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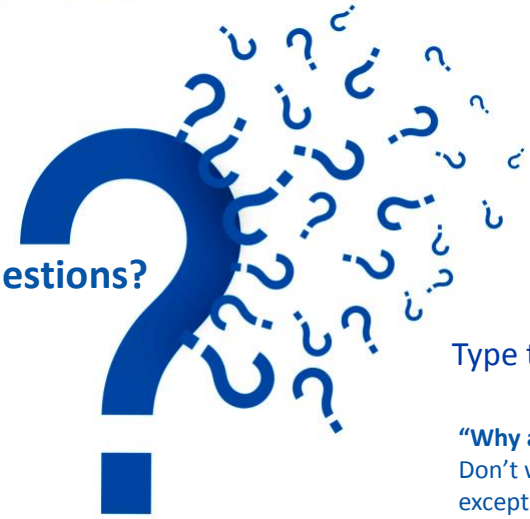
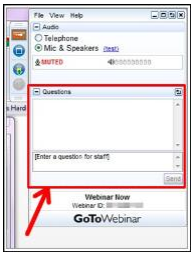


Have Questions?



Type them into questions box!

"Why am I muted?"
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An individual development planning tool for you!

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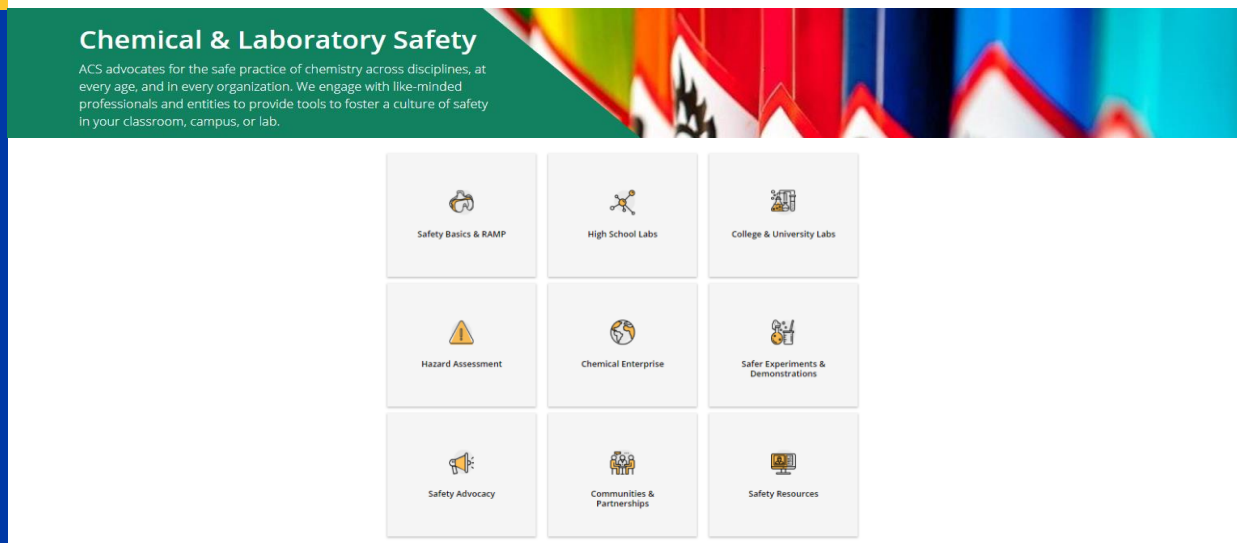
Explore Chemical & Laboratory Safety



https://www.acs.org/content/acs/en/chemical-safety.html

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Upcoming ACS Webinar

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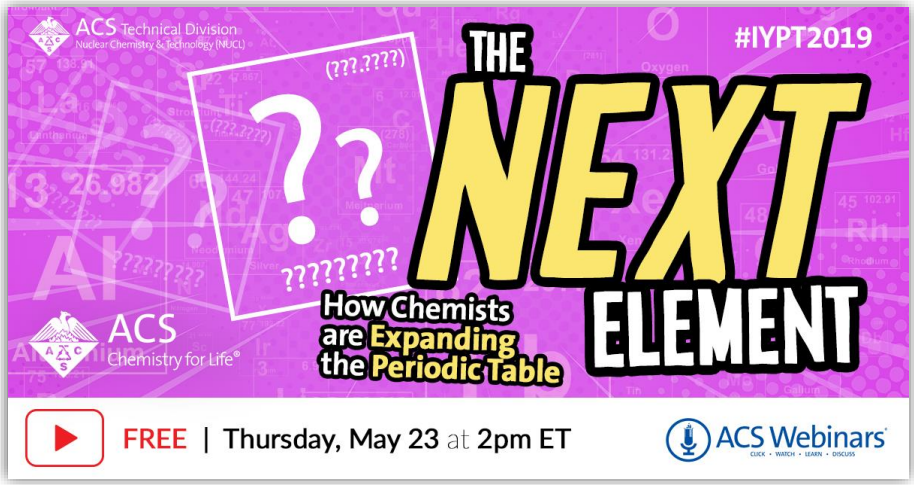

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ACS Safety Programs

THIS ACS WEBINAR WILL BEGIN SHORTLY...

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ACS Chemistry for Life®

Working Safely with Nanomaterials in the Laboratory

Chuck Geraci
Associate Director for Emerging Technologies, National Institute for Occupational Safety and Health

Debbie Decker
Safety Manager, Department of Chemistry , University of California, Davis

Ken Kretchman
Director of Environmental Health Safety, North Carolina State University

Craig Merlic
Professor of Chemistry, University of California, Los Angeles

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This ACS Webinar is co-produced with the National Nanotechnology Coordination Office and ACS Safety Programs

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Today's Objectives

CDC Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

- Reinforce that safe and responsible lab practices enable nanomaterial research
- Discuss how an effective lab safety program and culture accommodates a wide range of research
- Build awareness of existing information resources
- Ensure that lab safety is a key element of good research
- Discussion and share experiences

National Institute for Occupational Safety and Health NIOSH

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Nanomaterials: Some Safety Basics

UCDAVIS DEPARTMENT OF CHEMISTRY

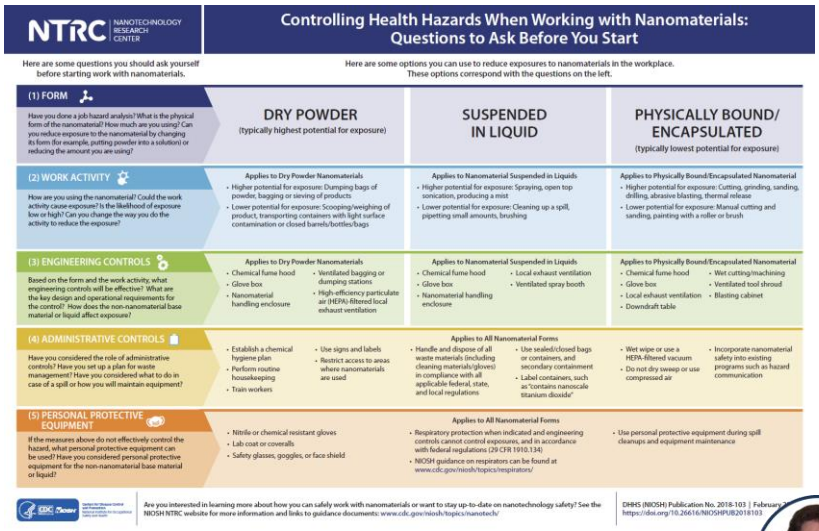
Debbie M. Decker
ACS Fellow and Safety Manager,
Department of Chemistry, University of California, Davis
dmdecker@ucdavis.edu

UCDAVIS

Administrative Controls

UCDAVIS DEPARTMENT OF CHEMISTRY

- **Operating Procedures**
  - Campus-wide template in development
  - Lab-specific Safety Plan
- NIOSH **"Approaches to Safe Nanotechnology"**
- **Training and mentoring**



NTRC NANOTECHNOLOGY RESEARCH CENTER

Controlling Health Hazards When Working with Nanomaterials: Questions to Ask Before You Start

Here are some questions you should ask yourself before starting work with nanomaterials.

