Ultrafine Particles from Ozone and Personal Care Products

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SinBerBEST | Singapore-Berkeley Building Efficiency and Sustainability in the Tropics

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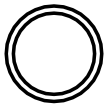
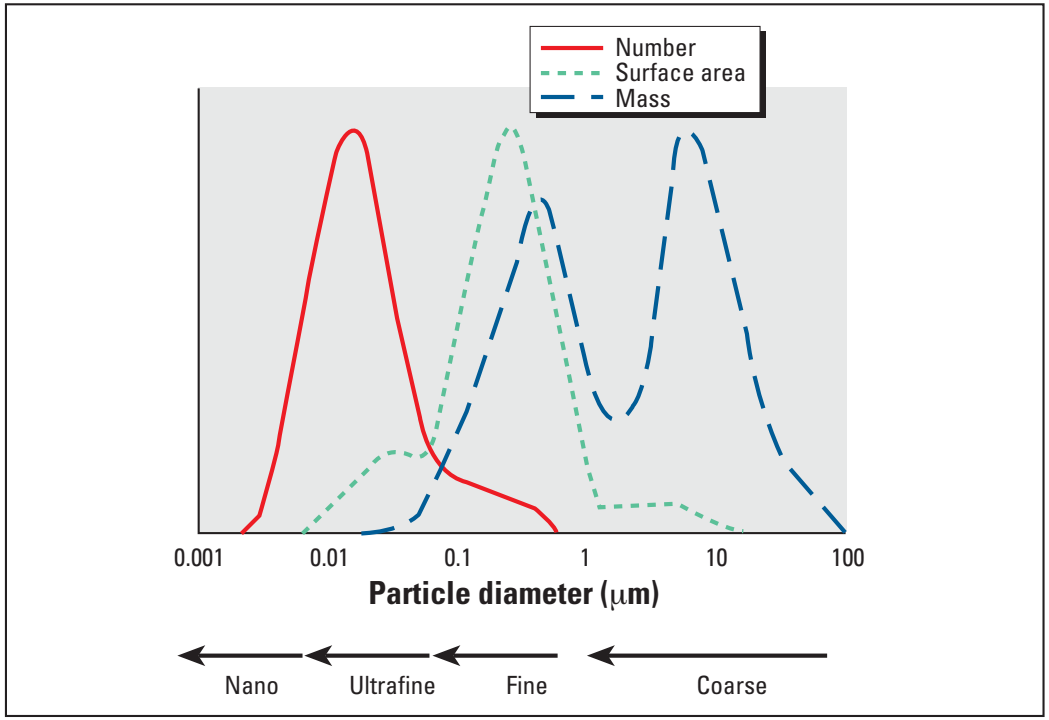
Motivation



- Ultrafine Particles affect human health
  - Highest number concentration of particles in air
  - Been linked to harmful effects
- Ozone can cause UFP's
  - Main driver of air reactions in indoor environments
  - Shown to occur in reactions with some household cleaners
- Source position is important
  - Where the emission occurs affects how much is inhaled
  - When very close to our bodies, inhalation is magnified

