Zufall Health Center Continuing Dental Education Series

TODAY'S PRESENTATION

PHOTOCATALYTIC OXIDATION (PCO) TECHNOLOGY FOR MEDICAL AND DENTAL OFFICE AIR PURIFICATION

WILL BEGIN SHORTLY

Housekeeping Items

Please …

- ✓ Mute yourself when not speaking
- ✓ Chat in your questions
- ✓ Raise your hand to ask a question
- ✓ Complete Needs Assessment and Evaluation Form

ZUFALL HEALTH COMMUNITY HEALTH CENTERS

Dr. Jason Field

Learning Objectives:	
	Learn fundamentals of different air purification technologies
	Describe Active PCO technology: Background, how it works, and its applications for medical and dental facilities
	Define how photocatalytic coatings are used for air purification and surface sanitation

PCO Technology for Medical & Dental Office Air Purification

THE UNIVERSITY OF ARIZONA

School of Natural Resources and the Environment

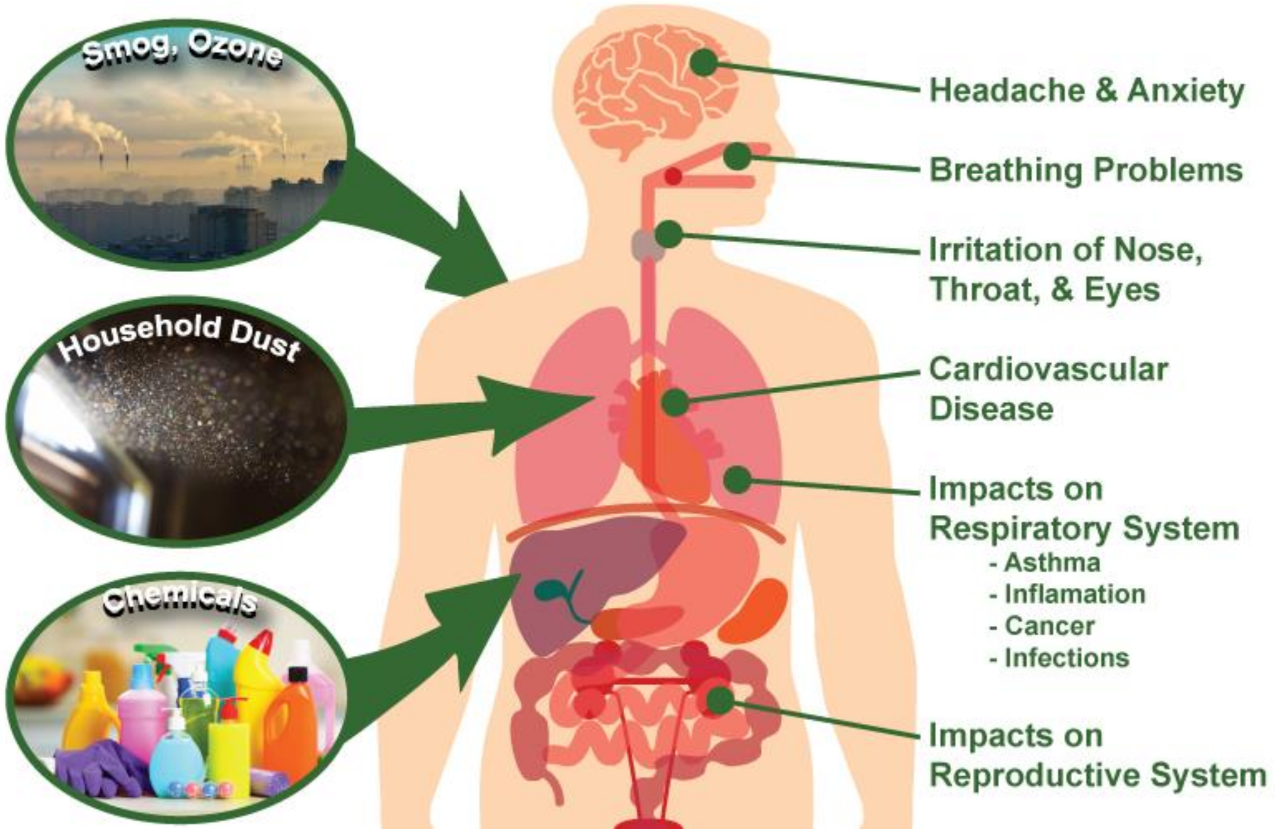
Disclosure: Dr. Jason Field is the Director of America Nanocoat.

Outline

1. Indoor air quality
2. Air purification technologies
3. PCO technology: background, safety, how it works
4. Air purification for doctoral and dental offices
5. Photocatalytic coatings for air and surface cleaning

Indoor Air Quality: Health Implications

- Most people spend more than 90% of their time in an indoor environment.
- Indoor air contaminants have been globally recognized as public health hazards during the last decade (US EPA).
- Long-term exposure to indoor air pollutants can be detrimental to human health and
- Can lead to sick building syndrome, building related illnesses and in extreme cases cancer.

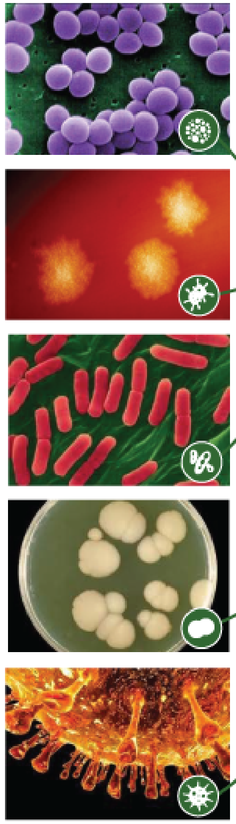


Soreanu, Dixon, & Darlington, 2013

Indoor Air Quality: Health Implications

- Levels of pollutants in indoor environment can be up to 10 times higher than that of outdoor air.
- Indoor sources such as combustion by-products, building materials, office equipment and consumer products [3,4].
- Many air purification technologies have been developed for removing contaminants from indoor air such as:
  - Filtration, adsorption [5–8],
  - ozonation [9–11],
  - non-thermal plasma [12,13],
  - photocatalytic oxidation [14–17].

A.H. Mamaghani et al. 2017. Applied Catalysis B: Environmental



Microbe	Duration of Persistence [range]
Bacteria - Gram (+)	
Mycobacterium tuberculosis (Tb)	1 day - 4 months
Staphylococcus aureus (MRSA)	7 days - 7 months
Enterococcus (VRE)	4 months
Clostridium difficile (C. diff)	5 months
Bacteria - Gram (-)	
Escherichia coli (E. coli)	1.5 hours - 16 months
Serratia marcescens	3 days - 2 months
Acinetobacter	3 days - 5 months
Fungi	
Candida	1 - 150 days
Viruses	
Norovirus	8 hours - 7 days
Influenza virus	1 - 2 days
Hepatitis B virus	Less than 1 week

*Maintaining sanitary **SURFACES** is critical for reducing the spread of communicable diseases.*

Air Purification Technologies

Air cleaning technology	Purification mechanism	Treated pollutants	Purification performance	Advantages
UV-PCO	Photocatalysts under exposure of UV light generate radicals in the presence of water and O_2. Radicals are reactive species to oxidize pollutants.	A broad range of indoor pollutants: soots, inorganic compounds, VOCs, airborne microbes	Performance depends on the humidity, light source, inlet concentration, photocatalyst, reactor	Degrade toxic compounds into non-toxic final products; operation at room temperature and pressure; low pressure-drop; low energy consumption
Filtration [87–89]	The mechanical or physical operation for the separation of solids from gases by trapping particles	Particulate matter, airborne microbes (if a filter treated with antimicrobial agents)	Higher removal efficiencies for larger particles; HEPA filter can remove 99.97% of 0.3 μm airborne particles.	No removal of most odors, chemicals, or gases; low efficiency for small particles; filter replacement
UV germicidal irradiation (UVGI) [96]	Airborne microorganisms are killed by adsorption of UVC light at 253.7 nm.	Airborne microbes	Performance depends on the lamp intensity, the distance of the microorganism from the lamp, temperature, RH, and air exchange rate.	Effective in inactivating airborne microorganisms; low energy consumption.
Ozonation [72]	Ozone, generated by UV or NTP discharge, takes reactions with pollutants and oxidizes them.	Microorganisms, some VOCs, some smells and gases.	Performance depends on retention time, humidity level, and nature of pollutants.	Ozone can produce hydroxyl radicals.
Electrostatic precipitator (ESP) [97,98]	Ionization of stream is followed by changing, migration, and collection of charged particles.	A wide range of particles	Collection performance relies on particle size and design parameters such as airflow rate, voltage, collection cell area, and the electric field strength	Effective at removing particles larger than 20 nm.

Air Purification: Chairside Aerosol Extraction

- Removes High Volume of Droplets & Aerosols Produced During Treatment (**Filtration System**).
- **HEPA Filtration System**: 3 Layers of HEPA filtration system, stopping virus and germs ≥0.3µm with 99.995% efficiency.
- **Medical Grade UV Light Disinfectant System:** Killing all the virus and germs in the filter.

Replacement Items:
- HEPA Filtration
- UV Light
- Suction Cover
- Primary Filtration
- Dust Filtration

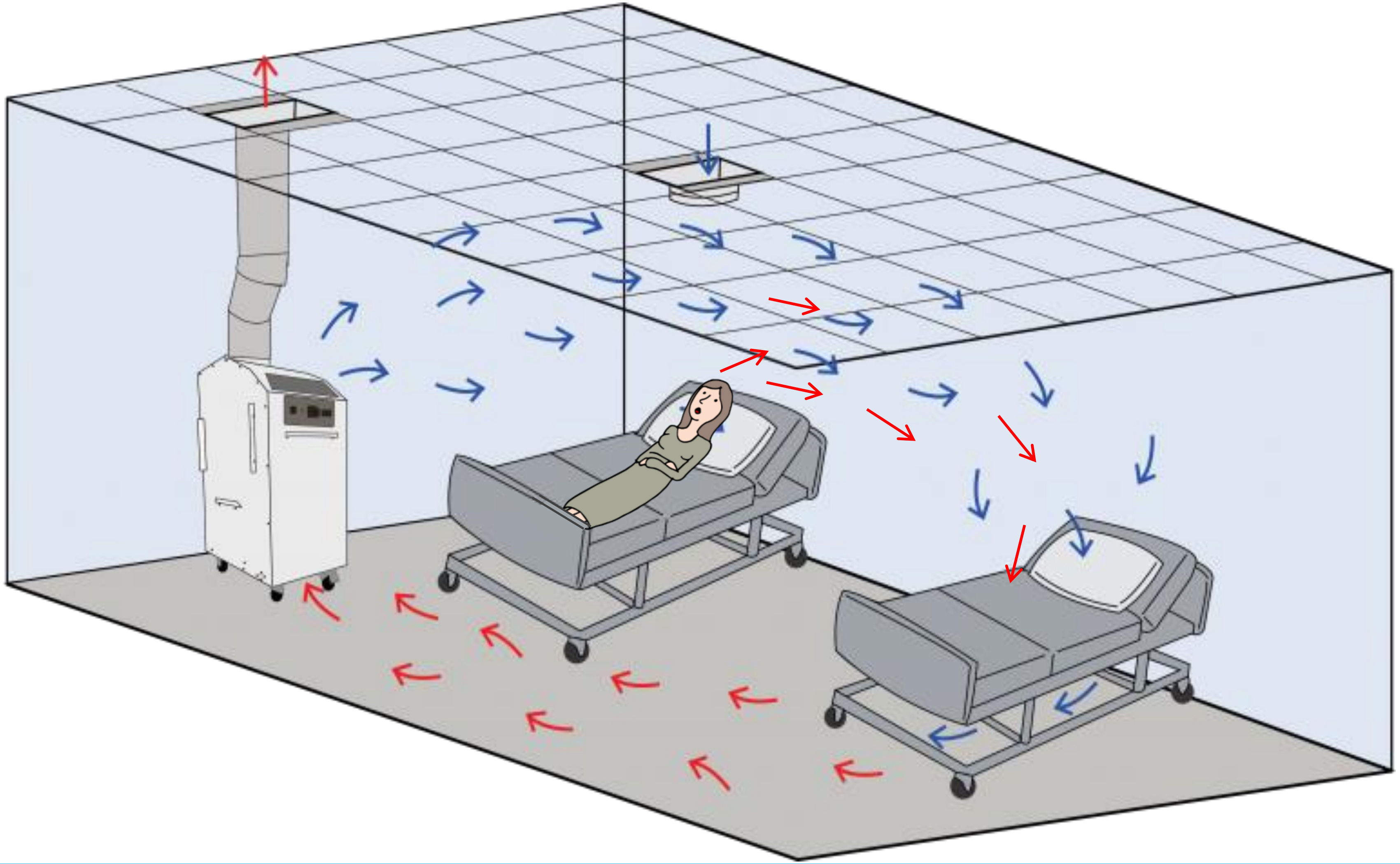
Specifications:
Mode: SP1000
Voltage: AC110V
Power: 1200W