Here are some options you can use to reduce exposures to nanomaterials in the workplace. These options correspond with the questions on the left.

	DRY POWDER (typically highest potential for exposure)	SUSPENDED IN LIQUID	PHYSICALLY BOUND/ ENCAPSULATED (typically lowest potential for exposure)
(1) FORM Have you done a job hazard analysis? What is the physical form of the nanomaterial? How much are you using? Can you reduce exposure to the nanomaterial by changing its form (for example, putting powder into a solution) or reducing the amount you are using?			
(2) WORK ACTIVITY How are you using the nanomaterial? Could the work activity cause exposure? Is the likelihood of exposure low or high? Can you change the way you do the activity to reduce the exposure?	Applies to Dry Powder Nanomaterials • Higher potential for exposure: Dumping bags of powder, bagging or sieving of products • Lower potential for exposure: Scooping/weighing of product, transporting containers with light surface contamination or closed barrels/bottles/bags	Applies to Nanomaterial Suspended in Liquids • Higher potential for exposure: Spraying, open top sonication, producing a mist • Lower potential for exposure: Cleaning up a spill, pipetting small amounts, brushing	Applies to Physically Bound/Encapsulated Nanomaterial • Higher potential for exposure: Cutting, grinding, sanding, drilling, abrasive blasting, thermal release • Lower potential for exposure: Manual cutting and sanding, painting with a roller or brush
(3) ENGINEERING CONTROLS Based on the form and the work activity, what engineering controls will be effective? What are the key design and operational requirements for the control? How does the non-nanomaterial base material or liquid affect exposure?	Applies to Dry Powder Nanomaterials • Chemical fume hood • Glove box • Nanomaterial handling enclosure • Ventilated bagging or dumping stations • High-efficiency particulate air (HEPA)-filtered local exhaust ventilation	Applies to Nanomaterial Suspended in Liquids • Chemical fume hood • Glove box • Nanomaterial handling enclosure • Local exhaust ventilation • Ventilated spray booth	Applies to Physically Bound/Encapsulated Nanomaterial • Chemical fume hood • Glove box • Local exhaust ventilation • Downdraft table • Wet cutting/machining • Ventilated tool shroud • Blasting cabinet
(4) ADMINISTRATIVE CONTROLS Have you considered the role of administrative controls? Have you set up a plan for waste management? Have you considered what to do in case of a spill or how you will maintain equipment?	Applies to All Nanomaterial Forms • Establish a chemical hygiene plan • Perform routine housekeeping • Train workers • Use signs and labels • Restrict access to areas where nanomaterials are used	• Handle and dispose of all waste materials (including cleaning materials/gloves) in compliance with all applicable federal, state, and local regulations • Use sealed/closed bags or containers, and secondary containment • Label containers, such as "contains nanoscale titanium dioxide"	• Wet wipe or use a HEPA-filtered vacuum • Do not dry sweep or use compressed air • Incorporate nanomaterial safety into existing programs such as hazard communication
(5) PERSONAL PROTECTIVE EQUIPMENT If the measures above do not effectively control the hazard, what personal protective equipment can be used? Have you considered personal protective equipment for the non-nanomaterial base material or liquid?	Applies to All Nanomaterial Forms • Nitrile or chemical resistant gloves • Lab coat or coveralls • Safety glasses, goggles, or face shield	• Respiratory protection when indicated and engineering controls cannot control exposures, and in accordance with federal regulations (29 CFR 1910.134) • NIOSH guidance on respirators can be found at www.cdc.gov/niosh/topics/respirators/	• Use personal protective equipment during spill cleanups and equipment maintenance

CDC Tacoma — Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health

Are you interested in learning more about how you can safely work with nanomaterials or want to stay up-to-date on nanotechnology safety? See the NIOSH NTRC website for more information and links to guidance documents: www.cdc.gov/niosh/topics/nanotech/

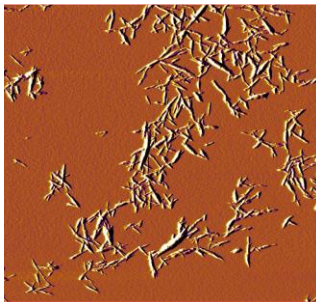
DHHS (NIOSH) Publication No. 2018-103 | February 2018
https://doi.org/10.26616/NIOSHPUB2018103

https://www.cdc.gov/niosh/docs/2018-103/pdfs/Nano_MP1_2018-103_508.pdf

UCDAVIS

Nanomaterials: Hazard Assessment

UCDAVIS DEPARTMENT OF CHEMISTRY



AFM Imaging of sulfated cellulose nanocrystals
Photo Credit: Sulkanen

Hazard assessment needs to include:

- Assume nanomaterial is at least as toxic as the bulk material
- And it's probably more toxic!
- Synthesis methods
- Solvents
- Particles vs. Pores
- Other hazards: lasers, pyrophoricity

Engineering Controls

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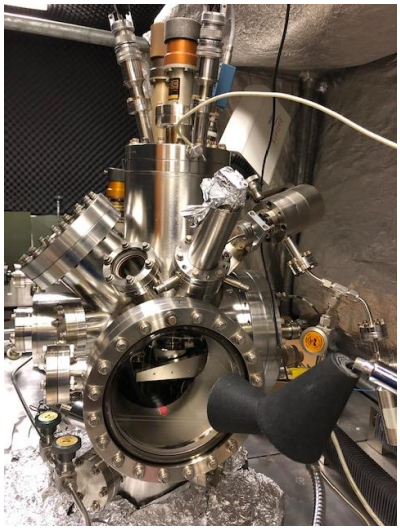
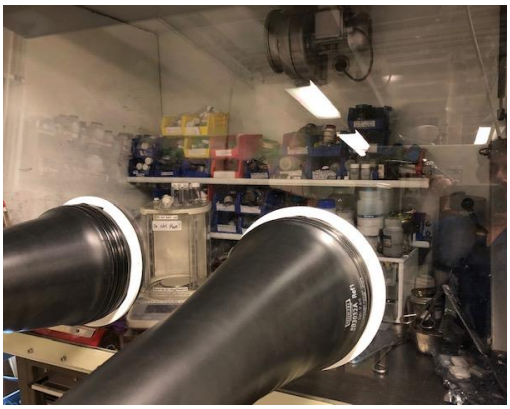


Atomic Force Microscope Photo Credit: Liu

- Fume Hood
- Exhausted enclosure
- Glove Box



Personal Protective Equipment

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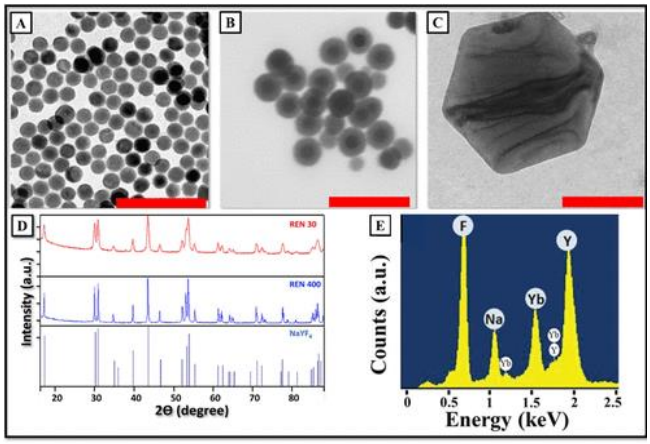
- Gloves
- Fire Retardant Gloves?
- Goggles vs. Safety Glasses



Rare-Earth doped nanocrystals.

