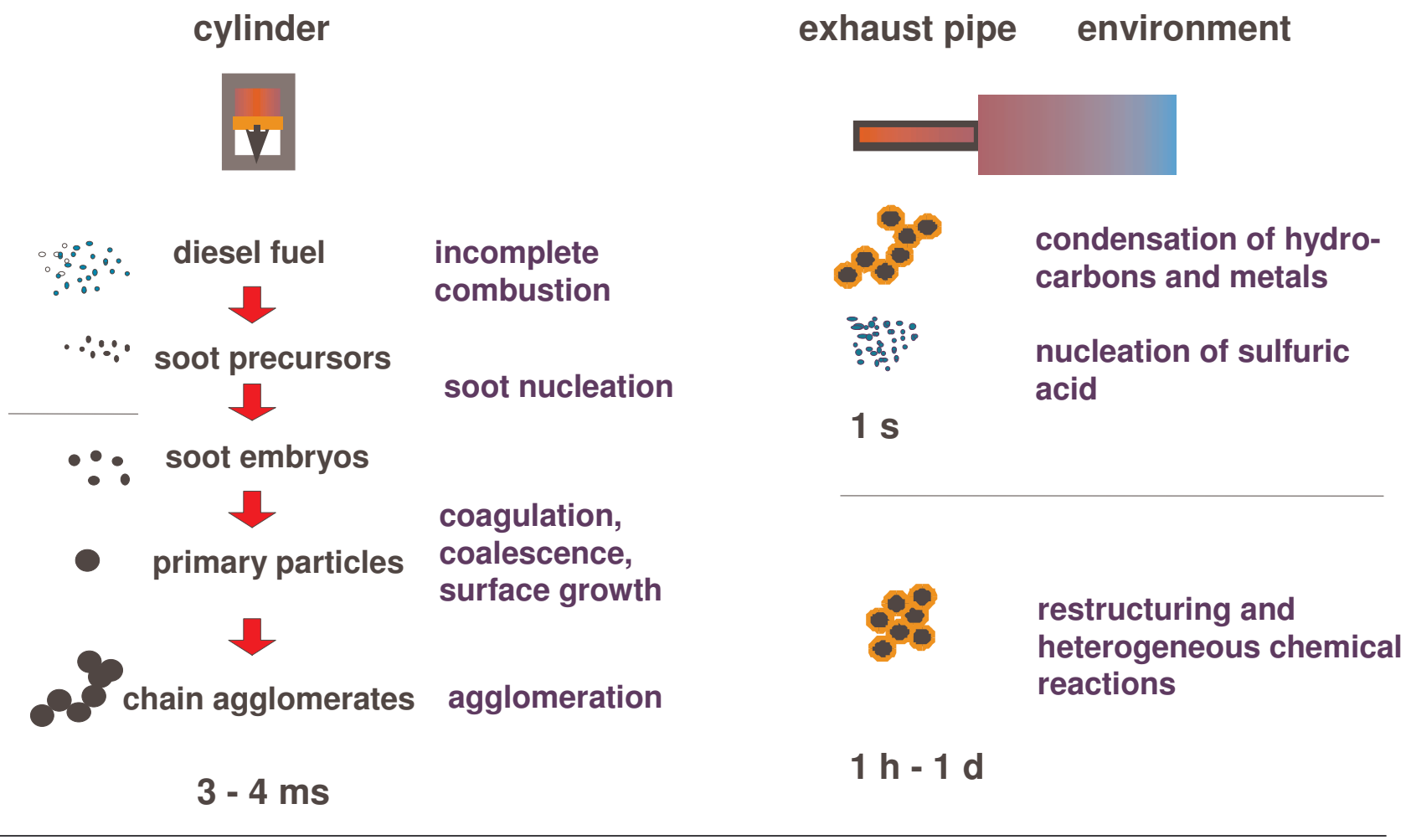


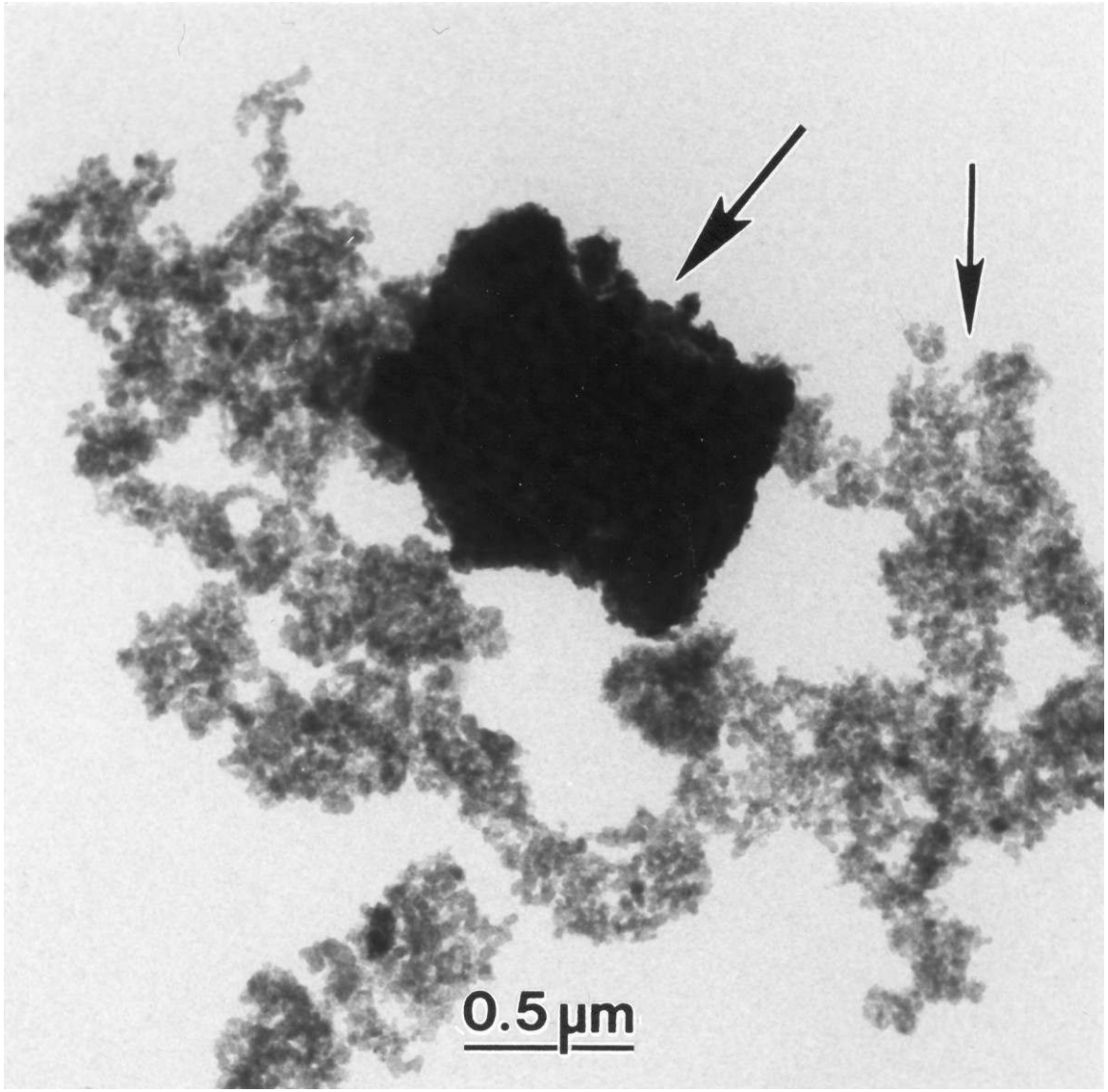
particle density: 1 g cm^{-3}

respiratory flow rate: 300 cm^3 s^{-1}

breathing at rest cycle period : 5 s

Formation of particulates from diesel engines

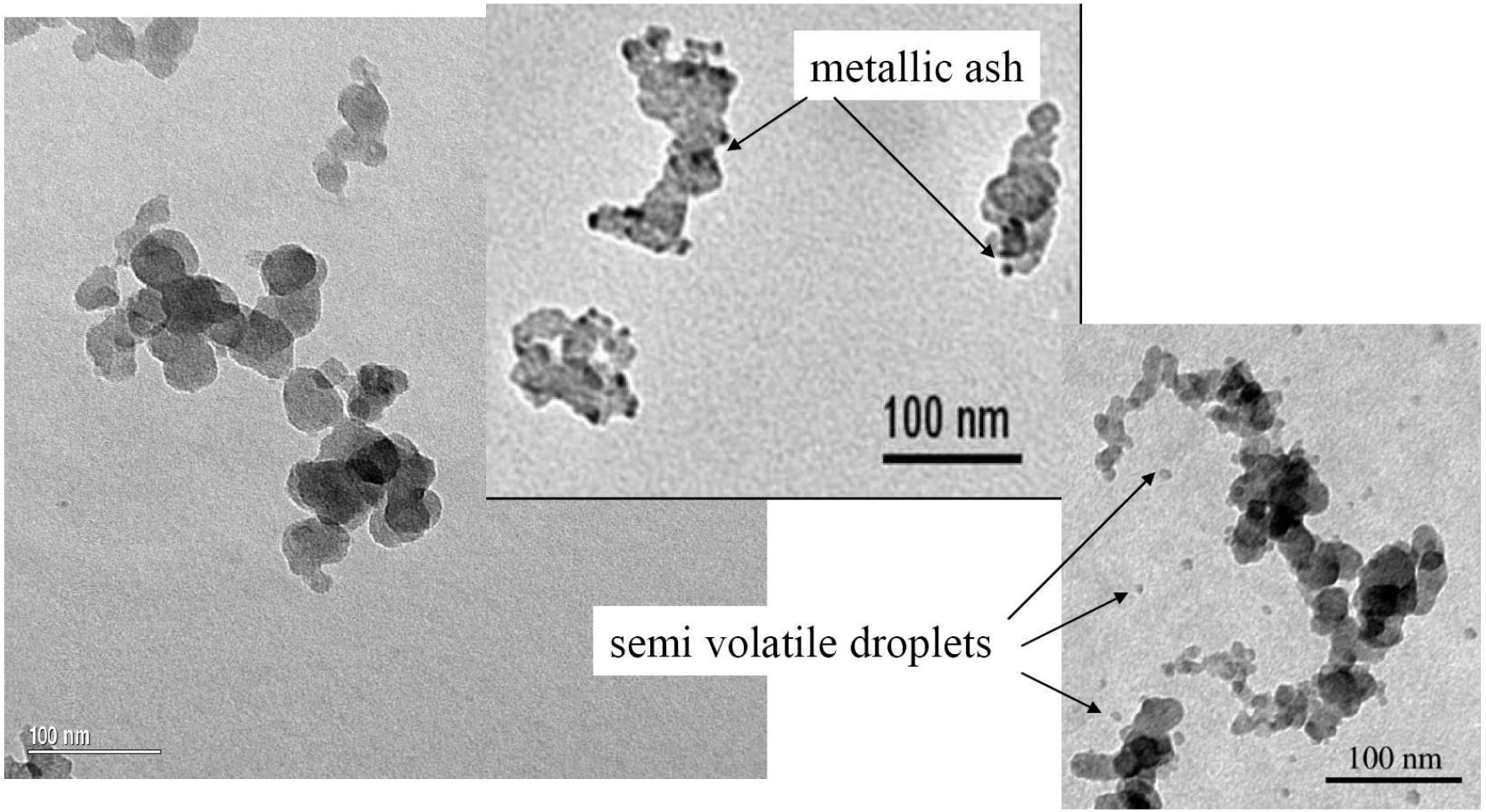




TEM micrograph of a tunnel sample showing a mineral particle (large arrow) and carbon aggregates (small arrow).