Air Purification: Negative Pressure

DESCRIPTION

- ***Combining known technologies into a portable unit***
- HEPA filtration for airborne particulate removal
- Ultraviolet (UV) light to aide in sterilizing airborne viruses and bacteria *trapped* in the HEPA
- Only air having passed through both UV and HEPA will be returned to hospital HVAC
- 12 air changes per hour via HEPA filters
- Pressure differential of 0.01” minimum between room and adjoining spaces (May require additional seals around doors or other significant leak points in large rooms with poorly sealed doors)

Air Purification: Negative Pressure

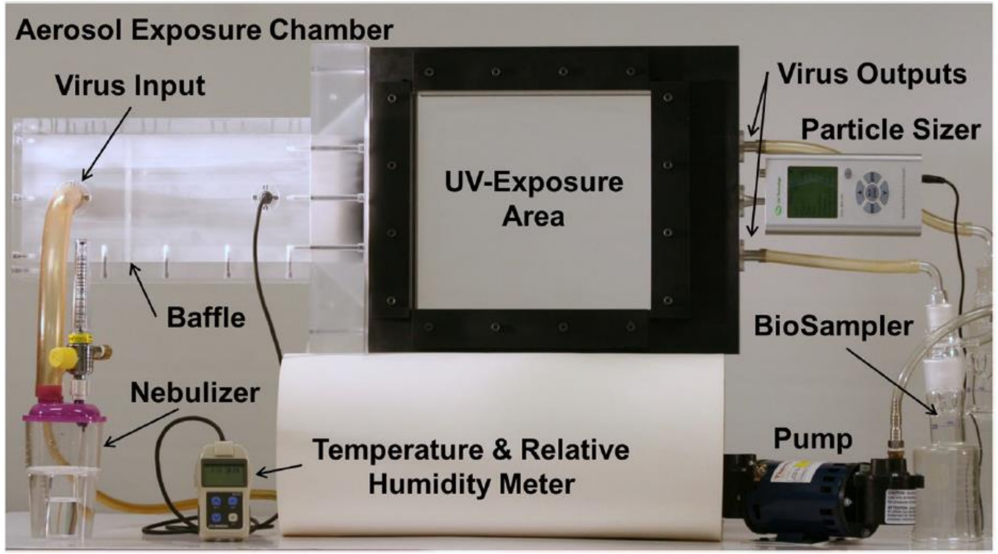


Air Purification: Far-UVC Lights

- Far-UVC light may represent a safe and efficient technology for controlling pathogens.
- ***Far-UVC light (207–222nm) efficiently inactivates bacteria*** without harm to exposed mammalian skin.
- This study shows for the first time that far-UVC efficiently inactivates >95% of aerosolized H1N1 influenza virus.
- ***More studies are needed*** on other pathogens and contaminants.
- Limitations for surfaces due to decreasing light intensity with distance from the source.

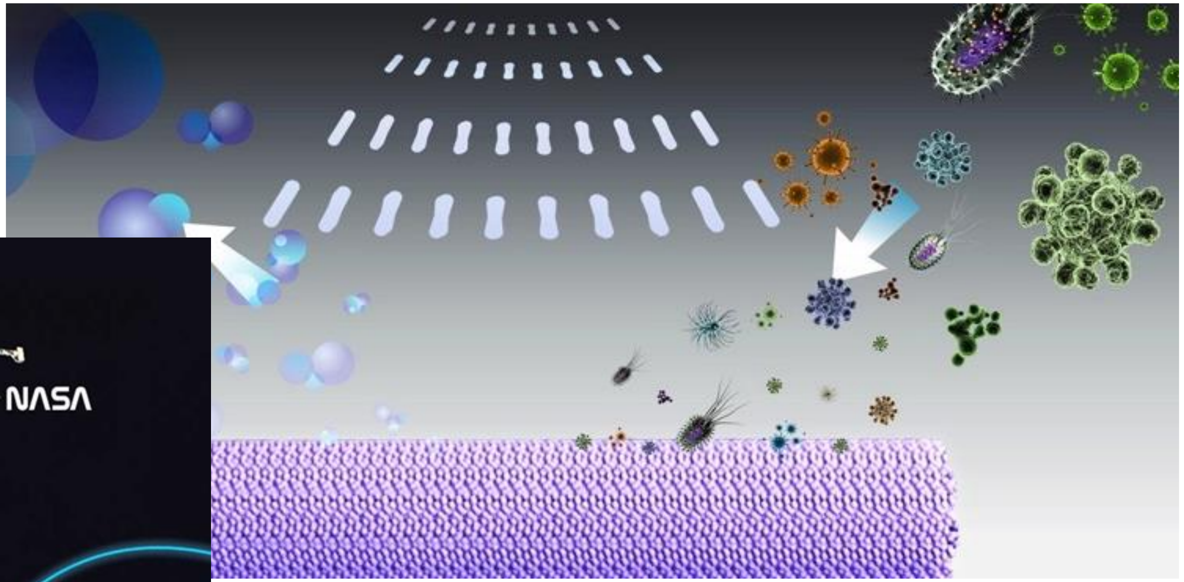
SCIENTIFIC REPORTS

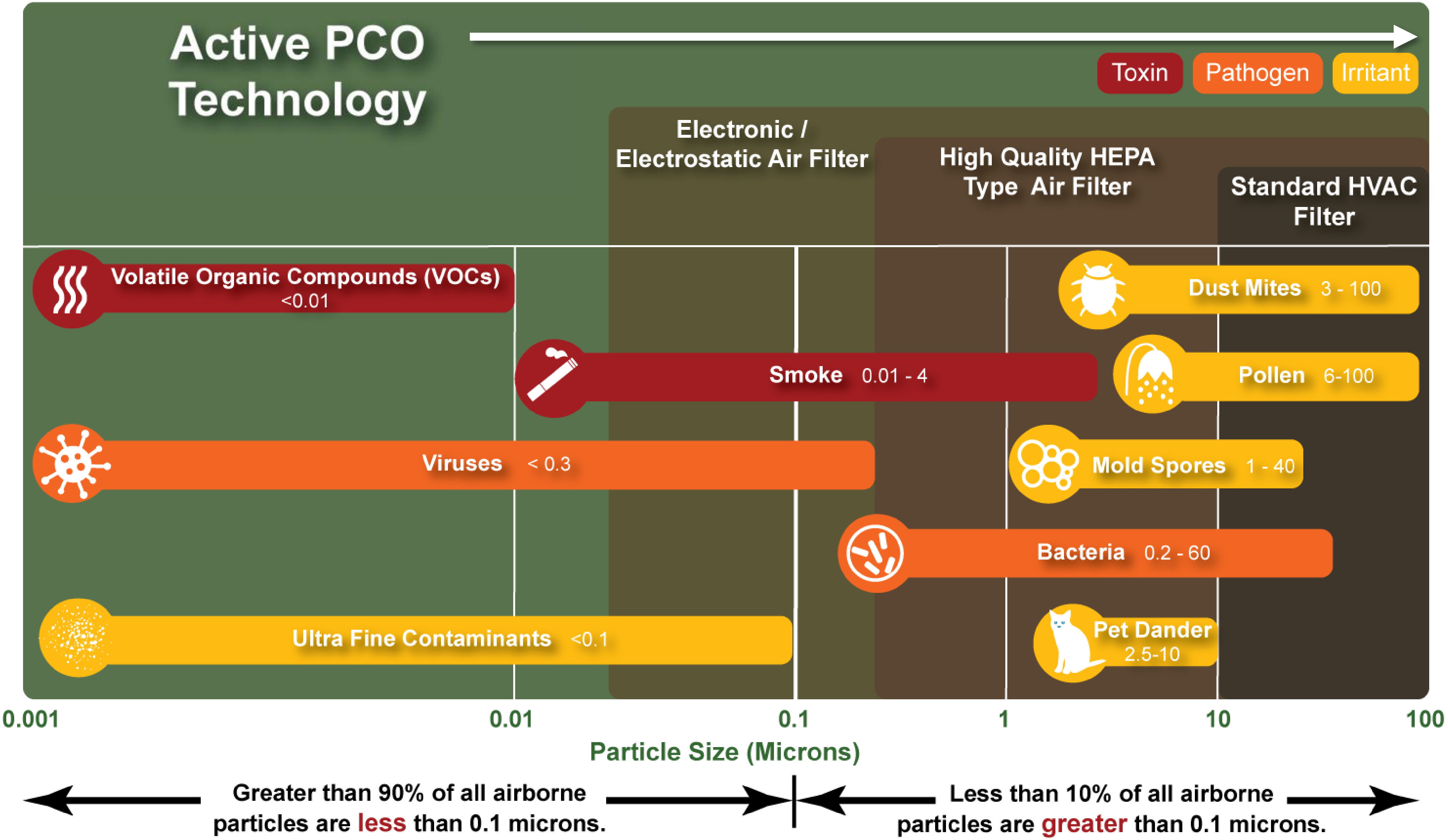
OPEN **Far-UVC light: A new tool to control the spread of airborne-mediated microbial diseases**



Air Purification: PCO Technology

- PCO = Photocatalytic Oxidation – ***developed more than 20 years ago by NASA***
- Most ***effective scientifically proven technology for killing viruses*** both in the air and on surfaces (hundreds of peer-reviewed publications showing this)
- Proven to destroy many viruses (>99.9), bacteria, volatile organic compounds (VOCs), molds, fungus and odors wherever they reside
- ***Proven both safe and effective*** in laboratory and industrial testing – no potentially harmful health effects




Active PCO Technology
Toxin
Pathogen
Irritant
Electronic / Electrostatic Air Filter
High Quality HEPA Type Air Filter
Standard HVAC Filter
Volatile Organic Compounds (VOCs) <0.01
Dust Mites 3 - 100
Smoke 0.01 - 4
Pollen 6-100
Viruses < 0.3
Mold Spores 1 - 40
Bacteria 0.2 - 60
Ultra Fine Contaminants <0.1
Pet Dander 2.5-10
0.001
0.01
0.1
1
10
100
Particle Size (Microns)
Greater than 90% of all airborne particles are less than 0.1 microns.
Less than 10% of all airborne particles are greater than 0.1 microns.

PCO Technology: NASA-developed

NASA had a Problem:

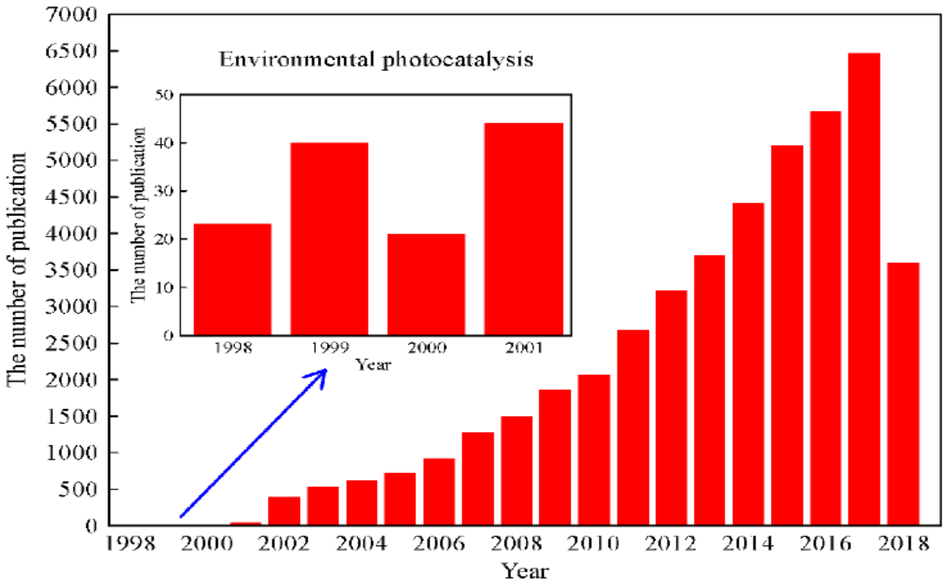
In planning for a manned mission to Mars; how to feed the crew? Plants that produce fruits and vegetables produce Ethylene, a hormone that signals the fruit to ripen. It becomes too concentrated and causes the fruit to ripen too quickly or rot.