Photo Credit: Owen

Handling and Synthesis Methods

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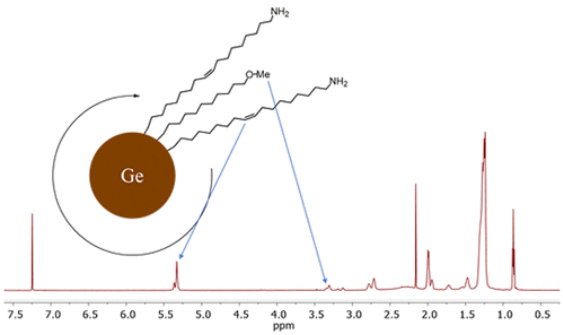

Solvent effects on the microwave-assisted synthesis of germanium nanoparticles.

Photo Credit: Bernard

- In suspension
  - Higher boiling solvent is better
- If using a substrate, make sure nanoparticles are well-stuck onto the substrate
- Cover surfaces with plastic-backed paper
  - Makes clean up easier
- Cautious about heat-generating equipment as it could provide an inadvertent ignition source

Analytical Methods

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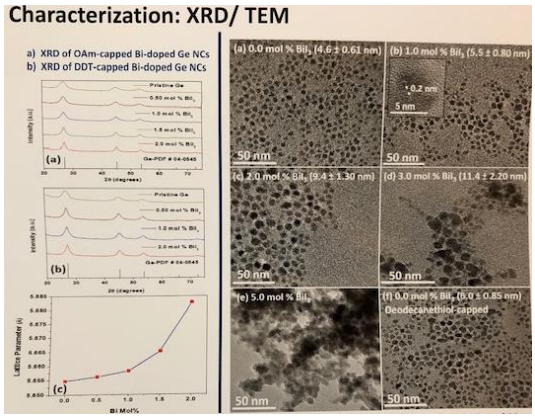
- **AFM, SEM, NMR, Ramen, FTIR, UV/Vis, etc.** – all require various sample preparation methods and different solvents
- **For analysis, many times have to manipulate dry powder:**
  - Drop dry onto substrate
  - Making sure material is well-stuck to substrate
  - Prep into a vial or similar
- **"Large Amount" is maybe 10mg**, dependent on molecular weight
  - Never working in gram scale



Increasing Bismuth levels leads in enhancing lattice parameter of Ge NCs up to 2 mol%

Photo Credit: Kauzlarich

Storage

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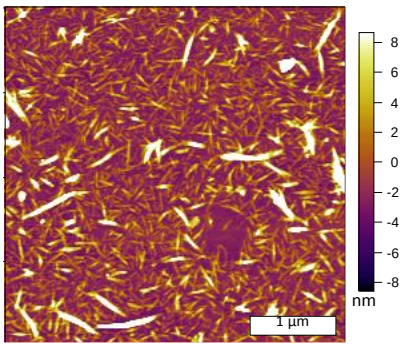


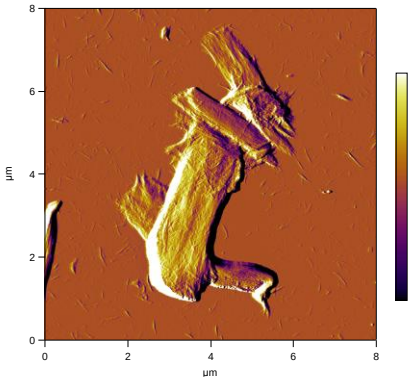
Long-Term Stability After 13 Months – Aqueous Cellulose Nanocrystals

Photo Credit: Sulkanen

Stored mostly in suspension

- Materials can aggregate
- Dry powders transferred in fume hood or glove box
- Careful labelling is critical

Disposal



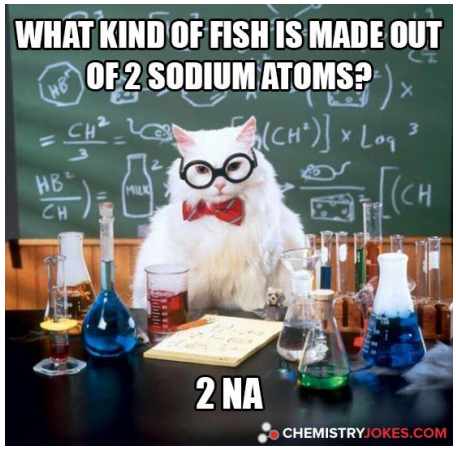
AQ-CNC aggregates showed alignment of individual fibers.
Photo Credit: Sulkanen

- Assume hazardous waste
- Within the laboratory, it may make sense for each researcher to have their own waste stream
- Labelling is important – identify solvent, if in suspension, and the identity of the nanoparticle
- Biggest hazard to hazardous waste workers may be the solvent

Acknowledgements

I wish to acknowledge Audrey Sulkanen, Matthew Owen, *(Research Lab of Gang-Yu Liu)* ***and Andrew Bernard*** *(Research Lab of Susan Kauzlarich)* ***for their input and advice.***

Photo credits to Sulkanen, Owen, and Bernard.



Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT

In your opinion, which of the following does your lab do well regarding nanomaterial safety? (choose all that apply)

- Administrative controls
- Hazard assessment
- Engineering controls
- Personal Protective Equipment
- Storage and disposal

** If your answer differs greatly from the choices above tell us in the chat!*

Managing Nanomaterial Safety in a Large and Diverse University Setting

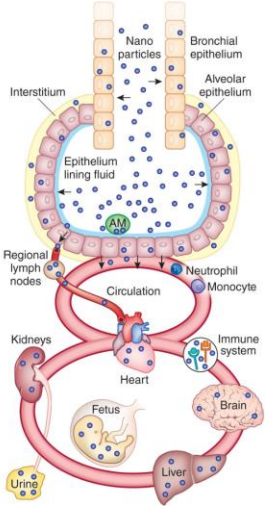
Ken Kretchman, CIH, CSP
Director, Environmental Health Safety,
North Carolina State University
kwkretch@ncsu.edu

Presentation Objectives

- Identify Challenges and Potential Solutions to Assuring Safety with Nanomaterials at Large, Diverse, Research Environment
- Share One Approach – Emphasize Goal of Achieving Basic Awareness
- Provide Listing of Resources - https://www.nano.gov/LabSafety

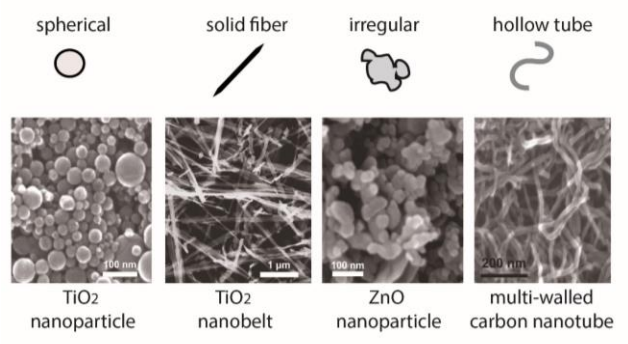
- Building a Safety Program to Protect the Nanotechnology Workforce
  https://www.cdc.gov/niosh/docs/2016-102/pdfs/2016-102.pdf
- AIHA Nanotechnology Working Group
  https://www.aiha.org/get-involved/VolunteerGroups/Pages/Nanotechnology-Working-Group.aspx

Systemic Translocation of Nanoparticles



"…non-cationic nanoparticles smaller than ~34 nm in diameter that do not bind serum proteins reach the regional lymph nodes within 30 min"

"Nanoparticles larger than ~34 nm are consistently retained within the lungs."