Kocbach *et al. Particle and Fibre Toxicology* 2006 **3**:1 doi:10.1186/1743-8977-3-1

Carbonaceous agglomerates comprise most of the mass from current Diesel engines but different structures are evident



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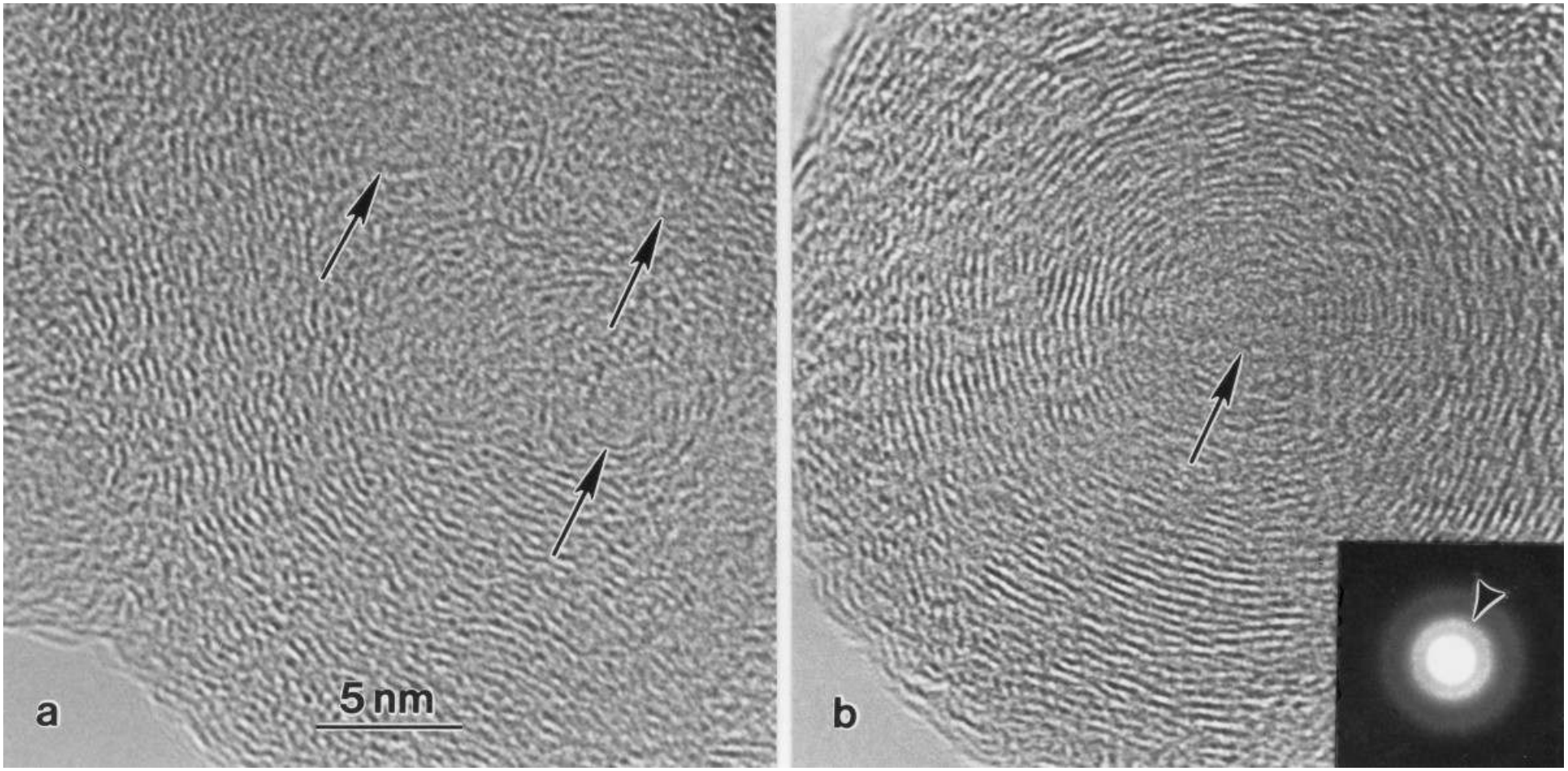
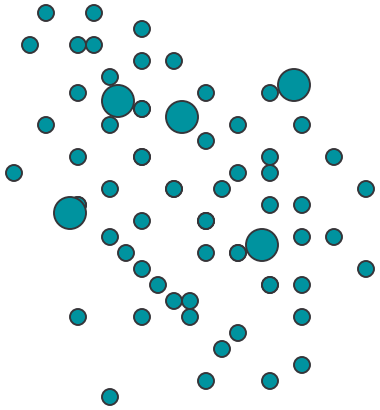


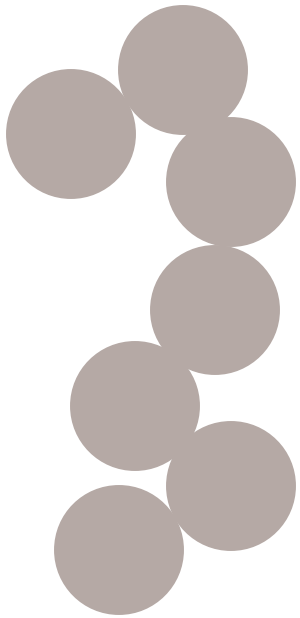
Turbostratic microstructure of primary carbon particles. TEM micrographs showing the turbostratic microstructures, consisting of concentric carbon layers surrounding a) several nuclei in vehicle exhaust (arrows), or b) a single nucleus in wood smoke (arrow). The inset shows a SAED pattern from a wood smoke particle. The arrowhead points at the ring corresponding to the 002 spacings in the turbostratic microstructure.

Kocbach *et al. Particle and Fibre Toxicology* 2006 **3**:1 doi:10.1186/1743-8977-3-1

DPM Carbon Components



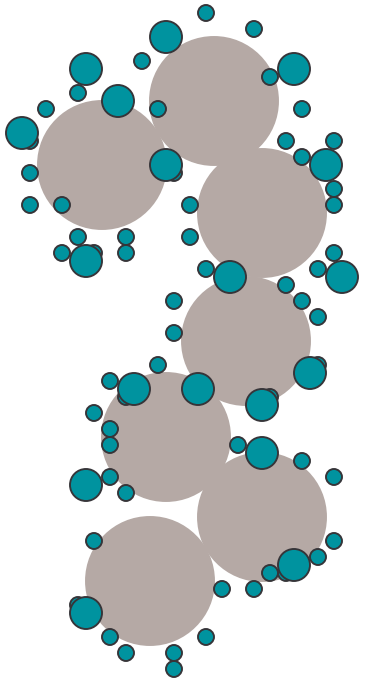
Vapor Phase Hydrocarbons (OC)



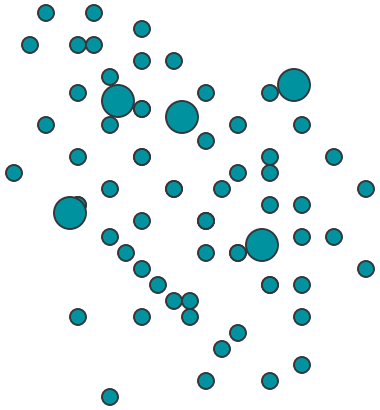
Elemental Carbon Cores (EC)

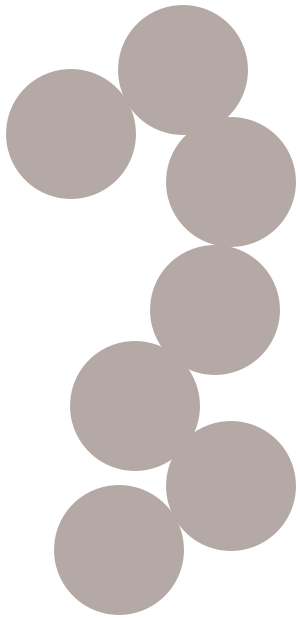
DPM Carbon Components

Hydrocarbons Adsorbed Onto Elemental Carbon Cores (OC + EC)



DPM Carbon Components



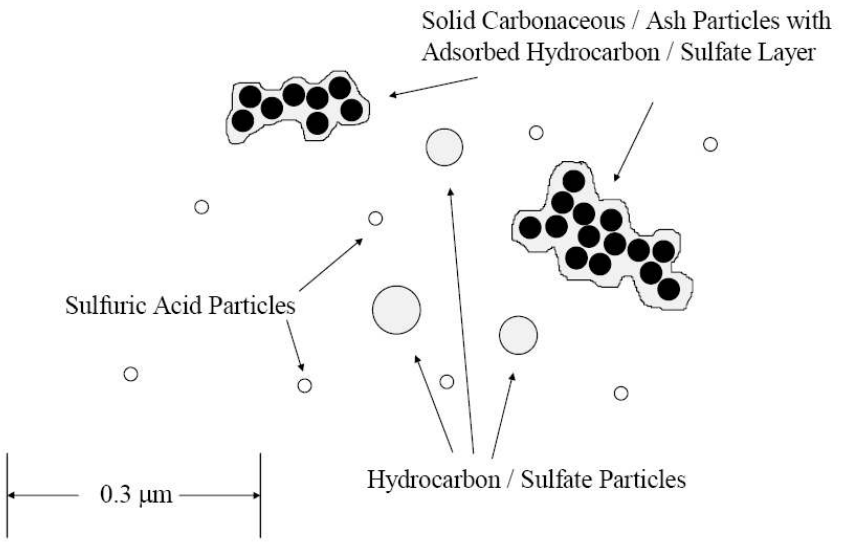


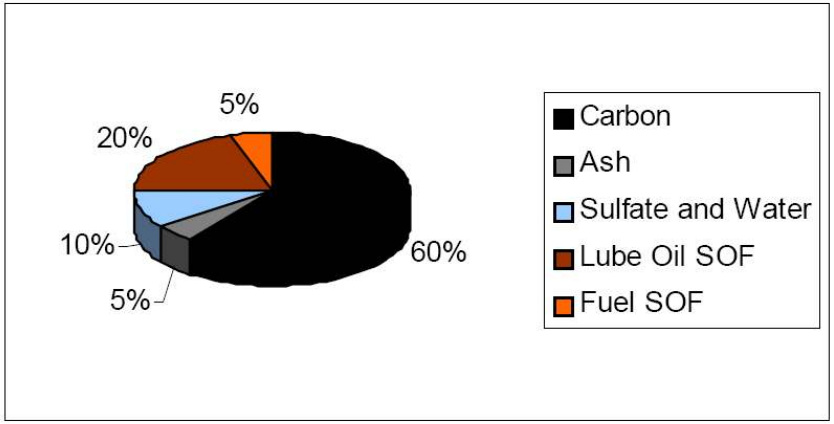
OC=23%

EC=77%

Typical composition and structure of diesel particulate matter – *heavy-duty, no aftertreatment*

- Solid particles are typically carbonaceous chain agglomerates (mainly elemental carbon, EC) and ash and usually comprise most of the particle mass
- Volatile or semi-volatile matter (sulfur compounds and organic carbon (SOF)) typically constitutes 35% (5-90%) of the particle mass, 90% (30-99%) of the particle number
- Carbon and sulfur compounds derive mainly from fuel
- SOF and ash derive mainly from oil
- Most of the volatile and semi-volatile materials undergo gas-to-particle conversion as exhaust cools and dilutes





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Center for Diesel Research

Particles from Diesel engines – without aftertreatment

- Formed by combustion
  - Carbonaceous agglomerates (soot)
  - Metallic ash
    - » From lubricating oil – typically ~1% metal
    - » Wear related
  - Precursors to particle formation during dilution
    - » SO_3 from S in fuel and lube oil – most of S leaves as SO_2 but 2–4% is converted to SO_3
    - » Unburned and partially burned hydrocarbons from fuel and lube oil
- Formed by gas to particle formation during dilution
  - Sulfuric acid and other sulfates
  - Heavy hydrocarbons and derivatives
  - Usually most of these materials adsorb onto carbonaceous agglomerates during dilution
  - However a small fraction of these materials nucleate to form ultrafine nucleation mode particles

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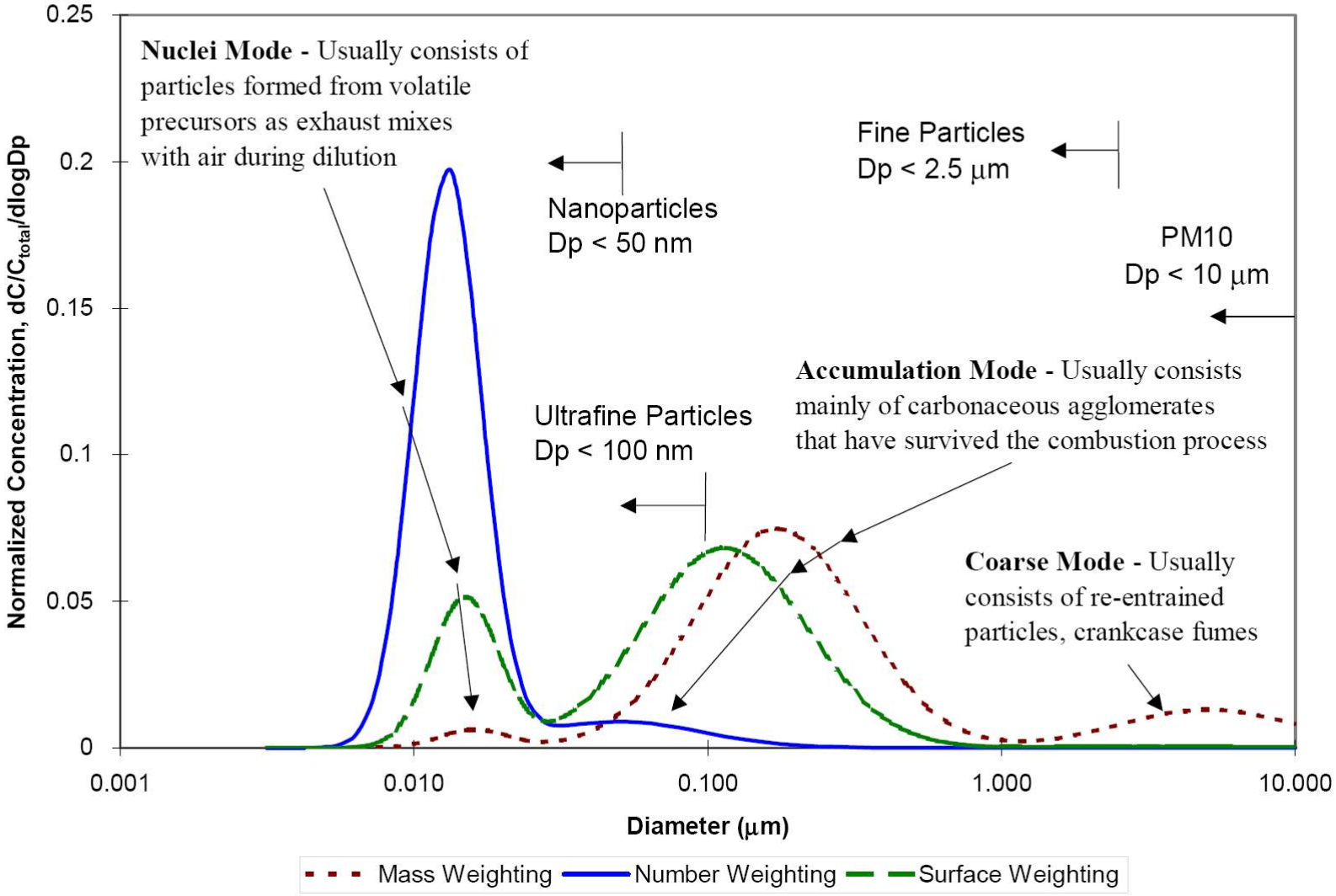
Typical Diesel Particle Size Distributions, Number, Surface Area, and Mass Weightings Are Shown



