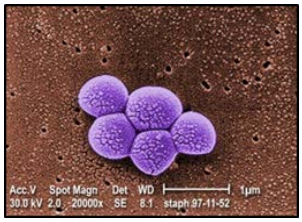
Active Photodynamic Oxidation Technology
Partial Knowledge Base of Test Results

How Nature Cleans®

UVAIRx products employ a proprietary enhancement to the established photocatalytic oxidation (PCO) technology developed more than 20 years ago. This *advanced* product: Active Photodynamic Oxidation Technology is the foundation of *UVAIRx* instruments currently being used to disinfect indoor air and surfaces. PCO has been proven to kill many bacteria, viruses, volatile organic compounds (VOCs), molds, fungus and odors wherever they reside. This is in contrast to some air only purification systems dependent upon air flow passing through the unit or through filters. PCO technology has been proven both safe and effective in laboratory and industrial testing. PCO technology similar to that used in *UVAIRx* products has been licensed for use in medical, food, military, residential, commercial, marine and hospital applications. They have been approved or registered by UL, ETL, FCC, TUV, CE and CSA. PCO is used by NASA on the International Space Station. The following is a summary of some of the peer reviewed testing and studies performed by third party independent labs and universities.

Bacteria

Methicillin-resistant Staphylococcus aureus (MRSA) - Easily transmitted in a hospital environment and resistant to most *staphylococcus* antibiotics including oxacillin, penicillin, amoxicillin and methicillin, MRSA has only a few expensive treatment options and there are challenging side effects. From 1999 to 2005 the estimated number of MRSA related hospitalizations more than doubled, from 127,036 to 278,203 causing a national priority for disease control. In 2010 encouraging results from the Center for Disease Control indicates a 28% decrease in invasive (life threatening) MRSA infections in a hospital setting. Estimated cost of MRSA treatment in 2005 was $3.2 billion to $4.2 billion nationwide. [1]



MRSA

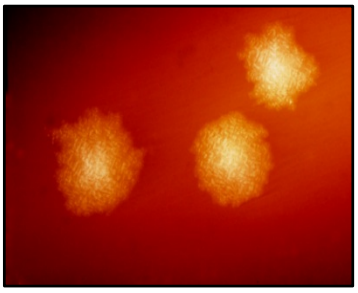
Effectiveness of Photocatalytic Oxidation Technology: ~ 99.9% reduction in viability of MRSA was observed within 80 minutes of photocatalytic treatment. [2]

Staphylococcus aureus - *S. aureus* can cause a range of illnesses, from minor skin infections such as pimples, impetigo, boils (furuncles), cellulitis folliculitis, carbuncles, scalded skin syndrome and abscesses to life-threatening diseases such as pneumonia, meningitis, osteomyelitis, endocarditis, toxic shock syndrome (TSS), bacteremia and sepsis. The systems it affects range from skin, soft tissue, respiratory, bone, joint, endovascular to wound infections. It is still one of the five most common causes of nosocomial infections and is often the cause of postsurgical wound infections. Each year, some 500,000 patients in American hospitals contract a staphylococcal infection.


S. aureus

Effectiveness of Photocatalytic Oxidation Technology: ~ 99.9% reduction in viability of Staphylococcus aureus was observed within 80 minutes of photocatalytic treatment. [3]

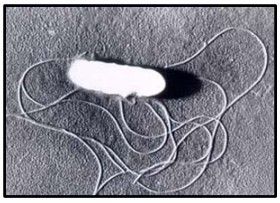
Clostridium difficile (C. diff) - *C. diff* is a bacterium that can cause symptoms ranging from diarrhea to life-threatening inflammation of the colon. *C. diff* most commonly affects older adults in hospitals or long term care facilities. In recent years, *C. diff* infections have become more frequent, more severe and more difficult to treat. While MRSA infection rates are decreasing in response to stepped-up prevention efforts within hospitals, infections caused by *C. diff* have increased each year since 2007. [Mayo Clinic Staff, 2010]



