

Research on Defense against Threat of Biological Warfare Agents

**My Salute to Ron Davidson, being
~~my mentor and role model for last~~
34 years**

Han S. Uhm

Ajou University, Korea

Flowers



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Research Motivation of CBW Defense

- Threat of CBW Agent Attack by Terrorists
- Increasing Military Conflicts between Nations
- 2003 Iraqi War; CBW
- 2001 USA 9.11 Terror; Anthrax
- 1995 Tokyo Subway; Sarin Gas
- Gulf War; CBW
- 731 Regiment of Japanese Army in World War II

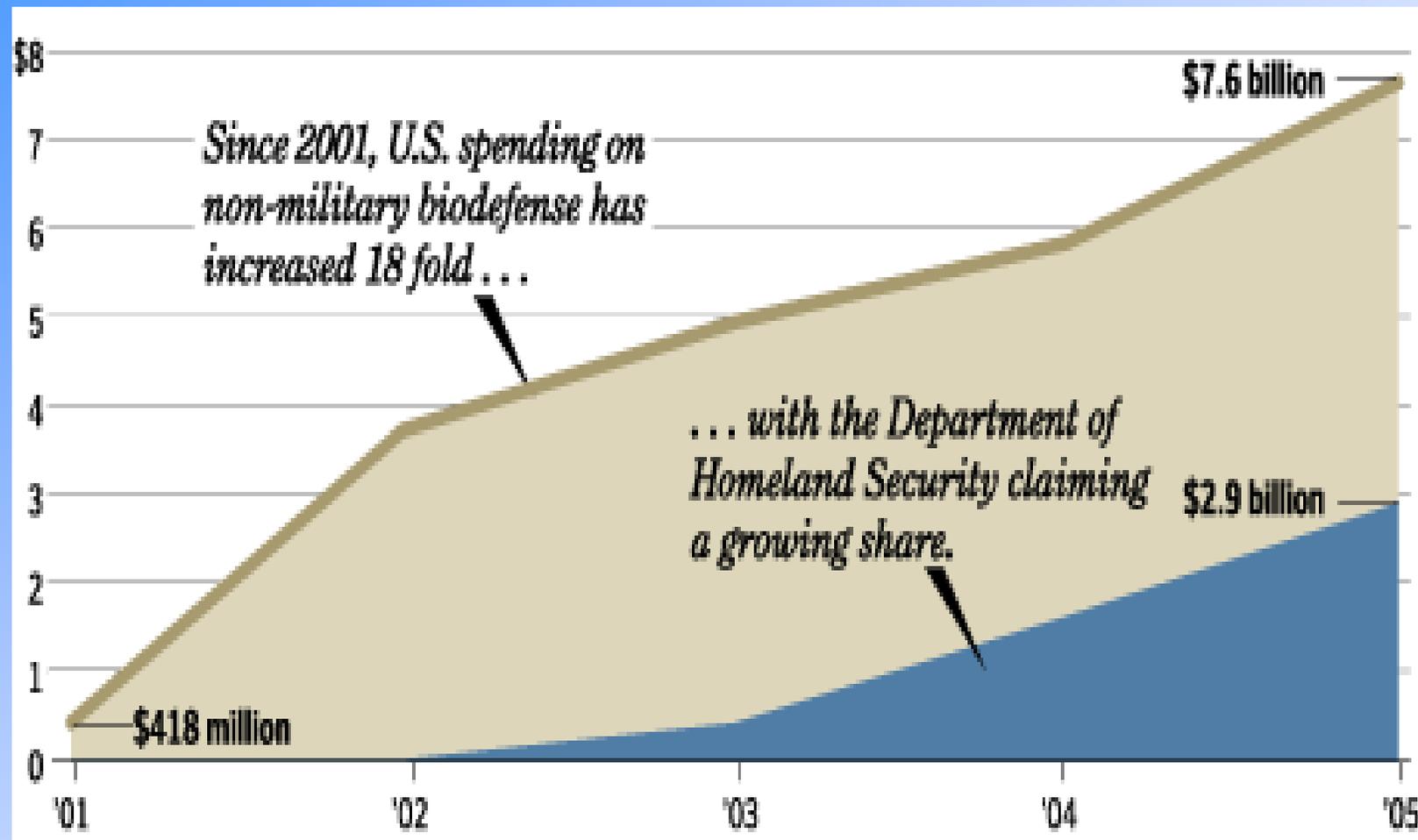
Hypothetical Casualty of Bio Weapon

- Throwing of a Plague Corpse into Kaffa Castle by Tatar Army at 1346: Spread of Plague over Europe, killing 1 out of 4
- Spain Influenza Pandemic at 1918, Killing 25 Million in Europe
- Anthrax Leak at Sverdlovsk Bio Lab on March 2, 1979, Killing 66 and Numerous Injuries; *Science* 1994; 266: 1202-1208

The Known Bio Weapon Now

- **Anthrax**, Botulinum Toxins, Brucellosis, Cholera, Clostridium Perfringens Toxins, Congo-Crimean Hemorrhagic Fever, Ebola Haemorrhagic Fever, Melioidosis, Plague, Q Fever, Ricin, Rift Valley Fever, Saxitoxin, **Smallpox**, Staphylococcal Enterotoxin B, Trichothecene Mycotoxin, Tularemia, Venezuelan Equine Encephalitis.

US Bio Defense Research Fund after 9.11 Terror (Washington Post)



US Dilemma of Bio Defense Research

- NBC World News on July 29, 2006.
- US bio-defense research after 9-11 terror
 - Development of new drugs: July 30, 2006 of WP
- But the search for new drugs of all kinds remains agonizingly slow, because the list of the biological agents today is rapidly expanding to include **man-made varieties**:
July 31, 2006 of WP

Conventional Strategy

- Detect and Identify
- Cure the patients
- Abandon and Run
 - But there is a situation not to abandon and run
- The only solution is prompt decontamination (New Strategy)

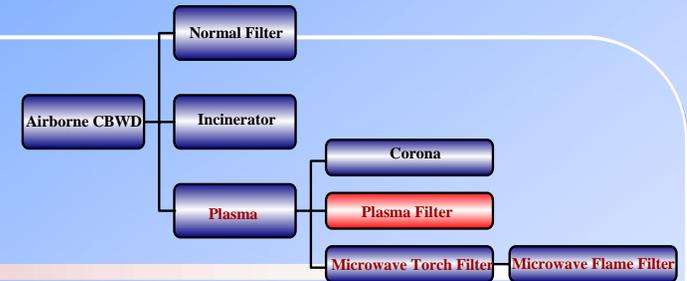
Defense against CBW Agent by decontamination



History of Plasma Decontamination System

- Contaminated Air Purification
 - NAVSEA (1994): US Army Lab. (1992)
 - Corona Discharge
 - ~ 2 lpm
 - NSWC (1995: US Patent)
 - Microwave Resonant Cavity Plasma
 - 1~2 lpm
 - Lawrence Livermore National Laboratory (1998)
 - Pulsed Corona Discharge
 - ~ 10 lpm
 - Ajou University (2002)
 - Microwave Plasma Torch (US Patent #6,806,439)
 - ~ 1000 lpm

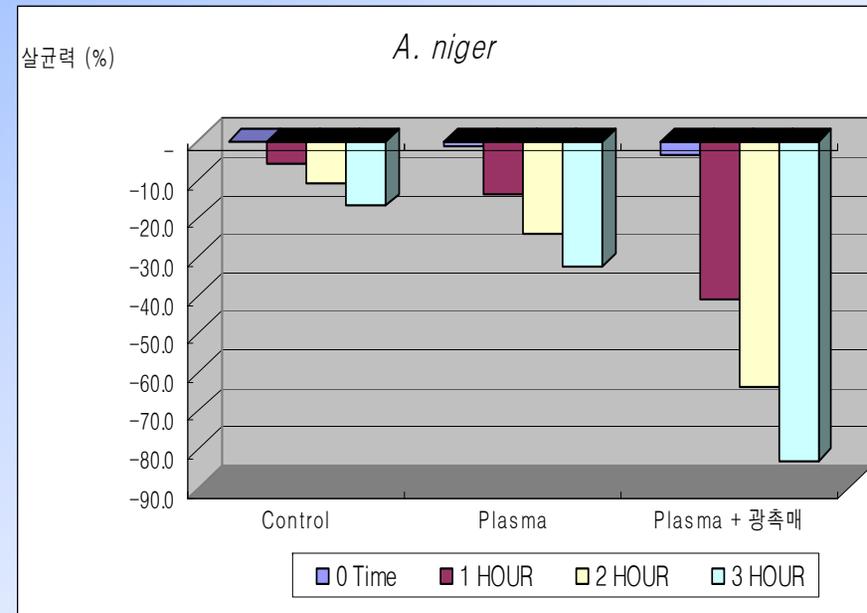
Atmospheric Plasma Filter



- Plasma Filter for Air Purifier



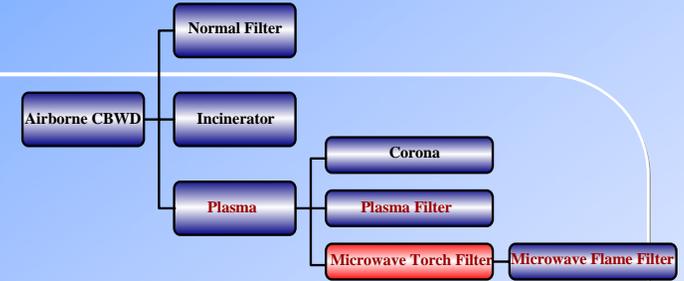
Plasma filter



Fungus (*A. niger*)