Credit: Kreyling et al., Nat Biotechnol. 2010 28(12):1275

The Challenge for the EHS Professional for a Large, Diverse, Decentralized, and Ever-changing Lab Environment

- How to Build a **Lasting Infrastructure** of Processes and Tools to Capture and Educate this Population with 100% Capture as the Goal?
- **If You Build It …They Won't Come** - Just Because It is on your website does not mean you have accomplished your goal!
- Concern About Small Particles of Known Substances is **Not Intuitive** *"We already know about small particles…have been working with them for years"* …
  - **You can't drown Principal Investigators with Information at the Outset** – They are already on Information Overload
    - **Sharing of Engineered Nanomaterials – Common** - Hazard Awareness Information Needs to Accompany the Material
      - **Key People – Leaving Today**
      - **New People – Starting Tomorrow** - Every Changing Workforce

NC STATE UNIVERSITY 29

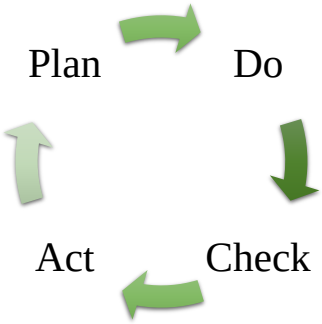
Nanotechnology or Microelectronics?

Got Gases?

Got TMAH?

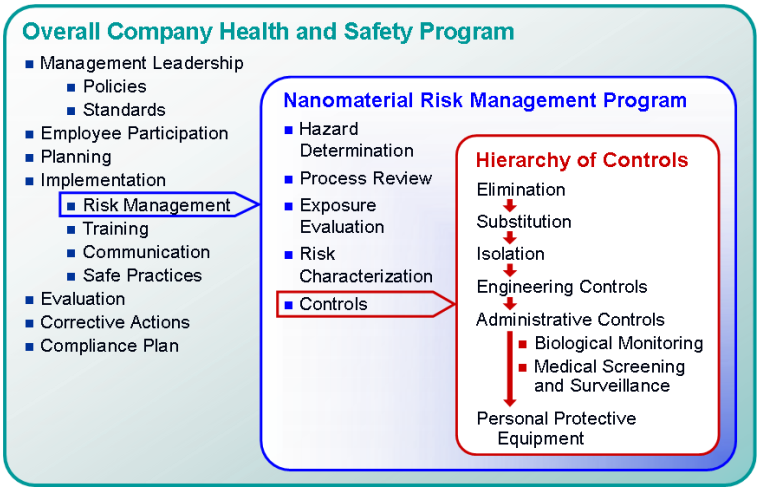
NC STATE UNIVERSITY 30

Plan, Do, Check, Act



- Strong Safety Culture Foundation
- Management Support (Accountability, Focus on Quality)
- Capture and Train
- Hazard Identification
- Hazard Assessment
- Hazard Abatement
- Critique and Adjust
- **Management of Change**

Drilling Deeper



Building a Safety Program to Protect the Nanotechnology Workforce - NIOSH 2016

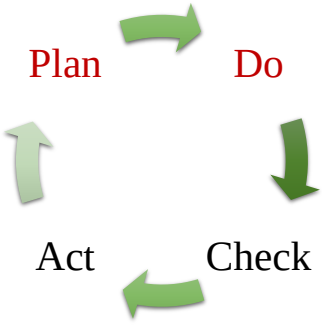
Steps

- **Develop Strategy** (Plan)
- **Provide Tools** - Awareness Training, SOPs
- **Implement Processes** - Incoming Material Reviews, Process Hazard Reviews, Communications (Do)
- **Inspections, Self-Inspection, Reviews** with Collaborators (Check)
- **Adjust as Needed** (Act)

Can't Be Dependent on Strong Leadership - Can't be Transient

Must be Integrated into Processes and Sustained by a Strong Culture

Plan



- **Collaborate**
- **Capture**
- **Communicate**

- **Sustainable Infrastructure**
  - People
  - Processes
  - Assistance Tools

- **Goal -** Process that is 100% Capable and Addresses Management of Change

Got Collaborators? Some of Mine…Who are Yours?

Internal

- Key Process Collaborators – Onboarding, **Purchasing**…
- Research Safety Committee Leadership and Members
- **Lab Safety Contacts**
- Subject Matter Expert Collaborators (just to name a few- past or present at NC State)
  - Nancy Montiero-Riviere – *Skin Nano Toxicology*
  - James Bonner – *Carbon Nanotube Toxicology*
  - Jacob Jones – *Director, Research Triangle Nanotechnology Network (RTTN)*
  - Phillip Barletta – *Operations Manager - Nanofabrication Facility (NNF)*
  - Khara Grieger – *Nanomaterial Risk Assessment and Communication (RTNN)*
  - Dawn Mason – *Eastman Chemical – Research Safety Culture*

External

- National Institute for Occupational Safety and Health – *Geraci, Hoover, etc...*
- American Chemical Society – *CHAS Division, SAP…other*
- American Industrial Hygiene Association – *Nanotechnology Working Group*
- University Environmental Health and Safety Directors and Staff

One Capture / Communication Process

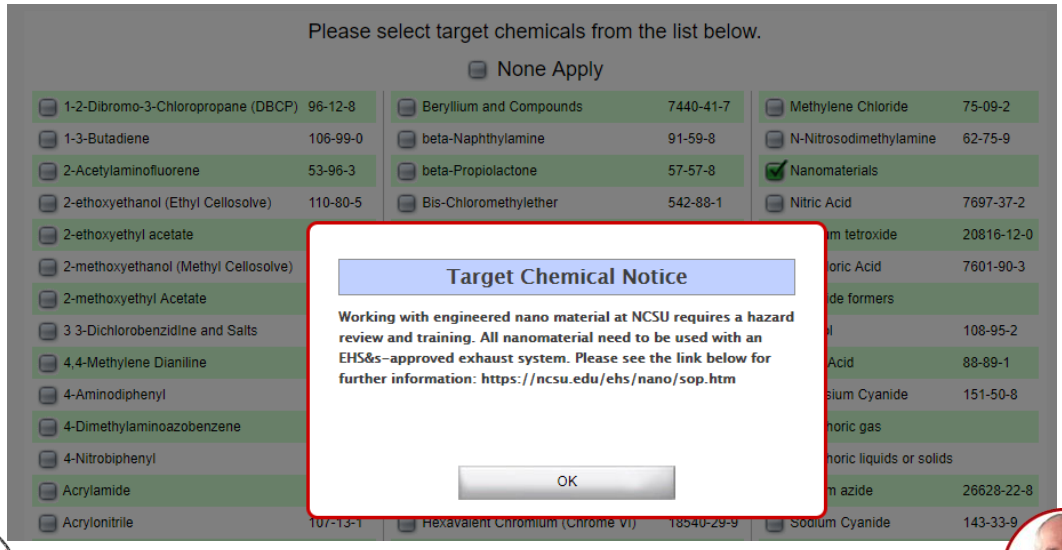
Onboarding – Everyone

- Includes General Safety Orientation - Online
  - Includes Completion of Training Matrix
    - Includes Use of Nanomaterials Training – Get Tagged – Get Short Message Real Time
    - Steered to One Page Summary
      - Take Awareness Training
      - Read N.C. State Requirements
      - Provide One Page Summary to those with whom you share materials

Principal Investigator Safety Plan – Initial and Updated Annually

- Includes Process Descriptions / SOP
- Includes Target Chemical Lists - Includes Nanoparticles – Key NP Message
- Includes Self Assessment Checklist – Includes Key NP Message
  - Includes **Hazard Review Requirements** - Includes NP requirement

Target Chemical Notice



Got Awareness Tools?