Ethylene Problem

It was able to remove the Ethylene becoming concentrated in the sealed space, and soon it was determined to have many other uses

What We Know – PCO Technology

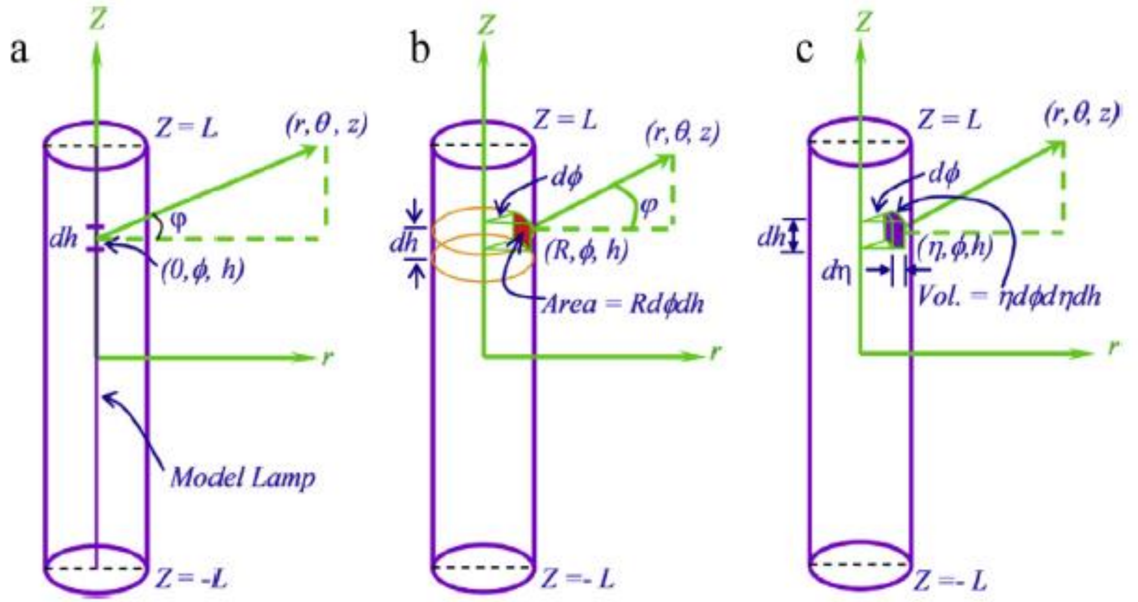
- ***Over 35,000 peer-reviewed articles*** on PCO.
- Many scientifically proven applications: air purification, water purification, wastewater treatment, etc.
- First articles published back in 1970s.
- Refine by applications using titanium dioxide = 2,340.



PCO Technology: Engineering and Design

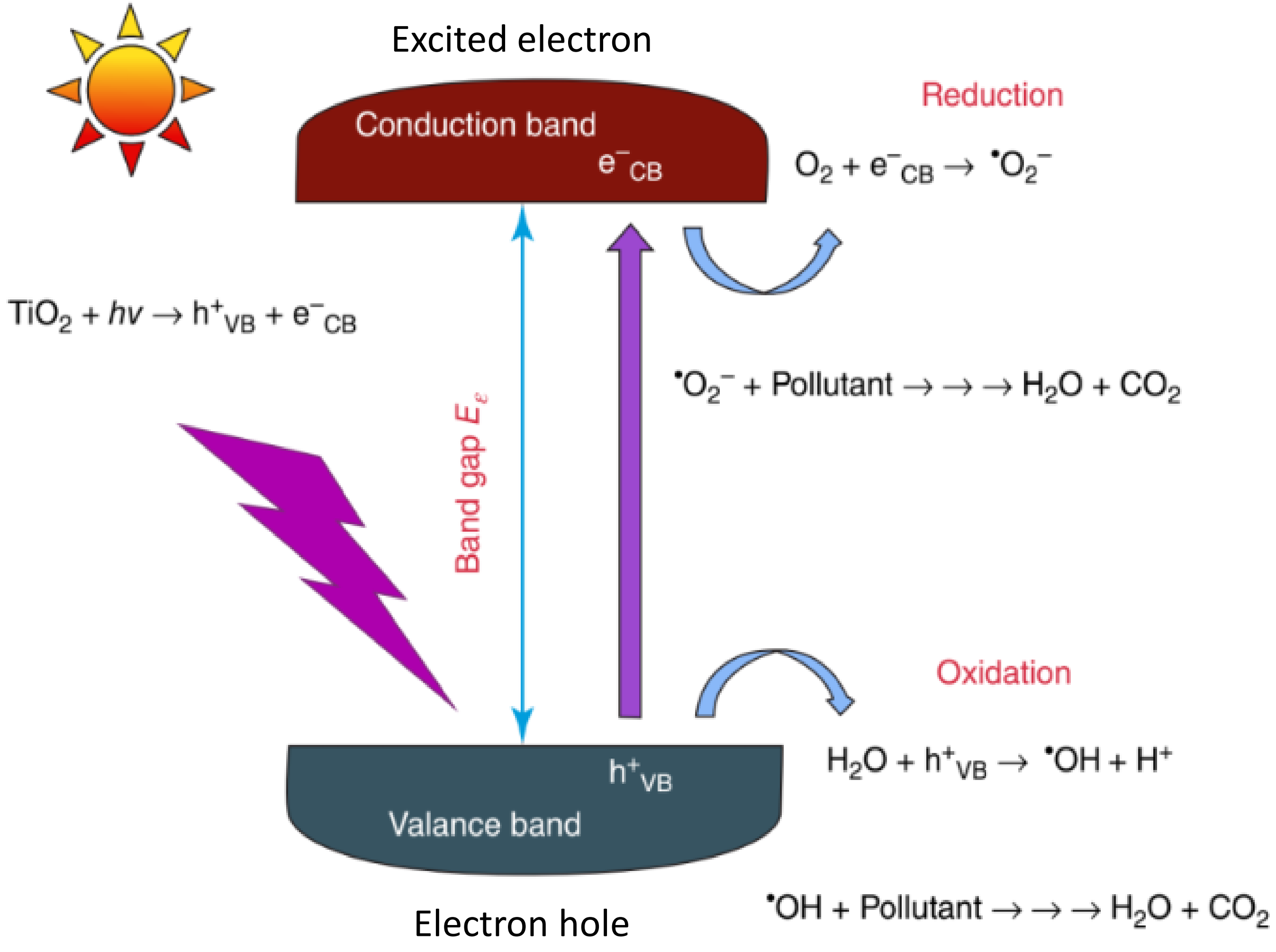
- Not all "PCO" units are engineered based on NASA-developed technology.
- Over 4 million gas-phase PCO reactors are currently in use worldwide.
- Technology was licensed for use in medical, food, military, residential, commercial, marine and hospital applications in 2003.
- ***Specified in the Norovirus and MRSA protection plan for restaurants, hotels, theme parks, cruise lines, public schools and hospitals.***

Y. Boyjoo et al./Chemical Engineering Journal 310 (2017) 537–559



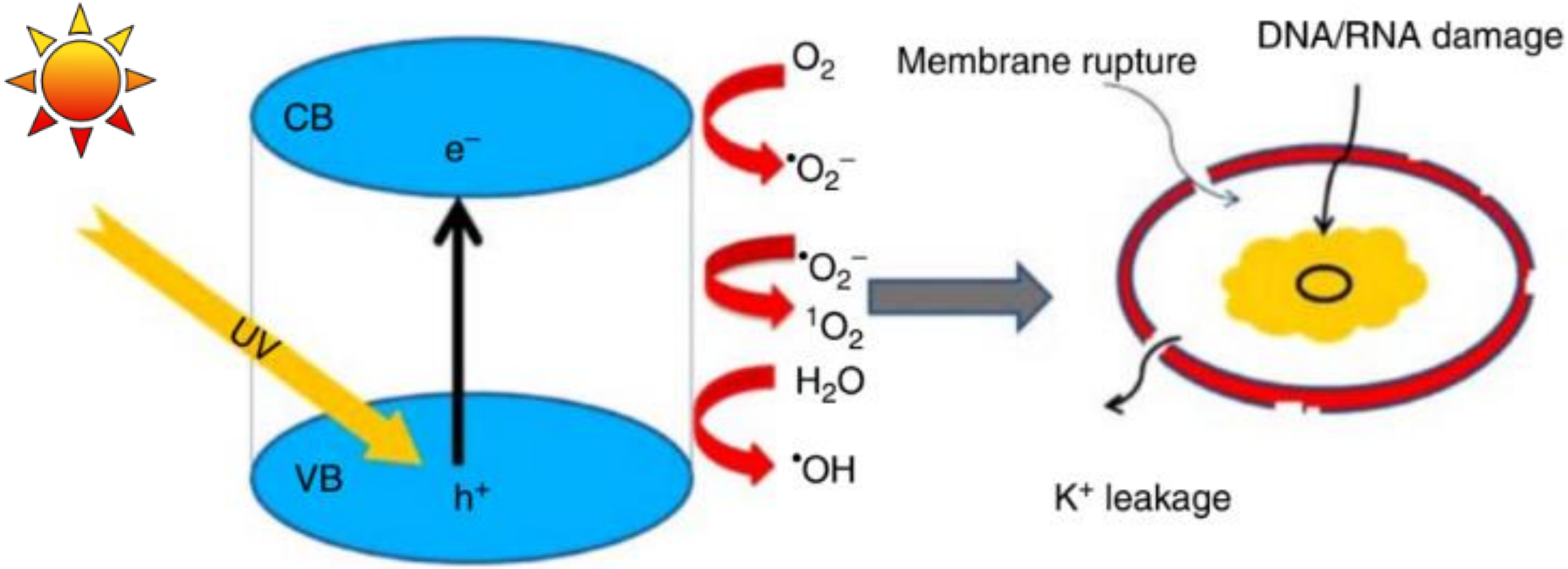
PCO Technology: Engineering and Design

- The excited electrons (e^-_{CB}) can react with atmospheric oxygen to form superoxide radicals ($\bullet O_2^-$) or hydroxyl radicals ($\bullet OH$).
- These reactive oxygen species will take part in the degradation of organic pollutants into water (H_2O) and carbon dioxide (CO_2).



PCO Technology: Engineering and Design

Mechanism of antibacterial action of photocatalytic oxidation



TiO_2 Catalyst

$$\text{Organic Pollutants} + O_2 \xrightarrow{\text{Catalyst+UV Light}} CO_2 + H_2O + \text{Mineral Acid}$$

Superoxide radicals ($\bullet O_2^-$)

Hydroxyl radicals ($\bullet OH$)

Byrne et al. 2018. *Advances in the Development of Novel Photocatalysts for Detoxification*

PCO Technology: Engineering and Design

- Certain air filters using photocatalytic oxidation have dangerous by-product, study shows.
- Results based on poorly engineered generic designs and bench-scale pilot reactors.

With countries like China and Korea eager to fix growing air pollution problems, **engineers and consumers desperate for new technologies have been forced to try to evaluate and compare PCO systems themselves in the absence of standards**. "*That's a big problem, there's lots of confusion in the market. We are trying to clarify that confusion and work on developing testing methods*," says Zhong.

Table 1
Comparison of available PCO air filters.

PCO air filter substrate	Catalyst	Pressure drop[a] (Pa)@170 m^3/h (100 CFM)	BET surface area (m^2/g)	Cost[b] (\$/m^2)
Aluminum honeycomb mesh	V_2O_5/TiO_2	1.8	~5[86]	20–50
Nickel foam	TiO_2	10.7	~34[22]	50–80
Fiberglass	TiO_2	35.5	~100[10]	~150
Carbon cloth	TiO_2	240.7	~800[10]	5–30

[a] The PCO reactor was set at one bank with two filters in a distance of 11 cm, which are perpendicular to the direction of air flow.
[b] The price can be quoted from www.alibaba.com.

PCO Air Purifier - $50.00

HEPA/PCO Air Purifier - $50.00

3500 PCO Air Purifier - $150.00

Zhong and Haghighat, 2015. *Building and Environment*

PCO Technology: Engineering and Design

- With proper engineering and design, and preparation/coating method, PCO reactors can achieve greater than 99% removal efficiency.

Photocatalyst	Preparation/Coating Method	Configuration	Compounds	Light Source	$\eta_{removal}$ (%)	Ref.
TiO_2	Sol-gel	F	Acetone, toluene *p*-xylene	UV lamp, 254 nm	77–62 (3 L/min)	[95]
TiO_2	Electrochemical	F	Acetaldehyde	UV	99+ (110 min)	[93]
TiO_2	Sol-gel	F	Toluene	Black light	52 (3.6 L/min)	[86]
TiO_2	Plasma deposited	F	*m*-Xylene	UV lamp	99+ (30 min)	[94]
$TiO_{2-x}N_x$	Calcination	P	Toluene	Visible light	99+ (3000 min)	[82]
Pt/TiO_2	Photo-deposition	P	Benzene	Black light, 300–420 nm	100 (100 mL/min)	[99]
$Fe\text{-}TiO_2$	Sol-gel	P	Toluene	Visible light	99+ (120 min)	[88]
$In(OH)_3$	Ultrasound radiation	P	Acetone, Benzene, Toluene	UV lamp, 254 nm	99+ (5 h)	[104]
$\beta\text{-}Ga_2O_3$	Chemical deposition	P	Benzene	UV-lamp, 254 nm	60 (20 mL/min)	[105]
$Ag_4V_2O_7/Ag_3VO_4$	Hydrothermal	P	Benzene	White fluorescent lamp	99+ (120 min)	[84]
Pt/WO_3	Photo-deposition	P	DCA, 4-CP, TMA	Visible light, >420 nm	99+ (3 h)	[112]
Pd/WO_3	Calcination	P	Acetaldehyde, toluene	Fluorescence/visible light	99+ (3 h)	[26]

Table 5. Summary of the PCOs used for formaldehyde degradation.