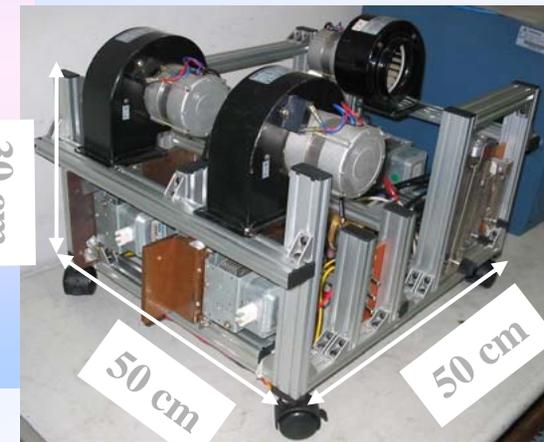
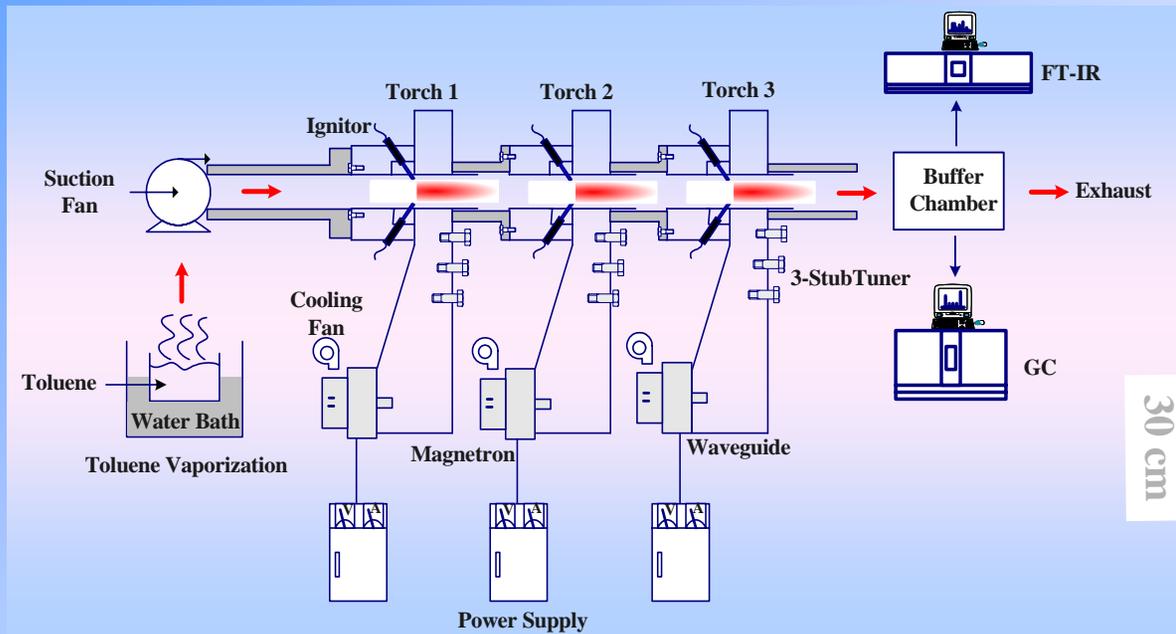
※ Sterilization Test by Korean Production Science Center

Microwave Plasma Torch



Decomposition of Toluene by 3-Plasma Torches in Series

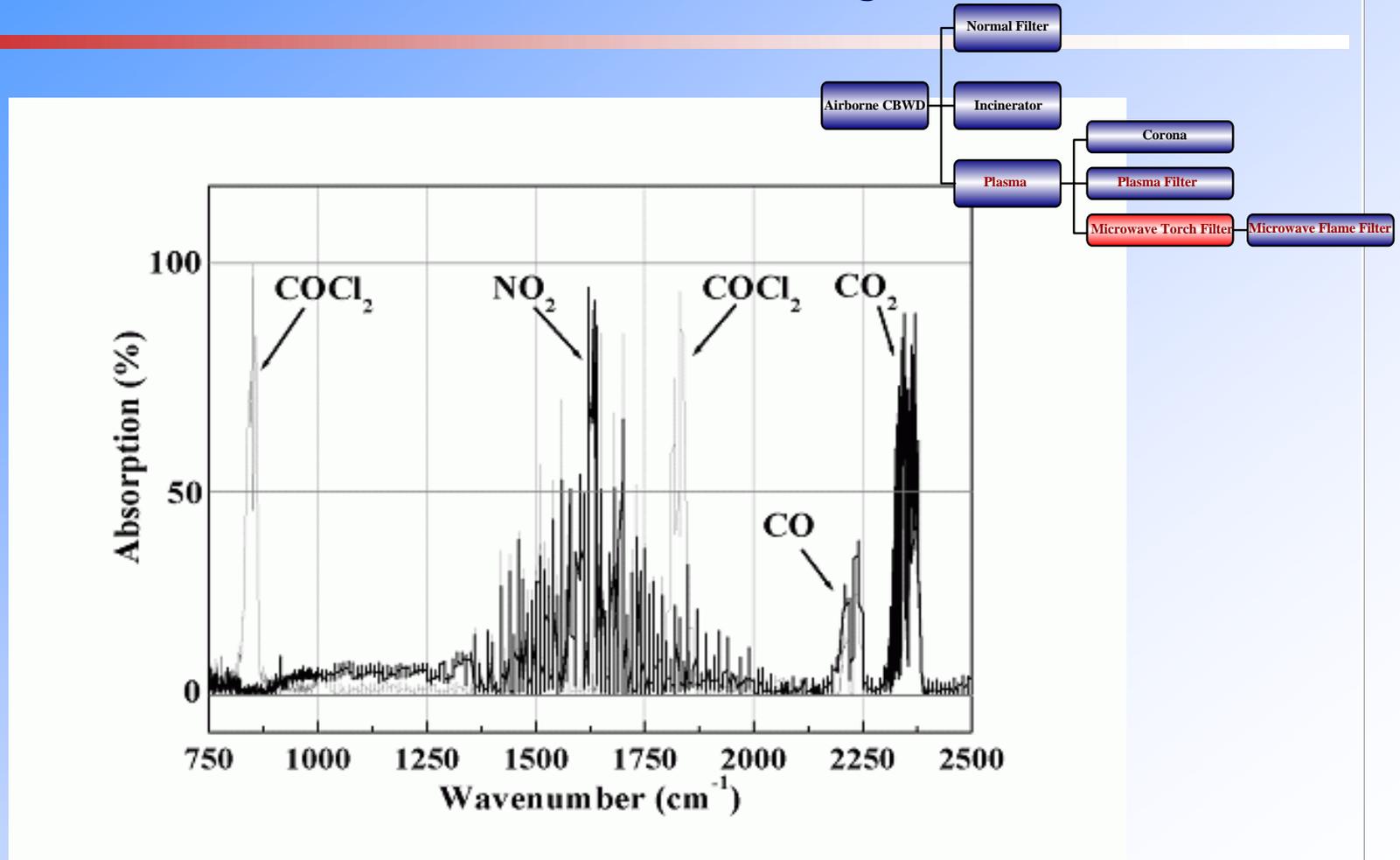
- Input Power: ~ 3 kW
- Total Flow Rate: 1000 lpm, 150 ppm Toluene



[Experimental Set-up for Toluene Decomposition]

