Chemical Safety (II)

Nanosafety, Waste Management & Emergency Response

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Health, Safety and Environment Office (HSEO)

HKUST

Important Reminder

Safety training courses provided by HSEO only cover BASIC safety principles. Your supervisor is responsible for your job-specific safety training, including operational safety procedures, departmental safety policies, etc.

Presentation Outlines

- Nanomaterials and nanosafety
- Chemical waste legal requirements
- HKUST chemical waste procedures
- Incidents and lessons learned
- Waste minimization
- Hazardous Material Inventory
- Emergency response
- Information Source

Nanomaterials & Nanosafety

Different Nano-Related Materials

- Materials with engineered nanostructure, e.g. zeolite with designed pore features
- Silicon-based nanomaterial or nanostructure, e.g. nanoelectronics
- Nanomaterials with one dimension not in nanoscale (i.e. >100 nm), e.g. nanotube
- Nanoparticles (diameter <100 nm)

Origins of Nanoparticles

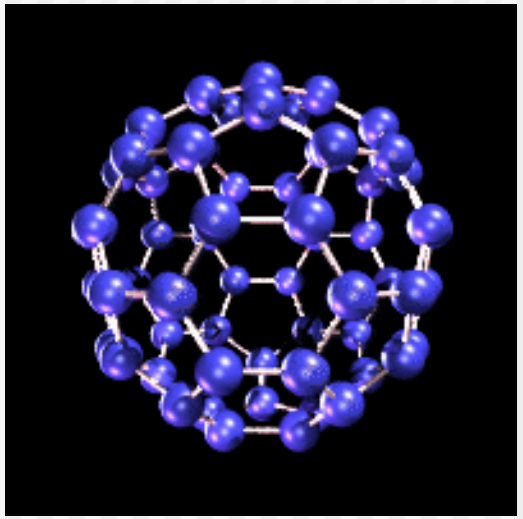
- Naturally occurring, e.g.volcanic activities, wild fires
- Anthropogenic incidental nanoparticles, e.g. engines, incinerators
  - Also known as ultrafine particles, <100 nm in AED
- Engineered nanoparticles
  - At least one dimension <100 nm
  - Relatively uniform in size, monodispersed

Unique Properties of Engineered Nanoparticles

- Novel physicochemical properties not found in parent materials
- Much higher reactivity, both chemical and biological
- Precisely designed molecules for specific purposes

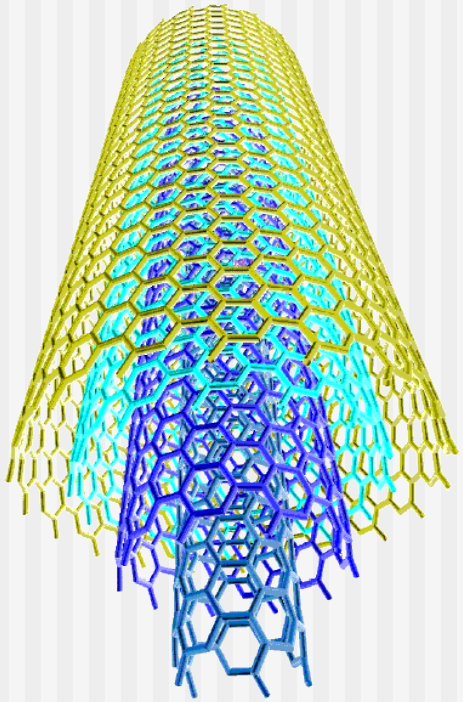
Buckyballs (C_{60})

- Extremely stable
- Can trap other atom or molecule inside
- Possible application
  - Superconducting material
  - Drug delivery system
  - Lubricant
  - Catalyst



Carbon Nanotubes

- Field emitters in flat plane display
- 100X strength, 1/6 weight of steel, mechanically stronger materials
- Ultra-miniaturized electronics, one candidate of nonsilicon microchips

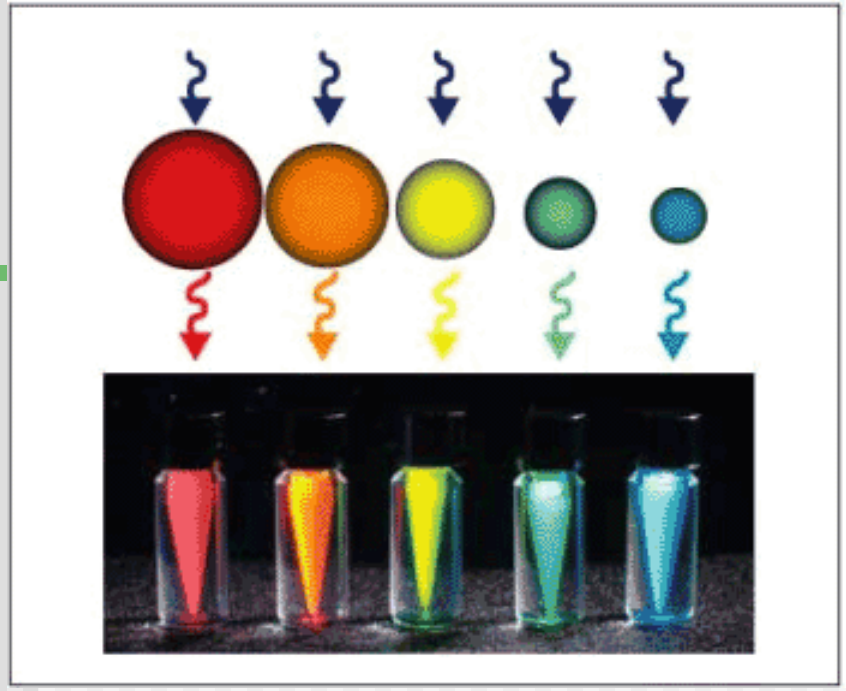


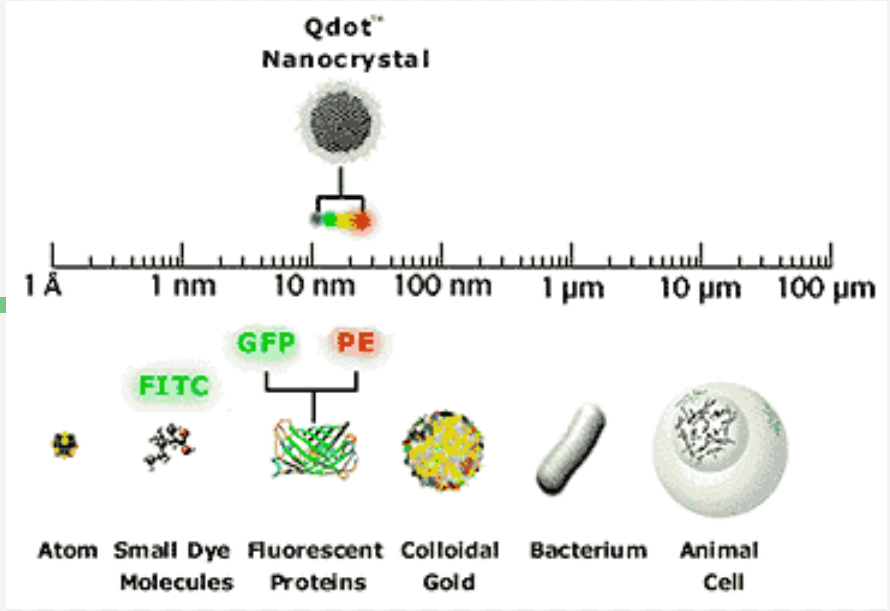
Metal and Metal Oxide Nanoparticles

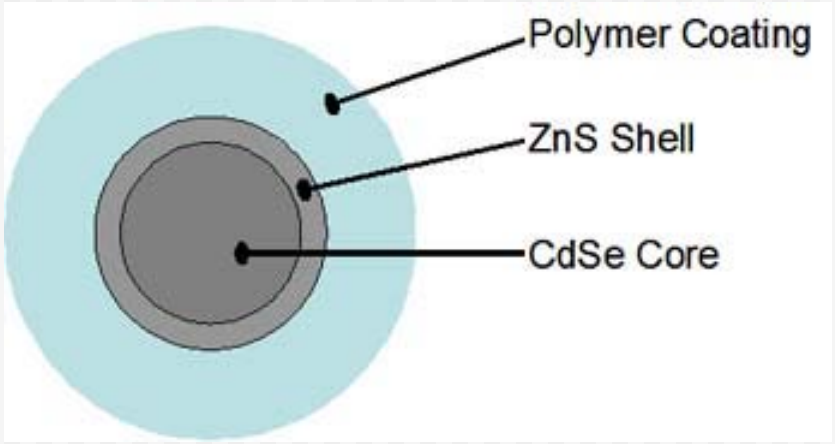
- TiO_2 for photochemical oxidation, self-cleaning paints, etc
- ZnO in cosmetics, sunblock
- Fe for oxidation of contaminants in groundwater
- CuO for antimicrobial agent
- Fe_2O_3 as contrast agent for MRI

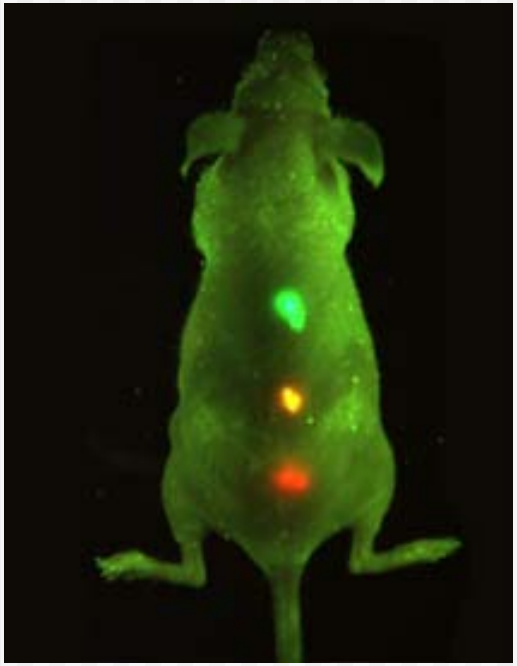
Quantum Dots (Q-Dots)

- Nanoparticles of semiconducting materials
- Size so small it interfere with quantum behavior of atoms
- Display tunable absorption and emission spectrum over visible wavelength
- Strong potential for medical imaging
- CdSe core with ZnS Shell




Qdot™
Nanocrystal
1 Å
1 nm
10 nm
100 nm
1 µm
10 µm
100 µm
FITC
GFP
PE
Atom
Small Dye Molecules
Fluorescent Proteins
Colloidal Gold
Bacterium
Animal Cell


Polymer Coating
ZnS Shell
CdSe Core



Biological Effects

- Ultra small size
  - Easy penetration
  - Fast distribution
  - Direct interaction with organelles
- Huge surface areas
  - Increased chemical activities (catalyst)
  - Increased biological activities

Two-Sided Sword

- Beneficial uses
  - Diagnostic (imaging, sensor)
  - Therapeutic (drug delivery)
  - Biomedical research
- Adverse health effects
  - Rapid uptake thru skin & epithelial cells
  - Translocation along neurons
  - Novel or amplified toxicity
  - Oxidative stress

Preliminary Toxicological Data

- Buckyballs caused lipid peroxidation in fish brain at 500 ppb for 48 hr
- Nanosize TiO_2 toxicity increased, proportional to surface area
- SWNT causes oxidative stress: free radical formation, depletion of antioxidants
- Metal impurity may also add toxicity
- Physical dimensions of some NT may cause pulmonary fibrosis and cancer similar to asbestos