Barrina UV LED Blacklight bar 9w 2ft T5 Integrated Bulb Black Light Fixture for Blacklight Po
5% Hydrogen Balance Nitrogen Industrial Mix, Size 200 Cylinder, CGA-350
SILANE 1PPM BAL NITROGEN SIZE 80
Zero Grade Air, Size 300 Cylinder, CGA-590 - Total Hydrocarbons < 0.1 PPM
HYDROGEN GRADE 6.0 SZ 300 W/RFO
FULRENE BUCKYTUBE/NANOTUBE 1G
10% NEUTRAL BUFF FORM 2.5 GALLON CUBE
ETHANOL 190 PRF 5G PAIL 5GAL
REAGENT ALCOHOL ACS 5GAL
Medical USP Grade Oxygen, Size 250 Cylinder, CGA-540
OPTIMA LC/MS 2-PROPANOL (IPA)
(R)-(+)-LIMONENE, 97%, 98% EE (GLC)(R)-(+)-LIMONENE, 97%, 98% EE (GLC)

I noted that you recently placed an order for *****

As you may be aware, this chemical is formulated as an engineered nanomaterial (<100nm). When working with engineered nanomaterial you need to take additional precautions, above and beyond normal safe chemical handling procedures. Additional training in the safe use of engineered nanomaterials is necessary and can be found at the follow presentation:

http://wisha-training.lni.wa.gov/training/presentations/NanotechnologySafety.ppt

Please consult EH&S if there is a potential for nanoparticles to become airborne in your processes. Engineered nanomaterials must be disposed of via the HAZTRAK system, more information of waste disposal can be found here; https://ehs.ncsu.edu/home-page-info/environmental-affairs/chemical-waste/

For more information on Engineered nanomaterials and there safe handling, Please see the following document: https://drive.google.com/file/d/0Bwfv9WVwZC73Z2JDa0dUSDFFSVk/view

If you are not the person who intends to use this chemical please, forward this email to the person(s) who will be using it, Thank you.

If you have any questions, Please ask

Personal Responsibility in Hazard Assessment

*NIOSH and Other Agencies – Health Hazard Findings and Hazard Control Information

EHS , Scientists Public

Principal Investigator

Lab Staff

Periodic Self Assessment !

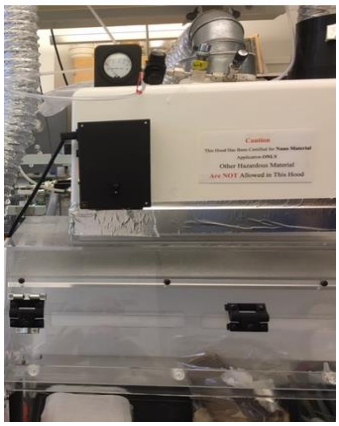
***ACS CHAS**, AIHA, Other

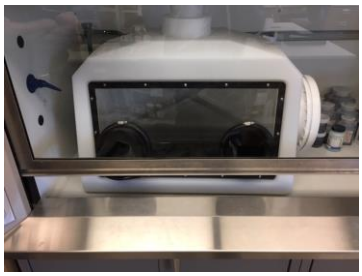
*March/ April 2019- Journal of Chemical Health and Safety – Published for ACS CHAS Division

- Evaluating Nanomateral Safety Data Sheets – Hodson, Eastlake, Herbers -NIOSH
- Emissions from 3D Printers – Stefaniak et all - NIOSH

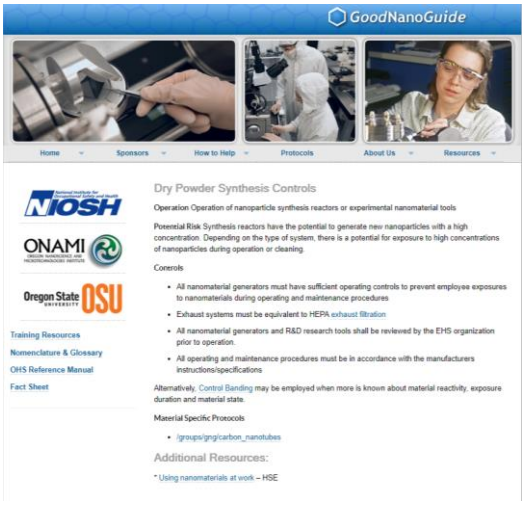
Personal Responsibility – Hazard Assessment - Check SDSs, literature, other Safety Resources along with site requirements before proceeding!

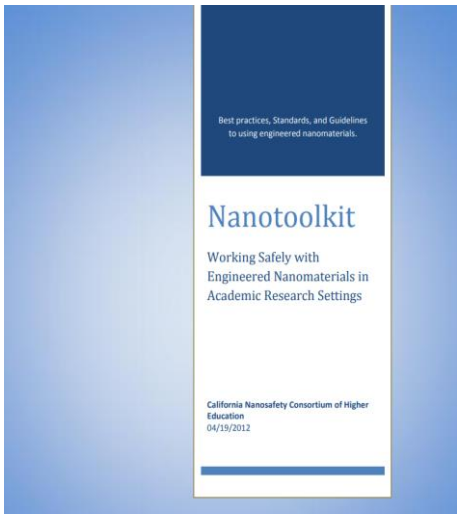
Got Engineering Controls?





Got Standard Operating Procedures (SOPs) ?

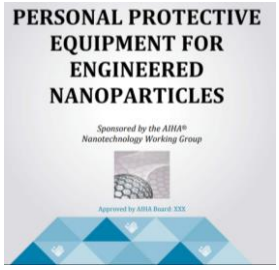




https://www.safenano.org/knowledgebase/guidance/safehandling/goodnanoguide/

http://www.cein.ucla.edu/new//file_uploads/nano_toolkit_2012_0419_updated1.pdf

Got Personal Protective Equipment (PPE)?



https://www.aiha.org/government-affairs/Documents/Personal%20Protective%20Equipment%20for%20Engineered%20Nanoparticles_Final.pdf

Got Awareness Tools?

Try to Narrow the Field and Provide Focus

SELECTED CHEMICALS WHICH POSE A SKIN ABSORPTION HAZARD

The following listing contains common substances, which are listed in the 2005 TLV (Threshold Limit Values) Booklet by the American Conference of Governmental Industrial Hygienists (ACGIH) as having a "potential significant contribution to the overall exposure by the cutaneous route, including mucous membranes and the eyes, either by contact with vapors, or, of probable greater significance, by direct skin contact with the substance."