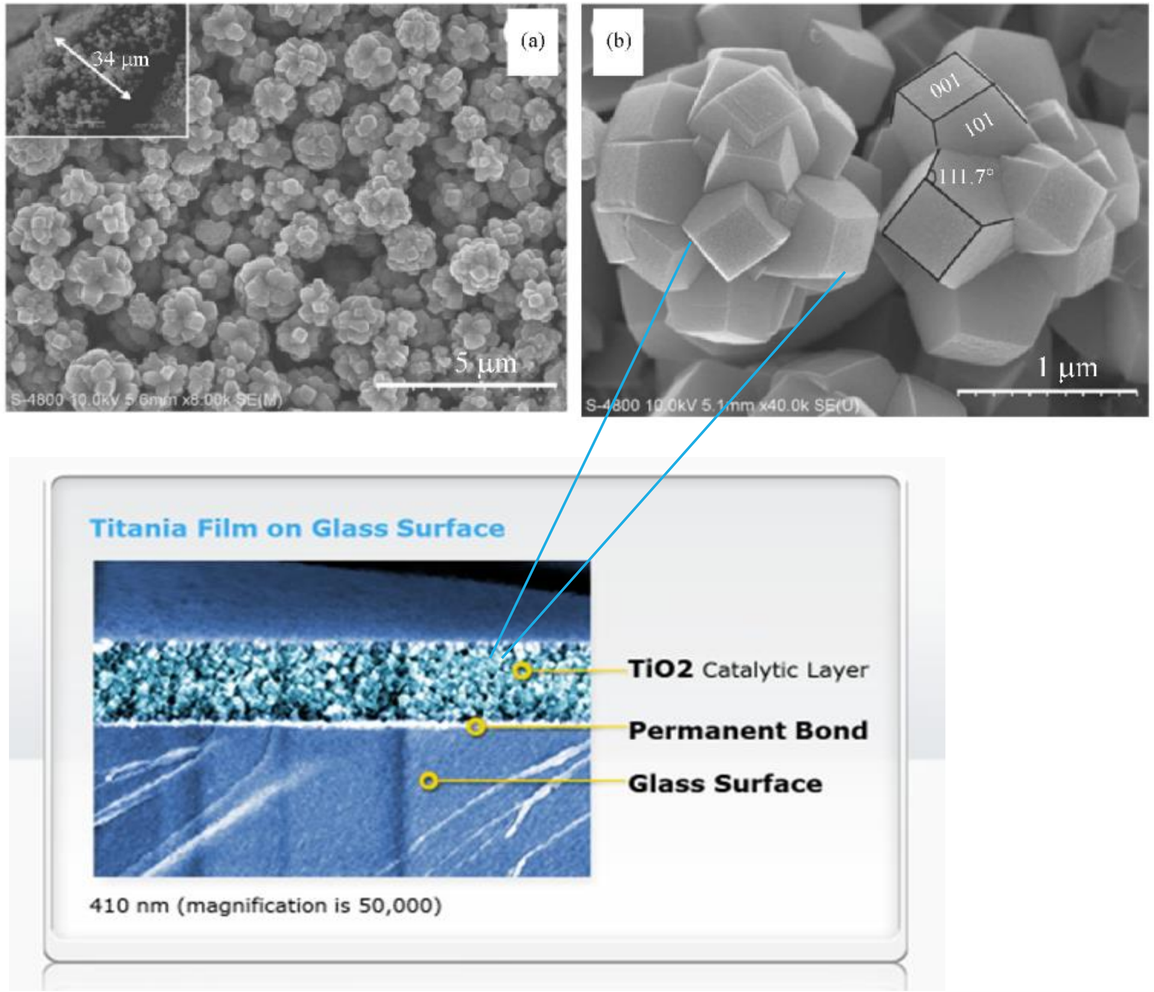
Catalyst	Preparation Method	HCHO Concentration	Light Source	Conversion Efficiency	Ref.
Mesoporous TiO_2	Evaporation-induced self-assembly	30 ppm	UV light	95.8%	[114]
Amorphous TiO_2 film	CVD method	50–55 ppm	UV light	80%	[115]
PEG modified TiO_2 film	Sol-gel method	20 ppm	UV light	95%	[116]
Ag/TiO_2	Incipient wet impregnation	500 ppm	UV light	Above 95%	[119]

Data from: Yu Huang, et al 2016. *Molecules*

PCO Technology: Reactor

- Using TiO_2 as a catalyst for air-cleaning devices:
  - ✓ ***TiO_2 must be deposited on*** a suitable carrier which are usually ***honeycomb monoliths***.
  - ✓ TiO_2 is also used to increase surface area.
  - ✓ Achieved by porous silica (clays, zeolites, mesoporous materials).
  - ✓ Mesoporous silica: ***chemically inert, possess high surface areas, transparent to UV radiation, have great physical stability, and have hydrophobic character.***

SEM images of TiO_2 films composed of flower-like TiO_2 microspheres

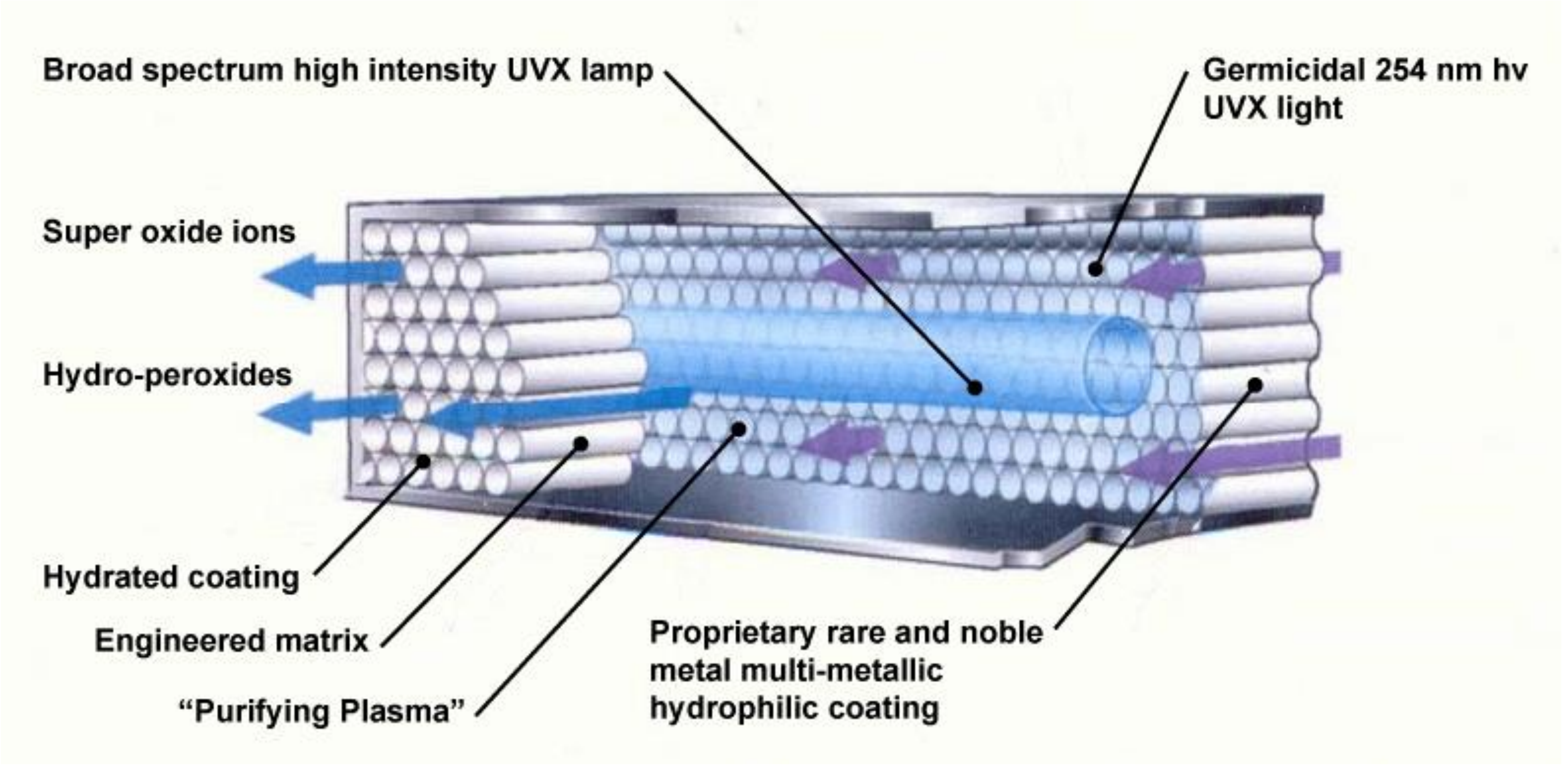


Xin Li et al. 2018. *Review on design and evaluation of environmental photocatalysts*

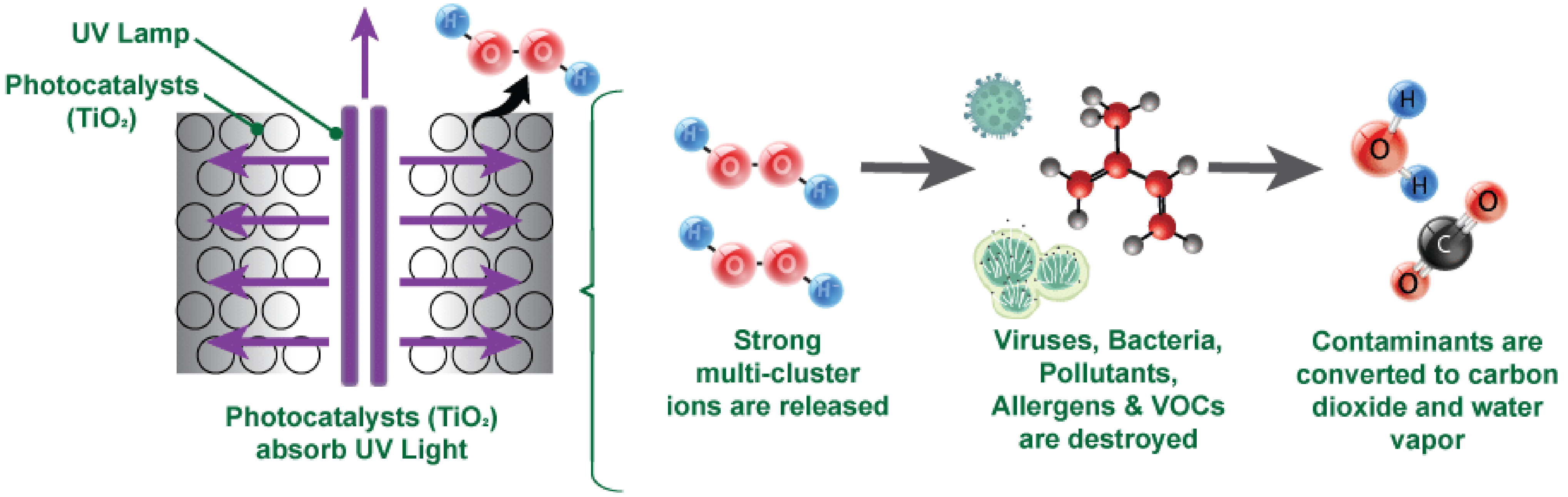
How it Works

- A low wattage UV light bulb is enclosed in a solid structure (the "catalyst") coated with Titanium Dioxide and other nanoscale elements.
- When the UV light is turned on, the catalyst is irradiated and a gaseous state is then created directly above its surface (often called "metastate").
- As air passes over the metastate, large clusters of positively and negatively charged ions are formed.