C. diff

Effectiveness of Photocatalytic Oxidation Technology: ~ 99.9% reduction in viability of *C. diff* within 80 minutes of photocatalytic treatment. Complete surface inactivation was demonstrated and bacterial re-growth following photocatalytic treatment was not observed. (2)

Listeria monocytogenes - Listeriosis is a serious infection usually caused by consuming food contaminated with *Listeria monocytogenes* and causes significant public health risks responsible for approximately 1,600 cases annually. Prior to 2011, the largest outbreak occurred in 2002, when 54 illnesses, 8 deaths, and 3 fetal deaths in 9 states were associated with consumption of contaminated turkey deli meat. The 2011 outbreak, caused by tainted cantaloupe, infected a total of 139 persons with any of the four outbreak-associated strains of *Listeria monocytogenes.* The outbreak spread over 28 states and resulted in 29 deaths. (4)



Listeria monocytogenes

Effectiveness of Photocatalytic Oxidation Technology: Testing on stainless steel surfaces using PCO resulted in ~ 99% microbial reductions. (3)

Escherichia coli - *E. coli* consists of a large and diverse group of bacteria. Although most strains are harmless, other strains of *E. coli* can cause illnesses such as diarrhea, urinary tract infections, respiratory illness and pneumonia. In most cases of disease causing outbreaks, shiga toxins produced by *E. coli* are responsible. Recent multistate foodborne outbreaks include: Lebanon Bologna 2011, Hazelnuts 2011, Shredded Romaine Lettuce 2010, and Beef 2010, resulting in massive product recalls. (5)

E. coli

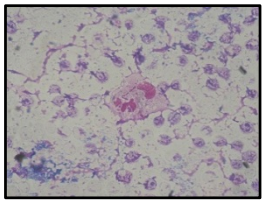
Effectiveness of Photocatalytic Oxidation Technology: Antibacterial activity of Ag doped TiO_2 showed ~ 99% deactivation of *E. coli*. The doped TiO_2 showed enhanced efficacy as opposed to the non-doped. (6)

Group A Streptococci (GAS) - *GAS* is a bacterium often found in the throat and on the skin. People may carry *Group A Streptococci* and have no symptoms of illness. Most *GAS* infections are relatively mild illnesses such as "strep throat," or impetigo. Occasionally these bacteria can cause severe and even life-threatening diseases when bacteria get into parts of the body where they are not usually found, such as the blood, muscle, or the lungs. These infections are termed "invasive *GAS* disease". About 9,000-11,500 cases of invasive *GAS* disease occur each year in the United States, resulting in 1,000-1,800 deaths annually. (7)

Group A streptococci

Effectiveness of Photocatalytic Oxidation Technology: Testing on stainless steel surfaces using PCO resulted in ~ 96% microbial reductions. (3)

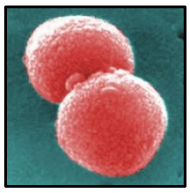
Pseudomonas aeruginosa - *P. aeruginosa* is an increasingly prevalent opportunistic human pathogen and the most common gram negative bacterium in nosocomial infections. *P. aeruginosa* is responsible for 16% of nosocomial pneumonia cases, 12% of nosocomial urinary tract infections, 8% of surgical wound infections, and 10% of bloodstream infections. [8]



Pseudomonas aeruginosa

Effectiveness of Photocatalytic Oxidation Technology: Testing on stainless steel surfaces using PCO resulted in ~ 99% microbial reductions. [3]

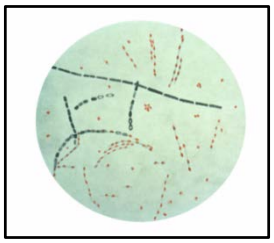
Streptococcus pneumonia – *S. pneumonia* typically enter the lung when airborne droplets are inhaled, but can enter through the bloodstream when there is an infection in another part of the body. There were 50,774 deaths in the US in 2009 attributed to pneumonia. It is estimated that up to 2.3% of all nursing home patients have pneumonia at any given time. [8]