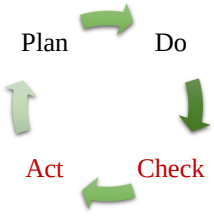
The recommended airborne exposure limits (TLVs) for these materials is also listed. Please take special note of avoiding skin contact and using the proper glove and eye protection for each of the materials listed below, particularly those which also have a low TLV. Note that this listing is not all inclusive, does not address materials, which cause a direct irritant effect on the skin surface (acids, bases, etc), and does not address materials, which may cause allergic reactions or dermatitis due to skin contact. Consult the TLV term definitions at the end of the list. Please take special precautions in handling hydrofluoric acid (not listed below). Remember that some materials, which do not readily pass through the skin, may do so when mixed with a carrier, which is readily absorbed (e.g. DMSO) or may pass through skin through cuts, breaks, or other damage such as dermatitis. Please also note that materials listed below, or others, may be components of solvent mixtures, so be sure to read your MSDS and use proper skin protection.

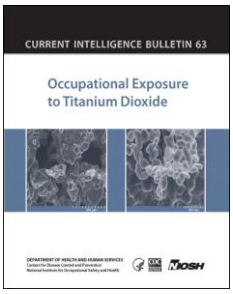
Contact the Environmental Health and Safety Center at 515-6860 with additional questions you may have concerning skin protection.

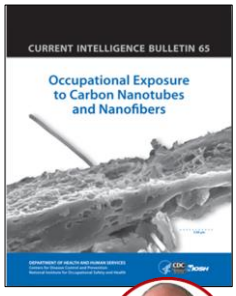
	TWA		STEL/CEILING(C)	
SUBSTANCE	ppm	mg/m^3	ppm	mg/m^3
Acetone cyanohydrin	-	-	C 4.7 (1.4)	C 5
Acetonitrile	20	33.6		
Acrolein	-	-	C 0.1	-
Acrylamide	-	0.03	-	-

Inspection / Assessment

- **Exposure Assessment**
  - Mass Based Air Sampling is Not Appropriate
  - Particle size, shape, surface area, and surface chemistry are important
  - Particle size and number most achievable
  - Compare to background levels
- **Self Inspection – Key**







Got Collaborators?

- Nano User lists
- Communications
- Seminars
- Sharing of Safety Information

Research Triangle Nanotechnology Network
A Partnership Between NC State University, Duke University, and UNC Chapel Hill

- Process Safety Reviews
- New Chemical Reviews
- Emergency Response Training

NNF
NCSU NANOFABRICATION FACILITY

Target Equipment Forwarding Lasers, Semiconductor Equipment, Radiation Producing Devices, other
Daily Chemical Order Forwarding
Real Time Compressed Gas Order Forwarding-Reviews and Approvals
Approved Electrical Equipment

NC STATE UNIVERSITY

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Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT

In your opinion, which of the following does your lab need guidance regarding nanomaterial safety? (Choose all that apply)

- Plan, Do, Check, Act process
- One capture or communication process
- Standard operating procedures
- Awareness tools
- Collaboration support

** If your answer differs greatly from the choices above tell us in the chat!*

Working Safely with Nanomaterials in the Laboratory: A View of Leadership

UC Center for Laboratory Safety

SAFETY TRAINING CONSORTIUM

Craig Merlic
Professor, Department of Chemistry and Biochemistry
UC Center for Laboratory Safety,
University of California, Los Angeles

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What is Most Important in Nanomaterials Laboratory Safety?

UC Center for Laboratory Safety

SAFETY TRAINING CONSORTIUM

- **Individual Researchers**
  - Initial and ongoing safety training
  - Adherence to lab safety standards
  - Hazard identification and risk assessments
  - Analysis of near misses and Lessons Learned
- **SOPs** – Detailed SOPs prepared and followed
- **Controls** – Required use of PPE and engineering controls
- **EH&S** – Rigorous lab inspections
  - Active as a safety resource

Answer – All of the above. So how to improve upon these?

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Laboratory Safety Triad

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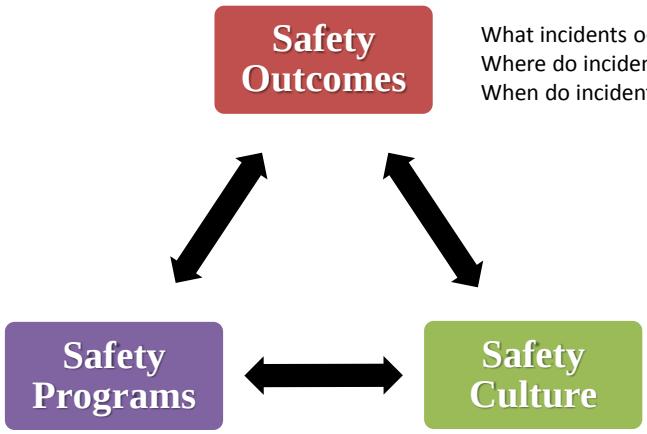
SAFETY TRAINING CONSORTIUM



What incidents occur?
Where do incidents occur?
When do incidents occur?

EH&S Actions, Using SOPs, PPE Usage, Safety Training

Actions by researchers in labs. Safety leadership by everyone.

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Safety Culture Survey

UC Center for Laboratory Safety

SAFETY TRAINING CONSORTIUM

Safety Culture: *Values, beliefs and behaviors resulting in a collective commitment to safety by everyone in an organization.*

Safety Culture Survey

- Determine the state of laboratory safety culture
- Identify factors that influence the safety culture
- Determine strengths and weaknesses of safety programs
- Identify factors that correlate with injuries

GOAL: Use data to drive improvements in laboratory safety practices, culture and outcomes

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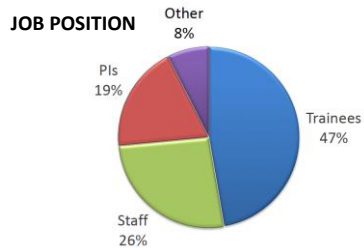
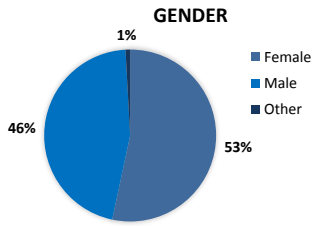
Safety Culture Survey

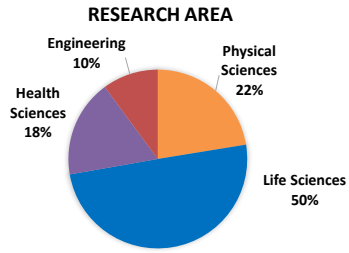
UC Center for Laboratory Safety

SAFETY TRAINING CONSORTIUM

- **Short:** < 10 minutes
- **38 questions;** 5-point Likert scale, 1 open-ended question
- **Bifurcated survey:** Students, postdocs & staff vs. Principal Investigators
- **Areas:**
  - Demographics
  - Safety communication
  - Safety attitude
  - Safety behavior
  - Lab incidents and near misses
- **4 Research universities**
- **> 1000 respondents**







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Safety Culture Survey Highlights

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Trainees (graduate students & postdocs) **and Staff:**

- **96%** Have access to all required PPE
- **96%** Regularly wear long pants in the lab
- **98%** Regularly wear close-toed shoes in the lab
- **93%** Regularly wear gloves in the lab

PIs/Faculty:

- **95%** Speak openly with EH&S about safety issues regarding work in their lab
- **97%** Would take immediate action if they saw a researcher in their lab act unsafely