PM_{10}

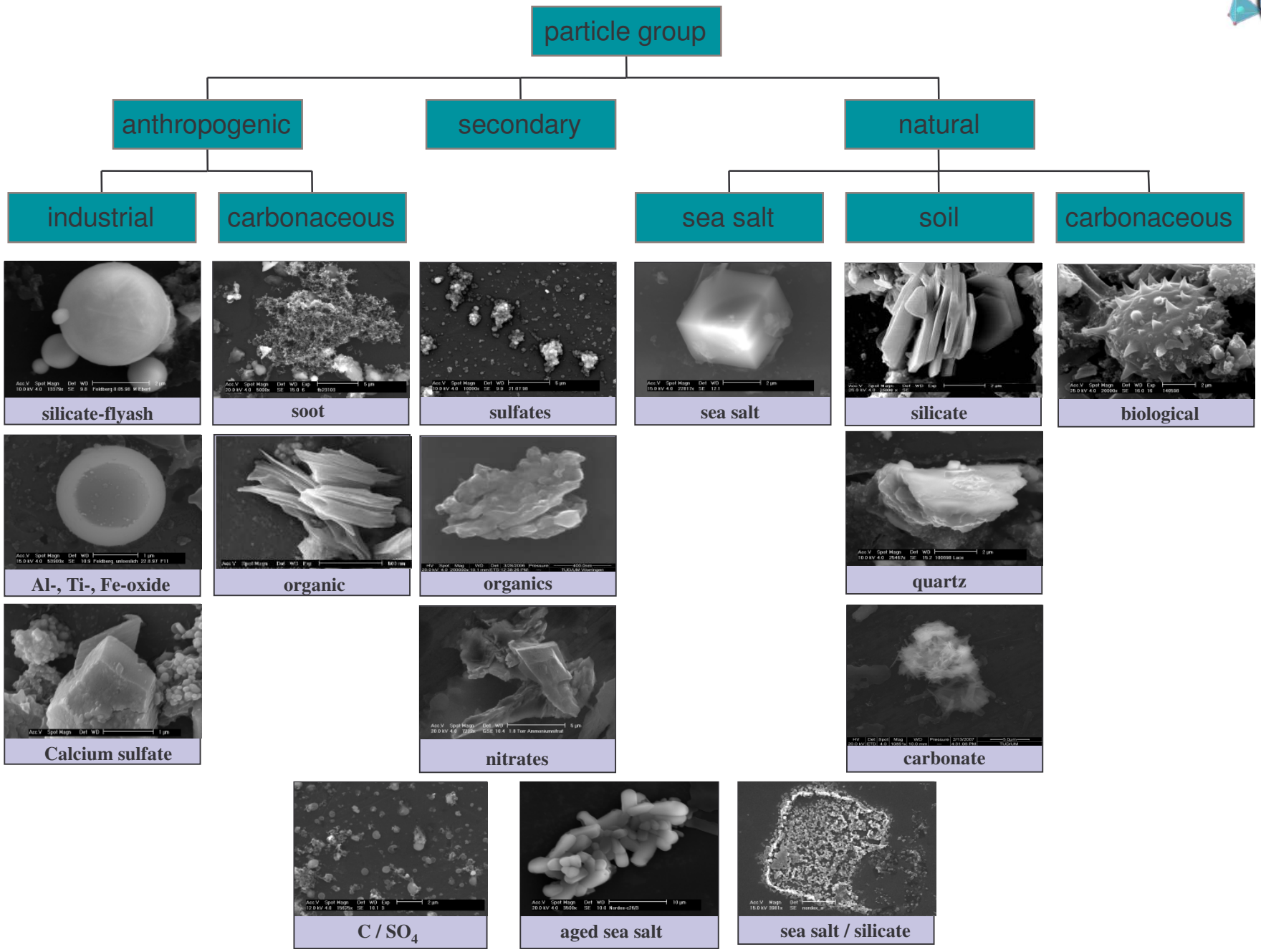
Carbon based particles
- Traffic and industrial
- Many ultrafine
- Transition metals

Sulphates/Nitrates
- Traffic/photochemical
- Mainly ultrafine

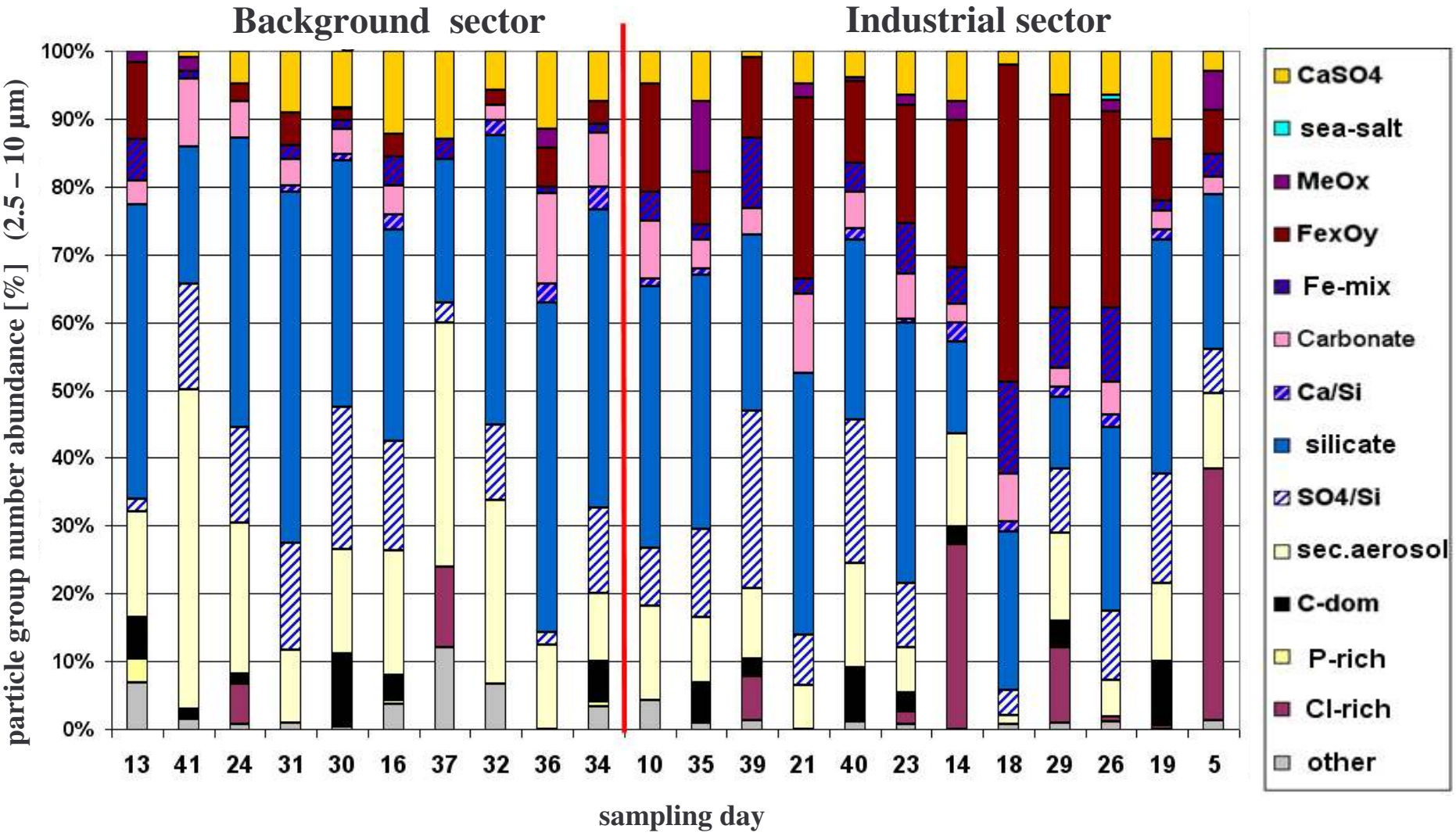
Wind blown dust
- Mainly coarse

Biological components
- Spores
- Pollen
- Mainly fine and course

ie Cocktail. Which component is responsible for the health effects?


particle group
anthropogenic
secondary
natural
industrial
carbonaceous
sea salt
soil
carbonaceous
silicate-flyash
soot
sulfates
sea salt
silicate
biological
Al-, Ti-, Fe-oxide
organic
organics
quartz
Calcium sulfate
nitrates
carbonate
C / SO4
aged sea salt
sea salt / silicate