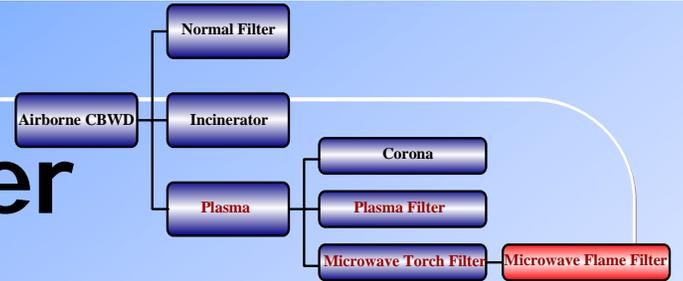
※ Physics of Plasmas Vol. 11, No. 2, 2004, US Patent #6,806,439

Microwave Plasma Torch : Phosgene Destruction

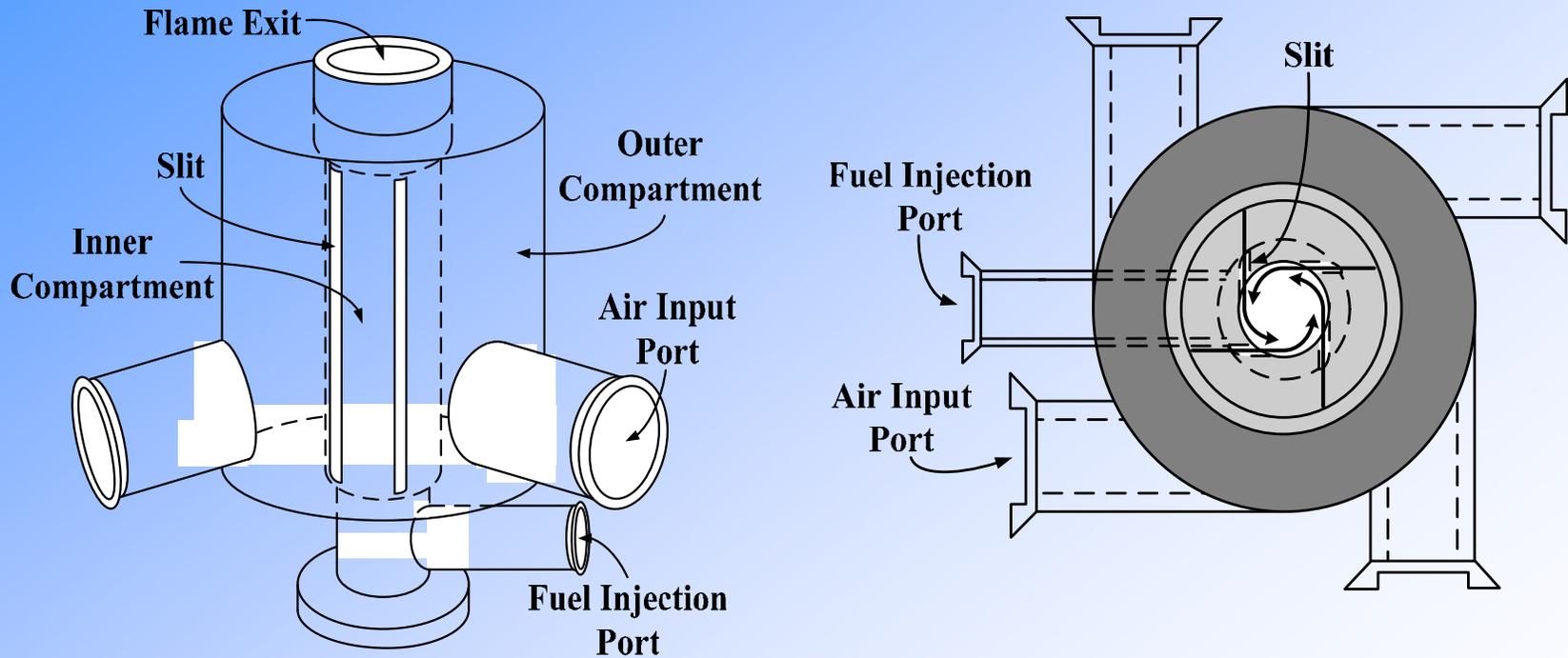


※ IEEE Trans. Plasma Sci., Vol. 33, No. 2, 2005

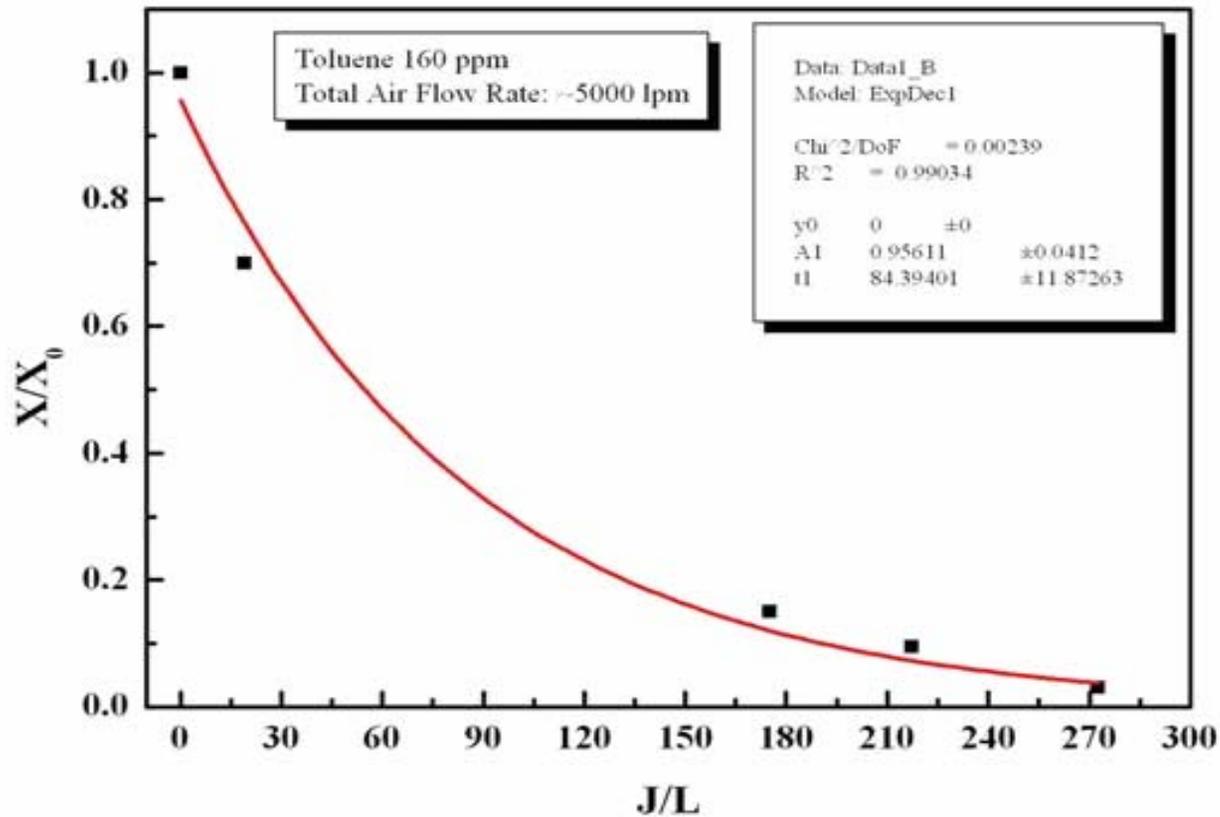
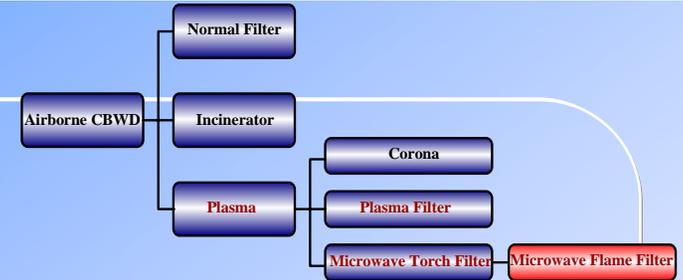
Microwave Flame Filter