Gas-phase PCO Technology: How it Works

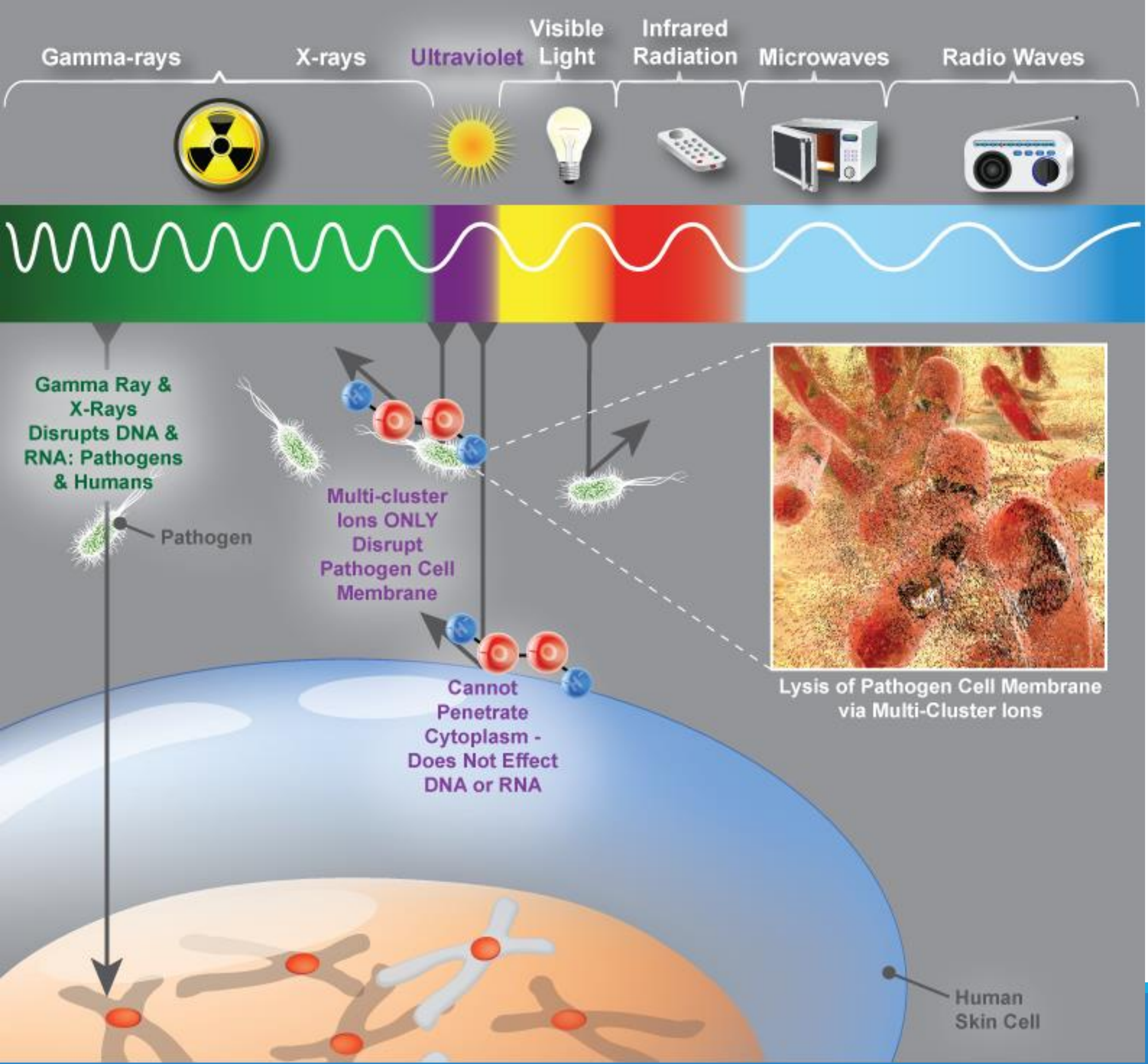


Reactor: Gas-phase PCO Technology



How it Works

As these ion clusters are released into an interior environment, they can be attracted to a negatively or positively charged cell of a pathogen (virus or bacteria), and they can break down chemicals such as volatile organic compound (VOCs).



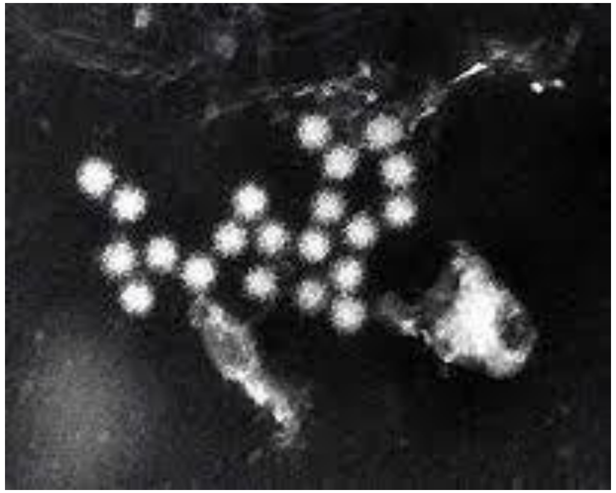
Gas-phase PCO: How it Works

- For pathogens, a minute electrical charge is then released, piercing the cell of the pathogen and killing it; even a cell as small as a virus.
- Multi-cluster ions cannot penetrate cytoplasm; they cannot affect DNA.
- These reactive oxygen species (ROS) could further react with organic pollutants, thus eventually achieving the mineralization of these compounds.

Gas-phase Reactor: Test Results

Norovirus

- Norovirus is a group of related, single-stranded RNA, highly contagious infections and the most common cause of acute gastroenteritis in the United States.
- Known by other names such as stomach flu and food poisoning, it is responsible for 50% of food-borne outbreaks of gastroenteritis.
- Noroviruses spread from person to person by direct contact, touching contaminated surfaces, and contaminated food and water supplies.



The effectiveness of Gas-Phase Photocatalytic Oxidation Technology:

Deactivation of > 90% of Murine Norovirus (MNV) microorganisms were achieved after 4 hours.

Gas-phase Reactor: Test Results

H1N1 Virus (Swine Influenza)

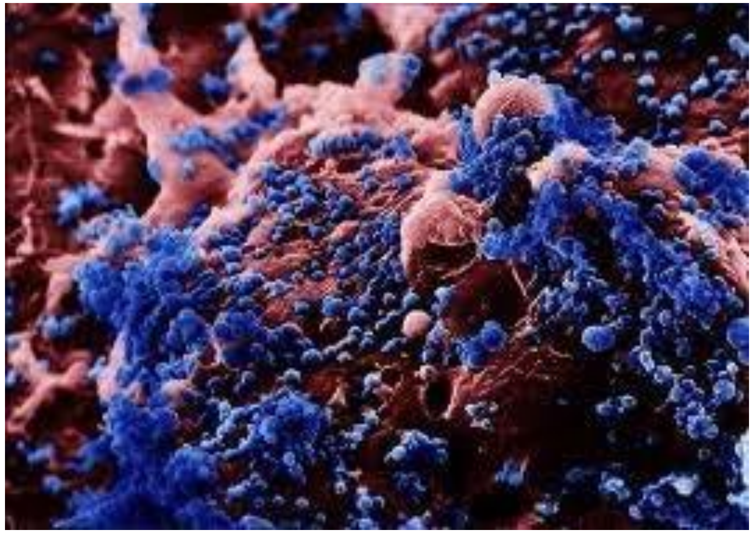
- The H1N1 virus is a unique strain of influenza.
- The Centers for Disease Control determined that the pressure contained genes from four different flu viruses – North American swine influenza, North American avian influenza, human influenza, and swine influenza viruses typically found in Asia and Europe.
- The virus spreads from person to person by droplets from coughing and sneezing and by touching a person contaminated with the virus, then rubbing one's eyes, nose or mouth.

The effectiveness of Gas-Phase Photocatalytic Oxidation Technology:
Testing on stainless steel surfaces using PCO resulted in ~99% microbial reduction.

Gas-phase Reactor: Test Results

H5N1 Virus Avian Influenza (Bird Flu)

- H5N1 has evolved into a flu virus strain that infects more species than any previously known strain, is deadlier than any formerly known strain.
- Epidemiologists are afraid the next time such a virus mutates; it could pass from human to human.
- Direct transmission of avian viruses to humans is possible.



The effectiveness of Gas-Phase Photocatalytic Oxidation Technology:
Testing on stainless steel surfaces using PCO resulted in ~99% microbial reduction.

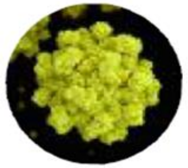
Gas-phase Reactor: Test Results

Sneeze Test

- Many microbials are transmitted in the air from one animal or human to another.
- It has been reported that tests were run at a simulated sneeze test lab using a sneeze simulation machine which showed a 78% reduction of microbials aerosols within 3 feet.

Ux105 Reactor: Test Results

Pathogen	**Results**
Norwalk Virus (Norovirus)	99.6% reduction
Methicillan-resistant Staphylococcus aureus (MRSA)	99.9% reduction
Staphylococcus aureus (S.aureus)	99.8% reduction
Clostridium difficile	99.8% reduction
Listeria monocytogenes (Listeria)	97.3% reduction
Group A streptococci (GAS)	97.4% reduction
Pseudomonas aeruginosa	99.9% reduction
Streptococcus pneumonia	99.9% reduction
Bacillus anthracis (Anthrax)	97.6% reduction
H1N1 (Swine flu)	99.9% reduction
H5N1 (Bird flu)	99.9% reduction
Stachybotrys chartarum (Fungus and spores)	99.4% reduction
Candida albicans (Mold and spores)	99.5% reduction
Volatile Organic Compounds (Over 60 VOCs)	91% average reduction
Volatile Inorganic Compounds (Ammonia/ Nox/ H_2S/ Sox/ O_3)	89% average reduction
Odors (Alkanes, Acetone, Alcohols, Ketones)	87% average reduction
Basidiospores (Allergens, Fungus, Ringworm)	99.4% reduction
Allergens (Pet dander, dust mite antigens)	91% reduction



Virus 99%

Bacteria 99%

Odors 55% - 98%

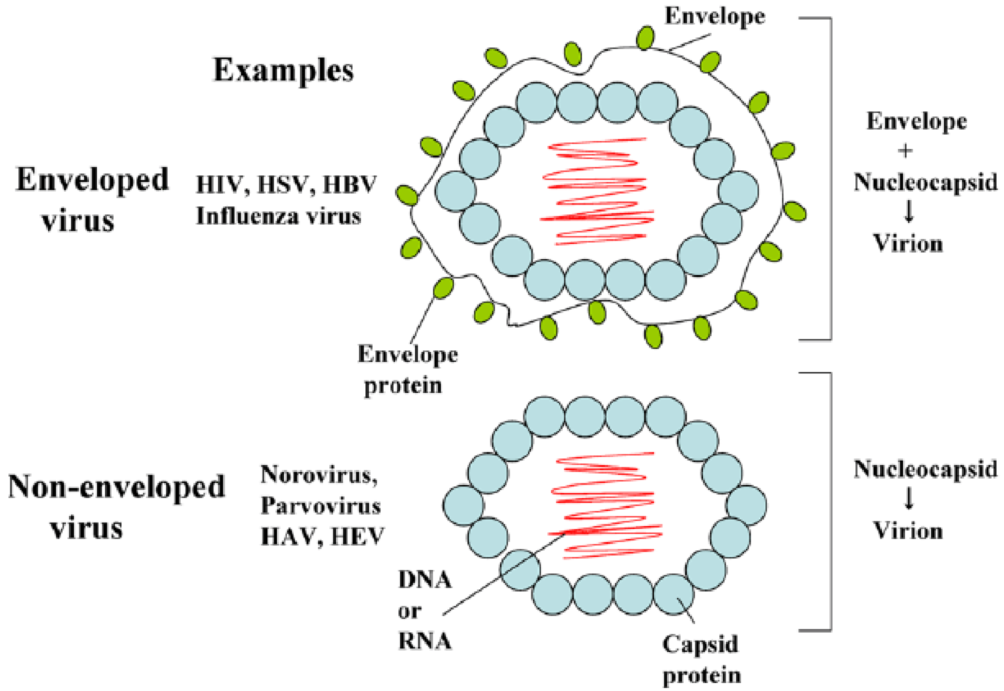
Mold 97% - 98%

VOCs 80% - 99%

Smoke 70%

Gas-Phase PCO Effectiveness: COVID-19

- To prove PCO kills a high percentage of **Coronavirus** (**COVID-19, an enveloped virus**), a surrogate or close relative of this strain was used for test purposes.
- Previous testing on H5N8, an enveloped virus used as a surrogate for H1N1 (Swine Flu) and H5N1 (Avian Flu) viruses, results **found a complete reduction in virus viability (100% in 24 hours)**.