A Series of Concerns

- Research safety
- Occupational safety
- Consumer safety
- Environmental impact

Nanoresearch at HKUST

Fullerenes Generation by Arc Discharge

Reaction Chamber

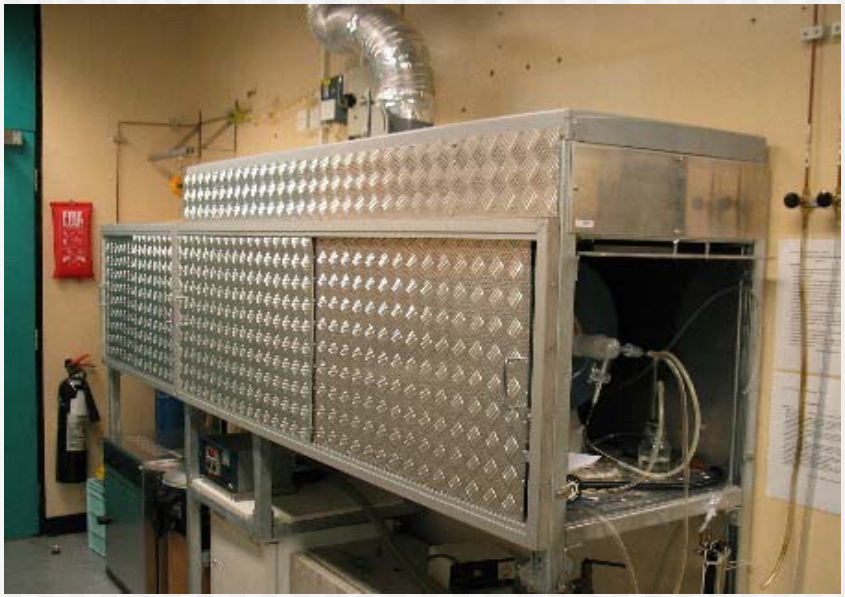
Graphite Rods and Powder

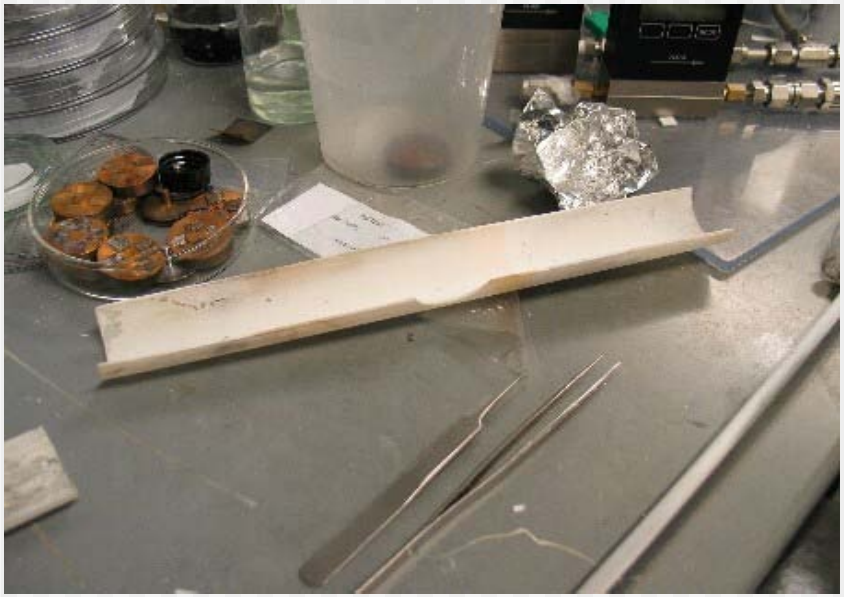
Purification of Fullerenes

Derivatization of Nanofiber

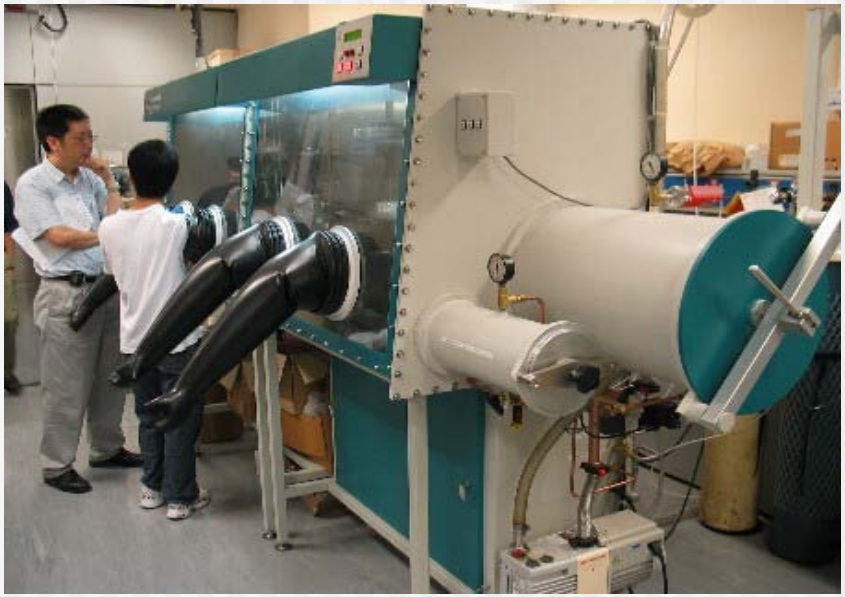
Carbon Nanotube by Chemical Vapor Deposition

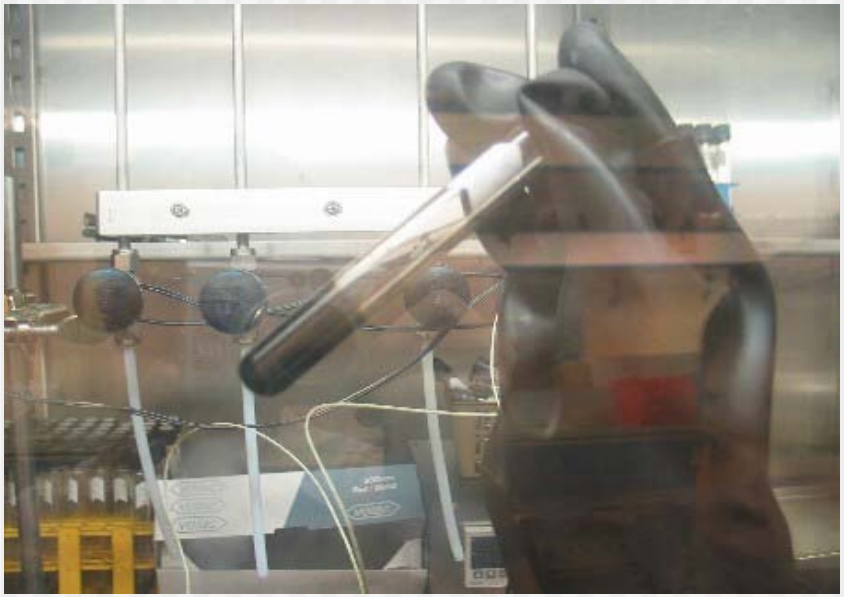
Nano-sized Zinc Oxide





Iron Platinum Nanoparticles

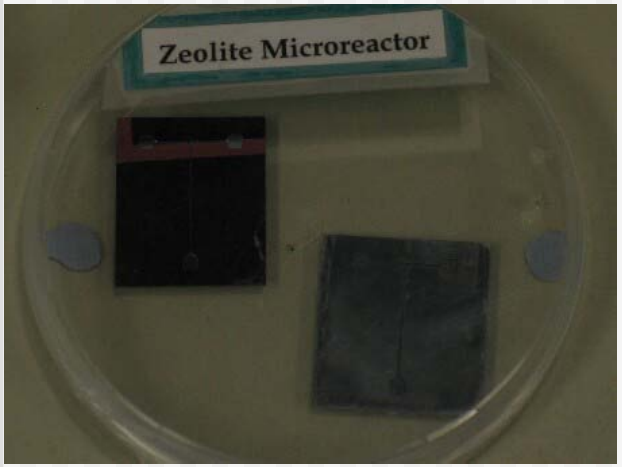




Synthetic Zeolite

- Hydrated alumino-silicate, porous material
- Both natural and synthetic
- Porous structure allow interesting chemistry
- Synthesis can be fine-tuned to produced desired nanostructure
- Potential applications as catalyst, fuel cell etc

Synthetic Zeolite

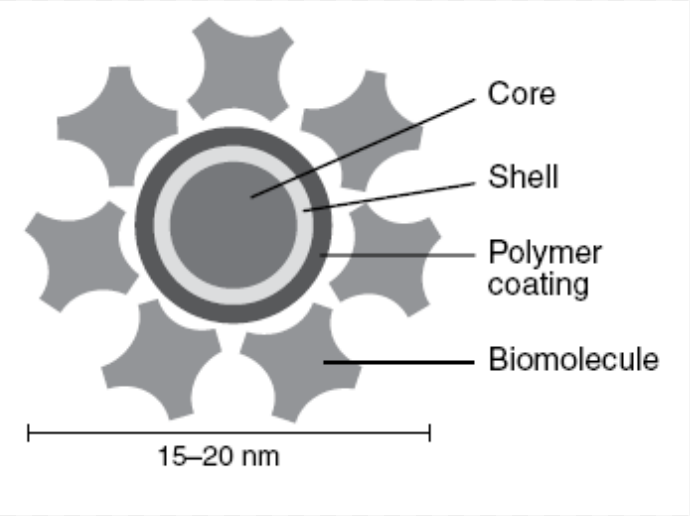


Other Nanomaterials

- Nano-Composites
  - Nanosized material e.g. $CaCO_3$ added to polymer as filler
  - Carbon nanofiber added to polymer to increase strength
- Silicon Nanowire
  - Silicon nanowire grown on substrate
  - Process under vacuum

Quantum Dots

- Quantum Dots conjugate used as fluorescence label
- Xenopus muscle cells grown on circular coverslip
- Advantage: Qdot does not “bleach” over time like traditional fluorescence



http://probes.invitrogen.com/products/qdot/overview.html

Elements of Nanosafety Program at HKUST

Nano, or Otherwise...

Scope of Nanosafety Program

- Nanoparticles (d<100 nm) & nanomaterials with one extended dimension, e.g. nanotube, nanowire, nanofiber
- Nanocomposite, e.g. $CaCO_3$/PP composite
- Materials with engineered nanostructure, e.g. zeolite with designed nano-size pores
- Silicon-based nanostructure, nanoelectronics
- Nano-enabled products
- “Nano-stuff”

Preliminary Nanosafety Program at HKUST

- Safety input to Nanolab facility
- Nanosafety in research proposal review
- Nanomaterial database
- Assessment of exposure potentials
- Nanosafety training and chapter in Safety Manual
- Precautionary measures
- Monitoring of nano-EHS development

Precautionary Measures for HKUST Researchers

- Mainly for engineered nanoparticles
- Key references
  - *Approaches to Safe Nanotechnology: An Information Exchange with NIOSH.* National Institute for Occupational Safety and Health, July 2006.

    http://www.cdc.gov/niosh/topics/nanotech/safenano/pdfs/approaches_to_safe_nanotechnology_28november2006_updated.pdf
  - *Nanoscience and nanotechnologies: opportunities and uncertainties*. The Royal Society & Royal Academy of Engineering, July 2004.

    http://www.nanotec.org.uk/finalReport.htm

Precautionary Measures—Risk Assessment

- Nanomaterials possess unique physical chemical properties, should be considered as “new chemicals”
- Treat as potentially hazardous
- MSDS of raw material can only be viewed as a starting point at best
- Carbon: practically non-toxic; buckyballs: oral LD_{50} 300 mg/kg

Precautionary Measures—Airborne Particles (1)

- Avoid aerosol generation
  - Many NPs generated in labs under contained conditions
  - NPs tend to agglomerate
  - However, many attempts to disperse NPs for various applications
- Suspended fine powder can become a fire and explosion hazard
- Do not allow escape into environment
- Intentional release into environment must show benefits clearly outweighing risks

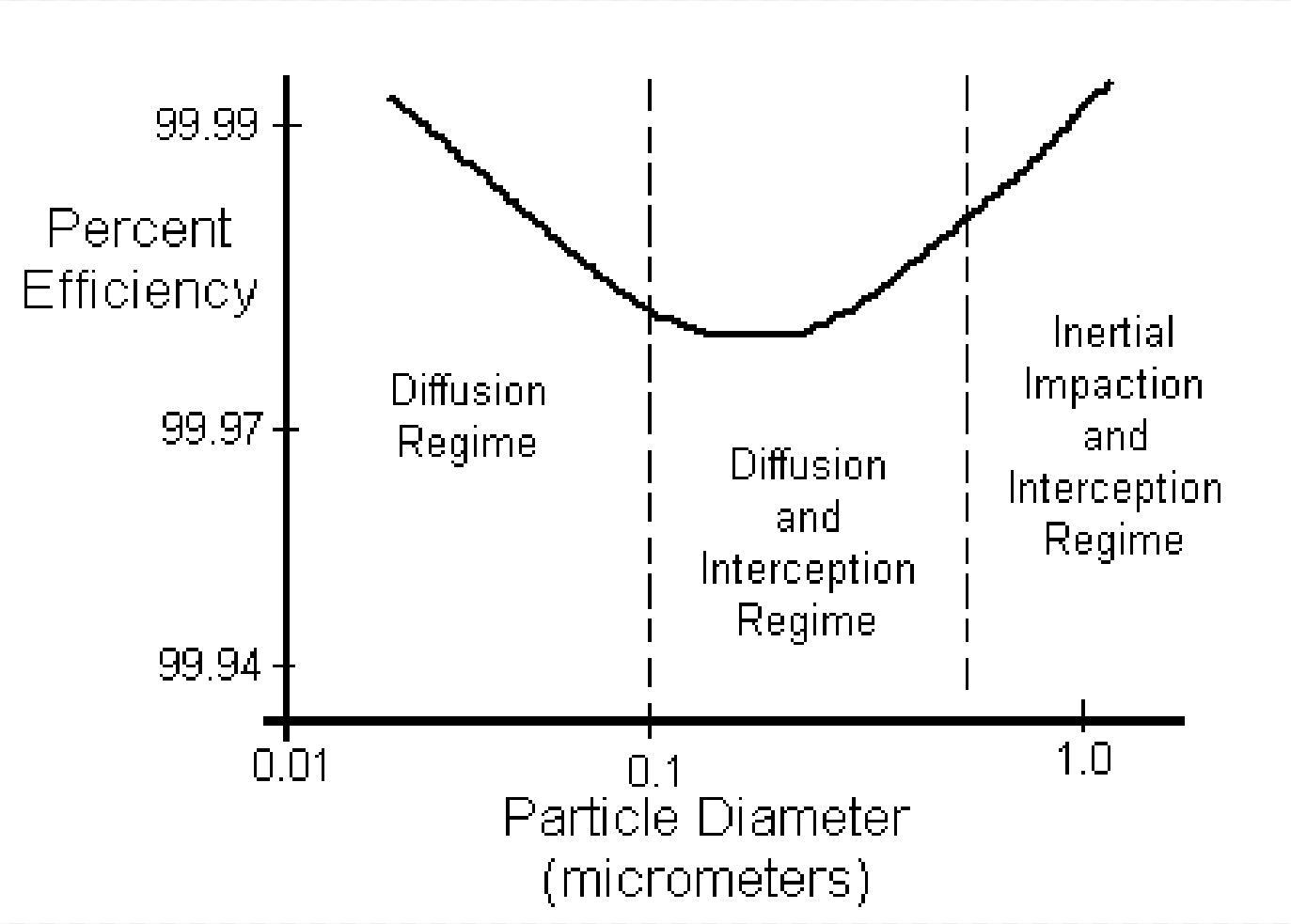
Precautionary Measures—Airborne Particles (2)

- Use local exhaust ventilation
  - Fumehood
  - Biological safety cabinets
  - Pharmaceutical hoods
- Use HEPA
  - Air treatment
  - Protection of personnel