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Safety Engagement by Gender

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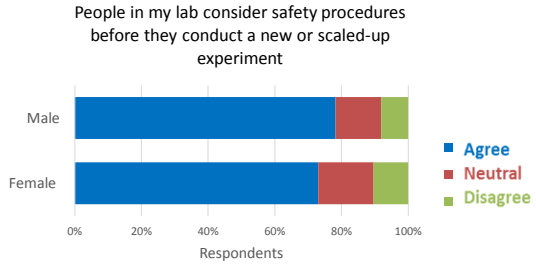
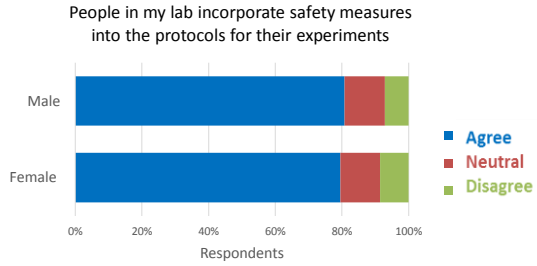
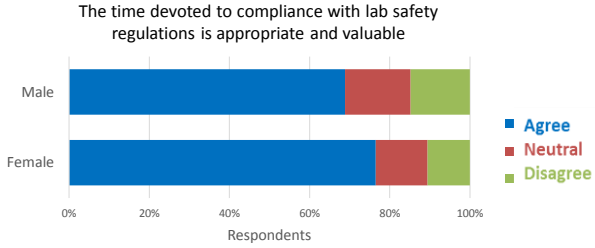
SAFETY TRAINING CONSORTIUM







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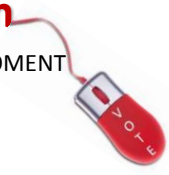
Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



How often does your lab group discuss how to conduct experiments safely?

- Daily
- Weekly
- Monthly
- Quarterly
- Yearly

** If your answer differs greatly from the choices above tell us in the chat!*

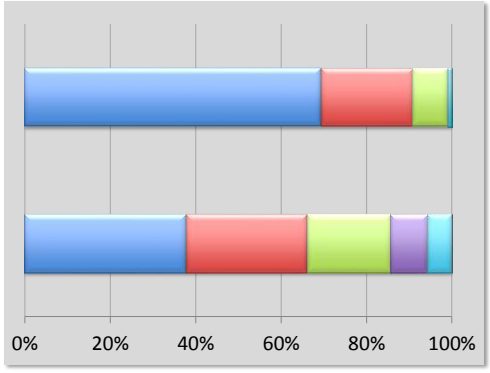
Perception Gap when Discussing Safety in Experiments

UC Center for Laboratory Safety

SAFETY TRAINING CONSORTIUM

PI: I discuss with my lab group how to conduct experiments safely.
89% Agree/Strongly Agree

Trainees/Staff: My PI discusses with me how to conduct experiments safely
66% Agree/Strongly Agree



Strongly agree — Strongly disagree

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Perception Gaps

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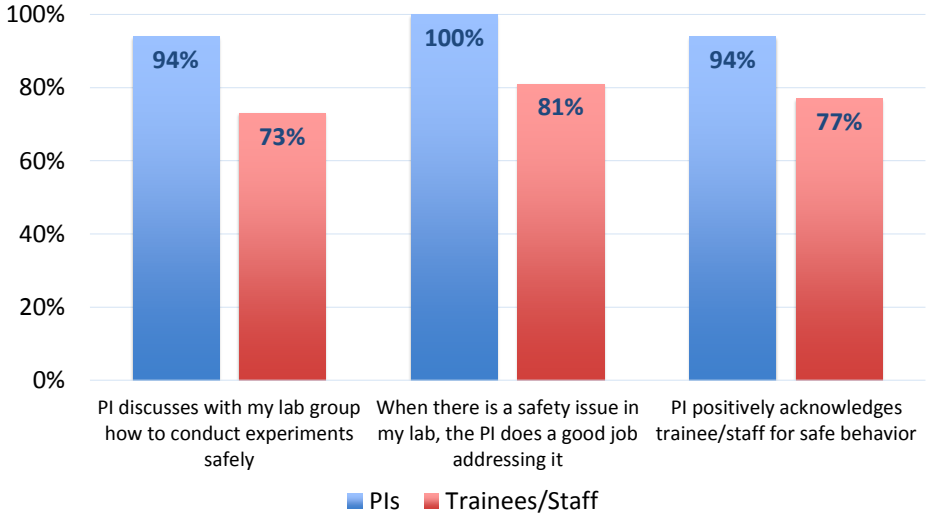

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Correlating PI Safety Recognition with Trainee/Staff Safety Behavior and Attitudes

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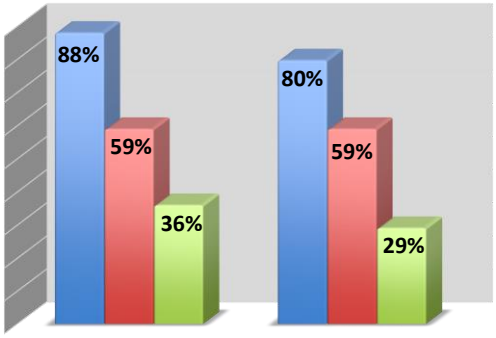
PI Action:

- Safety Recognized
- Neutral
- Safety Not Recognized



Trainees/Staff Reaction:

People in my lab incorporate safety measures into their experimental protocols.

Time devoted to compliance with lab safety regulations is appropriate and valuable.

Safety recognition by PI correlates with safe lab practices

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Correlating PI Safety Recognition with Trainee/Staff Safety Behavior and Attitudes

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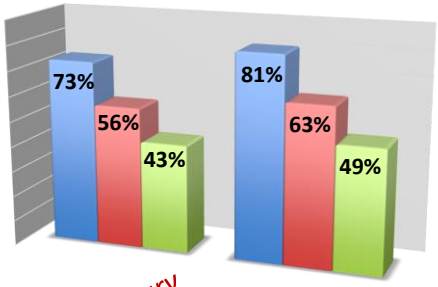
PI Action:

Formal Lab Safety Discussions:

- Weekly / Monthly
- Quarterly
- Yearly / Never



Trainees/Staff Reaction:

Trainees/staff would report to PI:

A minor injury

A near miss

Regular and frequent lab safety discussions strongly correlate with higher incident reporting

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Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT

How many injuries (minor or major) **has your immediate lab group had in the last two years?**

- 0
- 1
- 2
- 3
- 4 or more

** If your answer differs greatly from the choices above tell us in the chat!*

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SAFETY TRAINING CONSORTIUM

Do Faculty and Trainees Safety Attitudes and Behaviors Impact Safety Outcomes?

How Can Injuries be Prevented?

Correlating behavior with Safety Outcomes:

- Near misses
- Minor injuries
- Major injuries (see: *J Chem Health Safety 2016, 23:12-23*)

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Fewer minor injuries are reported when PI includes risk assessment in experimental design

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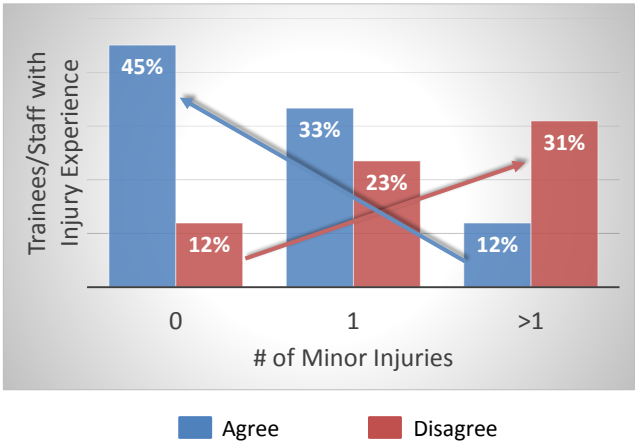
My mentor/professor discusses with me how to conduct experiments safely.