Streptococcus pneumonia

Effectiveness of Photocatalytic Oxidation Technology: Testing on stainless steel surfaces using PCO resulted in ~ 99% microbial reductions. [3]

Bacillus anthracis – *Anthrax* is an acute disease caused by *Bacillus anthracis.* Most forms of the disease are lethal and it affects both humans and other animals. *Anthrax* spores can be produced in vitro and used as a biological weapon. *Anthrax* is spread by spores of *B. anthracis*. These spores can be transported by clothing or shoes. The body of an animal that had active *Anthrax* at the time of death can be a source of *Anthrax* spores. A lethal infection is reported to result from inhalation of about 10,000 – 20,000 spores, though this dose varies among host species. Testing at the University of Cincinnati by Dr. Grinshpun used *Bacillus subtilis* as a surrogate.

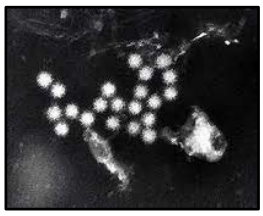


Bacillus anthracis

Effectiveness of Photocatalytic Oxidation Technology: Deactivation of > 90% of microorganisms was achieved in less than 60 minutes, the majority of which occurred within 10 minutes. [10]

Viruses

Norwalk Virus –This virus is a Norovirus. Noroviridae are a group of related single stranded RNA, highly contagious viruses 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. [12]



Norwalk Virus

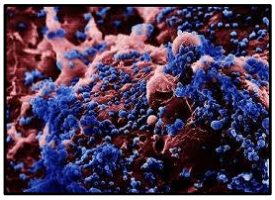
Effectiveness of Photocatalytic Oxidation Technology: Deactivation of > 90% of Murine Norovirus (MNV) microorganisms was achieved after 4 hours. [13]

H1N1 Virus (Swine Influenza) – The H1N1 virus is a unique strain of influenza. The Centers for Disease Control determined that the strain 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 touching one's eyes, nose or mouth. [14]

H1N1 Swine Flu Virus

Effectiveness of Photocatalytic Oxidation Technology: Testing on stainless steel surfaces using PCO resulted in ~ 99% microbial reductions. [3]

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 previously known strain, and continues to evolve, becoming both more widespread and more deadly. 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. Testing of photocatalysis on H5N1 was completed at Kansas State University using H5N8 as a surrogate. [15]



H5N1 Bird Flu Virus

Effectiveness of Photocatalytic Oxidation Technology: Testing on stainless steel surfaces using PCO resulted in ~ 99% microbial reductions. [11, 13]

Fungus, Molds and Spores

Stachybotrys chartarum – *S. chartarum* is a black mold that produces its conidia in slime heads and is found in soil and grain as well as cellulose rich building materials and damp or water-damaged buildings. It requires high moisture content in order to grow and is associated with wet gypsum material and wallpaper. Health problems related to this mold have been documented in humans and animals since the 1930s and more recently has been linked with "sick building syndrome." [16]

S. chartarum

Effectiveness of Photocatalytic Oxidation Technology: Testing on stainless steel surfaces using PCO resulted in ~ 99% microbial reductions within 24 hours. [3]

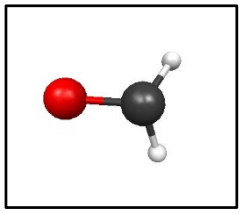
Candida albicans – *C. albicans* is a diploid fungus that grows as both yeast and filamentous cells and a causal agent of opportunistic oral and genital infections in humans. Systemic fungal infections (fungemias) including those by *C. albicans* have emerged as important causes of morbidity and mortality in immune-compromised patients (e.g., AIDS, cancer chemotherapy, organ or bone marrow transplantation). *C. albicans* biofilms may form on the surface of implantable medical devices. In addition, nosocomial infections by *C. albicans* have become a cause of major health concerns. [17]