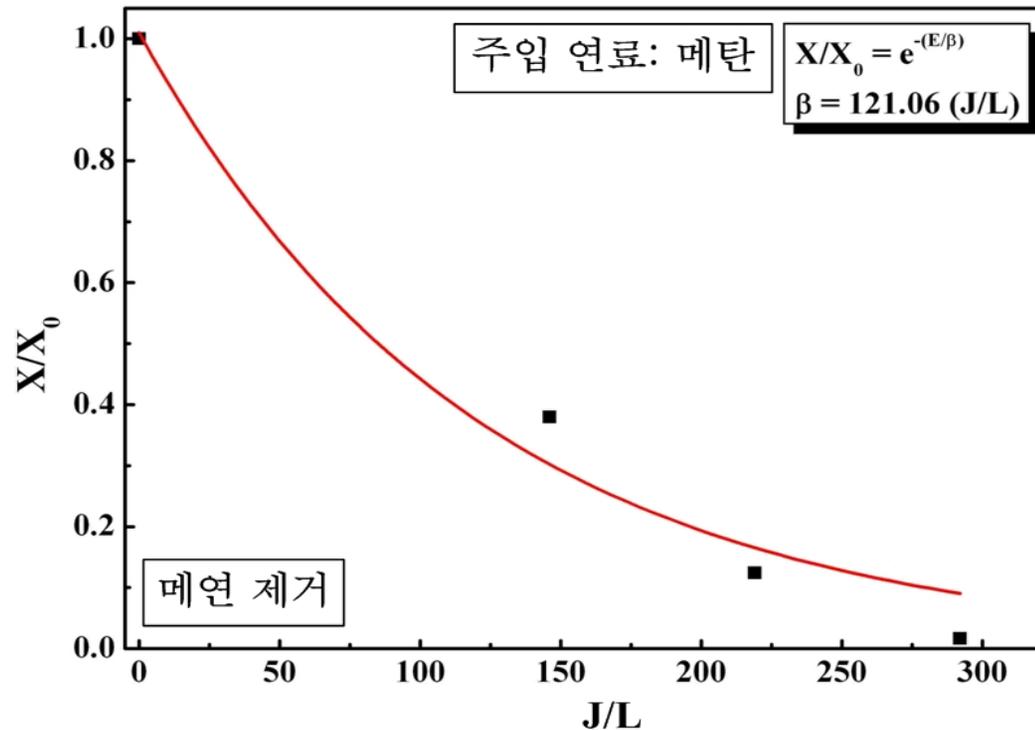
Reaction Chamber of Microwave Flame Burner



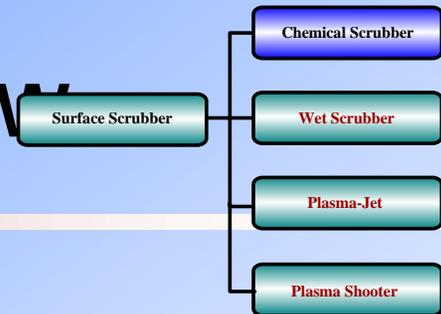
Microwave Flame Filter (APL 2006)



Microwave Flame Filter: Soot Elimination from a Large Bus



Surface Decontamination of CBV



- **STB (Super Tropical Bleach)**

A conventional alkali formula which was made of a mixture of lime powders and chlorine gas. STB was used for scrubbing surface of buildings and facilities, but **It is highly corrosive.**

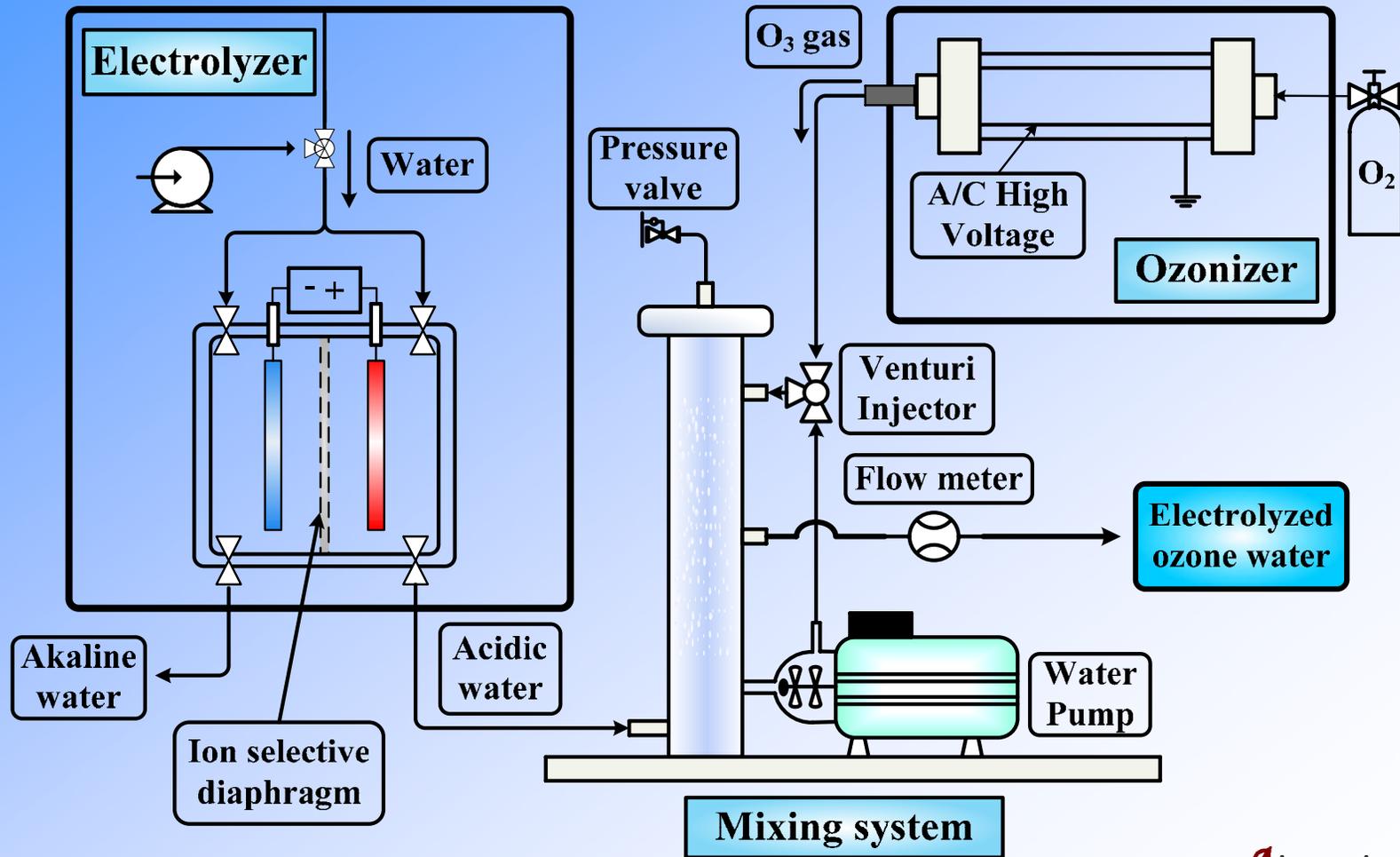
- **DS-2 (활성 작용제, Diethylene Triamine Sodium Hydroxide)**

Liquid. This material is used for decon for Bio and Chemical agents.

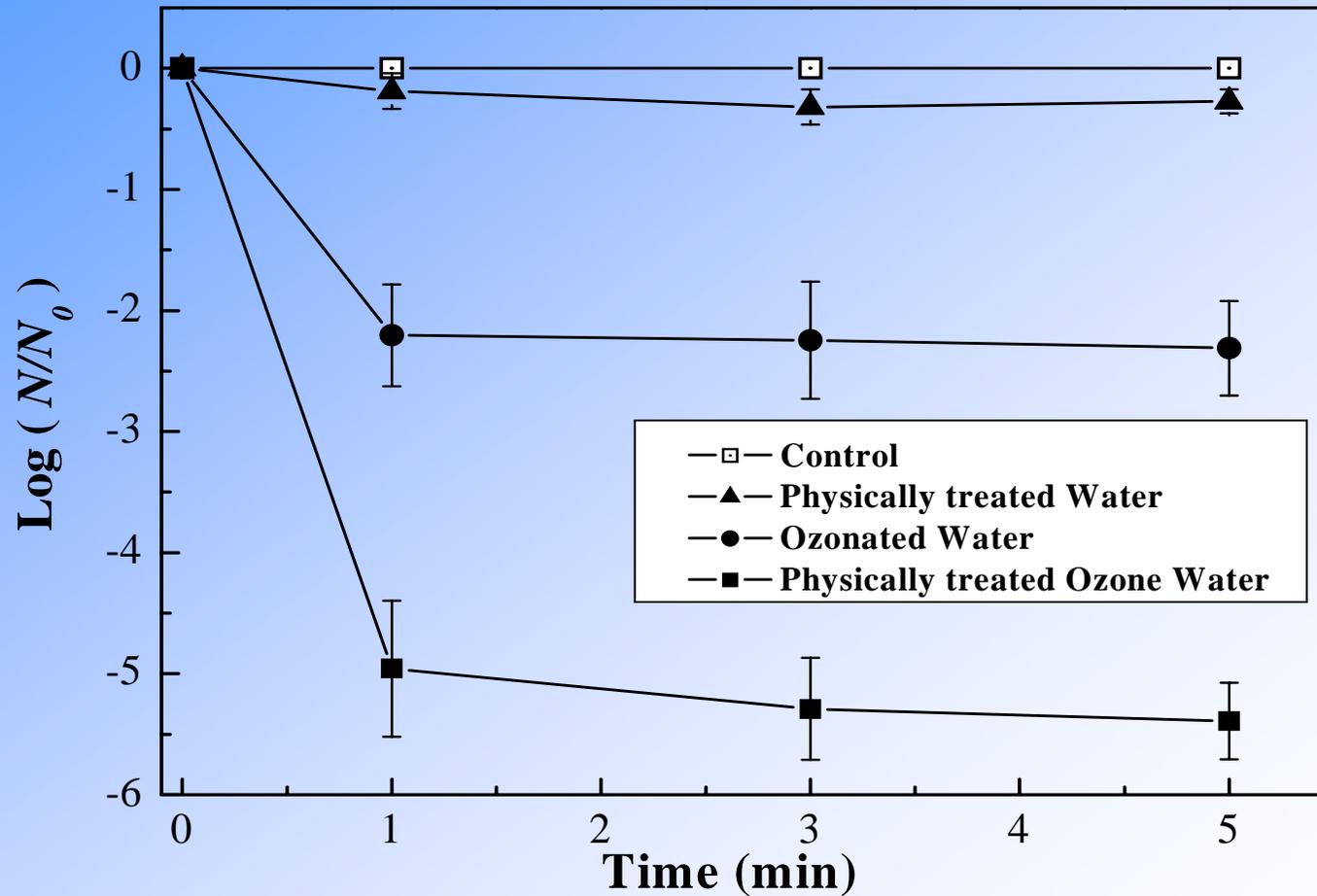
The anti-gas mask and gloves are needed to handle this material.