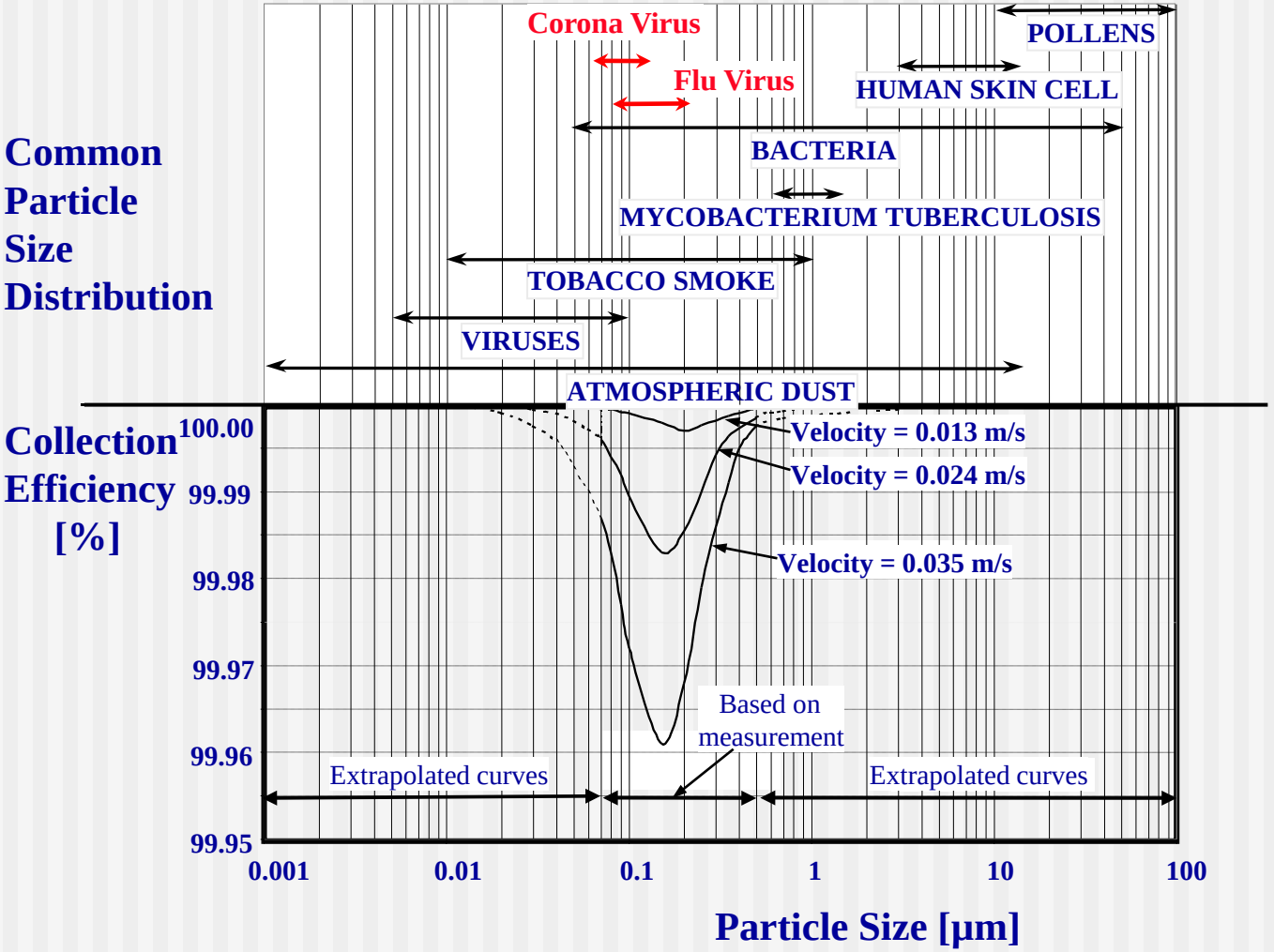
Can HEPA Filter Capture Nanoparticles?

- Theoretically efficiency increase with decreasing size below 0.1-0.3 μm
- Previously confirmed by data point down to 0.01 μm (10 nm)
- Recent study by U Minn confirmed HEPA filtration efficiency down to 2-4 nm, no thermal rebound observed
- Nanoparticles tend to agglomerate, instead of existing as single particles

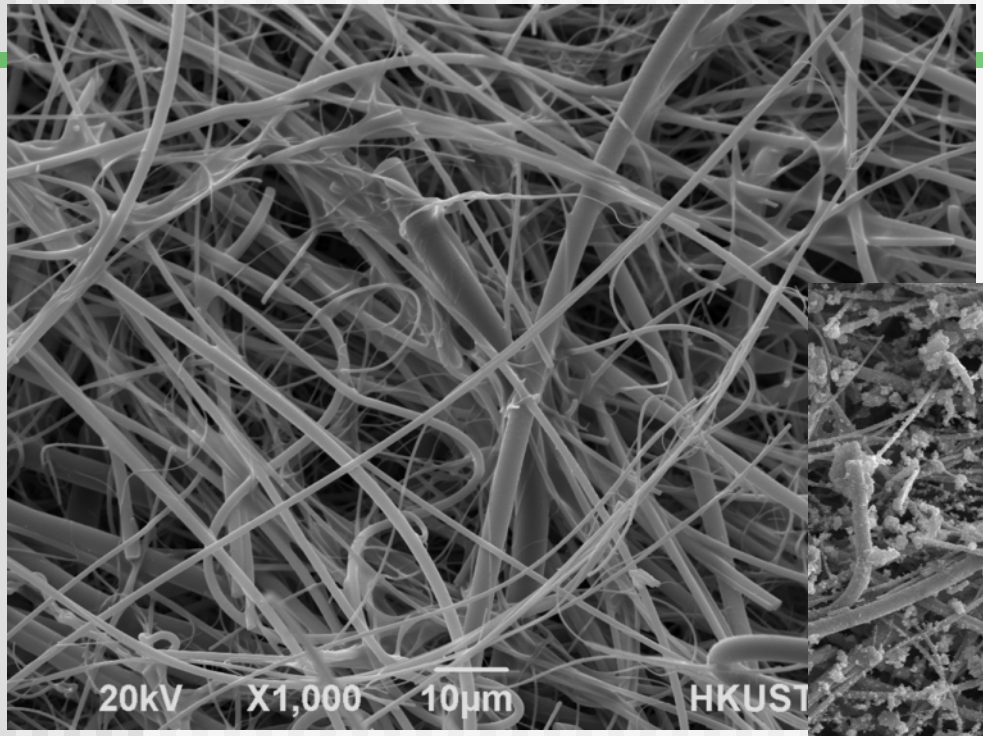
Particle Size and Filtration Efficiency



HEPA Filtration Efficiency

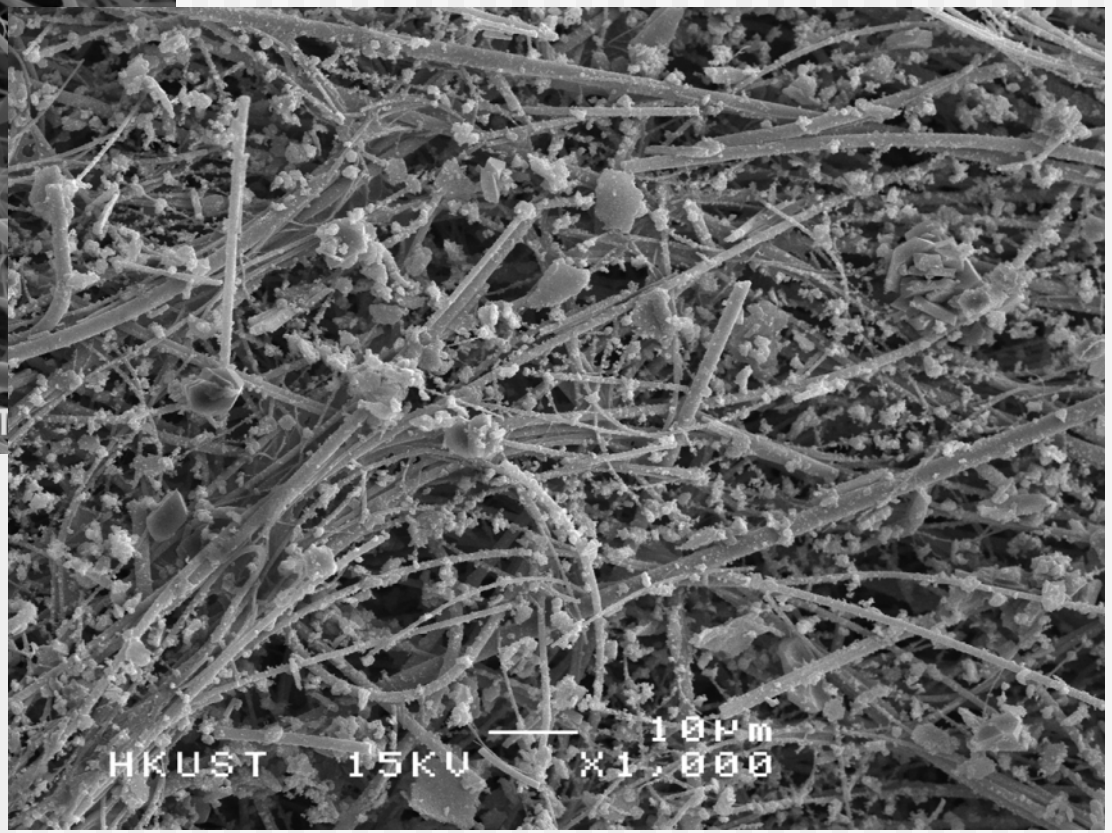


SEM of Fibrous Filter 1000 x

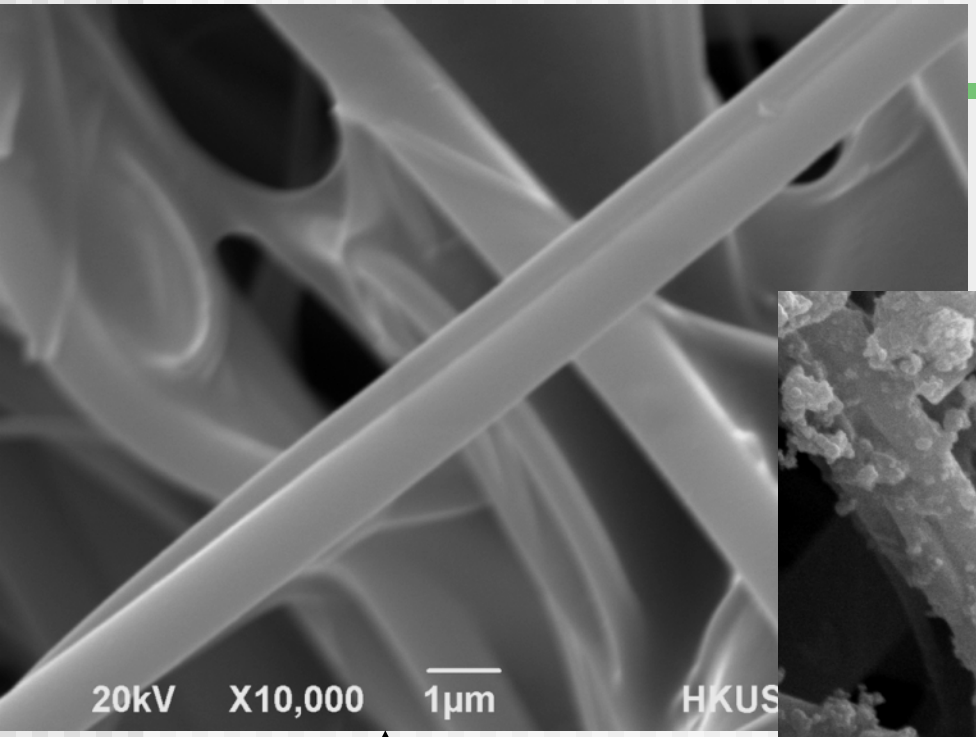


New Filter

Used Filter

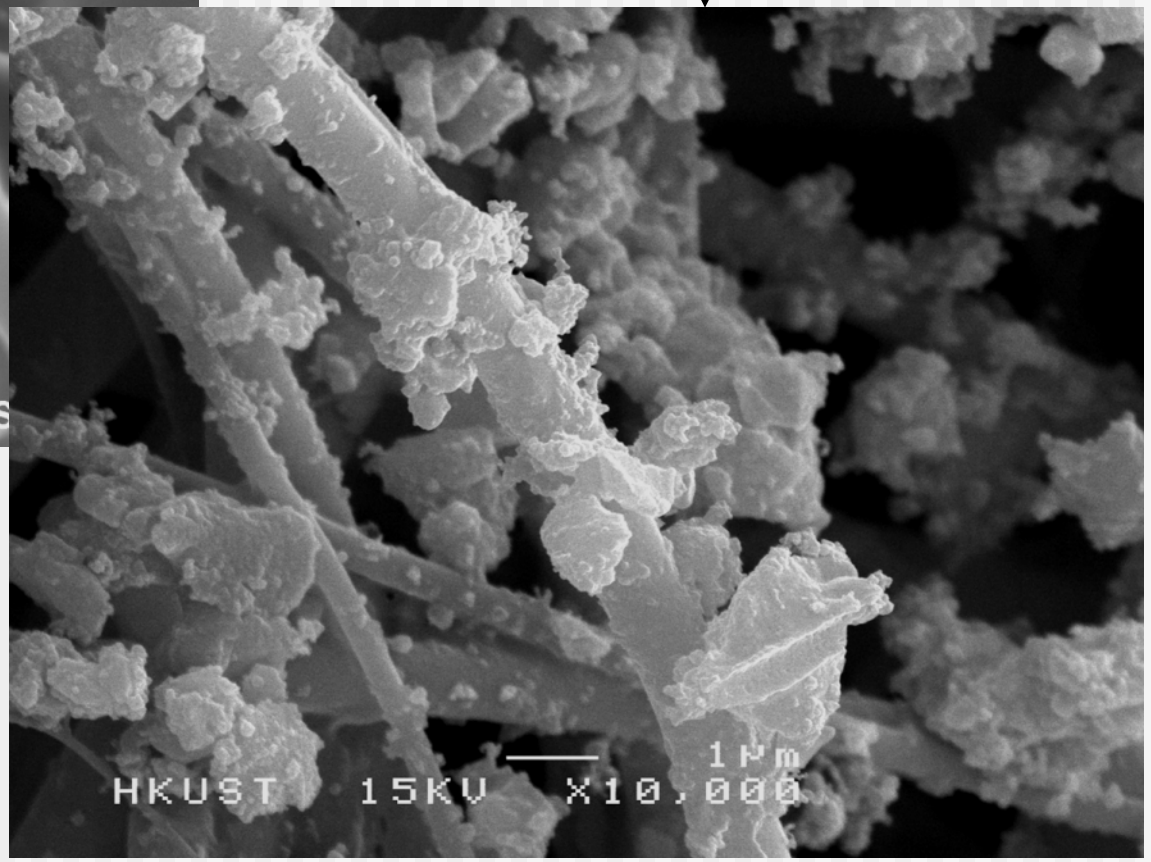


SEM of Fibrous Filter 10000 x



New Filter

Used Filter



Precautionary Measures—Liquid Solution/Suspension

- Avoid aerosol generation
- Avoid skin contact
- Use gloves at least protective against carrier solvent
- Do not allow escape into environment
- Intentional release into environment must show benefits clearly outweighing risks

Precautionary Measures—Waste Disposal

- Treat as chemical waste as a minimum
- Seek to remove from waste stream or destruct nanofeature as far as practicable

Quantum Dots Toxicity

- "We have not investigated the toxicity of the Qdot® streptavidin conjugate. The materials are provided in a solution which is ~2 mM total Cd concentration; however, the CdSe core is encapsulated in a shell of ZnS and the polymer shell, which may prevent dissolution of free Cd. We have demonstrated the utility of these materials in a variety of live-cell in vitro labeling experiments, but do not have systematic data investigating the toxicity of the materials to humans, to animals, or to cells in culture."