Relative number abundance of the different particle groups

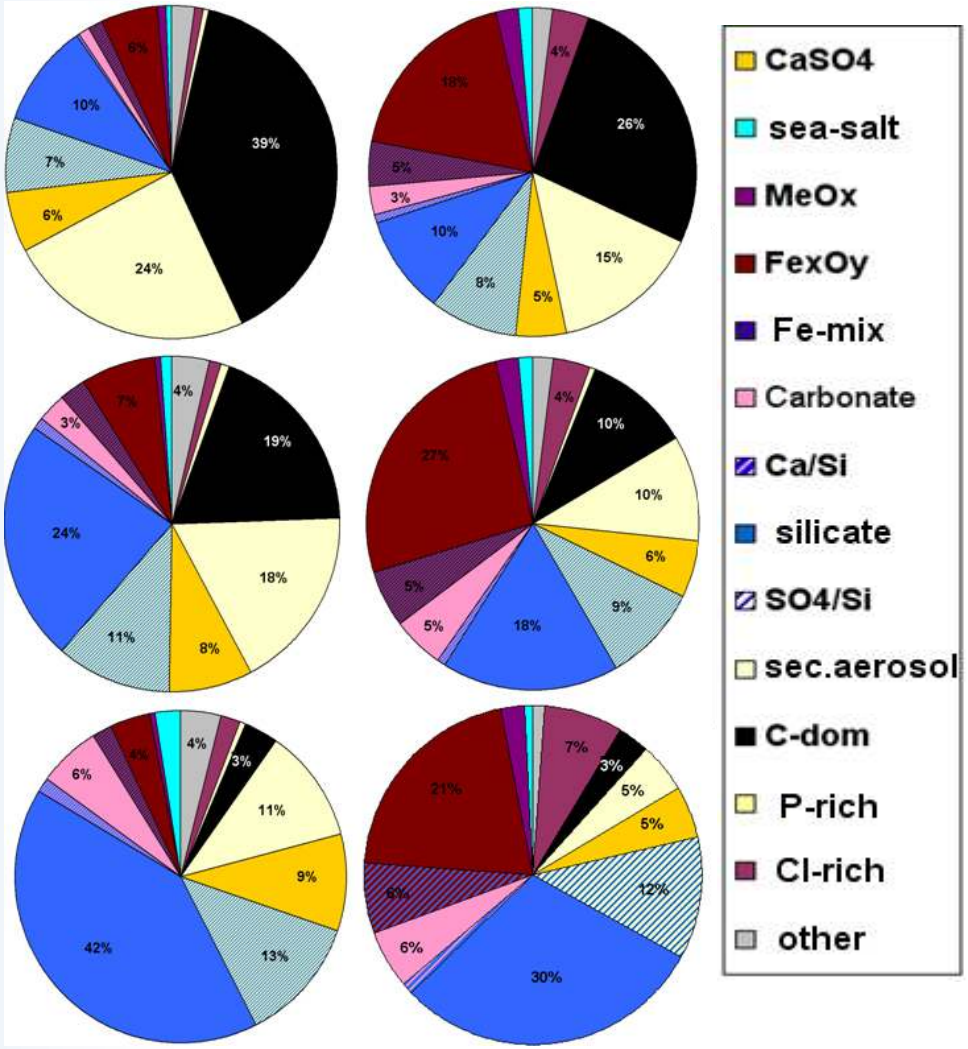


Size-resolved <u>average</u> particle group number abundance

0.5 – 1 µm

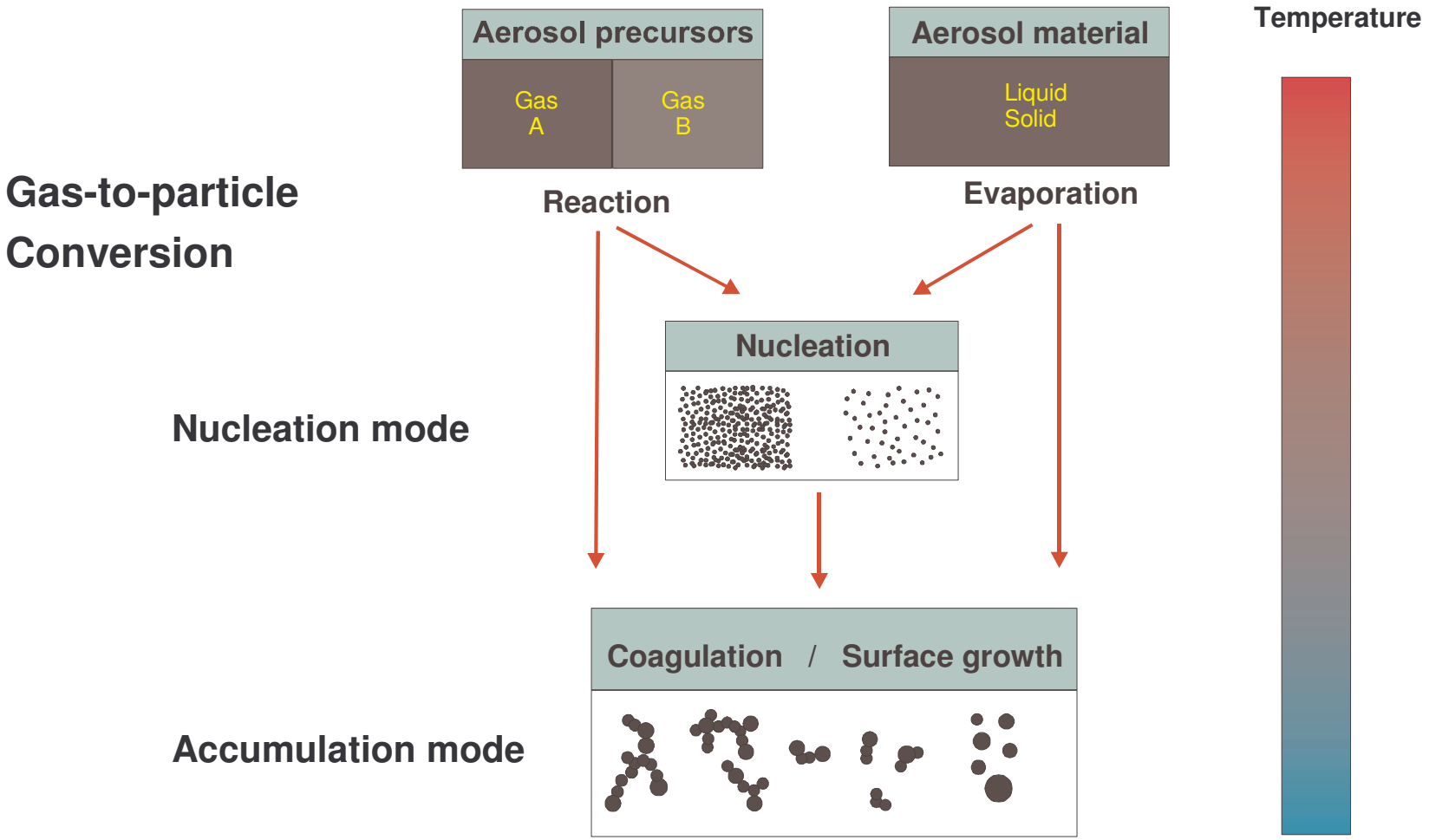
1 – 2.5 µm

2.5–10 µm



Background sector **Industrial sector**

Formation route



Aggregates, agglomerates, primary particles, singlets ….

Singlet:

single nano-particle

Primary particle:

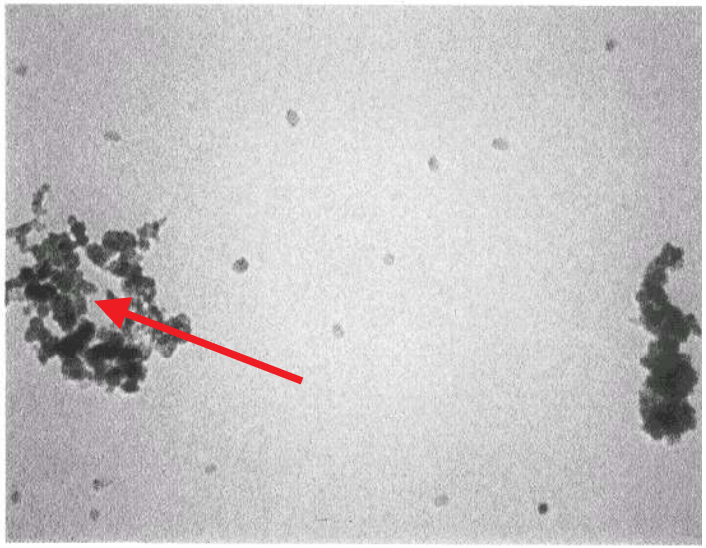
basic entity of a connected group of particles

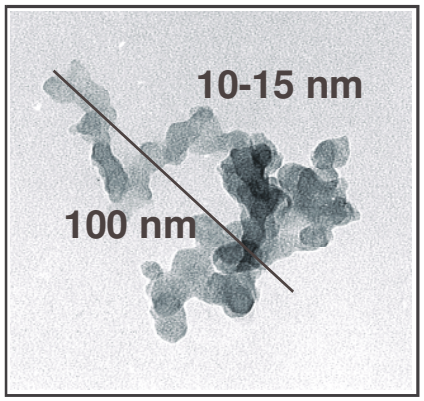
Aggregate:

group of primary particles connected by chemical and sinter bonds

Agglomerate:

aggregates / primary particles held together by van der Waals forces

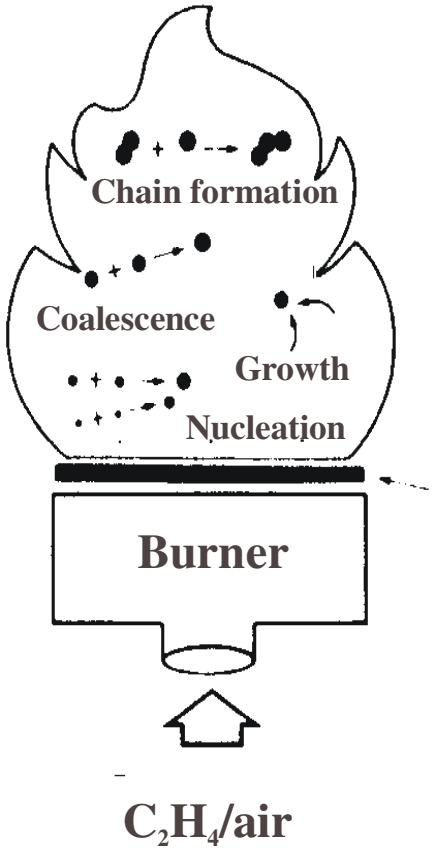




200 nm

Soot formation

t (ms)	C_N (cm^{-3})	x_p (nm)	C_M (g/m^3)
50	10^9	65	1
30	10^{10}	30	1
10	10^{11}	7	0.1
5	10^{13}	1	0.01



Silica fume

Melting of quartz sand in an induction furnace

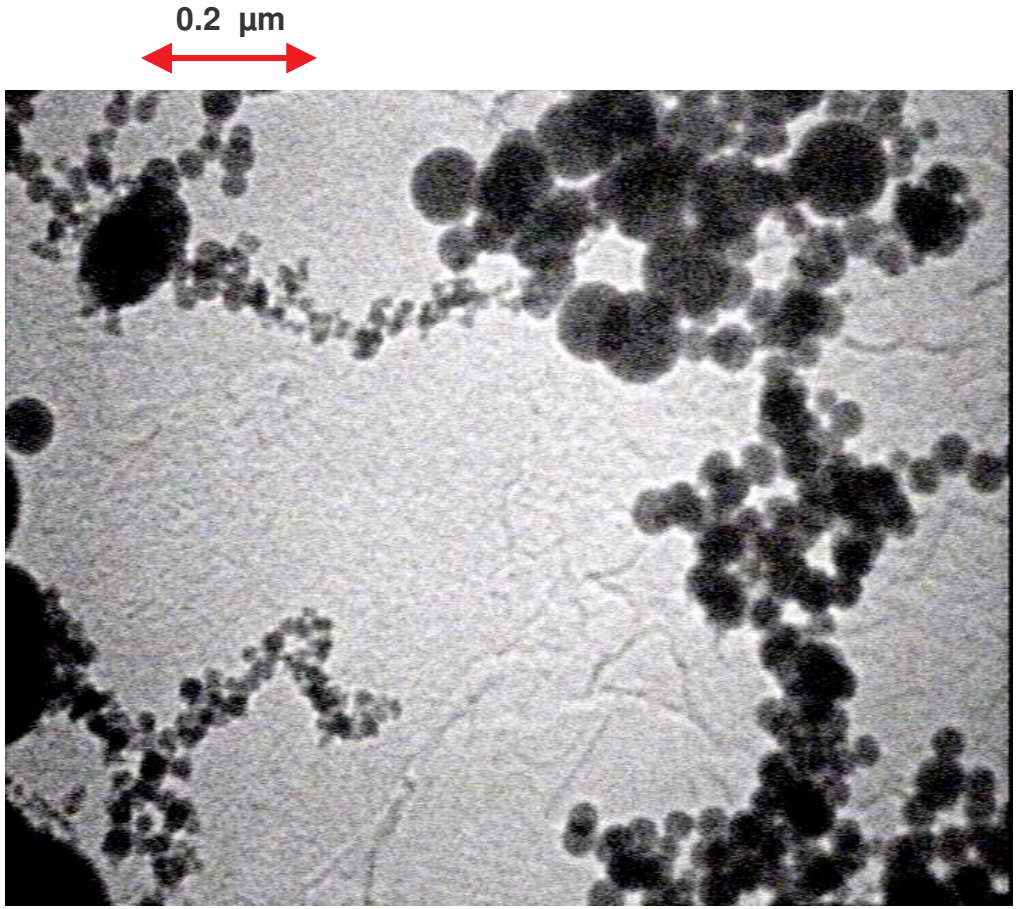
$$SiO_2 + 2SiO \rightleftharpoons Si + 2\,SiO_2$$

$$SiO_2 + C \rightleftharpoons SiO + CO$$

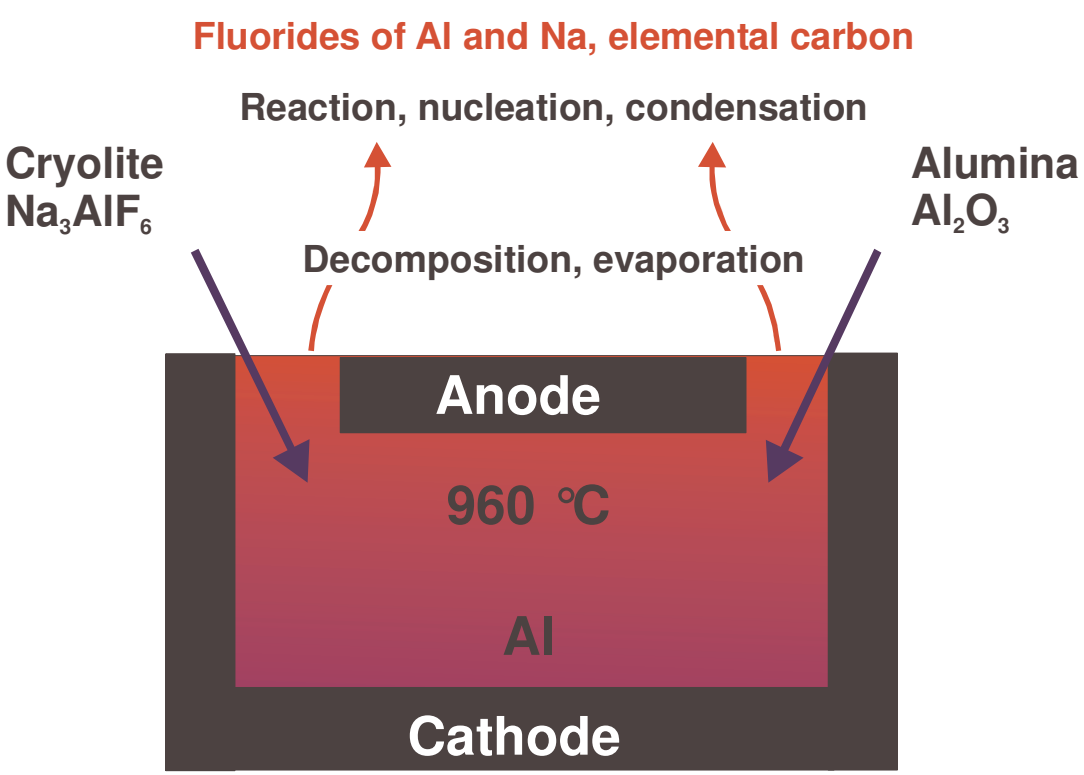
$$Si + O_2 \rightleftharpoons SiO_2$$

Silica fume

Silica fume



Formation route in alumium smelters



Measuring techniques

Number size distribution:

Bringing electric charge on particles

Classifying the particles in an electric field

Measuring the number concentration of mobility (size) fraction

Model 3034 SMPS Spectrometer

An easy-to-use, submicrometer particle sizer designed for a wide range of industrial measurements or continuous environmental monitoring applications.

This single-box spectrometer offers the ultimate in convenience and portability. Key features include:

Integrated design. The CPC and DMA are combined in a single cabinet. This translates into easy transport and quick set up—no parts to assemble or tubing to connect, and no flows to select or adjust!

Simple operation. Does not require an aerosol specialist to operate. Simply fill it with butanol, turn the power ON, let it warm up, and press "Start". The Model 3034 operates much like our easy-to-use Model 3321 Aerodynamic Particle Sizer® spectrometer, but for measurements in the submicrometer range.