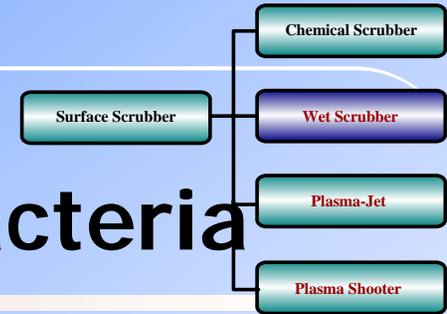
Water Cleaning is needed 30 minutes after application of this material to prevent corrosion.

Schematics of Electrolyzed Ozone Water

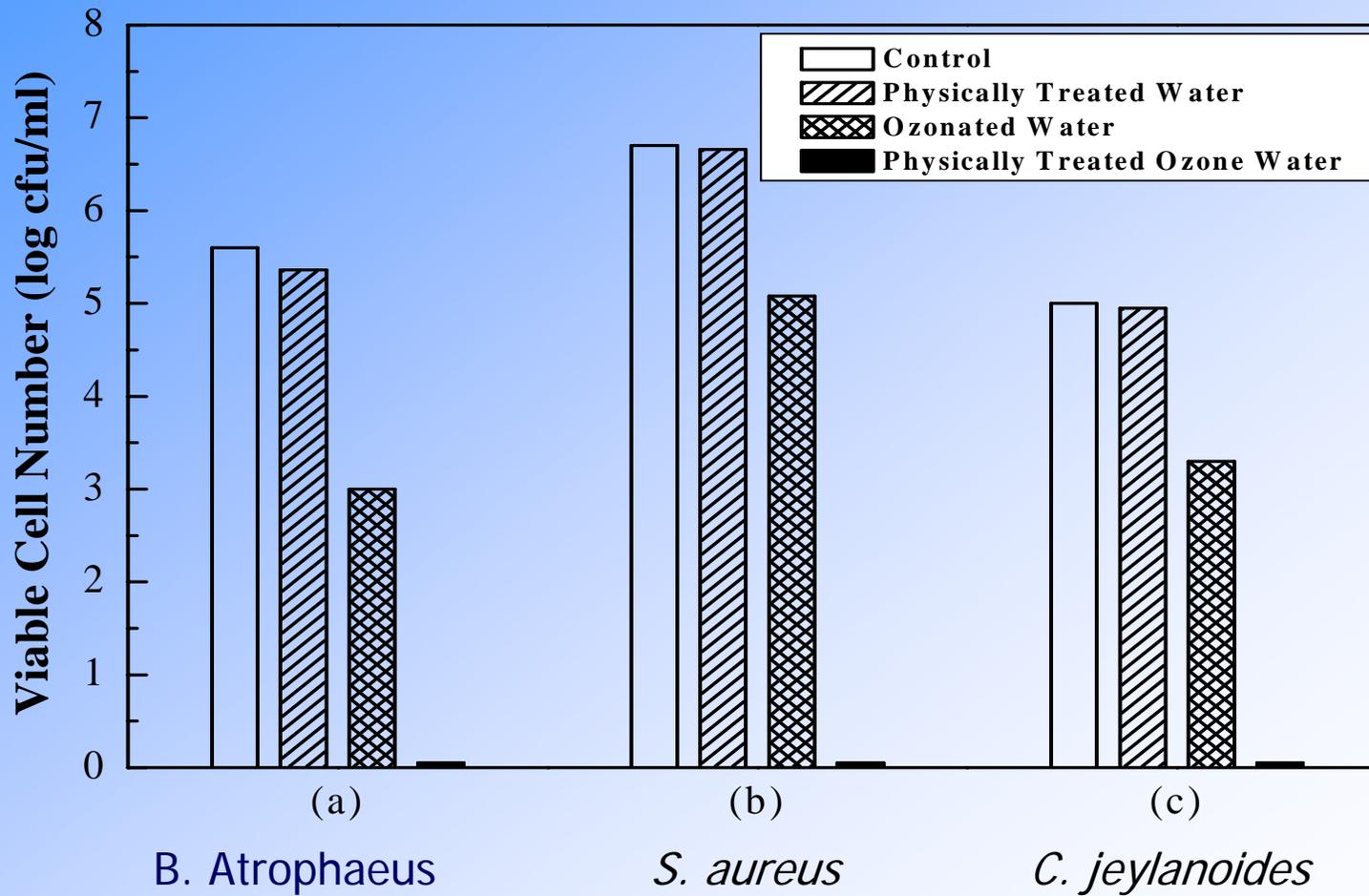


Sterilization of *Bacillus Atrophaeus* Spores (JAP 2007)