Candida albicans

Effectiveness of Photocatalytic Oxidation Technology: Testing on stainless steel surfaces using PCO resulted in ~ 99% microbial reductions within 24 hours. [3]

Other Studies

Volatile Organic Compounds (VOCs) – There have been studies showing the effectiveness of PCO on over 60 VOCs. A partial list includes *formaldehyde* and *chloroform* (found outgassing from common household materials), *Acetone, isopropyl alcohol, ethanol, methyl ethyl ketone, propene, toluene, methylene chloride* (frequently found in common chemical cleaners) *vinyl acetate and xylene* (found outgassing from common plastic products). Airborne tobacco smoke has also been shown to be a major cause of irritations and has caused other major health issues as well. Contact ***UVAIRx*** for a complete listing.

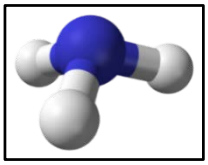


Formaldehyde

Effectiveness of Photocatalytic Oxidation Technology: Testing has shown reductions of > 90% in most cases. [18, 19]

Odors – Photocatalytic oxidation of odor compounds including *acetaldehyde*, *isobutyric acid*, *toluene*, *hydrogen sulfide* and *trimethylamine* at about 500 ppm were reduced by over 90%. The data suggest that photocatalysis should be considered for reduction of certain odor compounds. [20]

Inorganic Compounds – A few inorganic gas-phase compounds include *ammonia* (NH_3), *hydrogen sulfide* (H_2S), *nitrogen oxides* (NO_x), N_2O), *ozone* (O_3) and *sulfur oxides* (SO_x). Those compounds containing hydrogen, carbon and oxygen under conditions of complete oxidation form water and carbon dioxide.



Ammonia

Effectiveness of Photocatalytic Oxidation Technology: Testing has shown reductions of > 90% in the compounds tested. [21]

Allergens – Allergens are numerous and varied things such as dust mites excretions, pollen and pet dander. Basidiospores are considered a major source of airborne fungal allergens, which may include mushrooms, rusts, smuts, and brackets. A study in New Zealand has shown that 22% of patients with respiratory allergic disorders tested positive for basidiospores allergies. Heavy rainfall increases fungal spore releases which are listed as a major source of airborne allergens. [22]

Dust Mite

Effectiveness of Photocatalytic Oxidation Technology: Testing has shown reductions > 95% in most cases of airborne allergens including mold spores, basidiospores, dust mite excretions, tobacco smoke and protein molecules (animal allergens). [23, 24]

Sneeze test – *UVAIRx* PCO

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 within 3 feet.

Safety

Photocatalysis, a natural chemical process, is the acceleration of a photoreaction in the presence of a catalyst. These PCO materials can then break down organic molecules, like air pollutants and smog precursors, into environmentally friendly compounds. Using PCO has become more attractive than filtration or UV treatment because it is a non-invasive, non-toxic, and cost effective method to address a wide variety of technologies related to purification and degradation processes. These pollutants are converted into non-toxic compounds, such as carbon dioxide and water vapor. [25]

An emerging alternative method for air pollution control employs the use of semiconductors in photocatalytic oxidation (PCO) of organic contaminant to produce innocuous CO_2 and H_2O. Among the photocatalysts used, titanium dioxide (TiO_2) is the most widely implemented because it is inexpensive, nonhazardous, and chemically inert. [26]

Engineered PCO devices for intentional air ionization are more controllable than incidental sources. These units produce controlled outputs of specific ions on demand. The formation of undesirable byproducts, such as ozone, is minimized. In multifloor buildings, no new VOCs were identified as products of incomplete ionization at levels of detection. [27] The number of air exchanges may be significantly reduced resulting considerable in energy savings.

Green Technology – Energy Star Compliant

UVAIRx is committed to the environment by using low voltage technology to power our devices, designing our products with durability, refurbishment and reuse in mind, and packaging with recycled materials. Preference is shown to suppliers that share these values.

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