Long-term, unattended monitoring. Designed for 30 days of continuous operation without maintenance. In the event of a power outage, measurements automatically resume upon power restoration.

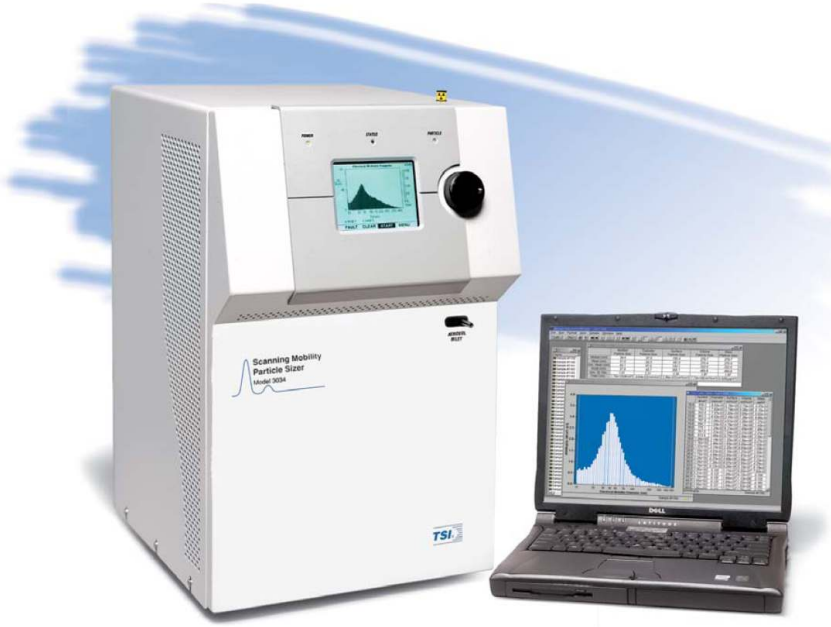
Automatic correction for ambient conditions. There is no need for data manipulation because measurements are corrected automatically for ambient pressure and temperature.

Nearly limitless data-storage capacity. Each particle size distribution consumes only one kilobyte of disk space. An entire year's worth of continuous measurements requires less than 180 megabytes.

Built-in diagnostics. Status and diagnostic functions are easily accessible via the front-panel display.

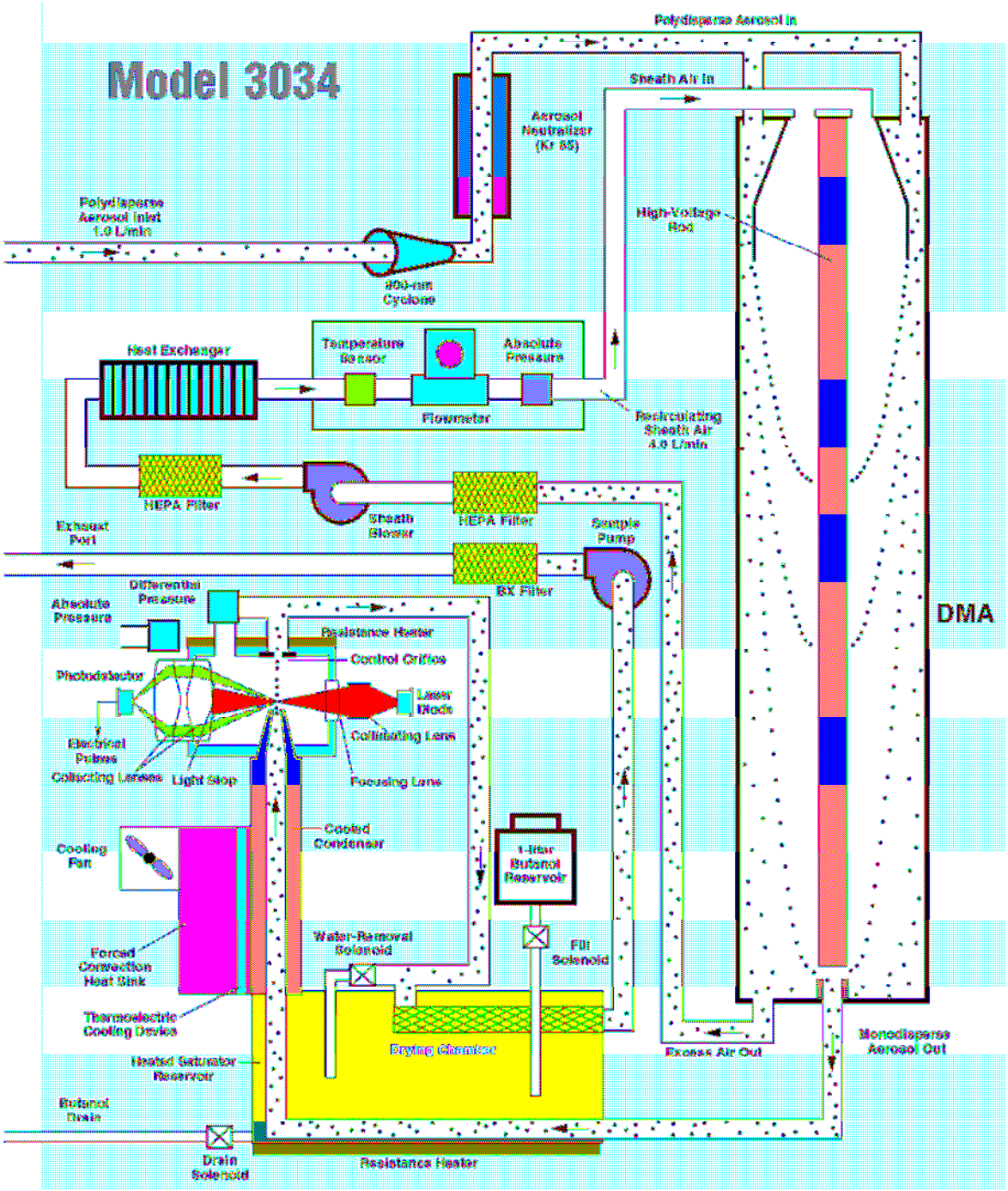
Real-time data display. Shows a new particle size distribution on the front panel and in the software every three minutes.

Views of results without interrupting data acquisition. The software allows operators to analyze data files while data logging continues in the background.



3034

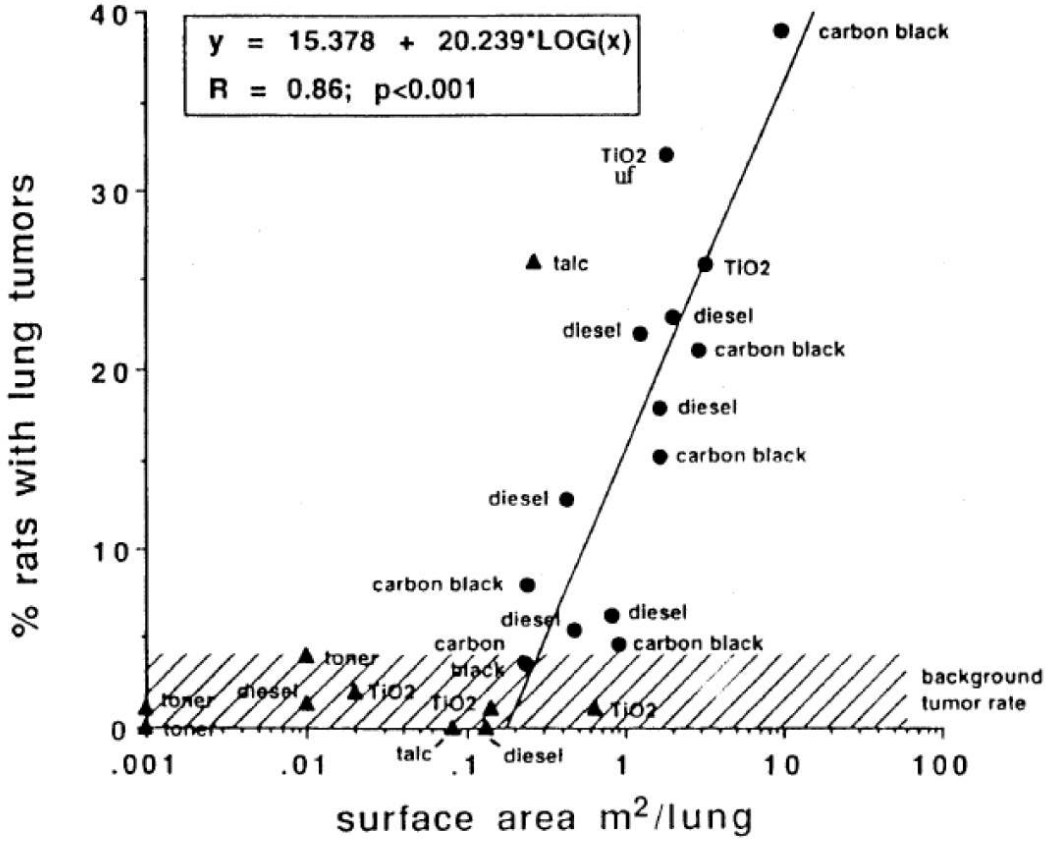
Computer not included


Model 3034
Polydisperse Aerosol In
Sheath Air In
Aerosol Neutralizer (Kr 85)
Polydisperse Aerosol Inlet 1.0 L/min
High-Voltage Rod
50-nm Cyclone
Heat Exchanger
Temperature Sensor
Absolute Pressure
Flowmeter
Recirculating Sheath Air 4.0 L/min
HEPA Filter
Sheath Blower
HEPA Filter
Sample Pump
Exhaust Port
BX Filter
DMA
Differential Pressure
Absolute Pressure
Resistance Heater
Control Orifice
Photodetector
Laser Diode
Collimating Lens
Electrical Pulses
Collecting Lenses
Light Stop
Focusing Lens
Cooled Condenser
Cooling Fan
1-liter Butanol Reservoir
Water-Removal Solenoid
Fill Solenoid
Forced Convection Heat Sink
Thermoelectric Cooling Device
Drying Chamber
Heated Saturator Reservoir
Excess Air Out
Monodisperse Aerosol Out
Butanol Drain
Drain Solenoid
Resistance Heater
CPC

AEROTRAK™ 9000
Aerosolmonitor för nanopartiklar

AEROTRAK 9000 *Aerosolmonitor för nanopartiklar anger ytan på partiklar som avlagras i lungorna.*

Correlation between lung tumor incidence in rats in chronic inhalation studies with different particle types and retained particle surface area

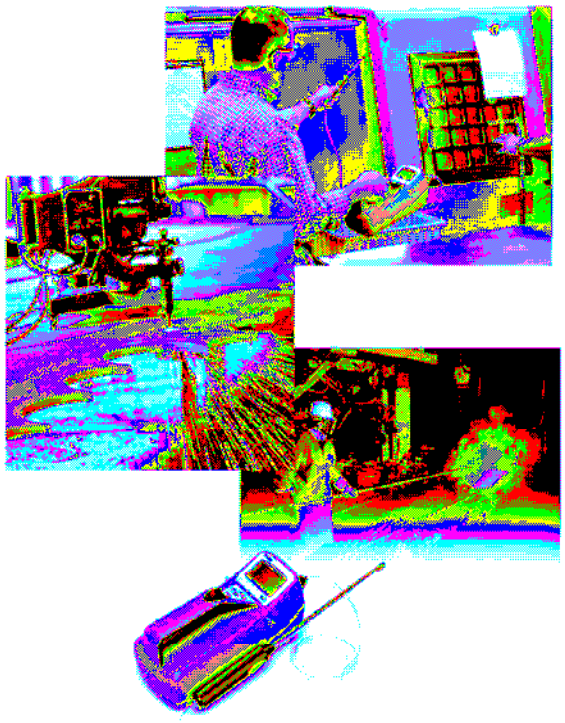


Source:

Summary by Driscoll 1996

P-TRAK®
Ultrafine Particle Counter

Do you know what your employees may be exposed to?



Fact:
It takes 1 billion 10 nm diameter particles to equal the mass of one 10 µm particle.

The P-TRAK Ultrafine Particle Counter measures aerosol particles ranging from 1 µm down to 0.02 µm in size (1,000 nm to 20 nm). Using TSI's proven technology, the P-TRAK gives direct, real-time measurement of workplace ultrafine particulate levels.

Ultrafine particles are defined as having a diameter less than 0.1 µm (or 100 nm). Engineered nanoparticles (nanomaterials) are a subset of ultrafine particles with dimensions from 1 to 100 nm. Nanomaterials are produced and used for industrial and high-tech applications, while ultrafine particles are the by-products of combustion and other chemical reactions. Unfortunately, the occupational health risks associated with manufacturing and using nanomaterials are not clearly understood. As a result, a need has arisen to assess workplace conditions.