Particle sizes in our air



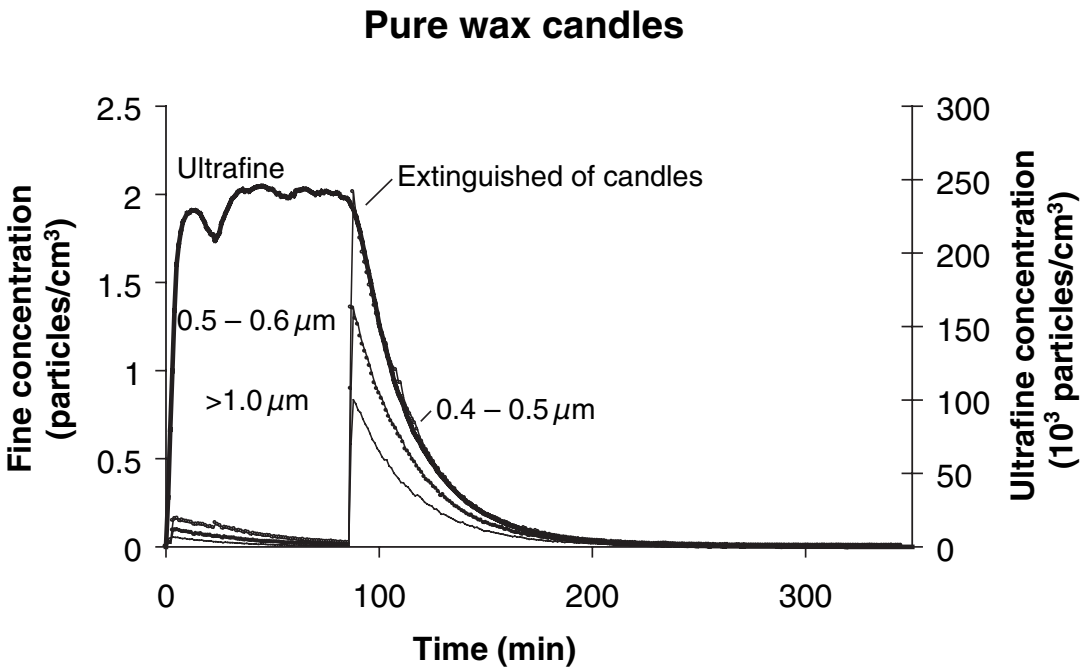
Typically particles are characterized as either coarse particles (2.5μm<Dp<10μm) or as fine particles (Dp<2.5μm). On a mass or surface area basis, ultrafine particles (Dp<0.1μm) contribute little, but they contain almost all of the count or number.

Philips Aerasense, www.aerasense.com/index.php?pageID=6; Ref: Oberdörster & Utell, *Env Health Perspect,* 110, 8, 2002

Sources of Ultrafine Particles Indoors

Other common sources:

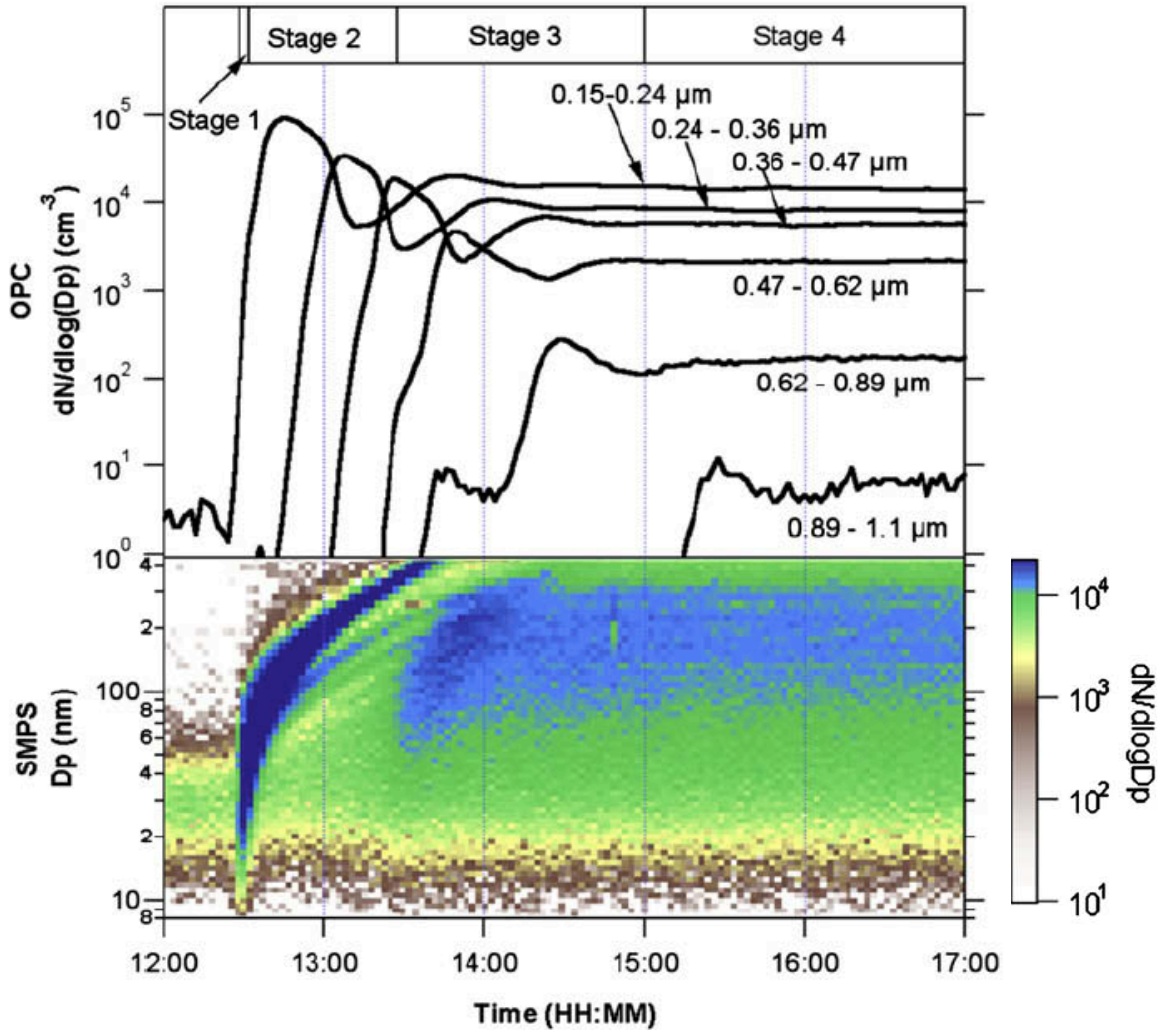
- Cigarettes
- Irons
- Vacuums
- Cooking surfaces
- Some cleaning agents