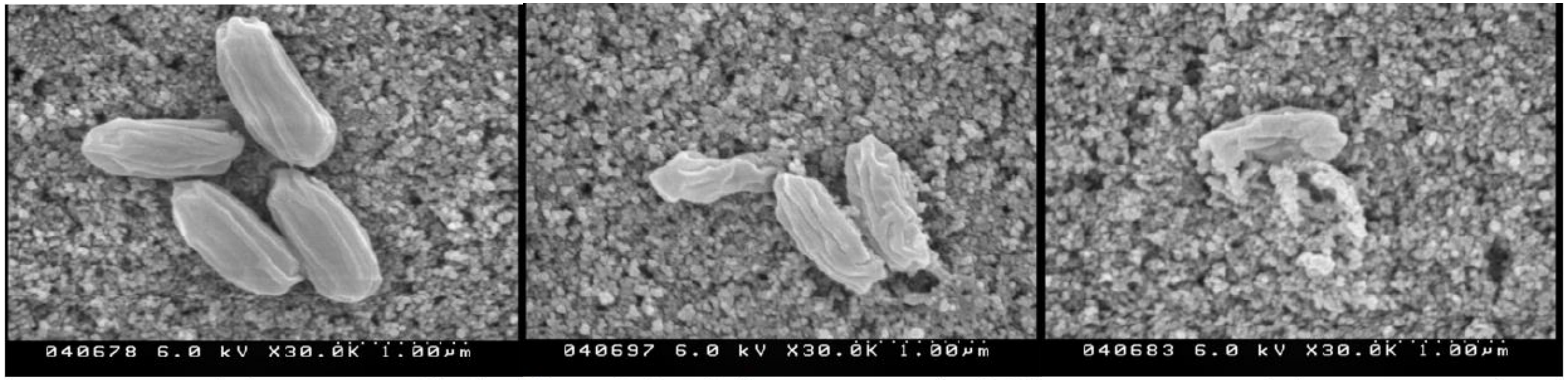


Since COVID-19 is very similar to H1N1 and H5N1, it is clear evidence that the ***gas-phase PCO reactor would have a significant impact on the current strain of Coronavirus.***

Testing by: Dr. Leila K. Riley RADIL, Columbia, Missouri
Dr. M.T. Ortega, et al 2007, Kansas State University
Reviewed by: Dr. Gregg Dickerson, MD
Dr. Claude Selitrennikoff, PhD University of Colorado School of Medicine

PCO Effectiveness: Cellular Mineralization

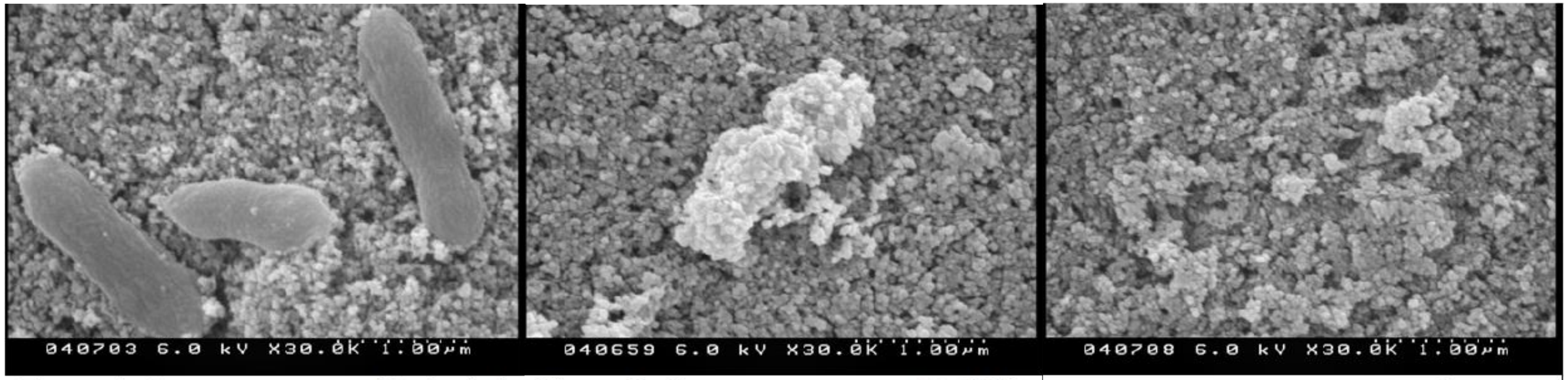
- The progression from initial Bacillus subtilis spore samples to samples that show significant cellular mineralization after PCO technology.



B. subtilis spores stored in the dark for 36 hours

B. subtilis spores exposed to PCO for 11.75 hours

B. subtilis spores exposed to PCO for 36 hours



S. marcescens stored in the dark for 36 hours

S. marcescens exposed to PCO for 11.75 hours

S. marcescens exposed to PCO for 36 hours

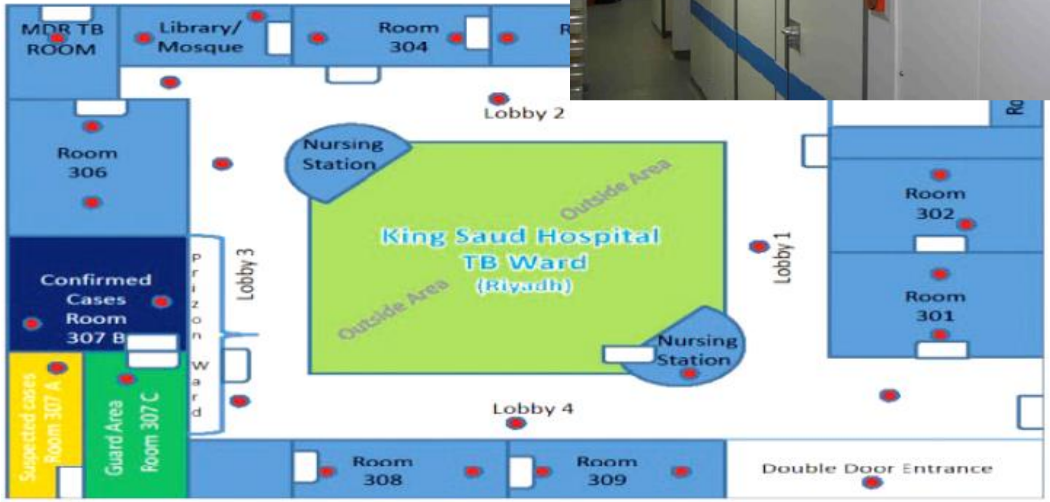
Greist et al. 2002. *Proc. Indoor Air*

PCO Technology: Medical Facilities

- Used in areas like the emergency rooms, waiting areas, patient rooms, CSSD, ICU and Out Patient departments.

- Installed in hospital ward: Bacterial count dropped by almost ***92% within minutes*** during an orthopedic surgery.

- In December 2001, a team of researchers at the University of Wisconsin conducted tests and published results, which showed that this technology killed 99.9998% of anthrax-like spores (*Bacillus thuringiensis*).



- ✓ Created by NASA
- ✓ Patented photocatalyst that does not degrade
- ✓ Produces no harmful byproducts (no Ozone)
- ✓ Uses no filters
- ✓ Listed by the FDA as a Class II Medical Device (501 K)

PCO Reactors: Dental Office Placement

▲ Ux105 GR40

✦ Ux105 BL

Example: *Ux105 reactor*

Factors to consider:

- Number of operatories: *private or open.*
- Number of occupants.
- Square footage.
- Desired treatment area.

1,702 SF Dental Office

Placement:
Desk or wall mount (in-duct systems less ideal for dental offices).

PCO Reactors: Dental Office Placement


Ux105 GR40


Ux105 BL

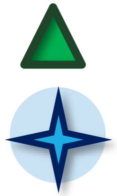
Example: *Ux105 reactor*

Factors to consider:

- Number of operatories: *private or open.*
- Number of occupants.
- Square footage.
- Desired treatment area.

1,500 SF Dental Office

PCO Reactors: Dental office placement



Ux105 GR40

Ux105 BL

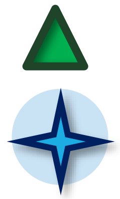
Example: *Ux105 reactor*

Factors to consider:

- Number of operatories: *private or open*
- Number of occupants
- Square footage
- Desired treatment area

2,400 SF Dental Office

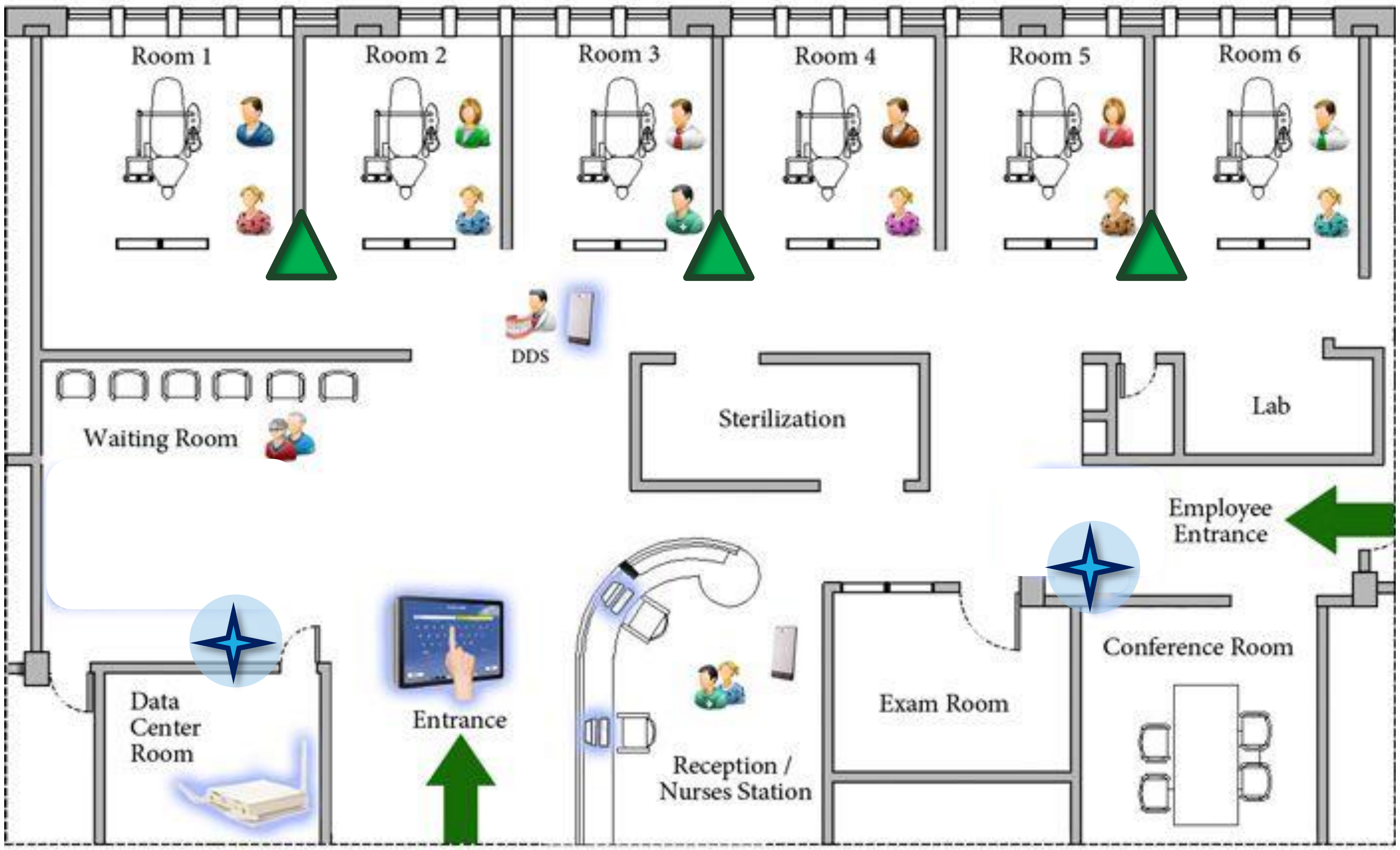
PCO Reactors: Dental Office Placement



Example: *Ux105 reactor*

Factors to consider:

- Number of operatories: *private or open.*
- Number of occupants.
- Square footage.
- Desired treatment area.