Source: Qdot Streptavidin Conjugates User Manual, Intrivogen

Quantum Dots Disposal

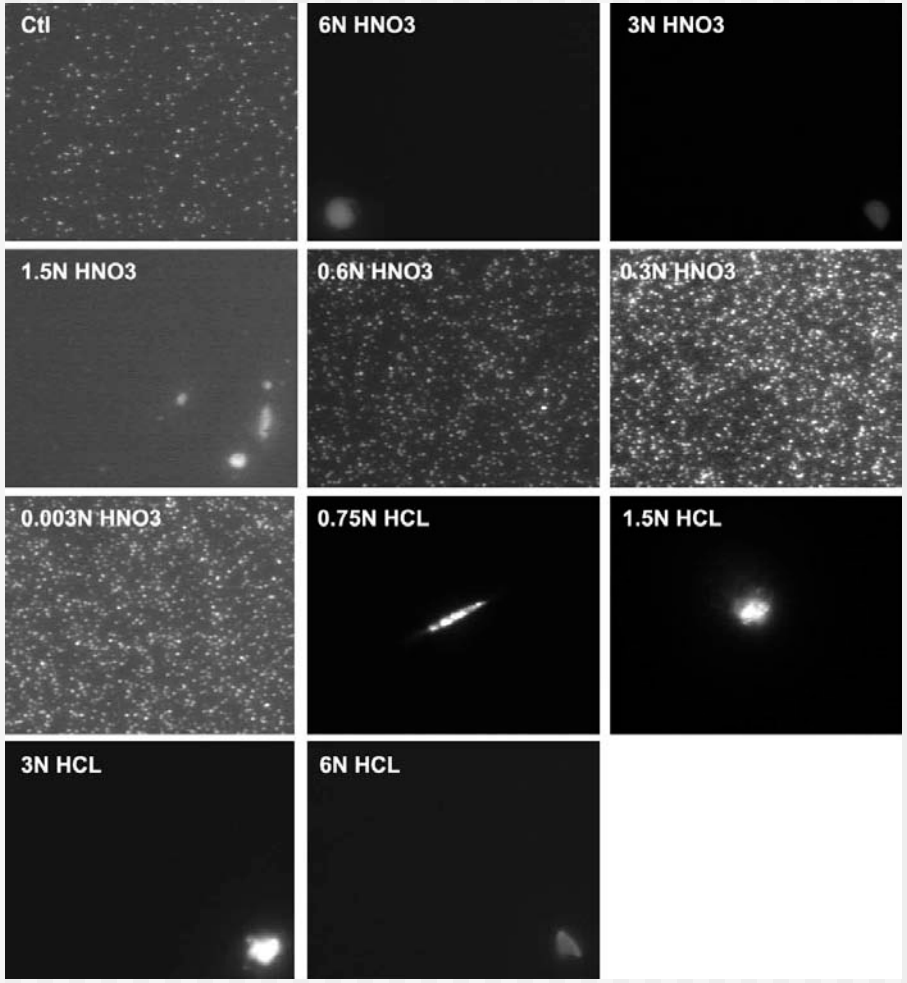
- "The Qdot® conjugate contains cadmium and selenium in an inorganic crystalline form. Please dispose of the material in compliance with all applicable local, state, and federal regulations for disposal of these classes of material. For more information on the composition of these materials, consult the Material Safety Data Sheet."

Source: Qdot Streptavidin Conjugates User Manual, Intrivogen

Qdot Destruction Experiment

- Tried different concentrations of HCl and HNO_3 to dissolve Qdots
- Use fluorescence wavelength under microscope to verify destruction
- May need to use TEM as confirmation
- Disposed as waste metal solutions may not destruct nano-feature

Acid-Treated QDot Solution



Precautionary Measures—Minor Spill Response

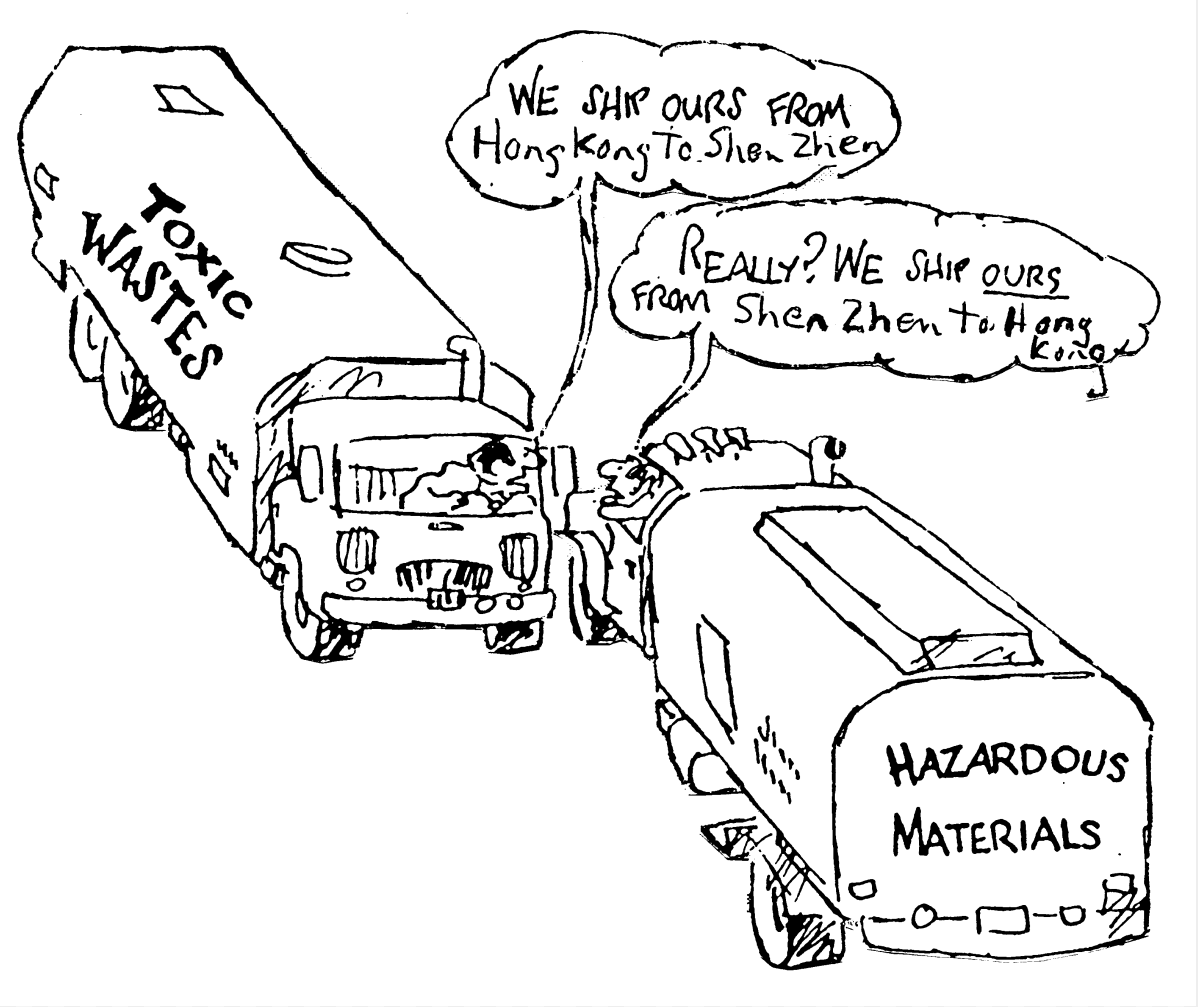
- Treat as hazardous material spill
- Evacuate area, wait 20 minutes to allow aerosols to settle
- Don respirator, gloves and coverall
- Remove spilled dry nanomaterials by HEPA vaccum cleaner
- Use normal sorbent materials for spilled liquid containing nanomaterials
- Contact HSEO for major spill

Legal Framework for Chemical Wastes

What Is Hazardous Waste?

- Chemical wastes
- Biological/infectious wastes
- Medical/clinical wastes
- Radioactive wastes
- Co-contaminated wastes

A Wrong Way to Deal with Hazardous Waste



Chemical Waste Regulations in HK

- Waste Disposal (Chemical Waste) (General) Regulations of 1992
- Set up a waste treatment facility
- Prohibition of disposal into sewer
- Registration of waste generators
- Packaging, labeling and storage of chemical waste
- Documented collection and disposal scheme

Penalties for Chemical Waste Violations (1)

Section of the Regulation	Offence	Maximum Penalty
6	Failing to register as a waste producer	$200,000 plus 6 months imprisonment
8	Failing to arrange for proper disposal of waste	$200,000 plus 6 months imprisonment
9-11, 13-15	Failure to comply with waste packaging & storage requirements	$100,000 plus 6 months imprisonment

Penalties for Chemical Waste Violations (2)

Section of the Regulation	Offence	Maximum Penalty
12, 18	Failure to comply with labeling and warning requirements	$50,000 plus 6 months imprisonment
37	Furnishing false information	$200,000 plus 6 months imprisonment
17	Failure to notify in relation to "Part A" waste or to comply with any given directions	1st offence - $50,000 2nd offence - 100,000 plus $500/day

Legal Definition of Chemical Waste

- Chemical Waste is legally defined by reference to a list of substances and chemicals in Schedule 1 of the Waste Disposal (Chemical Waste) (General) Regulation enacted 18 March, 1992.

Items Not Considered to be Chemical Waste

- Dilute acids and alkalines, if % by weight is less than figures in Appendix A of “A Guide to the Chemical Waste Control Scheme”, HKEPD, Sep 1992.
- Neutralized salts, not listed in App A.
- Elemental metals, not listed in App A (e.g., Copper, Iron, Tin, Zinc).
- Household chemicals used in labs.
- Apparatus rinsing water or wiping tissue.

HKUST policy and program

HKUST Safety and Environmental Policy

…The University will assume all reasonable directives possible to protect its appointees, students, facilities, and the environment, placing priority emphasis towards…

…Proper and safe procedures for the use, handling, storage, transport, and disposal of articles, hazardous materials and waste…

Chemical Waste Management at HKUST

Waste Generators are responsible to:

- Request the correct waste container from HSEO.
- Safely put their waste into the waste container.
- Fill out the Chemical Waste Log Sheet.

Chemical Waste Management at HKUST

Waste Generators are responsible to:

- Segregate waste materials in the laboratory.
- Safely and properly store and maintain all waste within the laboratory.
- Request collection of waste by HSEO.

Chemical Waste Management at HKUST

HSEO is responsible to:

- Provide waste containers and technical assistance to waste generators at HKUST.
- Transport waste from laboratories to the waste accumulation area.
- Manage the HKUST waste accumulation area.

Chemical Waste Management at HKUST

HSEO is responsible to:

- Prepare hazardous waste for pickup and disposal by the waste contractor.
- Maintain HKUST hazardous waste records.
- Liaise with Environmental Protection Department and Enviropace on hazardous waste issues.

Chemical Waste Collection Annual Summary		
Year	Quantity of Chemical Waste	
	Liquid (L)	Solid (pack)
1994 (Jul-Dec)	2,380	81
1995	10,530	113
1996	14,580	43
1997	20,830	30
1998	28,100	36
1999	29,180	37
2000	28,680	38
2001	31,520	23
2002	41,600	104
2003	38,280	237
2004	40,360	92
2005	33,140	52
2006	42,700	48
2007	35,740	30

Chemical waste streams

Three Main Types

- Liquid Chemical Waste picked up by Enviropace
- Lab Pack Waste picked up by Enviropace
- Solid Chemical Waste disposal arranged by HSEO

Enviropace Chemical Waste Streams (1)

- Halogenated Organic Solvents
- Non-halogenated Organic Solvents
- Organic Acids
- Inorganic Acids
- Hydrofluoric Acid
- Metal Solution
- Chrome (VI) or Boron

Enviropace Chemical Waste Streams (2)

- Alkalines
- Cyanides
- Lubricating Oil
- Photographic Film Fixer/Developer
- Gel Waste
- Phenol Sludge
- Metal Sludge
- Rags with Solvent and Oil

Chemical Waste Mixtures

- Select the container according to the MAJOR component of the mixture.
- Exceptions:
  - Always put halogenated compounds in the “Halogenated Solvents Container”
  - Always put cyanide waste into the “Cyanide” container (Always maintain alkaline, pH>7, to avoid HCN formation)

  even if these are the minor component in the mixture.

Different Chemical Waste Containers

- **Plastic** (Acids and Alkalies, Fixer/Developer
- **Carbon Steel** (Lube Oil, Other Oils)
- **Metal with inner plastic lining** (Halogentated & Non-halogenated Solvents)
- **Plastic, Open top** (organic gel)

Required Information on Waste Containers

- Waste generator name and phone number
- Waste stream name
- Standard Waste Label with Hazard Warning Symbol(s)
- A Waste Log Sheet in a plastic folder (for applicable waste streams)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CHEMICAL WASTE
CORROSIVE
IA980407/A

Hazard Symbols on Chemical Waste Labels

Intermediate Waste Containers

- Intermediate waste containers must be clearly labeled (waste stream, responsible person, contact)
- Containers that receive multiple sources of waste must have a log
- Same handling procedures, including logging and compatibility testing
- If empty reagent bottles are used, they must be thoroughly cleaned

Chemical waste procedures

Waste Handling Safety Precautions

- Carefully inspect each container for broken handles or leaks before use.
- Use appropriate personal protective equipment: splash-proof goggles, face shield, gloves, lab coat, respirator, etc.
- Use a fume cupboard for waste with hazardous or odorous vapors.
- Close container tightly after transfer.
- Be careful handling full containers.