UFP's can be produced indoors by combustion, chemical reactions and by some appliances

Source: Afshari, Alireza, U. Matson, and L. E. Ekberg *Indoor Air* 15, 141, 2005

Ozone reactions can also produce UFP's



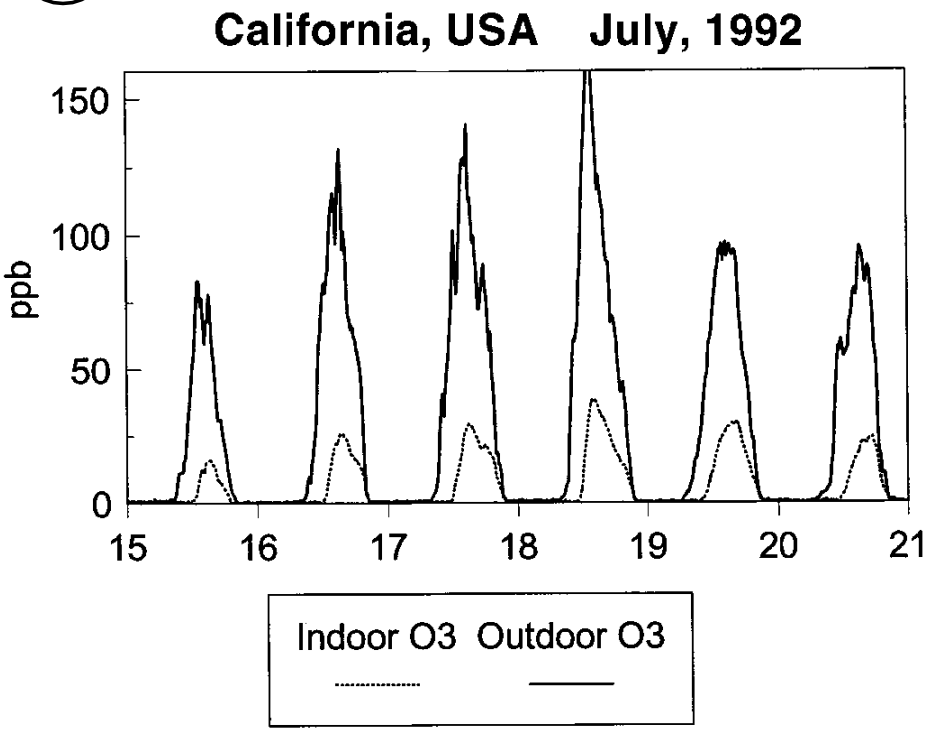
Characteristic growth of particles from ozone (~60 ppb at inlet) and pine-oil cleaner vapor. Tick marks represent 30 min intervals and the y-axis indicates particle diameter (nm)

