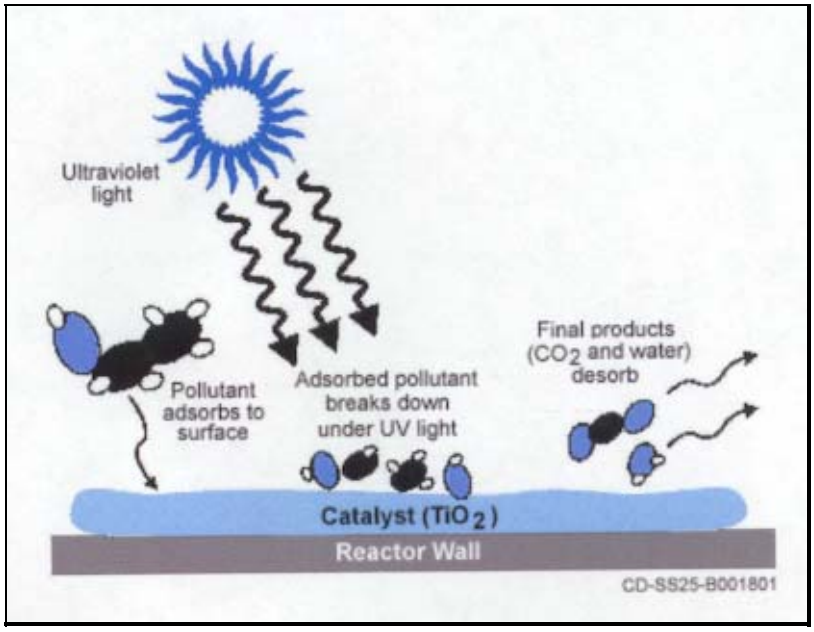
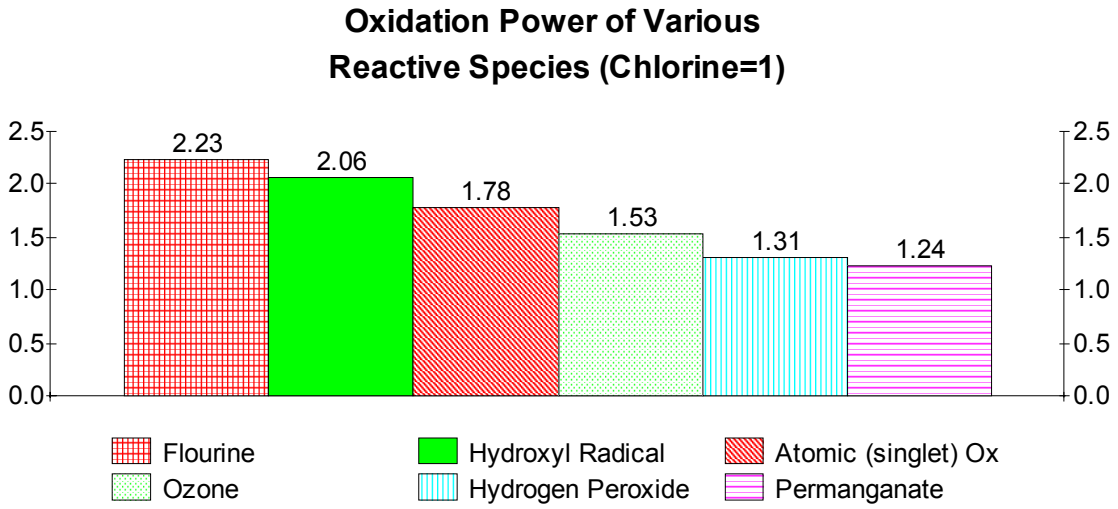
Photocatalytic Oxidation (PCO)