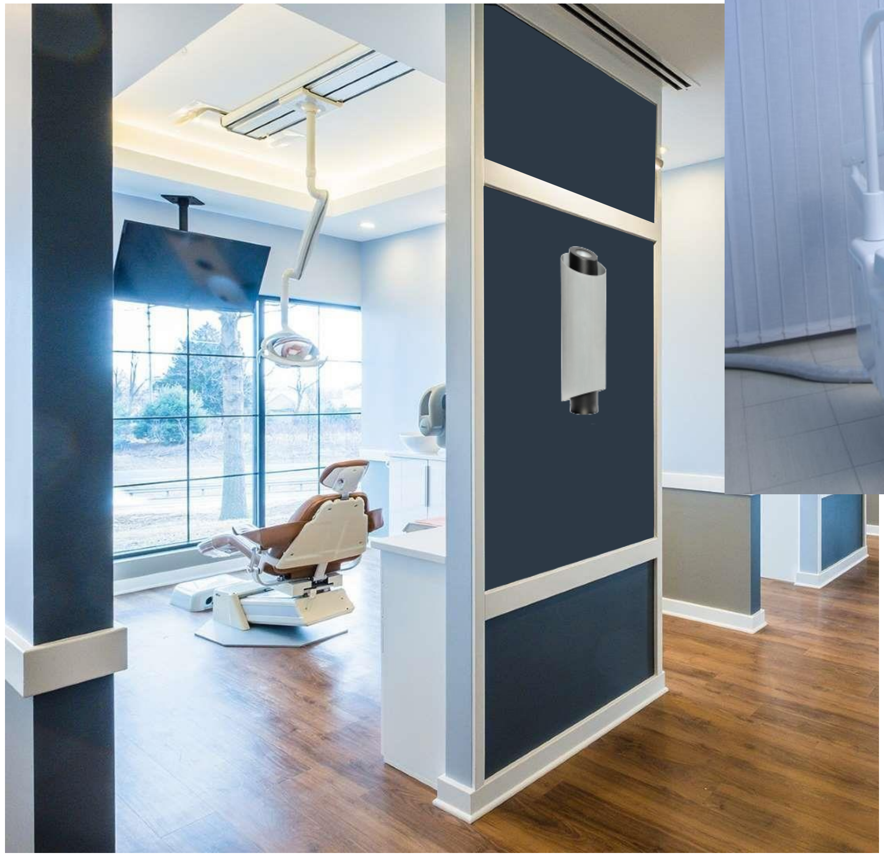


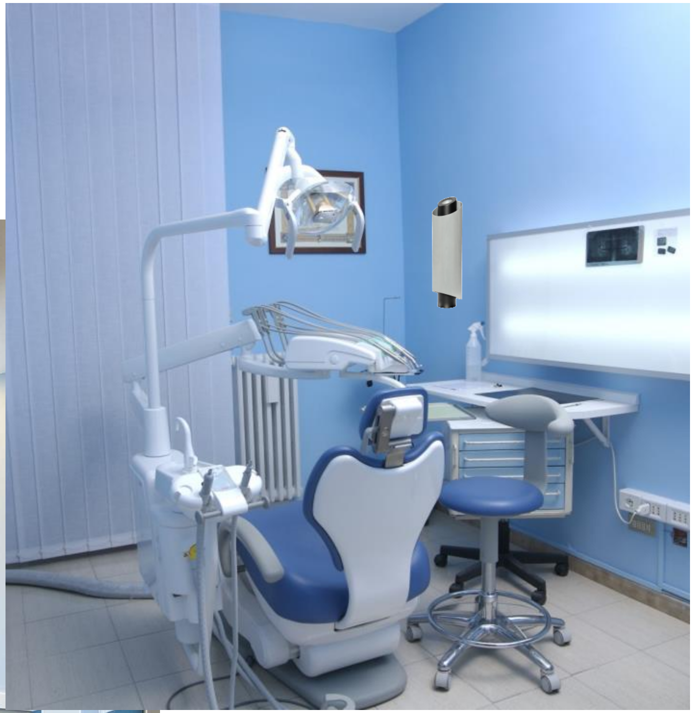
3,700 SF Dental Office

PCO Reactors: Dental Office Placement

Waiting rooms, lobbies, reception areas (*desk or wall mount*).

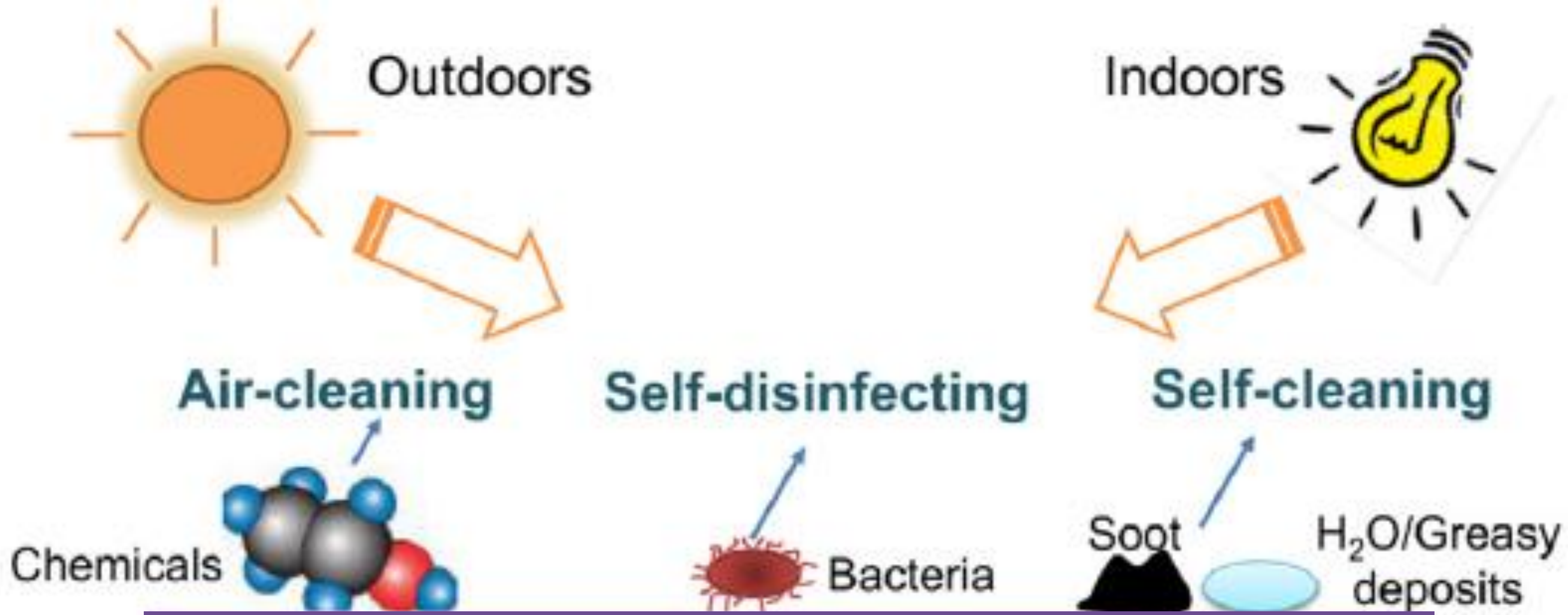
Open-bay operatories and hallways (*wall mount*).





Private operatories (*wall mount*).

Multi-functional Photocatalytic Coatings



Photocatalytic Coating

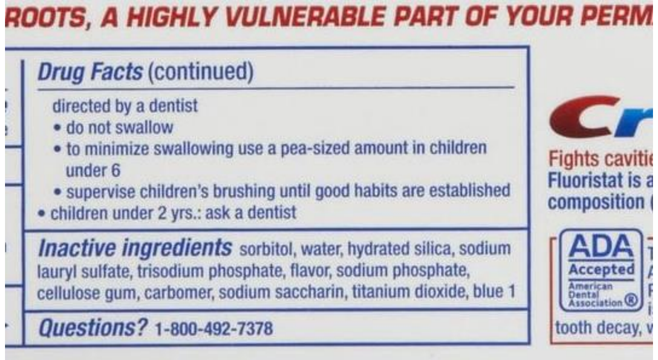
Substrate: plastic, fabric, ceramic, glass, metal, plastic, tiles, wood, vinyl, painted surfaces, and porous surfaces

Zhong and Haghighat, 2015. *Building and Environment*

Multi-functional Photocatalytic Coatings

Bactericidal

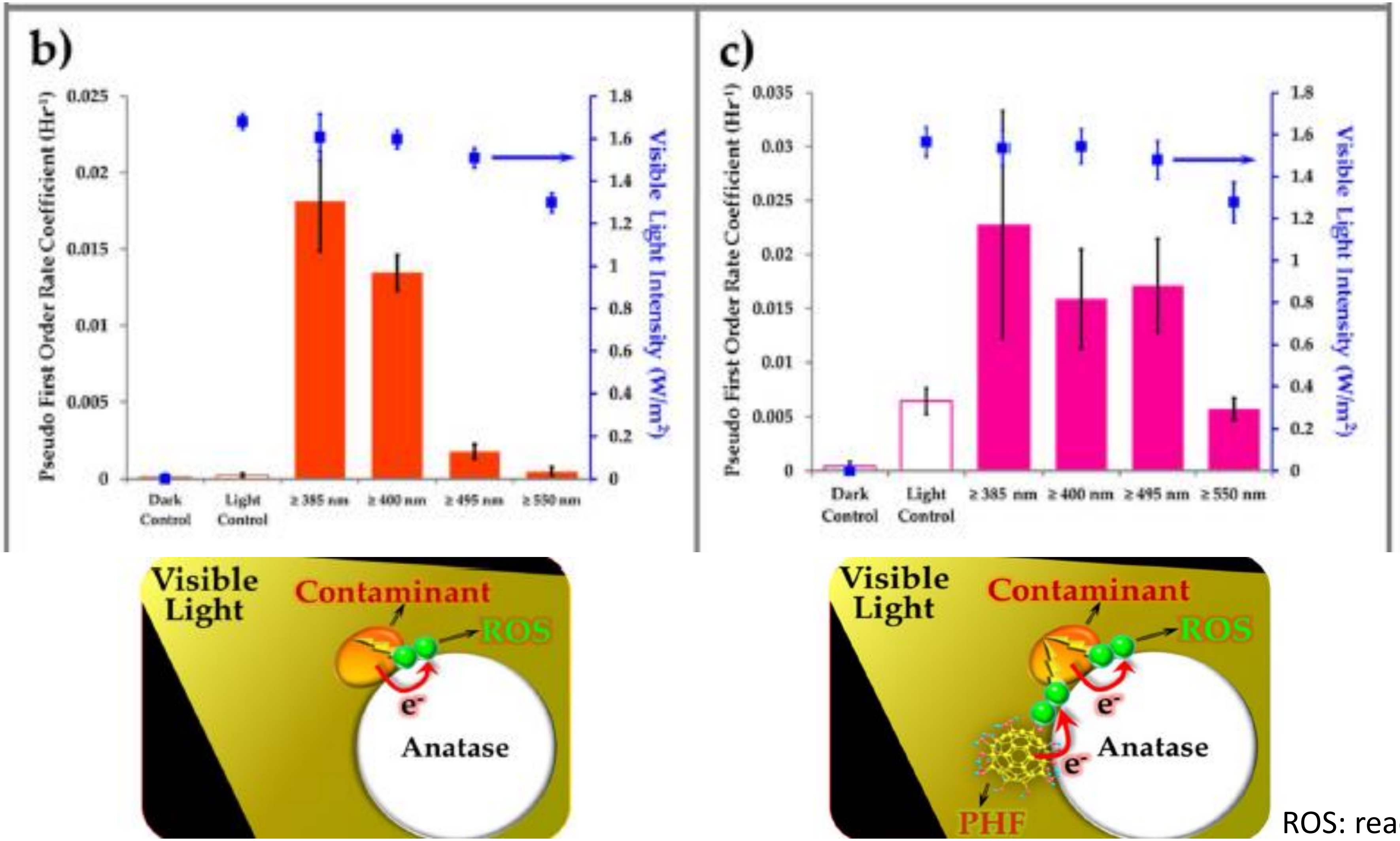
- Photocatalytic TiO_2 coatings have been used medical applications, construction of sterilized coatings for hospitals, indoor applications, and food industry.
- The UV-light induced photocatalytic antibacterial action of TiO_2 coatings was initially demonstrated two decades ago.
- The photocatalytic antimicrobial effect of illuminated TiO_2 arises from the production of OH•, $•O_2^-$, and H_2O_2 (hydroperoxides).



Titanium Dioxide is used in common household products such as food, medicine, toothpaste and sunscreen.