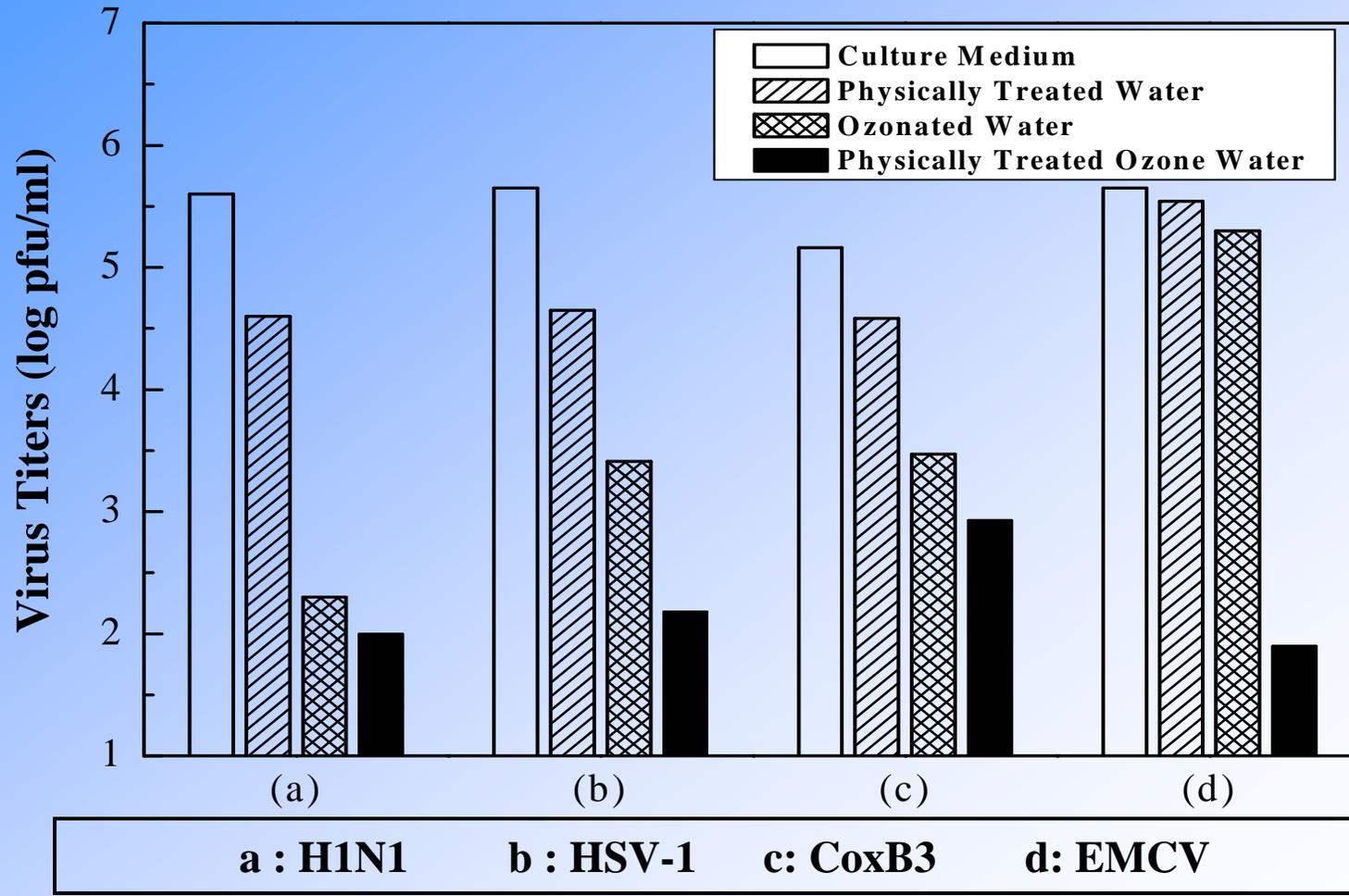


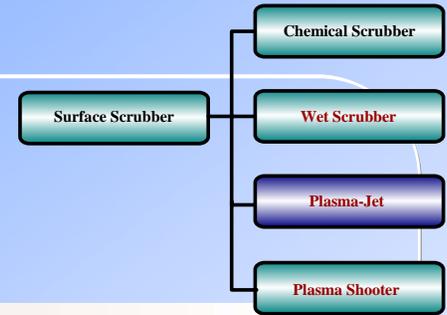


Sterilization of Vegetative Bacteria



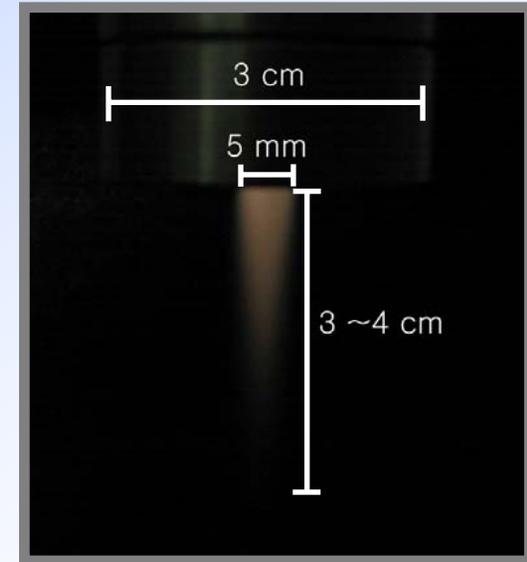
Sterilization of Viruses



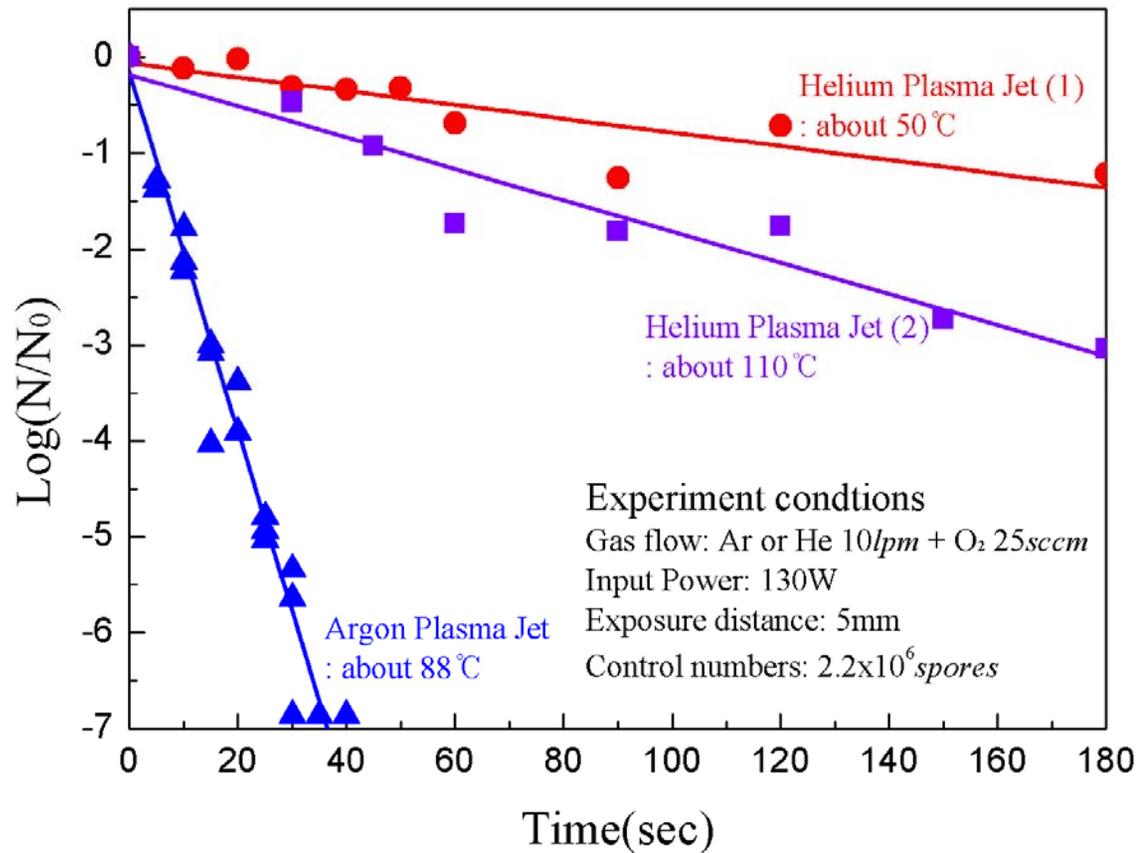


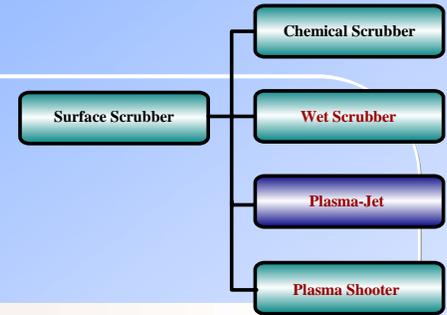
Plasma Jet

- Atmospheric RF and MF Plasma generation
 - : Plasma Flame: More than 1cm
 - : Under 100°C
 - : He, Ar, N₂, Air - Jet
- A small scale plasma Jet



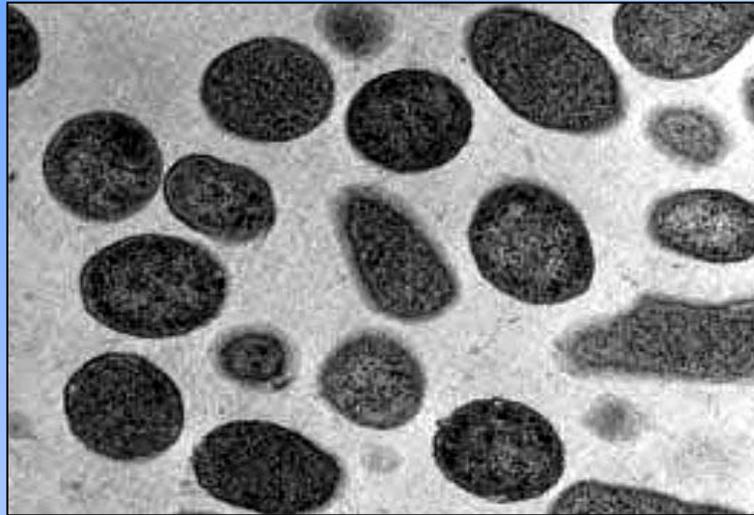
Comparison Between Argon and Helium Torches (Bacillus Atrophaeus) (APL 2007)