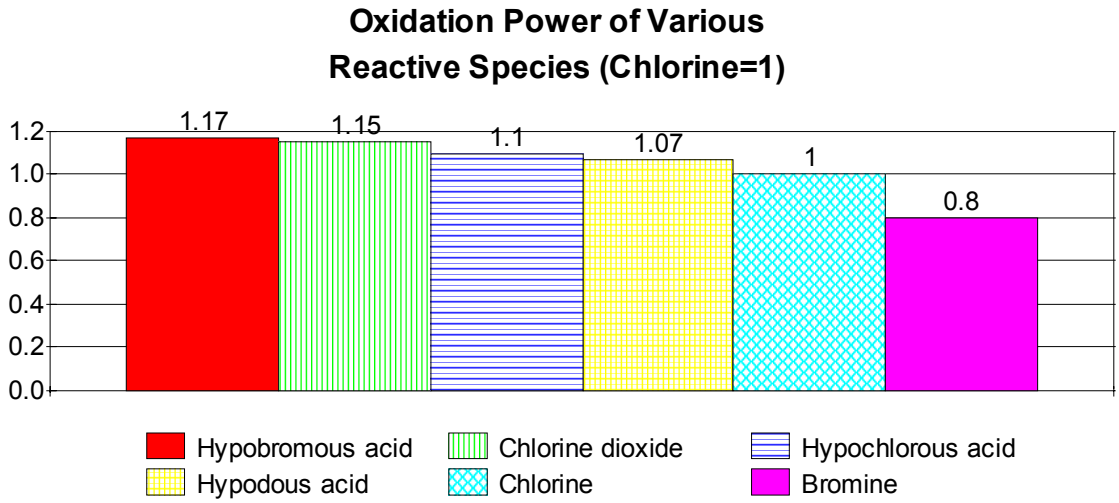
In order to fully understand photo-catalytic oxidation we must first learn a little about the metal catalyst involved (Titanium in our case). Titanium has been stated as being "light, strong and anti-corrosive", titanium has these characteristics due to its unique very thin layer of oxidized film on it called Titanium oxide (TiO2).This invisible barrier (TiO2) is quite remarkable in the fact that it will, if scratched or damaged, immediately restore itself in the presence of air or water. The TiO2 film also has a high refraction ratio and when it is irradiated by UV light, less than 385nm, the band gap energy (the level of energy photons need to be able to free electrons from their atomic bonds) is exceeded. What is created are electron/hole pairs, hydroxyl radicals (OH), thus attracting molecules (such as volatile organic compounds or bioaerosols) to the catalyst (Titanium). The contaminates are oxidized by reaction that takes place during this process due to the fact that the hydroxyl radicals need to attach themselves to something and when they do they oxidize it to CO2 or H2O primarily. View an Example of the process below:

DIAGRAM OF THE PHOTO-CATALYTIC PROCESS



A good analogy to think of when your pondering the concept is electronic air cleaners, they work due to the fact that you are charging the particle in the air and then attracting it to an oppositely charged plate (like a magnet). With PCO technology after the volatile organic compound or bioaerosols is attracted to the titanium strip it comes into contact with hydroxyl radicals which change the molecular structure of the contaminates. Photo-catalytic oxidation will kill and decompose absorbed bioaerosols, as well as addressing volatile organic compounds (VOC's) or odors. There are many methods used in reducing the toxicity of air and water. The following graphs show the oxidation power of various oxidizing species.





As can be seen from these charts the oxidation power of hydroxyl radicals is second only to that of fluorine. Looking at the oxidation power of ozone we can determine that it is not as powerful an oxidant as singlet oxygen, or hydroxyl radicals. Therefore an ozone generator at 1.53 (though a good method of oxidizing VOC's) is not as good as singlet oxygen 1.78 or hydroxyl radicals 2.06 in oxidizing contaminates.

The Second Wind family of air purifiers uses two different technologies in oxidizing contaminates singlet oxygen production and hydroxyl radical production. The main difference beside the fact that hydroxyl radicals are 16% more efficient in oxidizing contaminates, is that PCO creates no residual ozone. When using our units that produce singlet oxygen to oxidize contaminates some residual ozone can be created.

There are many advantages to PCO photo-catalytic oxidation:

- High destruction efficiencies at room temperature
- No chemical additives
- No residual ozone
- High oxidation yields for gas phase reactants and odors
- Low energy requirements
- Complete oxidation of organics to CO2 & H2O is possible (VOC's, Bioaerosols)
- Applies to a large number of organics (VOC's, Bioaerosols)
- Works in humid conditions
- Long service life
- Low maintenance requirements
- Negligible pressure drop

Now that PCO technology can be integrated into new and existing heating, ventilation, and air conditioning (HVAC) systems everyone (even the chemically sensitive) have an effective process for removing and destroying low level pollutants in indoor air, including bacteria, viruses and fungi.