Waste Handling Procedures

- Always check liquid level before adding new liquids.
- Perform compatibility test before adding new liquids.
- Fill container to no more than 75% of full capacity.
- For large volume transfers, use funnel.
- Fill in the chemical waste log sheet immediately.

Compatibility Test Procedures (1)

- Performed inside a fume cupboard, by an experienced person.
- Fume cupboard must be functioning properly.
- Transfer 50 mL existing waste from target container to beaker.
- Place thermometer into beaker.
- Slowly mix in new chemical waste, to the estimated volumetric ratio.

Compatibility Test Procedures (2)

- If bubbling, fuming, or a temperature increase of >10^{o}C occurs, stop mixing, the wastes are INCOMPATIBLE.
- If no observable reaction occurs within 5 minutes, the wastes are COMPATIBLE.

Chemical Waste Log Sheet

- Use a dark color permanent ink pen (not pencil, or water-based ink).
- Use chemical names of reagents and waste (full name in block letters, not abbreviations).
- Include the volume of waste being transferred.
- Estimate the percentage of mixture components.

The Hong Kong University of Science & Technology

Chemical Waste Log Sheet

C.W. P. Reg. No.: 9311-831-T2006-01 SEPO No.:_____

Waste Type: _____ CWTF-ID:_____

Department: _____ Room No.:_____ Contact Person: _____ Ext: _____

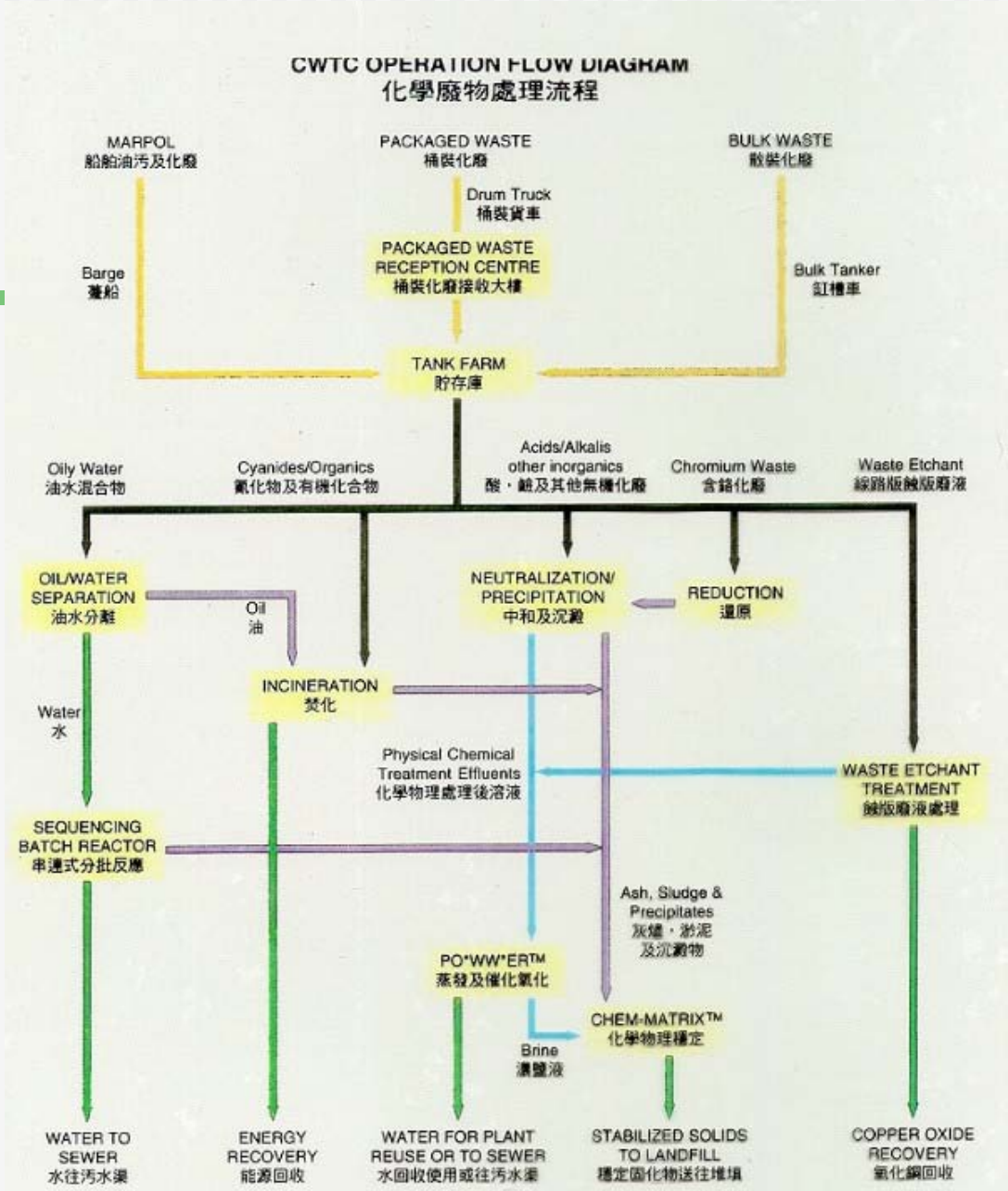
Date (DD/MM/YY)	Name of Reactant/ Product/ Waste (Full Name in Block Letter)	Quantity	Producer's Name	Phone No.

Why is Chemical Waste Log Sheet Important?

- Requirement of Enviropace: “Every waste entering into a chemical waste container must be properly logged. The filled log sheet must accompany the container at the time of collection by Enviropace. Enviropace will refuse collection of containers that do not carry a legible log sheet.”

Why is Chemical Waste Log Sheet Important?

- To comply with the “Code of Practice on the Packing, Labelling and Storage of Chemical Wastes” issued by the HK Environmental Protection Department.
- To provide information to Enviropace on the treatment of received waste containers.
- To provide clues about the compatibility of chemical wastes in container.


CWTC OPERATION FLOW DIAGRAM
化學廢物處理流程
MARPOL
船舶油污及化廢
PACKAGED WASTE
桶裝化廢
BULK WASTE
散裝化廢
Drum Truck
桶裝貨車
PACKAGED WASTE
RECEPTION CENTRE
桶裝化廢接收大樓
Barge
駁船
Bulk Tanker
缸槽車
TANK FARM
貯存庫
Oily Water
油水混合物
Cyanides/Organics
氰化物及有機化合物
Acids/Alkalis
other inorganics
酸、鹼及其他無機化廢
Chromium Waste
含鉻化廢
Waste Etchant
線路版蝕版廢液
OIL/WATER
SEPARATION
油水分離
Oil
油
NEUTRALIZATION/
PRECIPITATION
中和及沉澱
REDUCTION
還原
INCINERATION
焚化
Water
水
Physical Chemical
Treatment Effluents
化學物理處理後溶液
WASTE ETCHANT
TREATMENT
蝕版廢液處理
SEQUENCING
BATCH REACTOR
串連式分批反應
Ash, Sludge &
Precipitates
灰燼、淤泥
及沉澱物
PO*WW*ER™
蒸發及催化氧化
CHEM-MATRIX™
化學物理穩定
Brine
濃鹽液
WATER TO
SEWER
水往污水渠
ENERGY
RECOVERY
能源回收
WATER FOR PLANT
REUSE OR TO SEWER
水回收使用或往污水渠
STABILIZED SOLIDS
TO LANDFILL
穩定固化物送往堆填
COPPER OXIDE
RECOVERY
氧化銅回收

Chemical Waste Storage

- Use a spill tray / secondary container for spill containment.
- Keep the waste log sheet current.
- Every storage area must have a proper chemical waste sign.
- Store flammable waste in a flammable cabinet wherever possible.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CHEMICAL WASTE
化學廢物

Chemical Waste Collection Procedures

- Use the HSEO web page, “Request for Chemical Waste Collection”.

  http://www.ab.ust.hk/hseo/sub-menu/waste.htm
- Waste collection service by HSEO is on Tuesday, or the next working day if Tuesday is a holiday.
- Users should make a pickup appointment if a collection site is unattended.

Lab-Pack Program

- Highly reactive chemicals, water reactive chemicals, including conc. strong oxidizing or reducing agents
- Waste that cannot pass the compatibility test
- Unwanted or expired chemicals
- Disposed of in original containers
- Valuable for labs, unfortunately program not running well due to cost

Current Lab Pack Practice

- Generator produce list of chemicals need to be disposed
- EPD/Enviropace review list then give advice:
  - Dissolve/dilute chemical then put in suitable liquid chemical waste stream
  - Put originally packaged chemical in specified standard waste container
  - Enviropace pick up in regular rounds

The Hong Kong University of Science and Technology
Safety and Environmental Protection Office
Labpack Waste (Unwanted / Expired Chemical) Form

Name of waste producer: Leo LEE Dept: AEMF Post: Senior Technical Officer

Tel: 8665 Room: 4230 E-mail: chlee@ust.hk

Name of supervisor: _____ Post: _____ Tel: _____ E-mail: _____

Waste location: 4229

Date (DD/MM/YY): 27/08/09

Chemical Name	Chemical Formula	Physical State (S/L/M)*	Container Size (ml)#	Container Type (G/P/M)^	Lid Type (G/P/M)	No. of Container	Total amount (Kg/Litre)	Remarks (e.g. safety precaution, condition of container)
Potassium Permanganate	$KMnO_4$	S	500	G	P	1	500g	
Potassium Permanganate	$KMnO_4$	S	1000	M	M	1	1 kg	

* S = solid, L = liquid, M = sludge # size of container holding chemical ^ G = glass, P = plastic, M = metal

Note (SEPO use only): _____

Date: 5/14/2009

Labpack Waste Profile - Reagents / Chemicals (WPS1)

Producer Name	The Hong Kong University of Science & Technology	CWPN	9311-831-T2006-01	Date	9/11/2009
Contact Person	Edmond CHENG	Phone No.	2358 6456	Fax No.	2335 0074
Title	Senior EHS Specialist	Fume hood available? (Yes / No	Yes	Email	edmondc@ust.hk
Producer Address	Clear Water Bay, Kowloon				
Work area description (e.g. ventilation)					

*** Physical State: S = Solid; L = Liquid; M = Mixed / Other (describe)**

**** Container / Lid Types: G = Glass; P = Plastic; M = Metal**

Item No.	No of Bottle(s)	Chemical Name	Chemical Formula	Physical State *	Container Size (ml)	Container Type **	Lid/Cap Type **	Weight (g) or Volume (ml)	Remarks (Container Conditions, Special Packing, etc)
1	41	Sodium Dichromate Dihydrate	Na2Cr2O7.2H2O	S	500	P	P	20.5 Kg	
2	1	Potassium Permanganate	KMnO4	S	500	G	P	500 g	
3	1	Potassium Permanganate	KMnO4	S	1000	M	M	1 Kg	
4	1	Bromine > 99%	Br2	L	250	G	P	250 mL	

COMPANY NAME : THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

COMPLETED

CWPN : 9311-831-T2006-01

WPS1 DATE : 11 September 2009

TOTAL ITEMS : 4

CHEMICAL ITEMS (PRODUCER TO NOTE / FURTHER ACTION)

REJECT DUE TO : N/A

PROVIDE MSDS OR CHEMICAL COMPOSITION : N/A

CHECK NAME : N/A

CHECK FORMULA : N/A

CHECK pH : N/A

CHECK PHYSICAL STATE : N/A

CHECK CONTAINER TYPE : N/A

EPD "PART A" WASTE : N/A

C&E "CONTROL SUBSTANCE" WASTE : N/A

CWPN: 9311-831-T2006-01

COMPLETED

2009/09/15
Page: 1

Labpack Waste Classification List - Matched

Waste Name	Waste Code	Ctnr Code	Color	Pre-Treatment	CWTFID	Item	Remark
UNWANTED BROMINE, LABPACK	L36	I x 1	GOLD6	MAKE SURE THE LID IS TIGHTLY ENCLOSED AND THE BOTTLE IS NO LEAKING. WRAP EACH BOTTLE WITH PLASTIC BAG AND PACK IN A CARTON BOX. PUT THE CARTON BOX INTO OUR 20-L PLASTIC PAIL FOR RECEIVING.	10247548	4	
SPENT OXIDIZER, ACIDIC, LAB	L48	A x24	GRAY	DISSOLVE & DILUTE W/ WATER INTO ~5% (i.e.-WASTE:WATER=1:20) AND THEN TRANSFER INTO OUR PAIL.	10195577	1	
SPENT OXIDIZER, ALKALI, LAB	L58	A x2	GRAY4	DISSOLVE & DILUTE W/ WATER INTO ~5% (i.e.-WASTE:WATER=1:20) AND THEN TRANSFER INTO OUR PAIL.	10195578	2 3	

tracking form

ITEMS MATCHED : 4

CONTAINER CODE :
A = 20L PLASTIC (CLOSED TOP) PAIL
B = 20L CARBON STEEL PAIL
I = 20L PLASTIC (OPEN TOP) PAIL
* = 20L PLASTIC PAIL IN 30L CARBON STEEL PAIL
J = 50L FIBRE DRUM
K = 100L FIBRE DRUM
P = PRODUCER OWN PAIL (<= 50L)
M = PRODUCER OWN PAIL (> 50L)

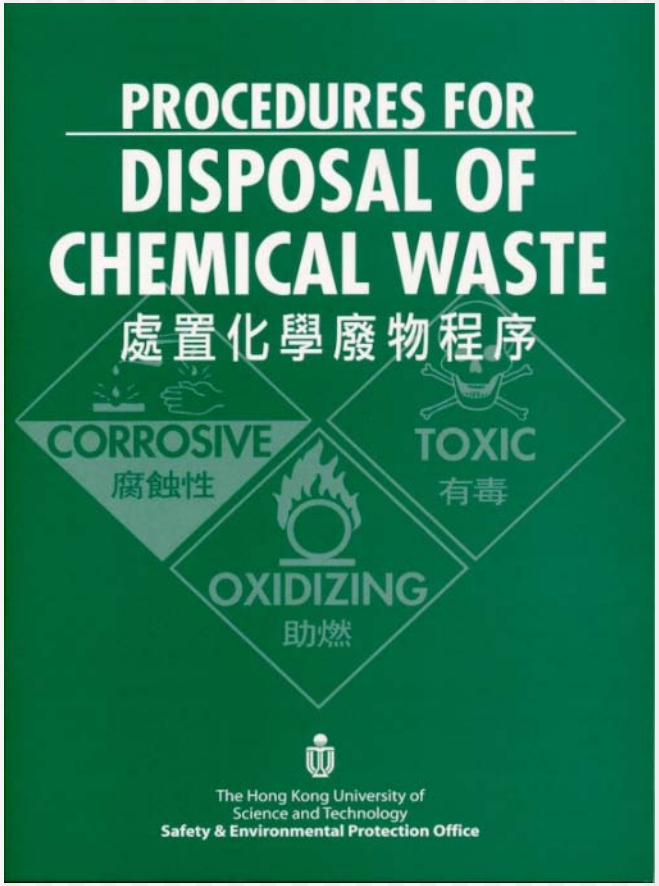
no rows selected

Solid Chemical Wastes

- Elemental mercury waste, periodically collected by Enviropace

  (Don’t use mercury thermometers!)
- Other solid chemical wastes, such as labware in contact with highly hazardous chemicals
- Special disposal arrangement through HSEO

Information on Chemical Waste Disposal



- Chemical waste lists
- Flowcharts to determine waste type
- Waste handling procedures
- Bilingual text
- http://www.ab.ust.hk/hseo/sub-menu/chem_waste.htm

Incidents & lessons learned

Case 1: Serious Injury

- Lab user wanted to dispose of several mL of conc nitric acid
- An empty reagent bottle intended to be used as intermediate container for non-halogenated solvent was used
- An explosion occurred several minutes after transfer and closing of the cap
- Serious injury to one hand of the user requiring surgery and hospitalization


Please fill in the log sheet after
dumping any organic waste.