Source: BK Coleman, MM Lunden, H Destaillats, WW Nazaroff, *Atmospheric Environment* **42**, 35, 2008

Indoor Ozone

Typical I/O:
0.05 – Tightly sealed or charcoal filtration

0.85 – Highly Ventilated Buildings



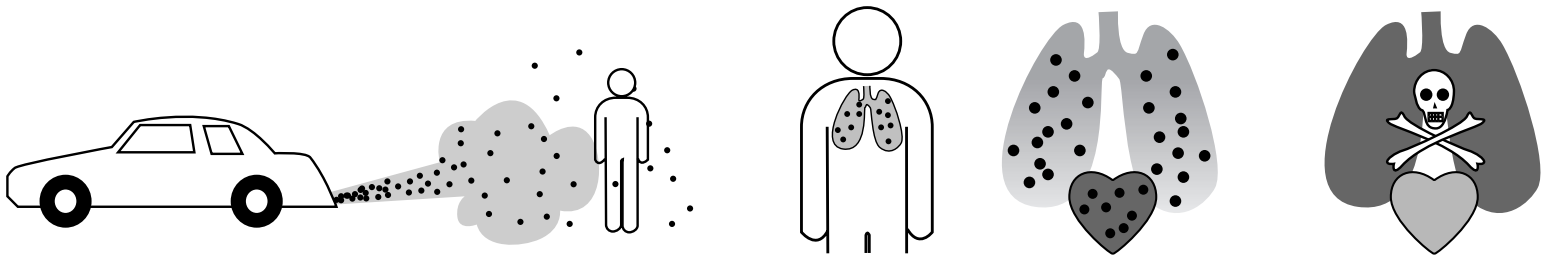
We know that UFP's are hazardous, they are produced in indoor environments, and ozone is a cause for some of these emission sources. Since we can control the concentration of indoor ozone with filtration, is this a good enough reason to do so?

Sources: C. Weschler, *Indoor Air,* 10, 269, 2000; C. Weschler et al, in: Vostal, JJ *Tropospheric Ozone,* 236-254

Intake Fraction

iF = mass of pollutant intake / mass of pollutant emission

$iF_{indoors} > iF_{outdoors}$



Emissions ⇨ Intake

Intake fraction measures how much of an emission is inhaled by any human, and is a metric for the magnitude of the health effect of a particular source

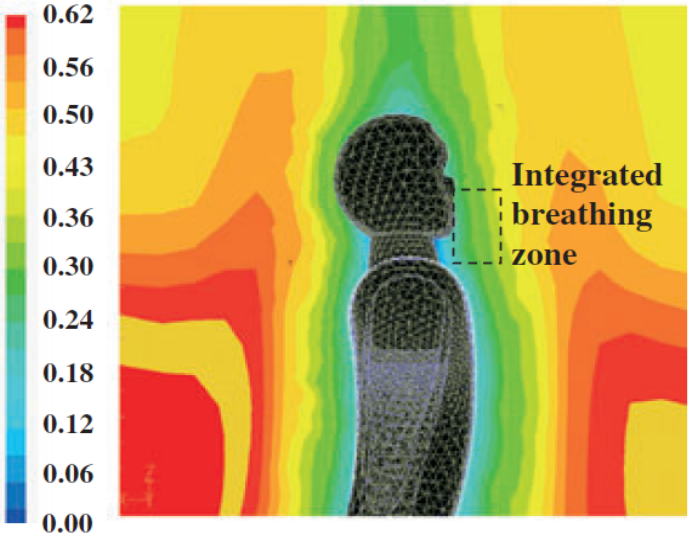
Source: J. Marshall and W. Nazaroff, *Exposure Analysis* 2006

Personal Reactive Cloud

- Personal monitoring devices consistently show higher levels then nearby monitors
- Particles/gases "cloud" inside a person's heat plume
- Personal reactive cloud expands this concept to include reactions that occurring inside the "cloud"