There have been numerous scientific studies, research and applications using PCO technology. Let me share just a few exerts from some:

"One effective method to destroy dilute concentrations of organic and chlorinated organic pollutants in air is heterogeneous photocatalytic oxidation (PCO), which uses a semiconductor catalyst such as TiO2 and near-UV radiation to decompose contaminates..." "The large number and variety of chemicals successfully treated by PCO indicates potentially broad range of application."
John L. Falconer, Ph.D. Professor of Chemical Engineering University of Colorado

- *Ph.D. (Chemical Engineering), Stanford University (1974)*
- *B.E.S. (Chemical Engineering), The Johns Hopkins University (1967)*

"Photocatalysts for the destruction of indoor air pollutants, including VOC's and gaseous inorganic pollutants such as nitrous oxides, carbon monoxide, and hydrogen cyanide... (Heller,1996). "Reports of tests show the technology capable of rapidly destroying toxic components of tobacco smoke such as formaldehyde, acrolein and benzene."
Taken from the American Lung Association webpage January 24, 2001

"...The PCO technique destroys pollutants in both air and water..."
NREL National Renewable Energy Laboratory

"...Carbon 13 labeled ethanol (CH3(13)CH2OH) was absorbed on the catalyst and photocatalytically oxidized..."
Darrin S. Muggli; Sheldon A. Larson; John L. Falconer Journal of Physical Chemistry 1996

"...The purpose of this study is to investigate the purification of air emissions contaminated with toluene via the heterogeneous photocatalytic oxidation (PCO) process..." " ...Experimental results indicated that near to 100% conversion ratio of toluene are achieved for the initial 30-minute reaction period.."
Chung-Hsuang Hung Photocatalytic Decomposition of Toluene Under Various Reaction Temperatures.

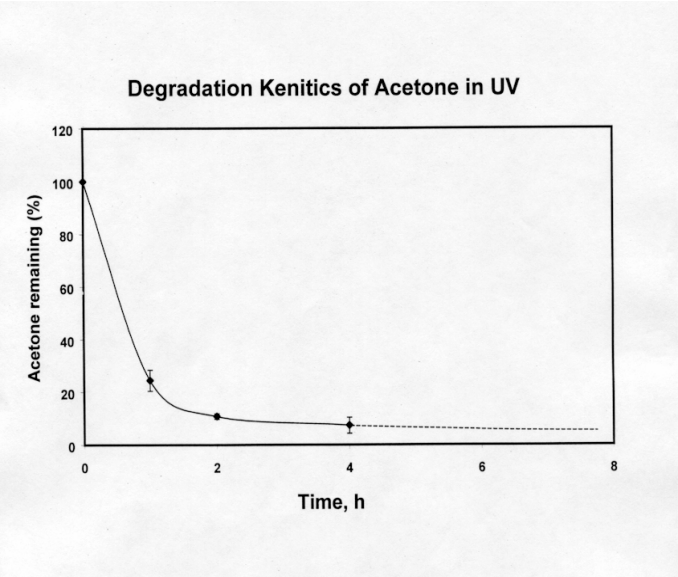
"...Photocatalytic oxidation (PCO) , a relatively new technology, shows promise for economically controlling hazardous air pollutants and volatile organic compounds from smaller sources, such as waste water treatment plants, dry cleaning facilities, painting facilities, carbon regeneration plants, air-stripping towers, soil venting processes, hazardous waste incinerators, and municipal landfills..."
Melanie Louise Sattler Method for Predicting Photocatalytic Oxidation Rates of Organic Compounds

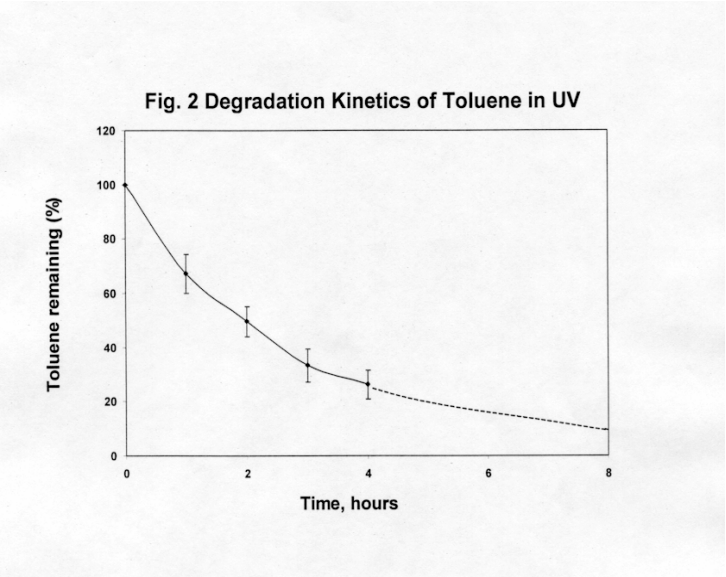
"... Potential applications for using titania-based materials as photocatalysts include...Destroying volatile organic compounds (trchloroethylene, benzene, formaldehyde, etc.). Reducing air pollution in homes and industries such as dry-cleaners, painting booths, and printers.."
Marc A. Anderson Professor Water Chemistry Program and Materials Science
University of Wisconsin, Madison