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Fewer minor injuries are reported when trainees/staff perform risk assessments

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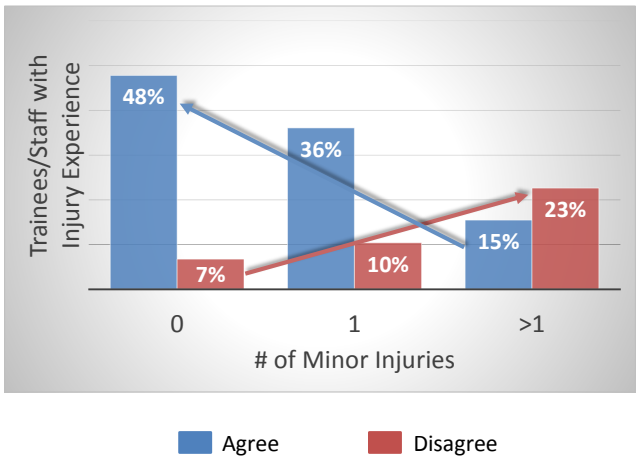
People in my lab consider safety procedures before they conduct a new or scaled-up experiment.



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Key Findings and Recommendations

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SAFETY TRAINING CONSORTIUM

PI/Faculty Engagement to Improve Laboratory Safety

- ✓ PIs should discuss with students and staff how to conduct experiments safely
- ✓ PIs should require students and staff to consider safety procedures before they conduct a new or scaled-up experiment
- ✓ PIs should teach hazard identification and risk assessment
- ✓ PIs should monitor students' safety practices
- ✓ PIs should regularly discuss safety in lab group meetings
- ✓ PIs should discuss near misses and Lessons Learned
- ✓ PIs should wear proper PPE
- ✓ PIs should exemplify proper safety

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Think Safety

UC Center for Laboratory Safety

SAFETY TRAINING CONSORTIUM

- ***What could go wrong?***
- ***How can I prevent it?***
- ***How can I prepare for the unexpected?***

The End – Be Safe!

Thanks to my outstanding colleagues in the UC Center for Laboratory Safety:

Dr. Imke Schroeder - *UCCLS Project Manager*

Dr. Elizabeth Czornyj - *UCCLS Researcher*

Dr. Nancy Wayne - *UCCLS Board Chair*

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Associate Director for Emerging Technologies, National Institute for Occupational Safety and Health

Debbie Decker
Safety Manager, Department of Chemistry , University of California, Davis

Ken Kretchman
Director of Environmental Health Safety, North Carolina State University

Craig Merlic
Professor of Chemistry, University of California, Los Angeles

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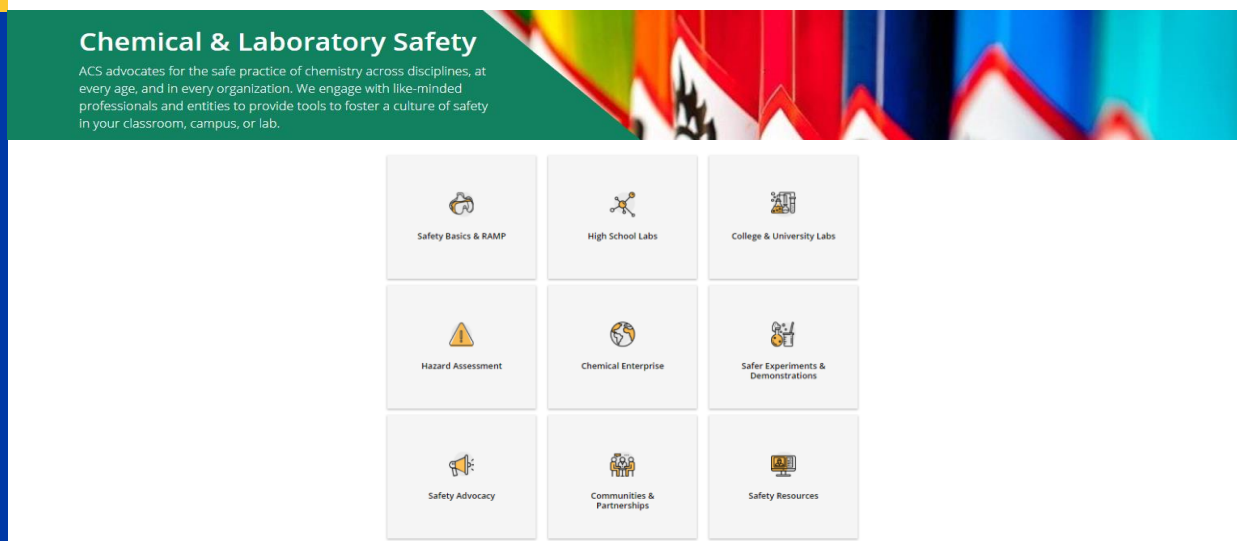

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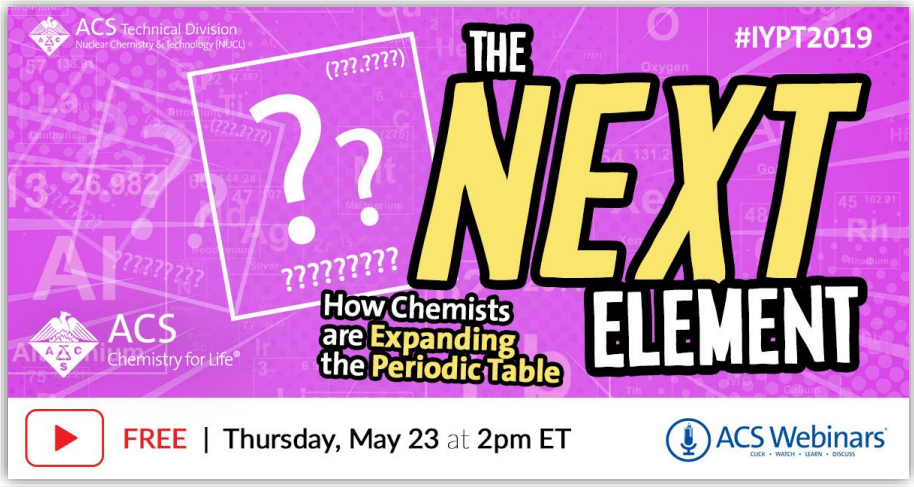

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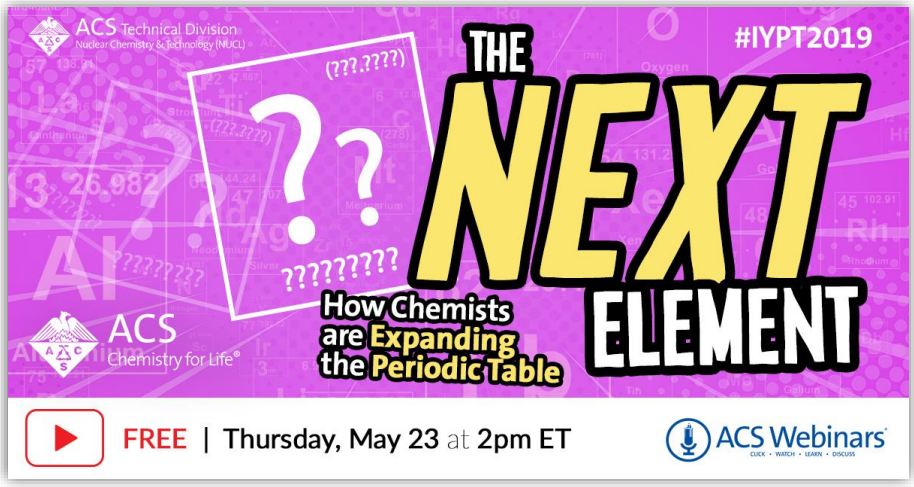

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