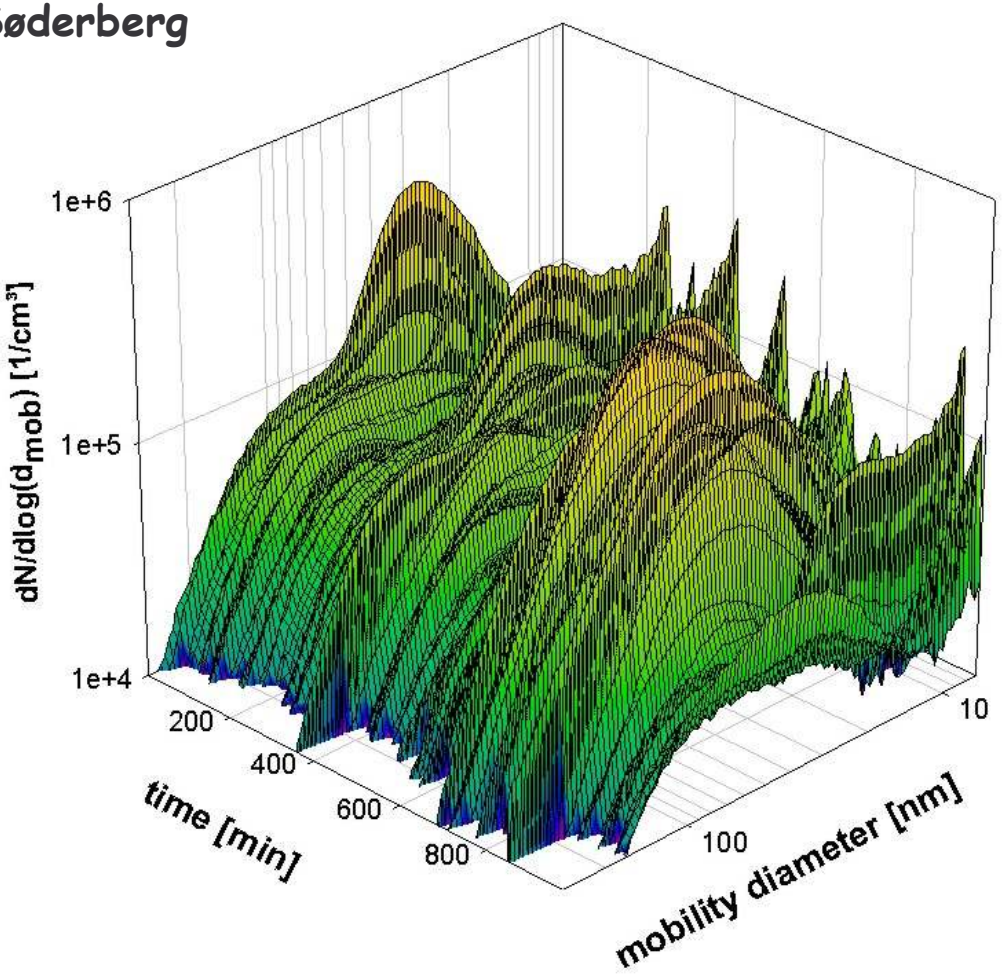
Measuring ultrafine and nanoparticles can be difficult because these particles have relatively little mass. Mass concentration is not a good indicator of concentration or exposure even though the particles occur in large numbers. Alternative, number-based measurements can effectively measure the amount of ultrafine and nanoparticles in the workplace environment. These measurements can be used to determine specific sources of ultrafine and nanoparticles in the workplace and evaluate the effectiveness of corrective actions or engineering controls.

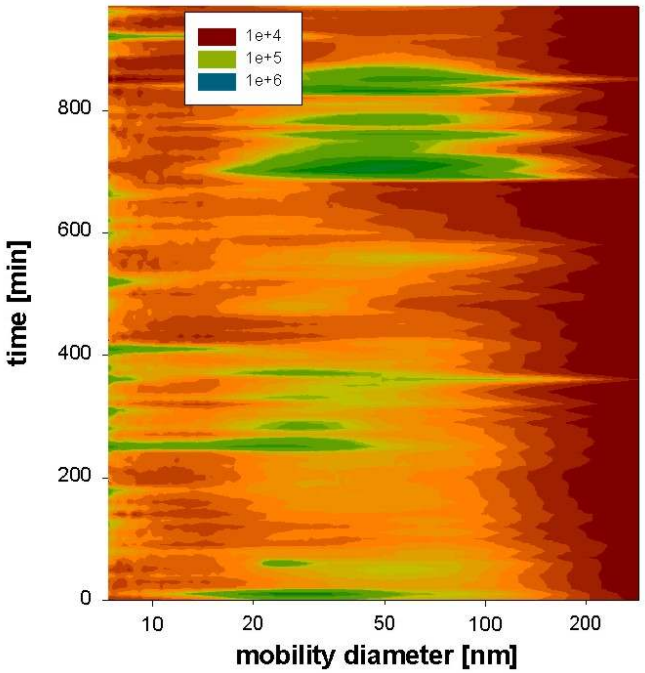
The P-TRAK Ultrafine Particle Counter can be used to qualitatively assess the workplace, check HVAC system filter efficiency, evaluate effectiveness of engineering controls, and track down point sources of ultrafine and nanoparticle generation.