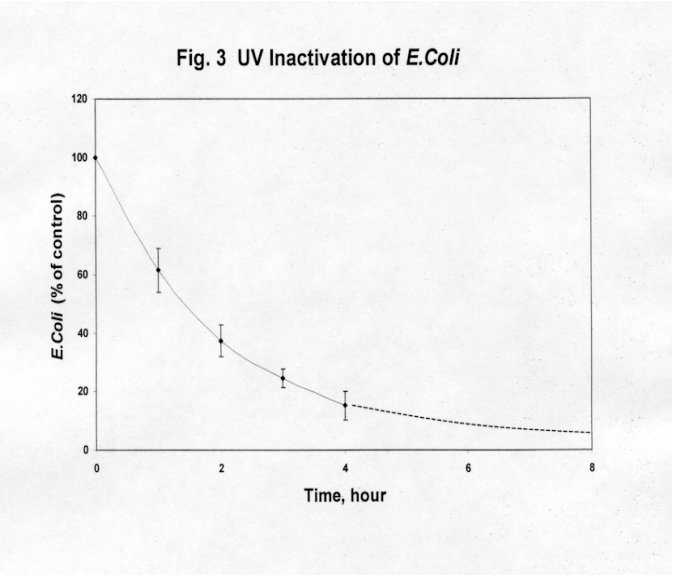
"... In addition to automobile exhaust cleaning, use of environmental catalysts such as titanium oxide photocatalysts is rapidly growing for control of residential environments, e.g., antimicrobial activity and odor control..."
Katsunori Yogo, Masamichi Ishikawa
Interdisciplinary Department, Frontier Science Institute, Mitsubishi Research Institute, Inc.

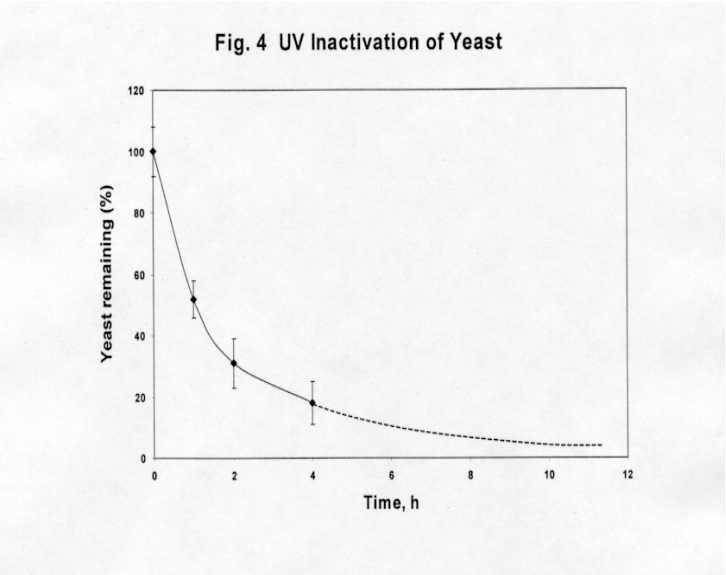
"...Titanium dioxide is therefore applied for deodorizing, by decomposing substances causing bad odor, and for prevention of air pollution by absorbing and oxidizing..."
Japan Chemical Week August 26, 1999

Those are just an example of the vast research that has been and is being done on PCO photocatalytic technology. Including Second Wind's own testing recently finished by the University of Waterloo on our photocatalytic air purifiers. Please view the dramatic results of our testing on the following page.









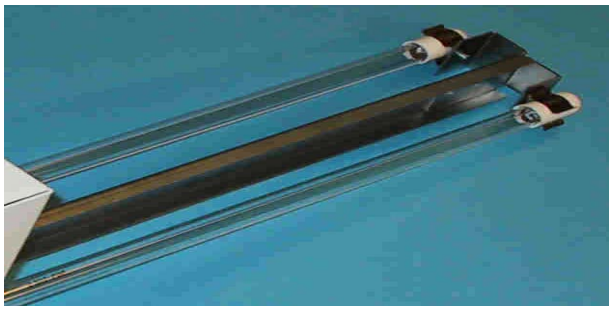
Any of the information in these pages
can be obtained for more in depth questioning.
All references and test data
are available
for review at any time.