Case 2: Serious Damage

- IC is regularly etched with conc acid, then wash with excessive solvent
- Mixed waste collected in a non-halogenated solvent
- Lab user added a large quantity of used acid into same container
- Container exploded causing extensive damage to cabinet and rest of the lab


MABLE
IRE AWAY

Case 3: Uncontrolled Release

- Lab user macerate silicon plastic with conc sulfuric acid
- Waste was put into spent acid container with other acids including nitric
- Fume was observed, lab user capped the container and left
- Container later ruptured shooting waste onto ceiling and surrounding areas

Lessons Learned

- Oxidizing (e.g. nitric) acid mixed with organics is the most common cause of chemical waste incidents
- Clean intermediate waste container thoroughly, if not sure, clean again
- Plan beforehand, especially for non-routine operation, may need to initiate a new waste stream

Lessons Learned

- Dilute conc acid (10 times) before transfer into waste container
- If fuming is observed after waste transfer, move the container into a running fume hood or open area
- NEVER CAP container with ongoing gas generating reaction inside
- Perform compatability test, NEVER mix incompatible waste!

Waste minimization

Waste Minimization

Users are encouraged to:

- Estimate usage rate carefully.
- Buy in container sizes appropriate to actual use. (Money savings from bulk purchases are easily consumed by the cost of waste disposal.)
- Reduce inventory to a minimum:

  (rotate old containers to front of shelf, review stock before purchase, etc.).

Waste Minimization

- Waste disposal costs are increasing. Recharge to waste generators in Hong Kong is current practice.
- Consider trading chemicals with other researchers before disposal.

Chemical Exchange Program

- Chemicals left after completion of projects
- Some are high quality chemicals in factory seals
- Give away free of charge
- Details in HSEO web page “Chemical Exchange Program”
- https://www.ab.ust.hk/wkx/kx_intro.html

Co-contaminated Wastes

- Chemical/Biological
  - Disinfect then treat as chemical waste
- Chemical/Radioactive
  - Treat as radioactive waste
- Biological/Radioactive
  - Chemically disinfect then treat as radioactive waste
- Do not autoclave waste with volatile organics or radioisotopes

Hazardous Materials Inventory System

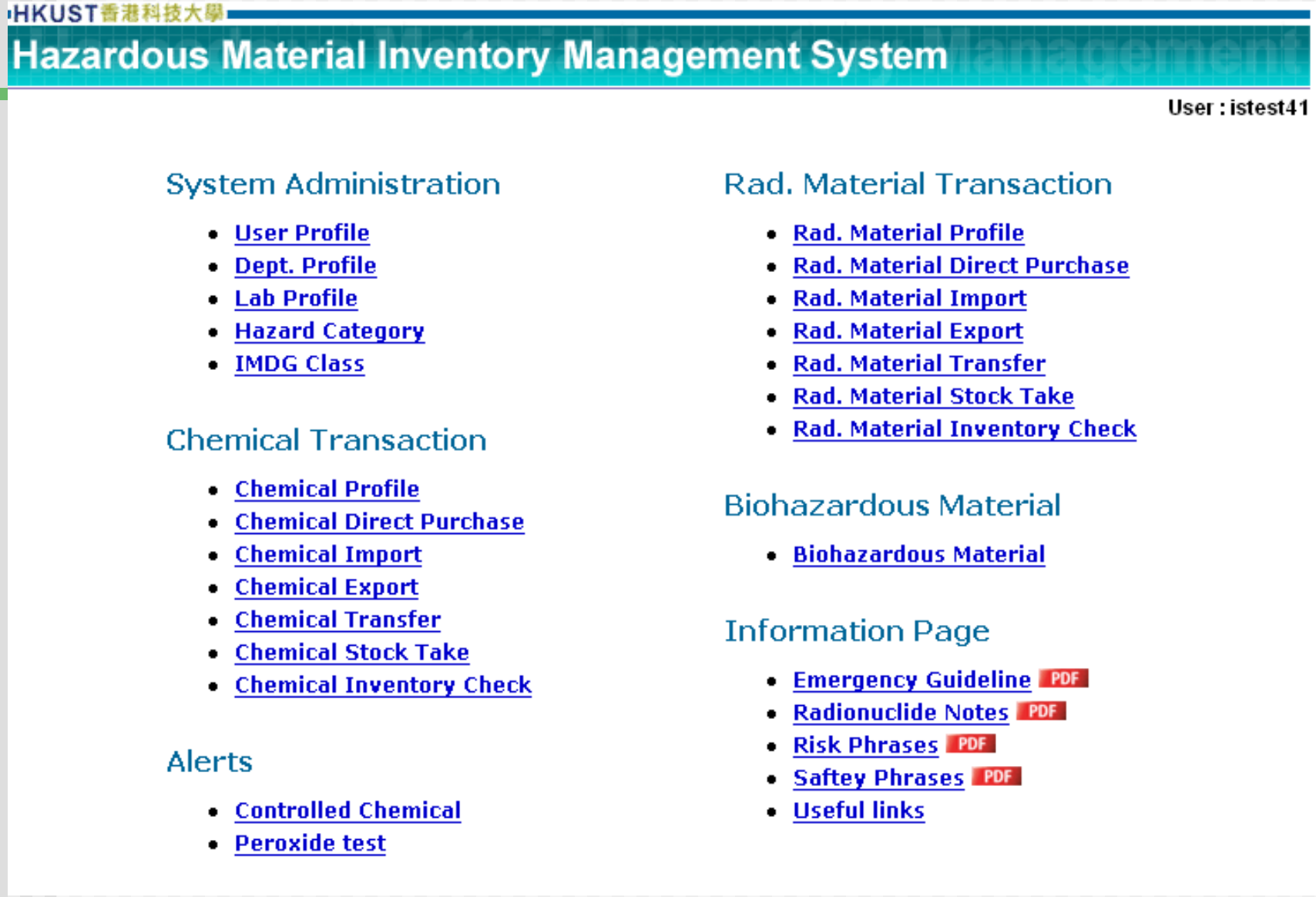
Purposes

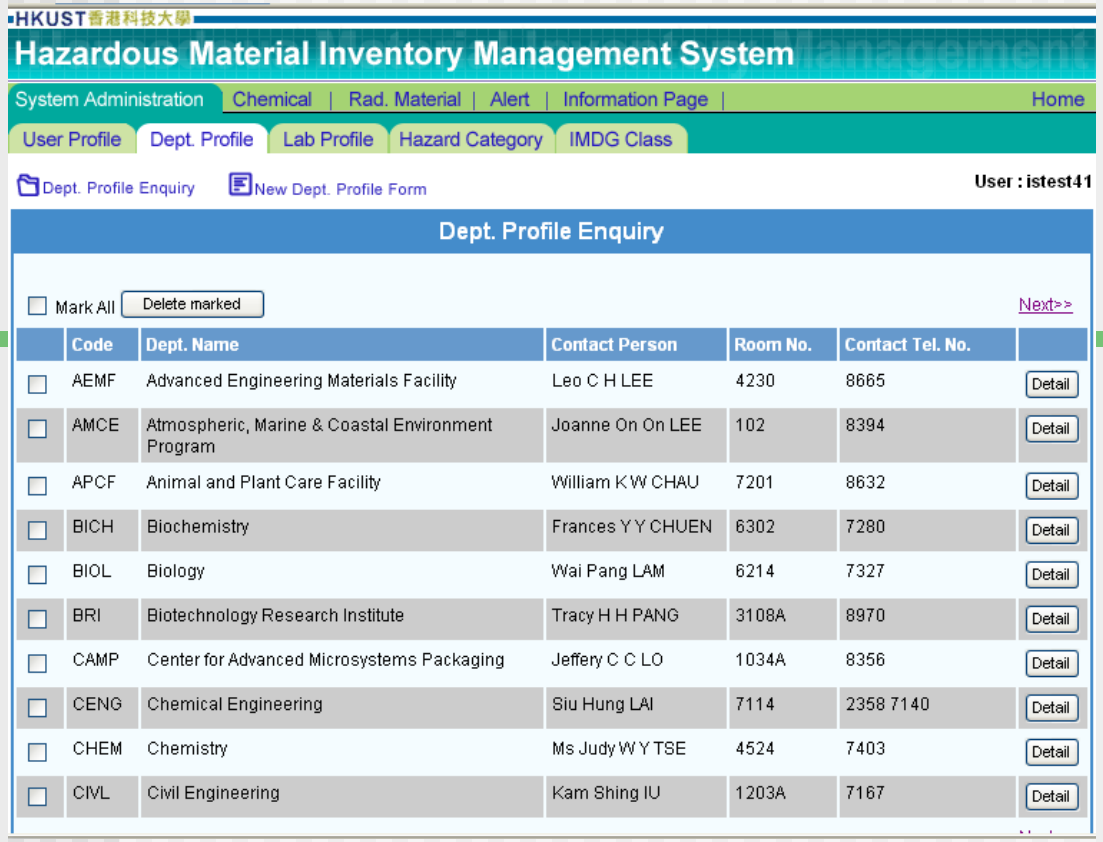
- A “cradle to grave” approach to track the usage of hazardous materials on campus
- A centralized system to assist University management and users to better manage storage and use of hazardous materials
- A platform for centralized purchasing and/or delivery of hazardous materials
- A crucial compliance tool for upcoming amendment of DG regulations

Features Highlights

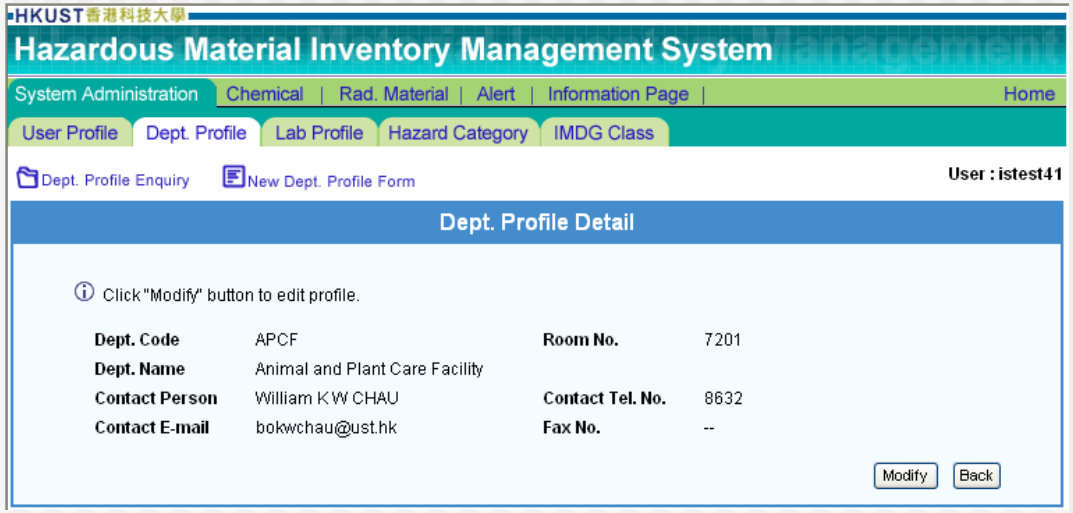
- Allow different levels of access authority
- Radioisotopes, legally controlled substances, and chemical warfare agents are tracked. Confirmation by lab supervisor is required for transfer or disposal
- Time-sensitive chemicals such as peroxidizables, picric acid, are flagged to remind user for checking
- Allow searching of specific types of chemicals such as DG by classes, other regulated chemicals, which helps regulatory compliance