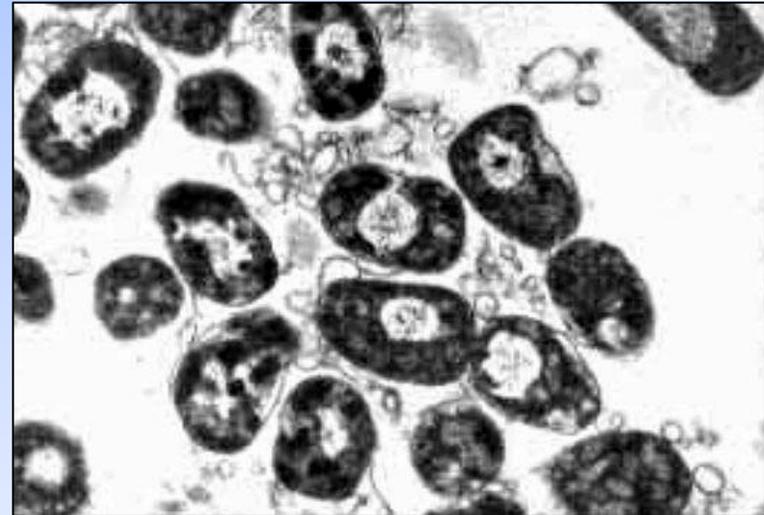


Atmospheric Plasma Sterilization

- Transmission Electron Microscopy (TEM) of *E. coli* after plasma treatments ($\times 4400$)



(a) control



(b) plasma treated cells

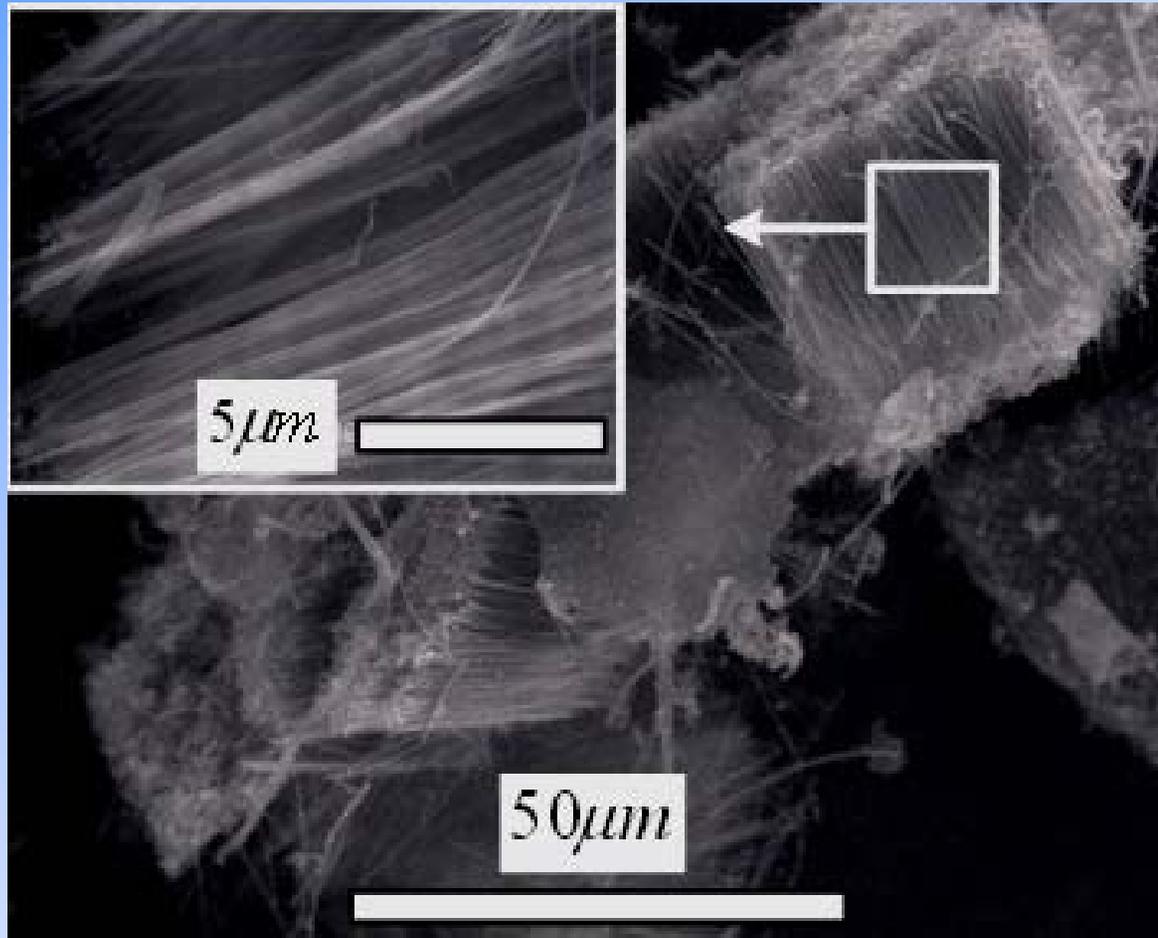
※ XXVIIth International Conference on Phenomena in Ionized Gases in Eindhoven, Netherlands
(2005.7.17-22)

Conclusions of Bio Defense Research

- Restoration of Contaminated Environment
- Protect Mankind from Chemical and Bio Weapons
- Disarm of CB Weapons permanently
- Prevent Terrorists from Using CBW
- Free the Mankind from Worry of CBW
- Apply these new defense Technologies to Mankind