View our comparative summary
of Air Cleaning Technology
On page 6.

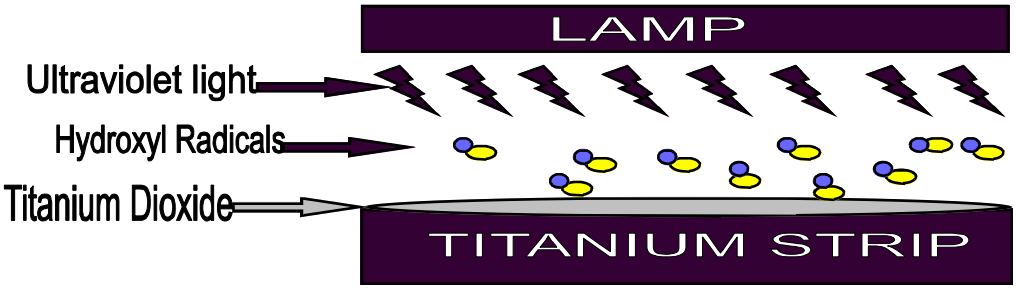
Comparative Summary of Air Cleaning Technology

	Second Wind PCO	Active Carbon Filter	HEPA Filter	Air Ozonation	Chemical Biocide	High Energy UV	Electrostatic Filter
CAPTURES MICROORGANISMS	X	X	X				X
DESTROYS MICROORGANISMS	X			X	X	X	
Creates No Hazardous Waste Products	X						
GENERATES NO OZONE	X	X	X		X		
CAPTURE'S HIGH MOLECULAR WEIGHT VOC	X	X					
CAPTURES LOW MOLECULAR WEIGHT VOC	X					X	
DESTROYS HIGH MOLECULAR WEIGHT VOC	X			X		X	
DETROYS LOW MOLECULAR WEIGHT VOC	X						
UNLIMITED CAPACITY	X			X		X	X
ELIMINATES ORGANIC ODORS	X	X		X			
LOW PRESSURE DROP	X			X	X	X	X
LOW MAINTENANCE COST	X			X			X
LOW OPERATING COST	X			X			X

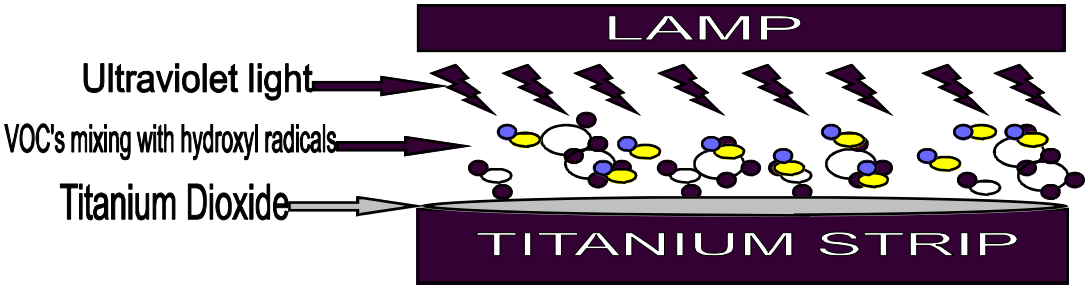
Photo of Photocatalytic Model 2000 lamps and Titanium strip.