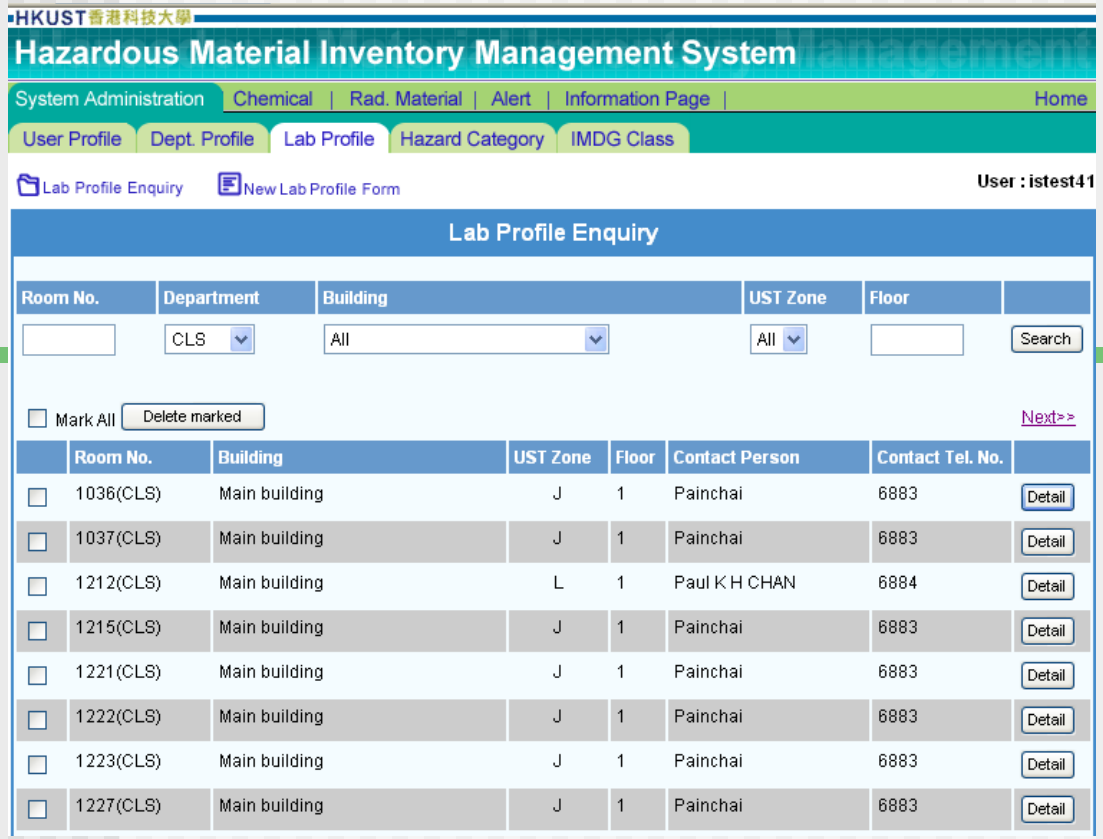
Hazardous Material Inventory Management System Overview



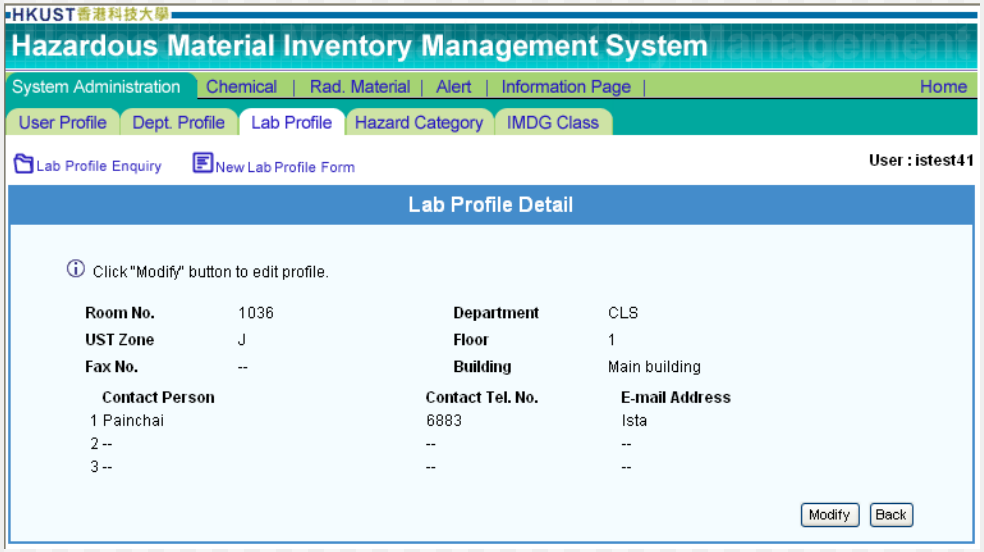


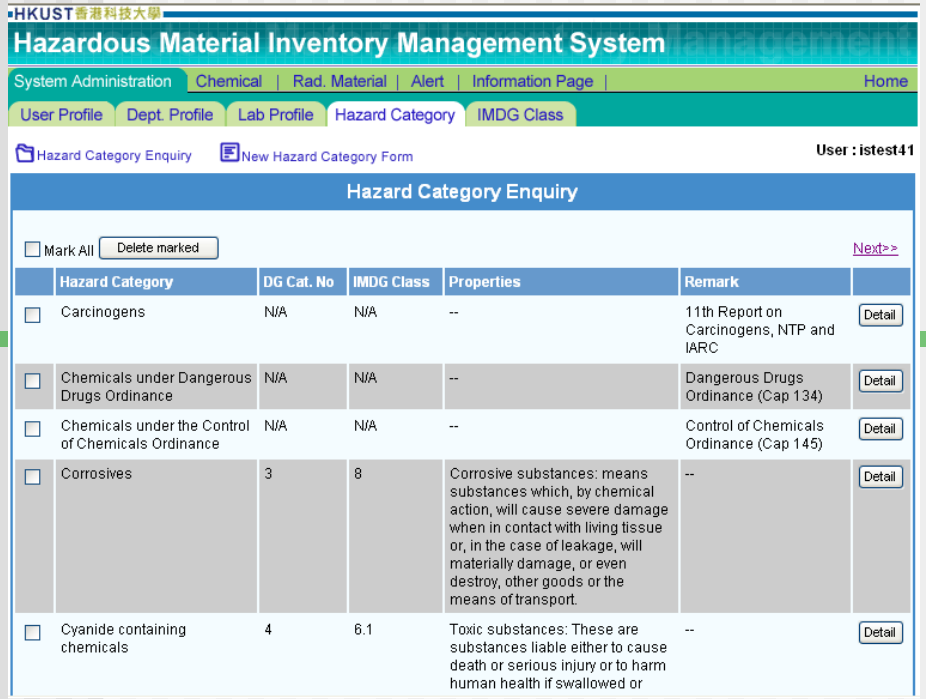
Department and laboratory profiles are established during the initial setup of the system





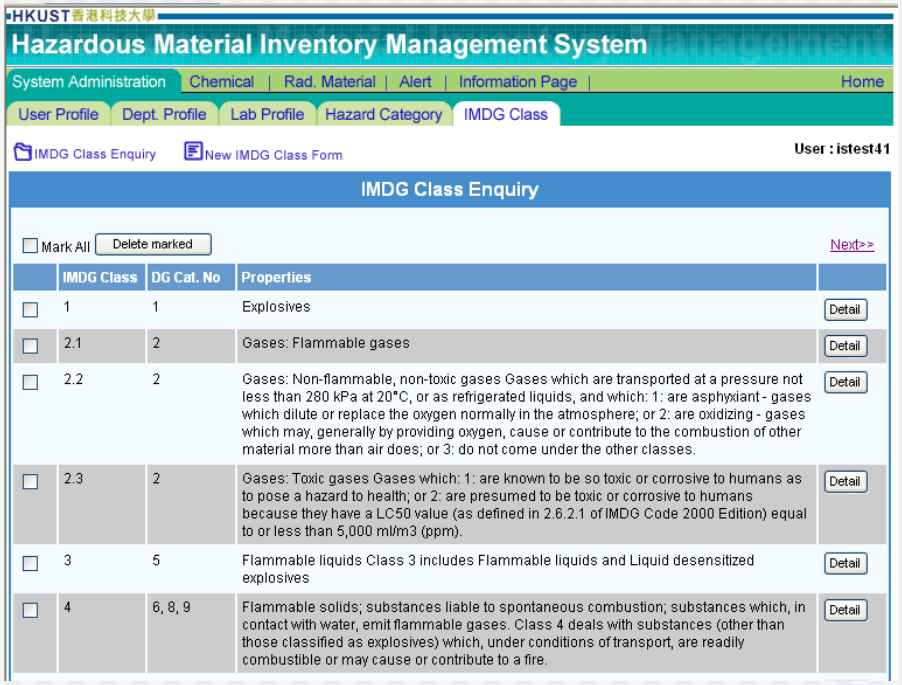
Individual laboratory profile

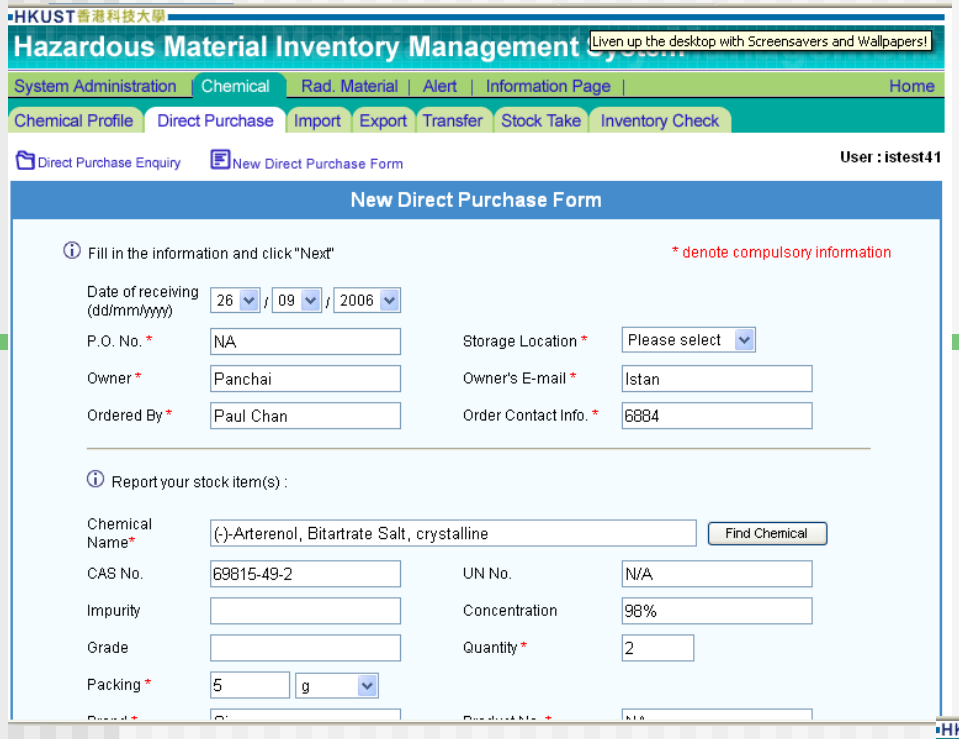




Chemicals are classified under several hazard categories and the International Maritime Dangerous Goods Code (IMDG) in the inventory system.

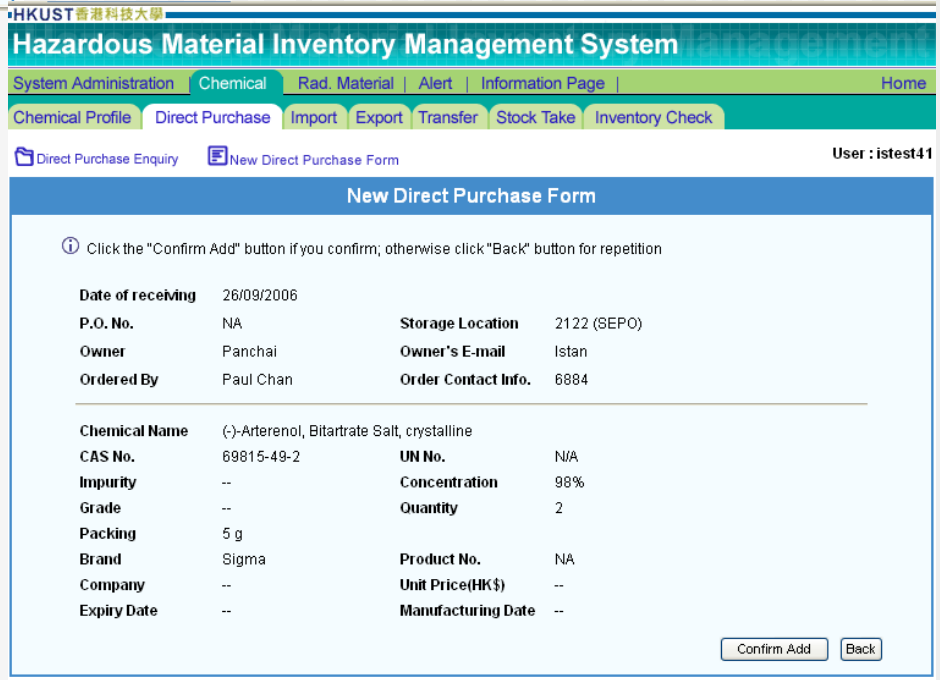
IMDG has been adopted as the basis of the Dangerous Goods classification of the revised DG Ordinance in Hong Kong.