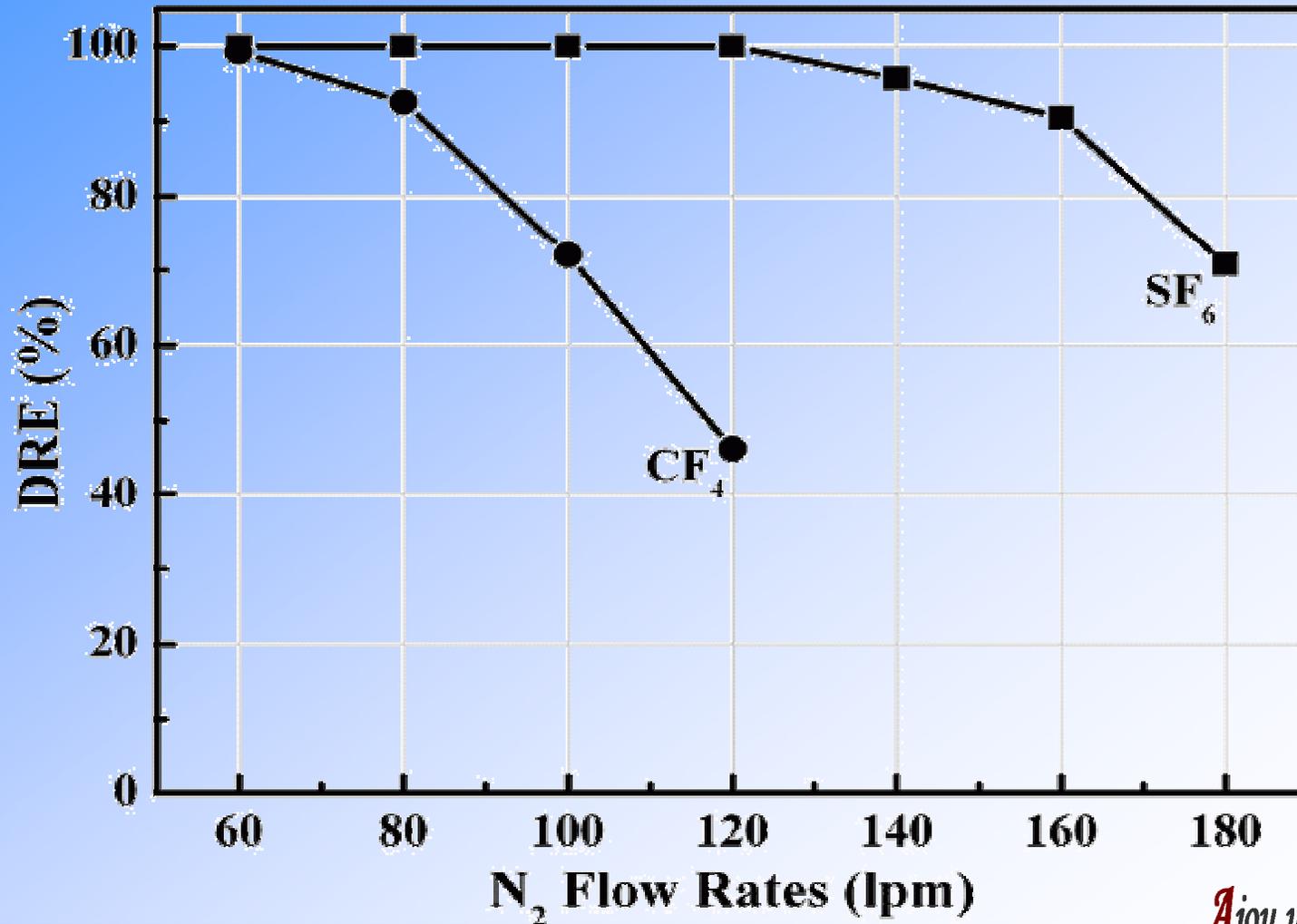
Various Nano Particle Synthesis

e.g.: Carbon Nano Tubes

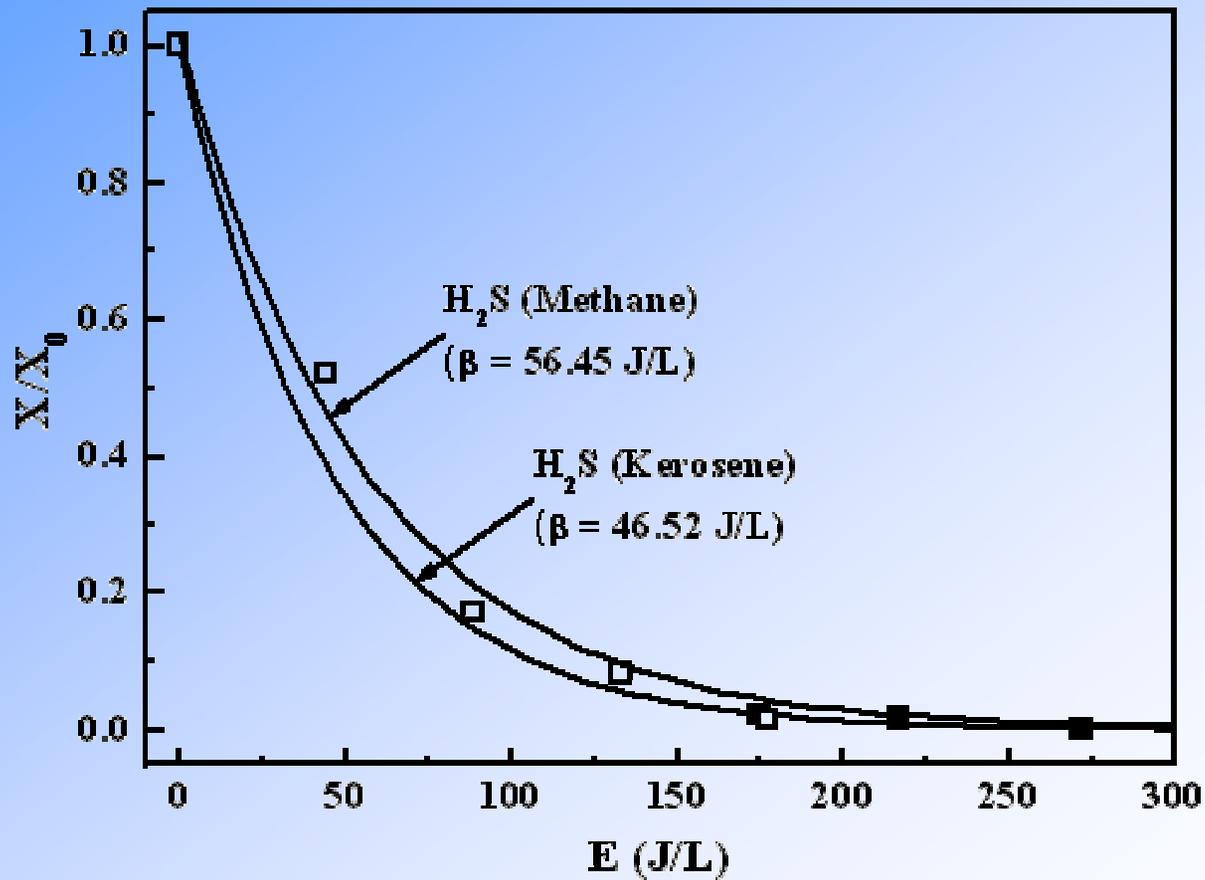


Application to Semiconductor Industry

PFC (CF₄, SF₆, etc) Elimination



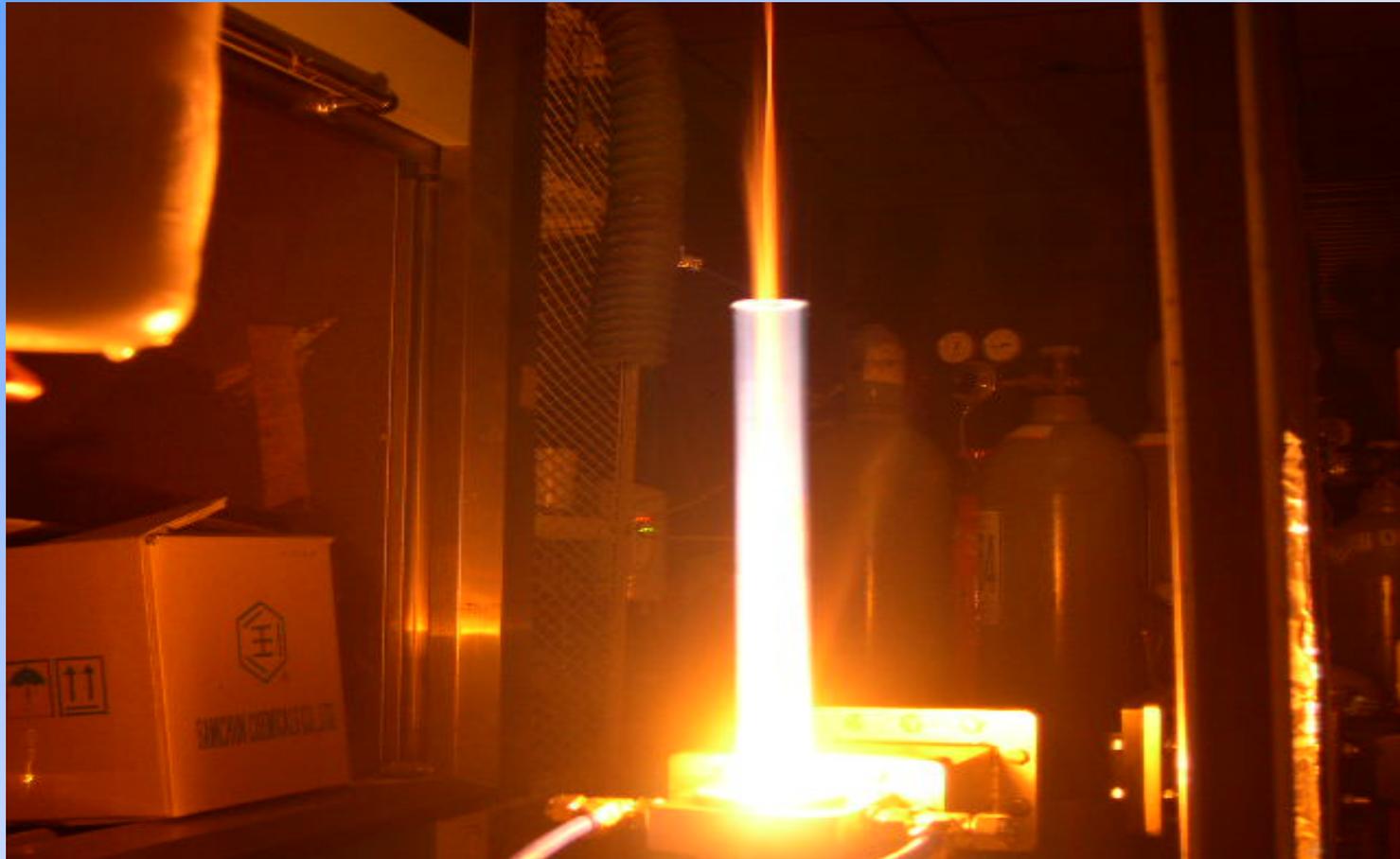
Emission Control Clean Air



Application to Energy

(Perfect Burner, Water Fire, Hydro Produc etc)

WF: Against 陰陽五行 (金 > 木 > 土 > 水 > 火 > 金)



Sterilization and Decontamination

- Control disease and pest in agriculture crops
- Prevent the spoilage of products and prolongation of shelf life
- Prevent disease in livestock industries
- Prolongation of seafood by EOW ice
- Cleaning Food
- Useful in hospitals or other germ-infested areas for disinfections

Plasma Medical Tools Dental and Surgical Tools, etc