Hydro
Aluminium

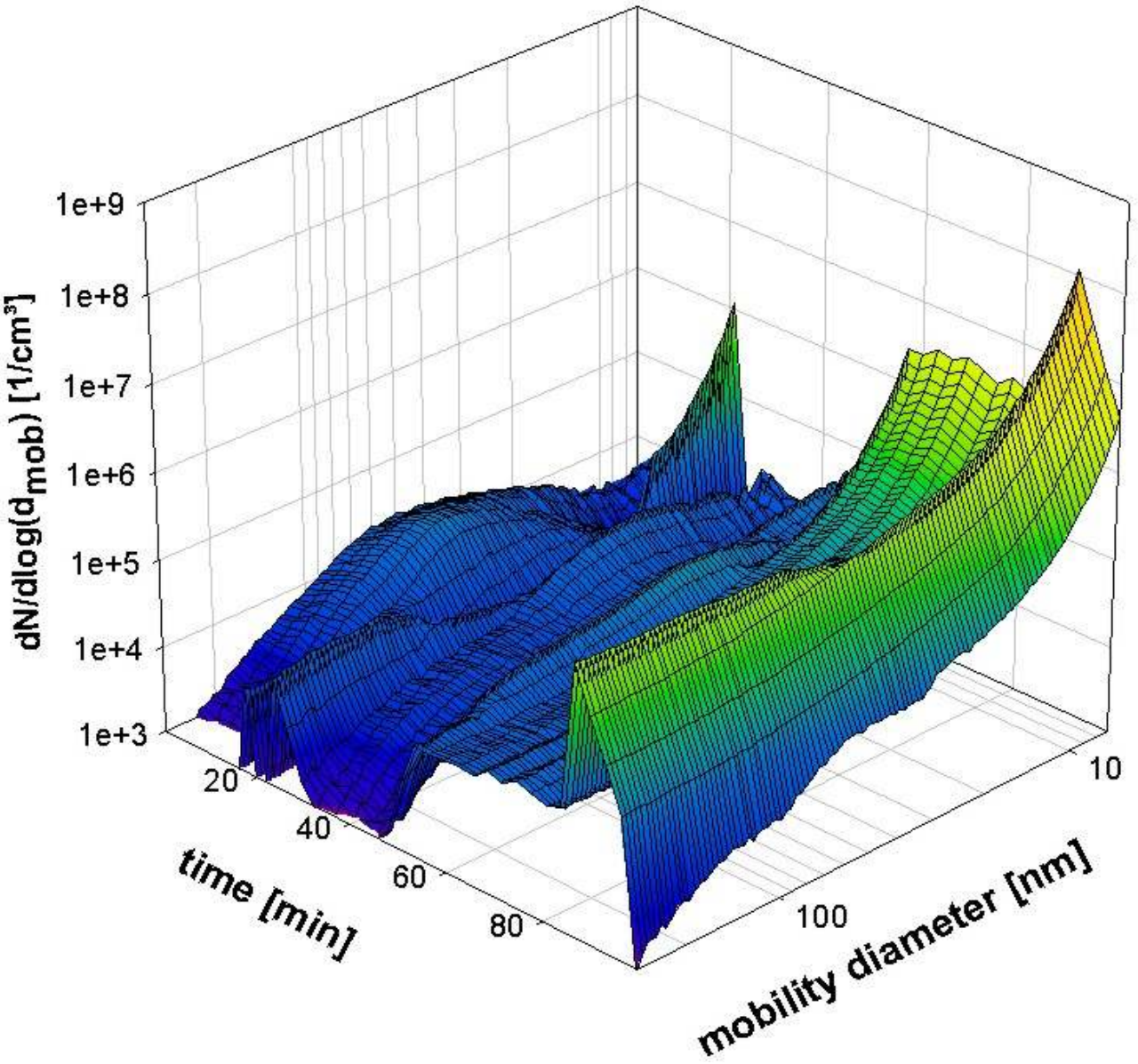
Particle size distribution

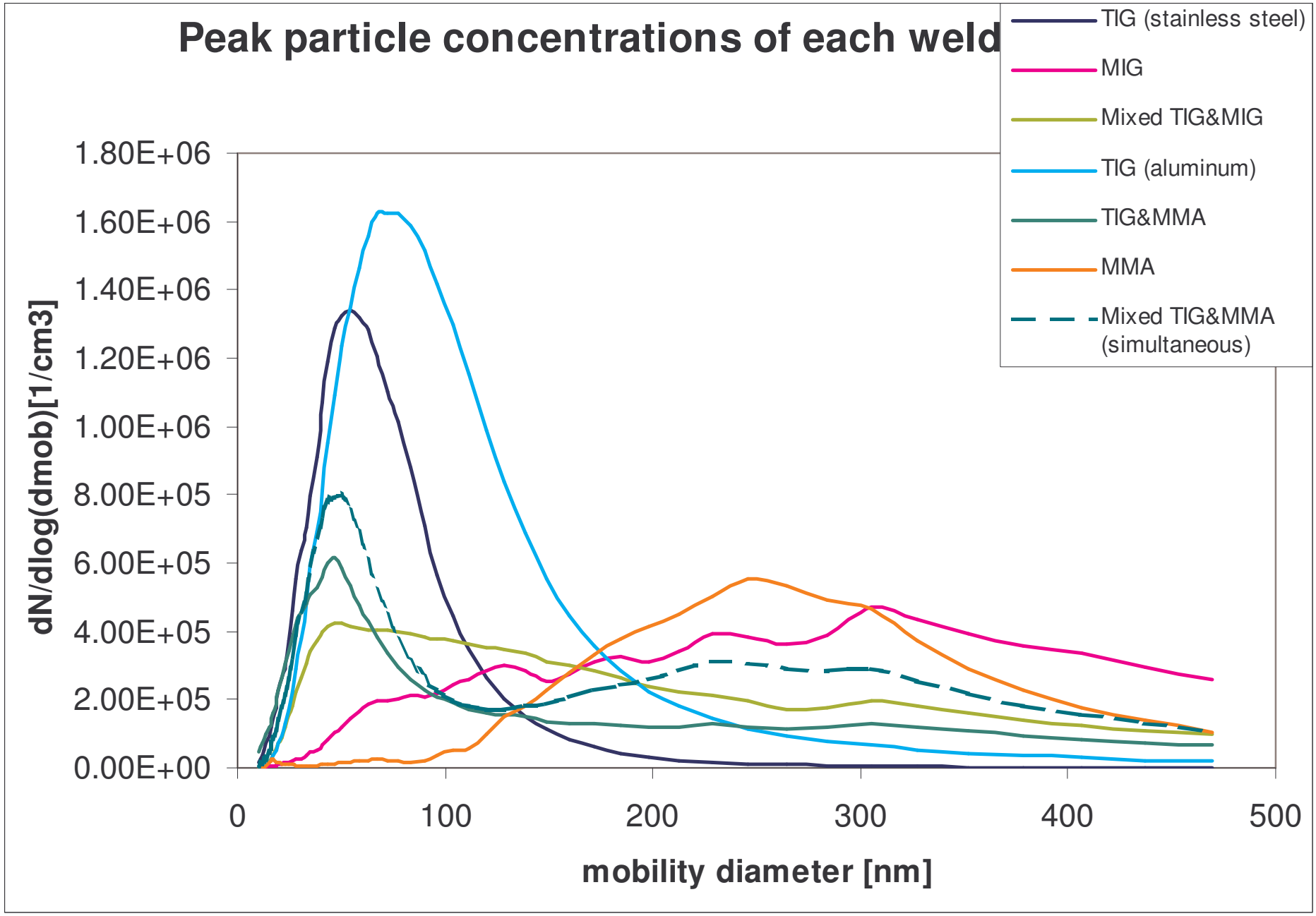
Søderberg



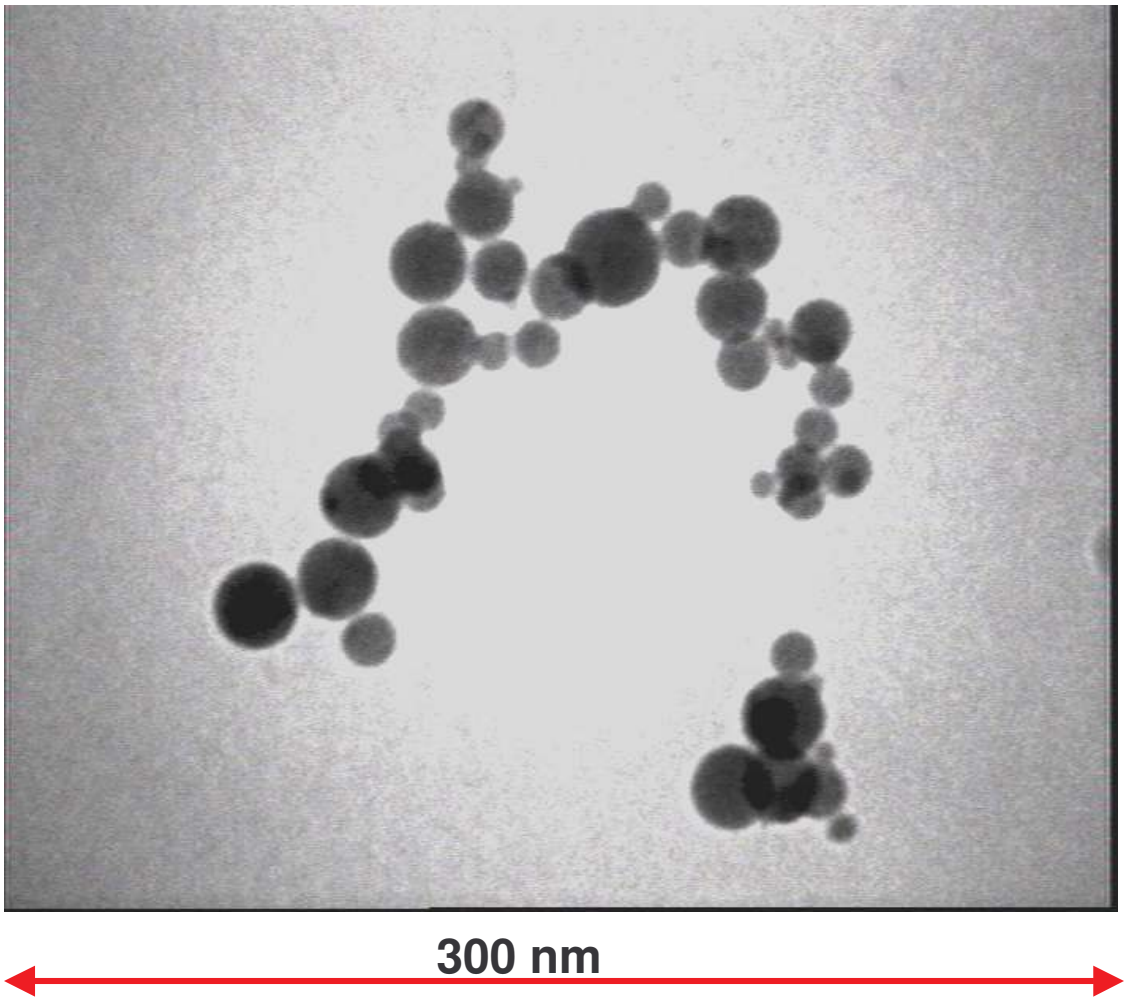


3-d and contour plot of the mobility size distribution during anode change operations

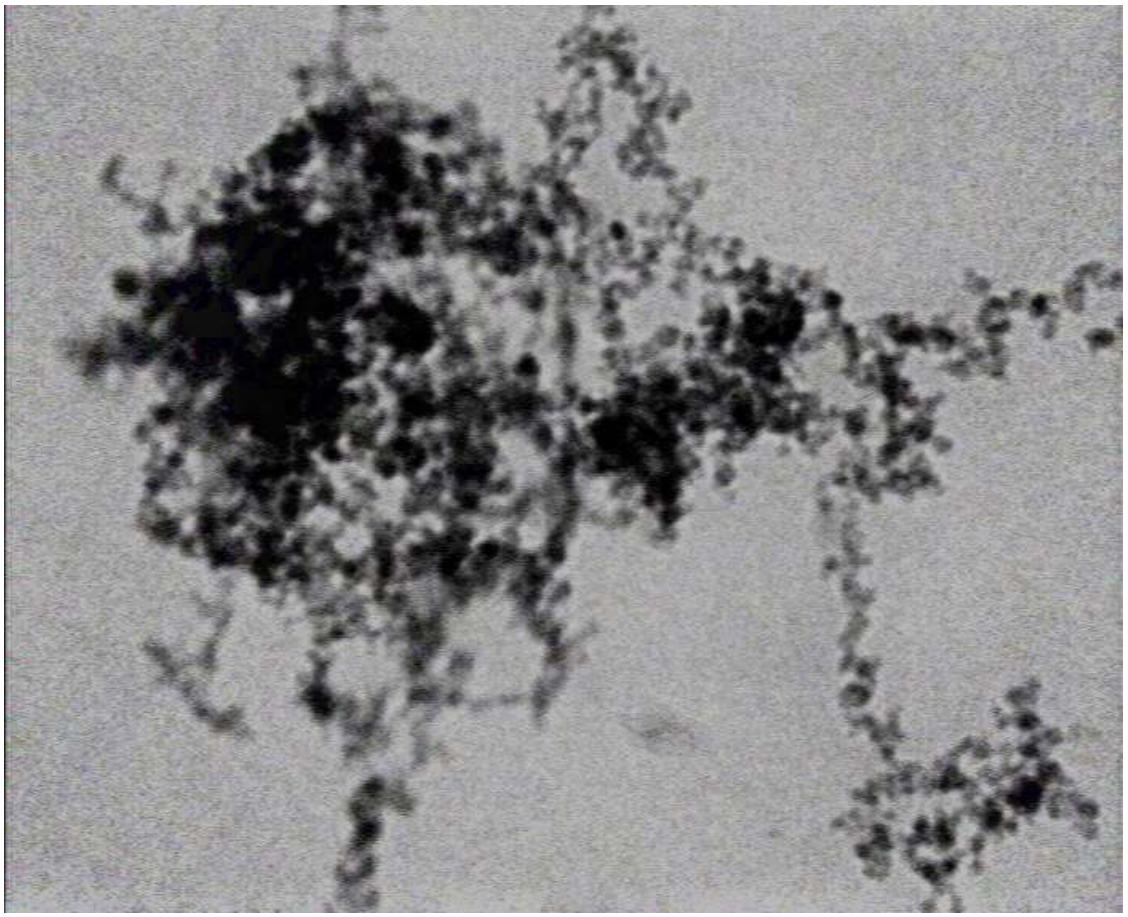



Peak particle concentrations of each weld
TIG (stainless steel)
MIG
Mixed TIG&MIG
TIG (aluminum)
TIG&MMA
MMA
Mixed TIG&MMA (simultaneous)
dN/dlog(dmob)[1/cm3]
1.80E+06
1.60E+06
1.40E+06
1.20E+06
1.00E+06
8.00E+05
6.00E+05
4.00E+05
2.00E+05
0.00E+00
0
100
200
300
400
500
mobility diameter [nm]

Morphology: welding fume



Morphology: welding fume



Ufp scavenging by larger dust particles

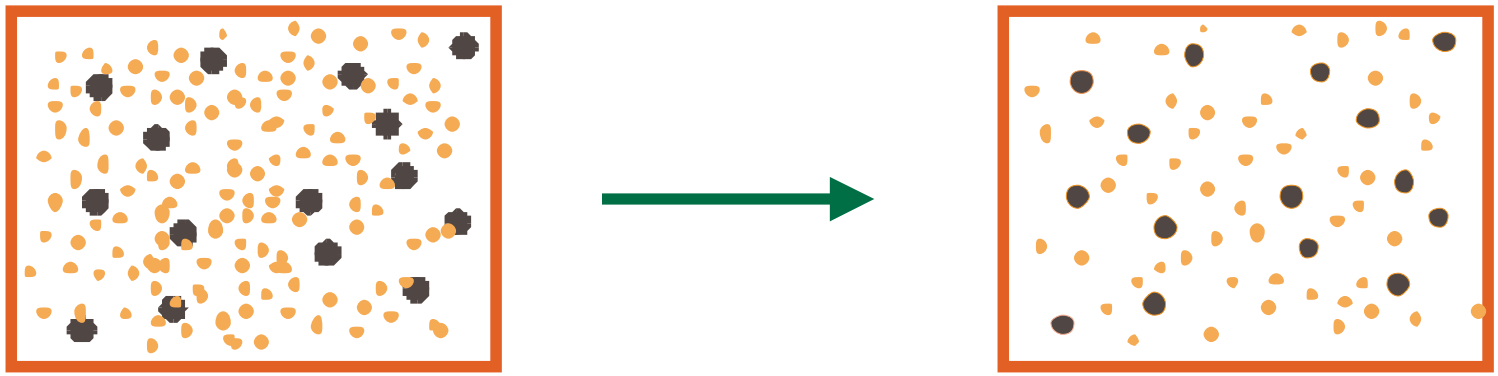


Table 1. Number concentrations measured with the P-Trak, Portacount or SMPS

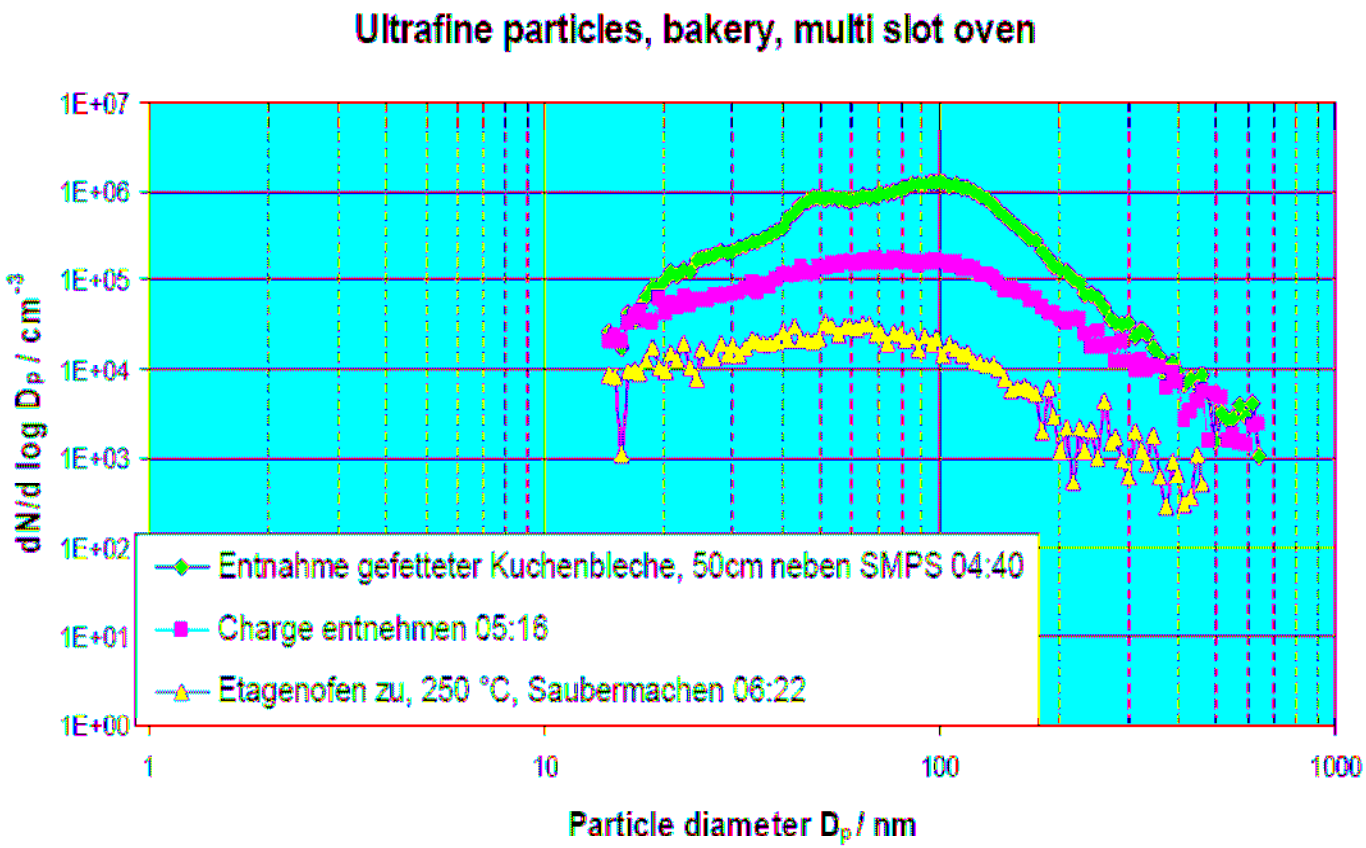
Type of Industry	Outside		Workplace		Activity
	Minimum particles/cm^3 × 10^3	Maximum particles/cm^3 × 10^3	Minimum particles/cm^3 × 10^3	Maximum particles/cm^3 × 10^3	
Carbon black*	694	3836	3.5	49.9	Bagging
Nickel powder	3.3	15.5	3.7	212	Bagging
Precious metal blacks	19.3	61.6	23.1	70.7	Sieving
Titanium dioxide	9.7	58.4	4.2	16.6	Bagging
Zinc refining (1)	20	23	12	24	Sintering
Zinc refining (2)	20	23	56	100	Casting
Plasma coating*	2.3	8.0	2.8	905	Wire coating
Galvanizing*	15.4	37	10.3	683	Galvanizing
Steel foundry	13	72.5	118	>500	Fettling
Welding	9.8	19.3	117	>500	MIG
Plastic welding*	1.2	5.2	111	3766	Welding
Hand soldering	2.2	10.7	11.7	>500	Tinning

*Total number concentrations measured by the SMPS.