"Pigpen" Effect

$iF_{near\ person} > iF_{indoors} > iF_{outdoors}$



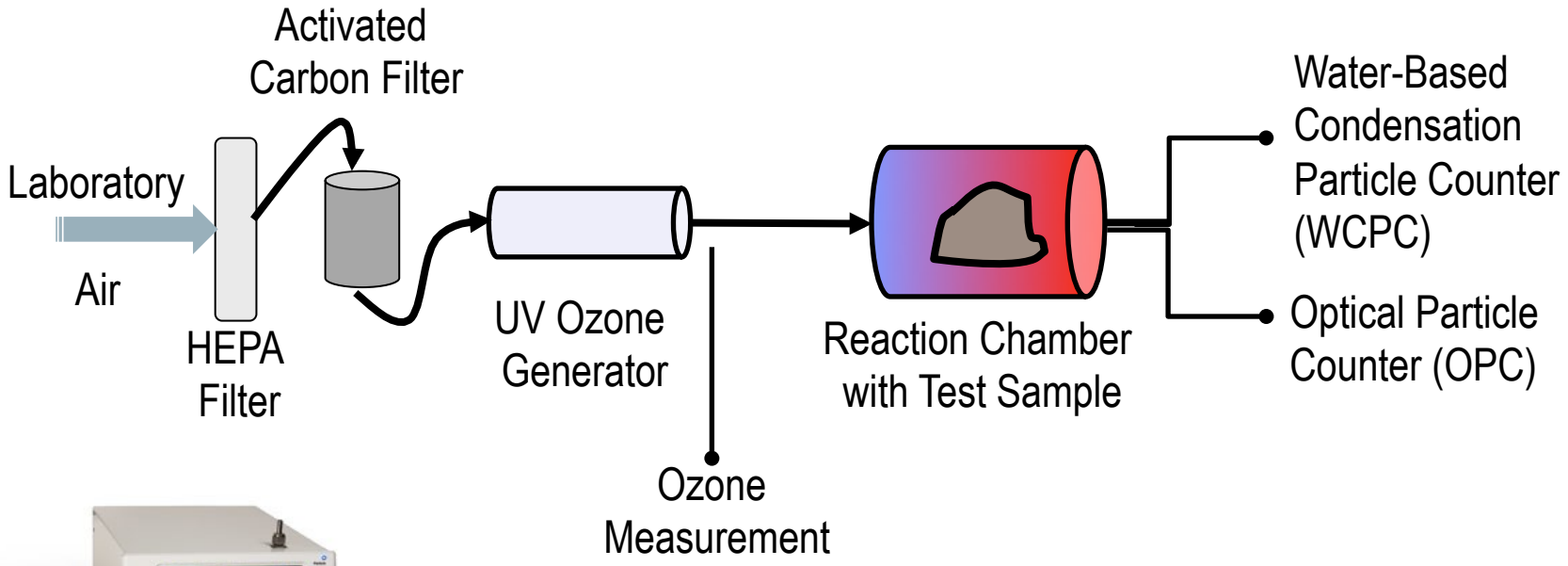
Source: D Rim, A Novoselec, G Morrison, *Indoor Air* 19, 324, 2009

The Role of Personal Care Products

- Personal care products are applied to our skin and well within our personal reactive cloud
  - Primary emissions with fast reaction times
  - Surface reaction products
- They have emissions on the order of hours
  - Fragrances emit for as long as it can be smelled
  - Products that coat have opportunities to react with ozone until they are removed

Experimental Scope

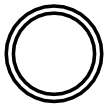
We are exploring whether or not ultrafine particle production is present when ozone reacts with personal care products



MSP Corp, model
1120 WCPC

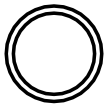
A differentially heated chamber is used to recreate the personal cloud

Status and plans



- Current Status
  - Building experimental setup
  - Purchasing Singaporean and American samples
- Projected: 6 months
  - Primary data collection completed
  - Data analysis and seek publication
- Begin work on next phase
  - Based on current findings

Implications with SinBerBEST



- Ultrafine particles have an effect on human health
- Indoor environments and near person emissions of particles have amplified effects
- If personal care products are a significant source of inhaled UFP's it may be worthwhile to address it
- In order to balance energy consumption, productivity and healthfulness it is important to know what emissions should be controlled