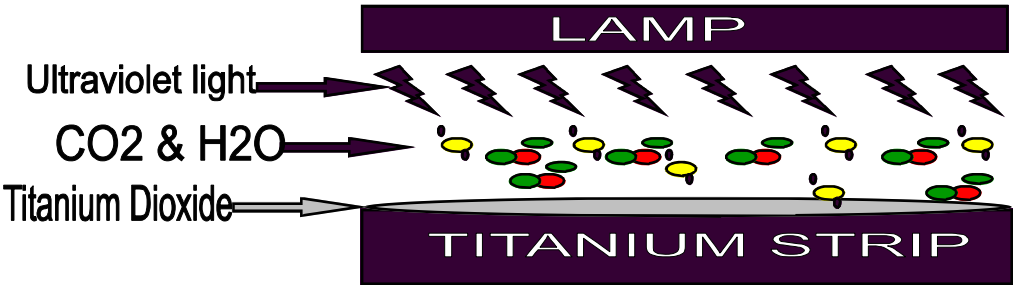
BEFORE OXIDATION



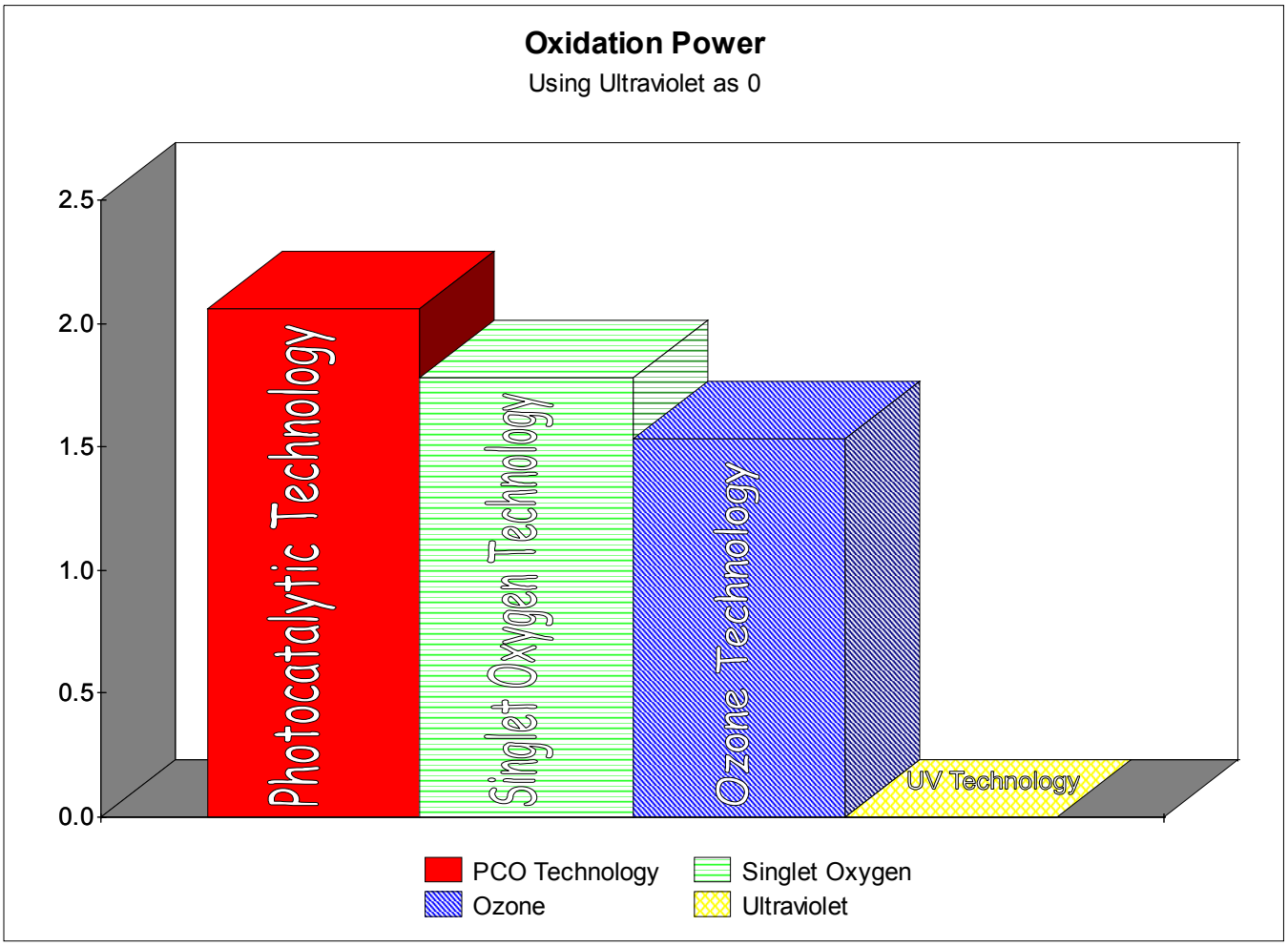
DURING OXIDATION



AFTER OXIDATION



The Second Wind photocatalytic process
will oxidize volatile organic compounds,
odors and off-gasses.
While also sterilizing molds, mildews and bacteria that comtaminate
many homes and businesses.
The incorporation of our filtration will
also aid in the removal of particulates from the indoor air.



For an indepth look at the various
research projects going on throughout the world,
concerning PCO technology
log on to Http://sites.netscape.net/photocatalysis/photocat-people.htm.