Table 2. Median electrical mobility diameter values and geometric standard deviations of the number-weighted size distributions as measured by the SMPS

Type of Industry	Outside		Workplace		Activity
	Number median diameter (nm)	Geometric standard deviation	Number median diameter (nm)	Geometric standard deviation	
Carbon black	44	3.2	51–399	2.4	Bagging
Nickel powder	23	1.9	49	3.3	Bagging
Plasma coating	41	2.2	587	1.3	Wire coating
Zinc refining (1)	503	5.3	70	2.2	Sintering
Galvanizing	64	2.0	99	2.1	Galvanizing
Steel foundry	46	1.9	66	2.0	Moulding
Welding	53	2.1	179	2.2	MIG
Plastic welding	31	2.0	37	1.7	Welding
Hand soldering	41	2.0	72	2.3	Tinning

Bakery



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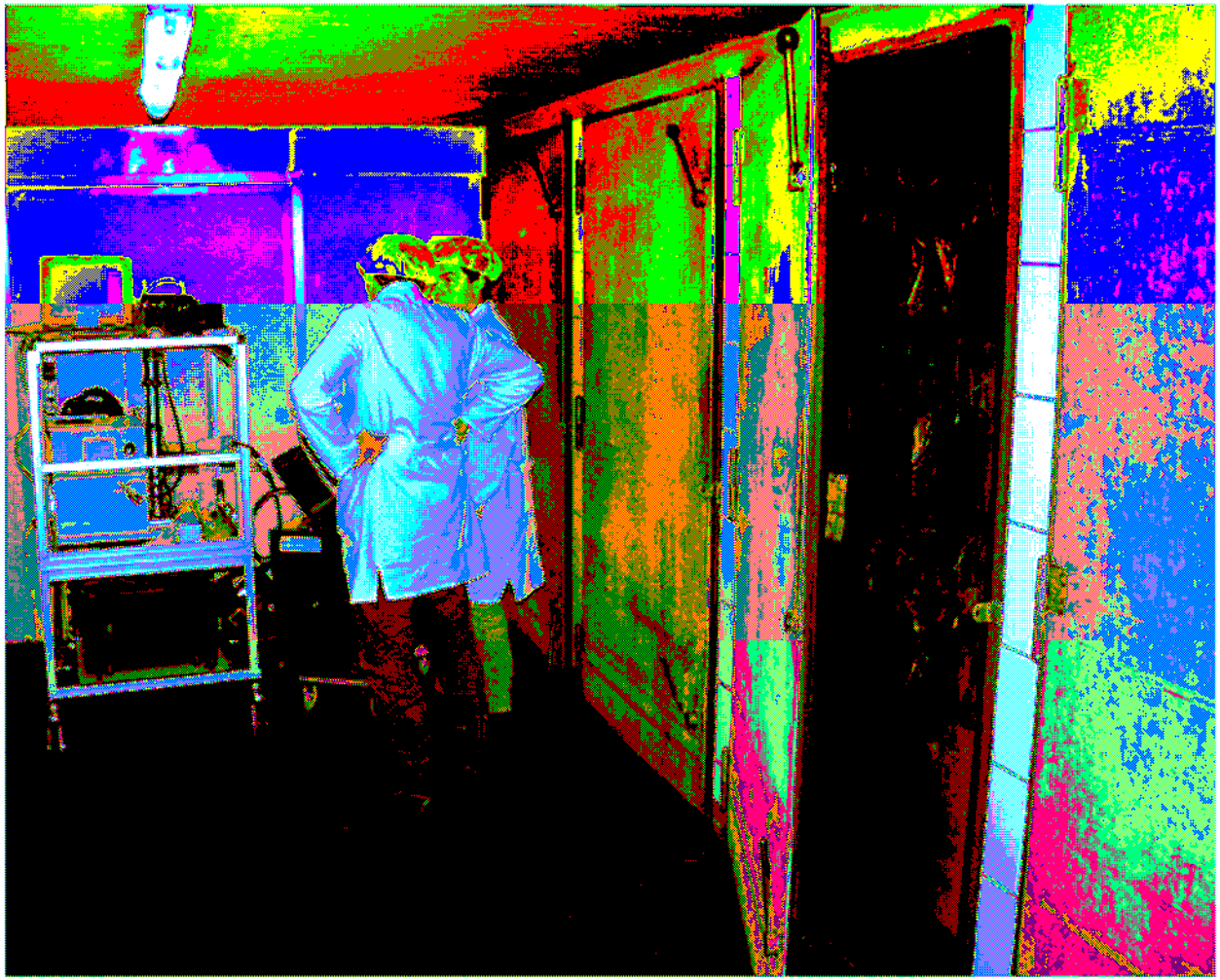
Smoke in a meat smokery



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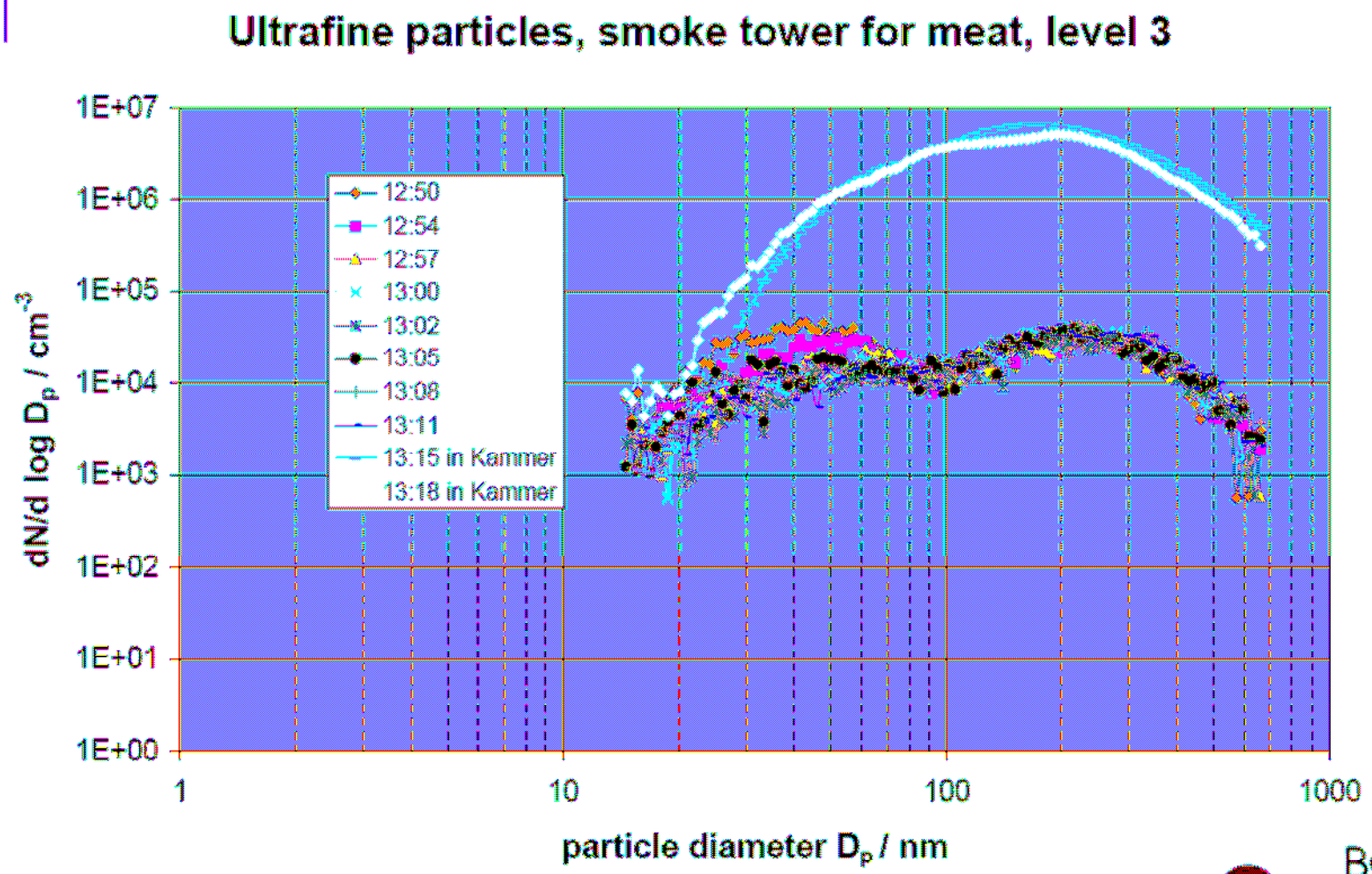
Smoke in a meat smokery



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Summary of results

Process	Total concentration in measurement range 14-673nm particles/cm³	Maximum of number concentration nm
Outdoor, office	up to 10 000	
Silicon melt	100 000	280-520
Metal grinding	up to 130 000	17-170
Soldering	up to 400 000	36-64
Plasma cutting	up to 500 000	120-180
Bakery	up to 640 000	32-109
Airport field	up to 700 000	<45
Hard soldering	54 000 up to 3 500 000	33-126
Welding	100 000	40-600

Comparison of two carbon analysis methods for monitoring diesel particulate levels in mines

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Received 29th June 1999, Accepted 20th September 1999

J. Environ. Monit., 1999, **1**, 541–544

PAPER

JEM
www.rsc.org/jem

Evaluation of the SKC® DPM cassette for monitoring diesel particulate matter in coal mines†

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Received 2nd July 2004, Accepted 7th September 2004
First published as an Advance Article on the web 5th November 2004

Results for the DPM Cassette were essentially identical to those obtained by the BOM impactors in a previous study. At a respirable coal dust concentration of 5.46 mg m^{-3}, which is 3.8 times the regulatory limit, the DPM Cassette collected only 34 μg m^{-3} of coal-source elemental carbon.

SKC DMP personal cassette

Occupational Exposure to Diesel Exhaust Fumes

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Received 20 May 2003; in final form 23 October 2003; published online on 17 May 2004

Ann. occup. Hyg., Vol. 48, No. 4, pp. 369–376, 2004

Published by Oxford University Press
DOI: 10.1093/annhyg/meh018

Table 1. Exposure to diesel fumes by depot

Depot	n[a]	CO_2 (p.p.m.)		Respirable dust ($\mu g/m^3$)		Elemental carbon ($\mu g/m^3$)		Organic carbon ($\mu g/m^3$)	
		GM	Range	GM	Range	GM	Range	GM	Range
1[b] (eng)	Static (6)	535	497–565	120	<80–195	38	21–79	54	45–76
	FLT (6)	533	511–572	98	80–120	51	34–118	56	40–90
2 (eng)	Static (6)	527	482–575	106	<80–203	49	30–82	47	29–73
	FLT (6)	563	455–828	179	109–227	55	37–81	57	47–68
3	Static (6)	522	463–636	99	<80–198	20	12–48	28	19–53
	FLT (6)	535	487–580	123	96–184	28	21–45	36	26–49
4 (vent)	Static (2)	436	397–478	<80	<80–84	15	11–20	32	29–35
	FLT (1)	489		<80		22		30	
5 (eng)	Static (6)	476	406–545	87	<80–101	16	8–23	26	16–37
	FLT (6)	476	433–530	105	86–138	16	12–21	29	25–36
6	Static (4)	492	428–561	<80	<80–278	7	5–12	11	9–16
	FLT (4)	484	471–501	<80	<80–105	7	6–8	11	7–14
7 (eng)	Static (4)	519	498–548	141	85–172	30	20–42	47	28–60
	FLT (4)	512	475–556	166	122–225	42	38–48	69	61–83
8	Static (4)	525	489–559	<80	<80–111	21	14–31	33	24–39
	FLT (4)	485	463–542	<80	<80–89	23	18–34	38	28–53
9 (vent)	Static (2)	515	480–553	<80	<80–99	16	11–22	21	19–24
	FLT (2)	452	445–459	121	113–130	22	21–25	27	25–29

[a]n denotes the sample size for carbon analysis. Anomolous respirable dust results not included ($n = 3$) (see text for details). Some FLT CO_2 samples were lost from vehicles ($n = 4$)

[b]Lorries loaded inside depot. eng, on-site engineer; vent, dilution ventilation.

Table 2. Measured TWA background levels of PAHs and ultrafine particles

Depot	*n* (days)	PAHs (ng/m^3)		Ultrafine particles (particles/cm^3 × 10^3)	
		Mean TWA	TWA range	Mean TWA	TWA range
2	3	NA	NA	158	123–179
3	3	18.6	10.8–30.1	147	96–225
4	1	8.6		50	
5	3	16.5	15.2–18.1	181	161–205
6	2	6.2	6.1–6.3	66	58–74
7	2	34.7	32.5–36.9	218	206–231
8	2	17.4	12.5–22.2	110	90–130
9	1	10.5		107	

Ann. occup. Hyg., Vol. 48, No. 4, pp. 369–376, 2004

Published by Oxford University Press
DOI: 10.1093/annhyg/meh018

Table 3. Correlation coefficients for diesel fume pollutants

	Resp	TC	EC	OC	EC/OC	PAH	UP
TC	0.72[a]						
EC	0.67[a]	0.97[a]					
OC	0.73[a]	0.97[a]	0.89[a]				
EC/OC	0.29[a]	0.63[a]	0.76[a]	0.44[a]			
PAH	0.90[a]	0.93[a]	0.91[a]	0.91[a]	0.52[a]		
UP	0.76[a]	0.70[a]	0.62[a]	0.75[a]	0.43	0.85[a]	
CO_2	0.37[a]	0.47[a]	0.51[a]	0.39[a]	0.49[a]	0.36	0.34

[a] $P < 0.05$.

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results. CO levels ranged from mostly not detected to 1–2 p.p.m., consistent with previous reports (Purdham *et al.*, 1987; Ulfvarson and Alexanderson, 1990).

Many consider CO to be a usable chemical tracer for diesel exhaust !