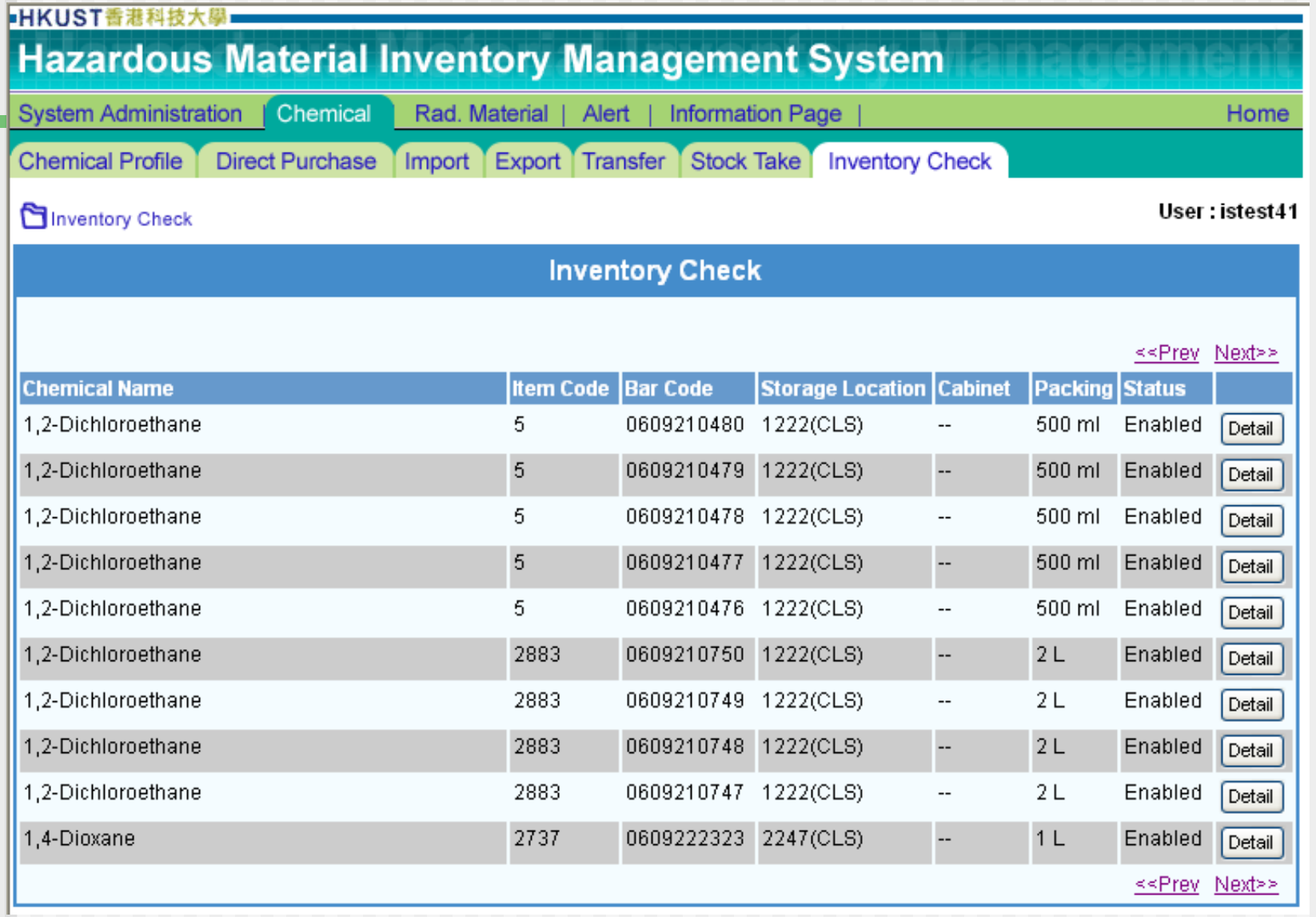


The system allows reporting of any chemicals purchased directly by users. Once the record is verified by CLS, the record will be added to the inventory of the storage location and a barcode for the item will be sent to the user.

For all purchase made through CLS, a barcode will be affixed on the item and the inventory of the storage location will be updated automatically.

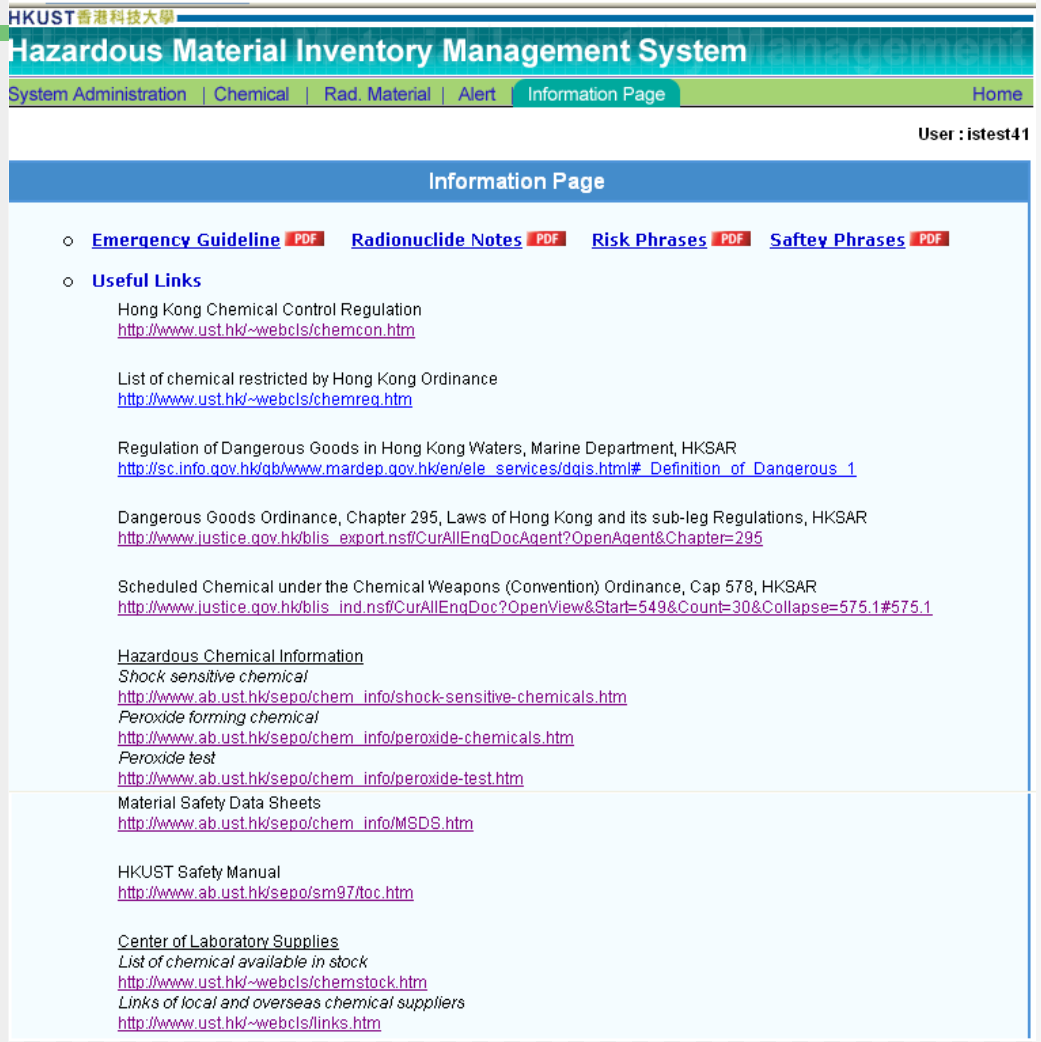


Chemical Inventory



Information Page

- Contains information and links which help users manage chemical safety and procurement

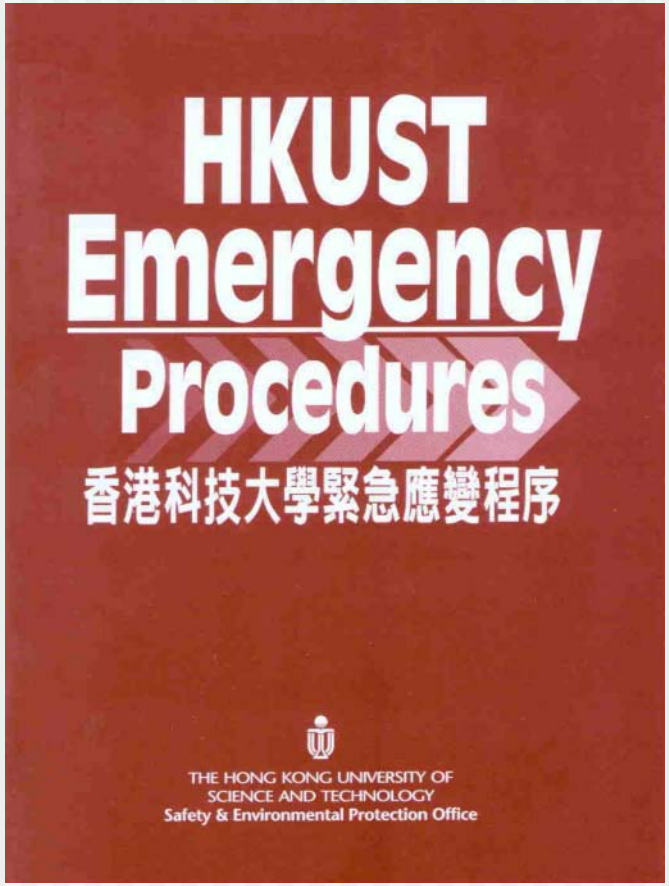


What Should Users Do?

- Make sure chemicals not purchased thru CLS are entered into inventory and barcode affixed to container
- Check inventory (own lab and others) before buying chemicals
- Check out empty reagent bottles to keep inventory updated
- Make sure stock-taking is done at least once a year

Emergency Procedures

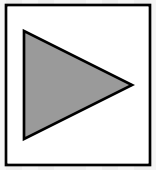
Information on Campus Emergency Response



- Important phone numbers
- Emergency preparedness
- Response procedures for various incidents
- Bilingual text
- http://www.ab.ust.hk/hseo/emergncy.htm

Plan for Emergencies

- What are emergencies which could happen?
- What systems will you need to alert you to an emergency situation?
- What equipment and supplies will you need in the event of an emergency?
- What training will you need?
- Is it safe to work alone in the area?
- What is the phone number for emergency response assistance?



The Basic Responses for Emergencies (I)

- Notify others in the lab
- Evacuate and isolate the area
- Activate Emergency Ventilation if necessary
- DO NOT activate EV if there is a fire
- Call Security Control Centre at 8999
- Provide rescue only if you are trained and have proper protective equipment
- Provide first aid assistance

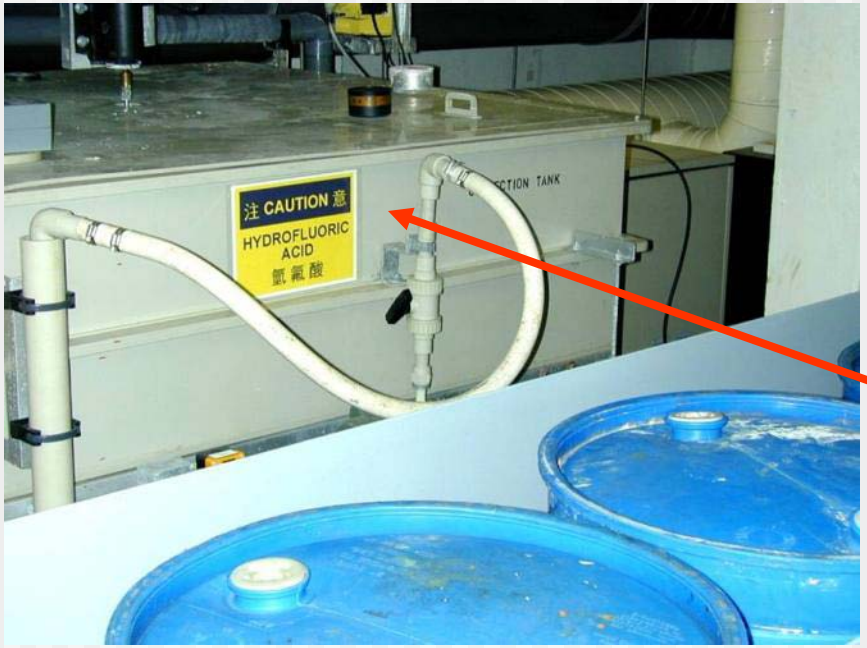
The Basic Responses for Emergencies (II)

- For chemical splash in eyes or on skin:
  - Use eyewash and shower to rinse area for 20 minutes
  - Remove contaminated clothing in the shower
  - Get medical attention
- For small spills, conduct clean up if:
  - Materials is not highly toxic
  - You have supplies
  - You know what you are doing

Hydrofluoric Acid

Concentration	***Health Hazard***
>50%	• *Immediate burns* • *Rapid destruction of tissue/pain*
20-50%	• *Delayed burns (1-8 hrs)*
<20%	• *Painful reddening may be delayed up to 24 hrs*
As low as 2%	• *Delayed skin burns* • *Necrosis/slow healing*

HF waste container



Hydrofluoric acid storage tank

Hydrofluoric Acid Injury

- For low conc exposure, onset of symptoms is often slow and unnoticed
- Damage is often prolonged: for example, contamination around the fingernails may lead to a chronic painful condition and ultimately to amputation of the finger
- Healing is usually slow

Prepare for Hydrofluoric Acid First Aid

- All potential workers and supervisor should be trained in first aid care for HF burns.
- First aid actions should be planned before beginning work with HF.
- Calcium gluconate gel should be readily accessible in areas where HF exposure potential exists.

CALCIUM
GLUCONATE GEL
50g NET
CONTAINS CALCIUM
GLUCONATE 2.5% w/w

Hydrofluoric Acid First Aid

1. Immediately shower with large quantities of water (within seconds after contact or suspected contact) - and completely remove all clothing while in the shower (gloves removed last).
2. Flush the skin thoroughly with water for 5 minutes - 5 minutes is sufficient - more time will delay treatment.

Hydrofluoric Acid First Aid

3. Apply calcium gluconate gel (2.5%) at the burn site or area of contamination by rubbing it continuously - wear impervious gloves.
4. Do NOT use calcium gluconate gel for eyes
5. The person should be examined & treated by a physician as soon as possible.

Information Sources

Chemical Information Sources

- Material Safety Data Sheet (MSDS) associated with each chemical

  (On-line CCINFODISC and Sigma-Aldrich MSDS Databases)
- Chemical Dictionaries and other references
- Chemical Catalogs
- Labels on reagent bottles

Labels on Reagent Bottles

Harmful

Harmful and Oxidizing

Materials Safety Data Sheet

- A Material Safety Data Sheet (MSDS) is designed to provide both workers and emergency personnel with the proper procedures for handling or working with a particular substance.

Materials Safety Data Sheet

MSDS's include the following information:

- Physical Data
- Risk Phrase, Safety Phrase
- Toxicity
- Health Effects
- First Aid
- Reactivity
- Storage
- Disposal
- Protective Equipment
- Leak / Spill Procedure

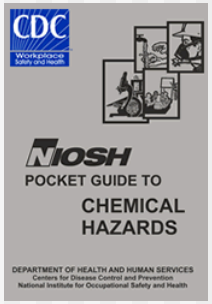
On-Line Chemical Safety Information

- International Chemical Safety Cards (by ILO)

http://www.ilo.org/public/english/protection/safework/cis/products/icsc/dtasht/index.htm

- NIOSH Pocket Guide

http://www.cdc.gov/niosh/npg/npg.html



- MSDS Search

http://www.msdssearch.com/DBLinksN.htm

Other Chemical Safety Training Courses

- *Respiratory Protection*, if you need to use respirators
- *NFF User Safety Training*, if you need to work in MFF
- *Chemical Safety for Operational Staff*

~End of Series~

Thank you