Byrne et al. 2018. *Advances in the Development of Novel Photocatalysts for Detoxification*

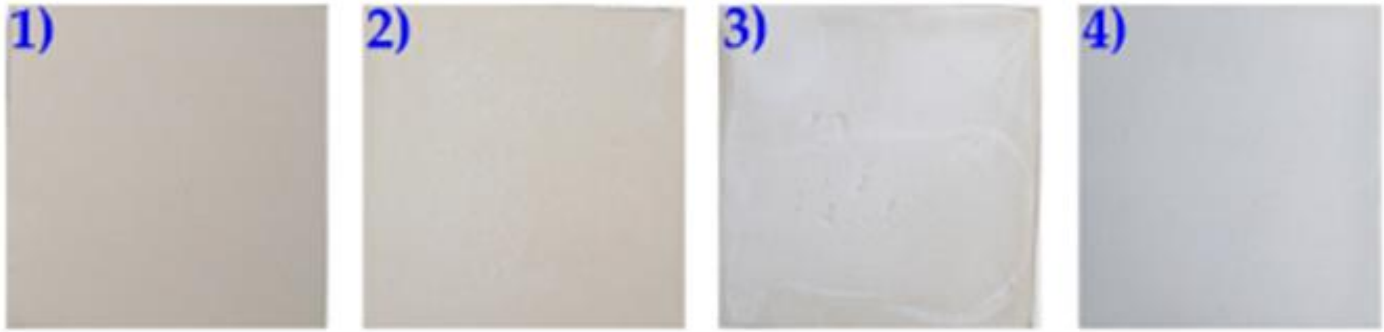
Photocatalytic Coatings: Visible Light Reaction

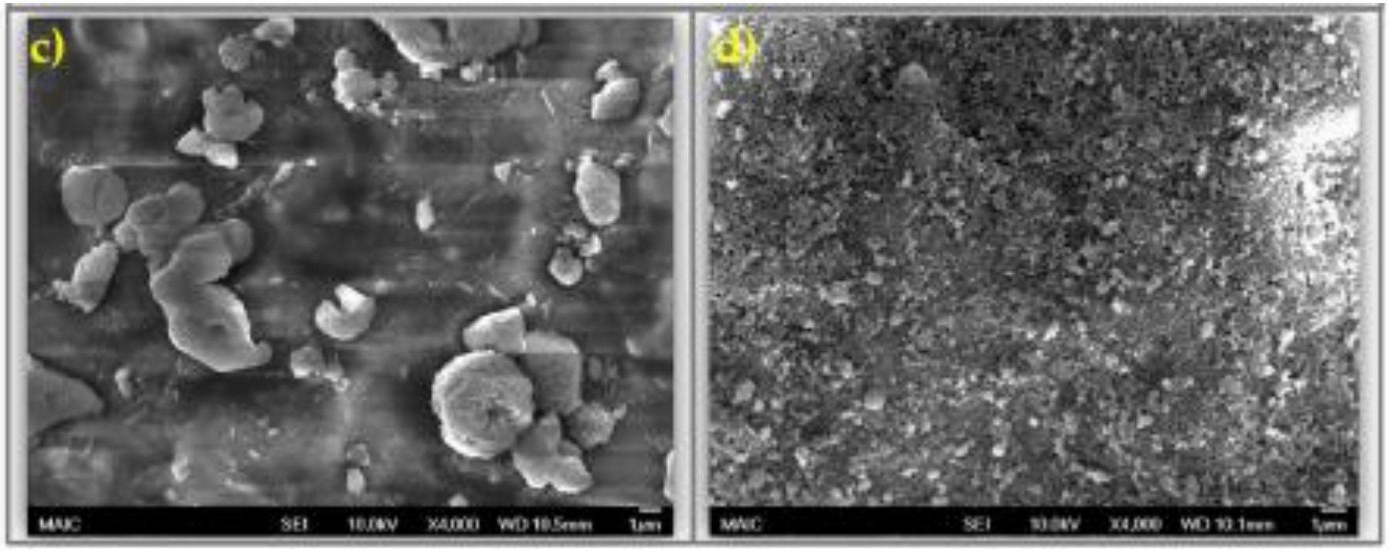


ROS: reactive oxygen species

Krishna et al. 2018. *Scientific Reports*

Photocatalytic Coatings



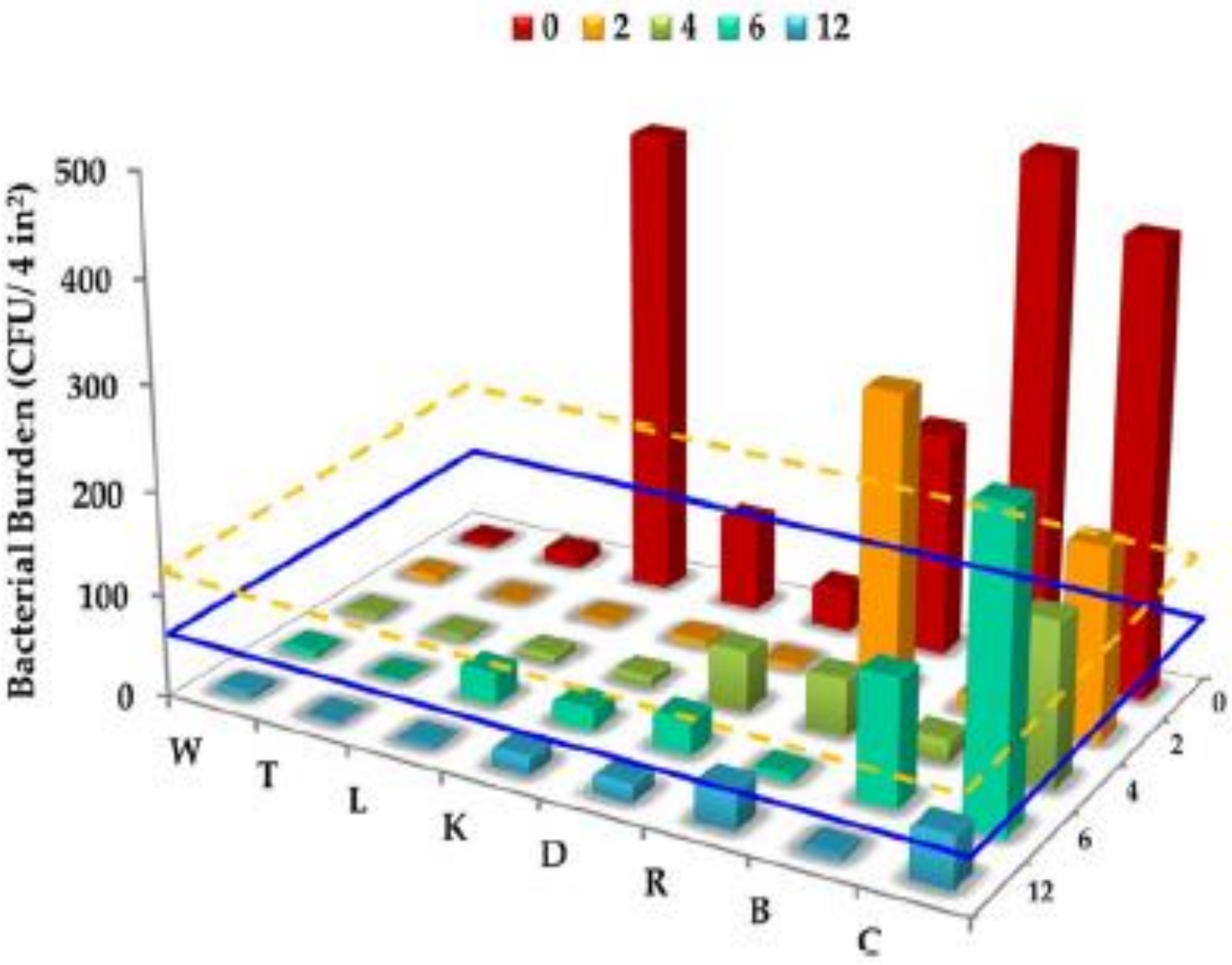


- **Design of transparent photocatalytic coating:** Changes in appearance of tile surfaces achieved with application of TiO2 coating at particle loadings of:
  1) 0mg/cm2
  2) 0.128mg/cm2
  3) 1.28mg/cm2
  4) 6.4mg/cm2

- Scanning electron micrographs of TiO2 coatings prepared from formulations (c) without any dispersants and (d) stabilized with 0.01M NaOH as dispersant.

Krishna et al. 2018. *Scientific Reports*

Photocatalytic Coatings



Reduction in bacterial burden on hospital surfaces with antimicrobial photocatalytic coating.

- For a given surface, the bars represent counts (n=3) at times from 0 to 12 months.

W = Wall
T = Thermostat
L = Locker
K = Knob
R = Bathroom Rail
B = Bed Rail
C = Counter
D = Soap Dispenser

Yellow dashed line indicates the average microbial counts on copper surfaces in a clinical trial.

Blue line indicates the threshold of microbial counts for benign surfaces.

Photocatalytic Coatings

How to apply:
- Simple wipe and/or trigger-spray application
- HPLV sprayer or fogger

When to reapply:
- Up to 10 years on low-touch surfaces
- 3-5 years on most surfaces
- 1-2 years on high-touch surfaces, depends on use, abrasion and cleaners

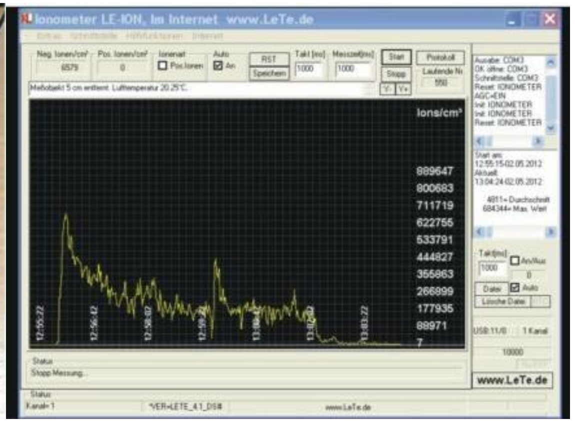
Where to apply:
- Walls
- Light fixtures
- Ceilings
- Windows

High-touch surfaces
- Countertops
- Floors
- Dental chairs
- Equipment
- Scrubs/lab coat
- Stationary

Other areas
- Operatories
- Waiting rooms
- Exam rooms
- Offices/kitchens

Simple Methods for Testing PCO Effectiveness

Ion Meter



Air ion meter for precise measurement of positively charged air ions and negatively charged air ions. This air ion meter is a true ion density

- Extremely sensitive measuring range.
- Response time: approximately 1 second.
- Practically temperature independent.
- Very easy to use.

ATP Meter

- ✓ Provides real-time feedback
- ✓ No data loss if battery or power failure
- ✓ Range of instrument reading: 0-9,999 RLUs
- ✓ Produces test results in 15 seconds
- ✓ Durable (withstand 1-meter drop test

Designed with state of the art electronics the ATP Meter is easy to use, extremely sensitive.

- ATP testing is a universally recognized tool used by organizations of all sizes for measuring the hygiene levels of surfaces in order to ensure consistent sanitation practices as well as public safety.

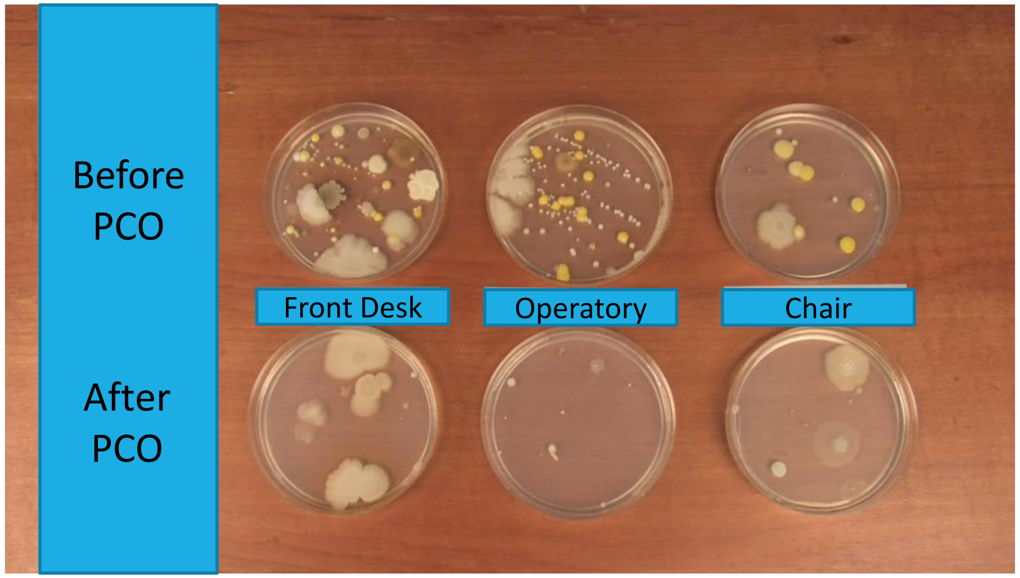
Simple Methods for Testing PCO Effectiveness

- Agar plates should be placed in a refrigerator upon arrival, minimum shelf life of 3 months.

Brief Instruction:

1. Take out one sterile cotton swab. Gently wipe a test area with the cotton swab to pick up bacteria.
2. Gently streak the agar plate with the cotton swab to transfer the bacteria onto the surface of the agar plate.
3. Cover the agar plate and place it in an upside-down position in an incubator with a temperature between 85 and 100 ^{o}F..
4. Incubate for 12-48 hours.

Note: *Must control for environmental parameters.*



Thank you!!

Please complete the evaluation to receive CE

Save The Date:

The New generation of Tobacco Addition

May 8th at 12 noon ET

ZUFALL HEALTH COMMUNITY HEALTH CENTERS