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NNI's Nano4Earth Kick-Off Workshop

Key Takeaways and Opportunities for the Nano Community

Matthew Hull, PhD
Research Professor, Virginia Tech
Director, Nanoscale Characterization & Fabrication Laboratory
NNCI/NanoEarth AD, Innovation & Entrepreneurship
President/Founder, NanoSafe, Inc.

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NanoEarth

Nano4EARTH – NNI National Nanotechnology Challenge

- Advance Biden-Harris commitment to the climate crisis in **<4 years**
- Nano-enabled batteries, catalysts, coatings, CO_2 capture technologies
- Share resources, entrepreneurship barriers, technology adoption strategies
- *"Just the beginning"* – B. Brough
  - Build a community *(>400 participants)*
  - Start a conversation
  - Add focus

The White House OSTP and the NNI National Nanotechnology Challenges aim to mobilize the nanotechnology community to help address global issues.

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https://www.nano.gov/nano4EARTH

US DOE Office of Science Perspective

- 2050 net zero carbon goal
- Nano Research Centers at DOE
- DOE Office of Science Initiatives
  - RENEW: Training in under-served/represented institutions
  - FAIR: Funding for Accelerated & Inclusive Research
  - PIER: Promoting Inclusive & Equitable Research

Dr. Asmeret Asefaw Berhe,
Director, US DOE Office of Science

Justice 40 Initiative

JUSTICE 40
PEOPLE POWER PROSPERITY

Focus on communities most impacted by climate change, pollution, environmental hazards.

Directs 40% of the overall benefits of certain Federal investments to flow to disadvantaged communities.

Includes investments in:

- Clean energy, energy efficiency;
- Clean transit;
- Affordable, sustainable housing;
- Training, workforce development;
- Remediation, reduction of legacy pollution;
- Clean water infrastructure

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$200M DOE Energy Earthshot Research Centers (EERCs)

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Hydrogen

1 Dollar | 1 Kilogram | 1 Decade

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Storage™

Long Duration Storage Shot

Reduce storage costs by 90%* | ...in storage systems that deliver 10+ hours of duration | ...in 1 decade

*from a 2020 Li-ion baseline

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Carbon Negative™

<100 Dollars | 1 Ton | 1 Decade

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Enhanced Geothermal™

90% Reduction | 2035

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Floating Offshore Wind™

>70% Reduction | 2035

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Industrial Heat™

85% Reduction | 2035

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Led by national labs. Accelerate breakthroughs of more abundant, affordable, and reliable clean energy solutions within the decade.

https://www.energy.gov/policy/energy-earthshots-initiative

Kavli Foundation Perspective

- Funding nanoscience as a field – *one of the only philanthropies to do so*
- >20 years to implementation – remember, we're trying to impact commodities with low margins
- Focus: Where can we have the greatest impact?
  - Biodegradable plastics from nanoparticle-wrapped enzymes
  - Hydrogen storage using"passionfruit" nanospheres
  - Solid state refrigerants based on 2D perovskite layers
  - Carbon-capture using metal organic frameworks (MOFs)
- The Mosaic Materials story

Dr. Cynthia Friend, President, The Kavli Foundation

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mosaic materials

From Basic Science to Deployment
MOFs for carbon capture

Acquisition, deployment

Baker Hughes

Tom McDonald
Mosaic Materials co-founder
Activate Cohort 2015 Fellow

SBIR·STTR America's Seed Fund

arpa·e

mosaic materials

Commercialization
SBIR/STTR, ARPA-E

Activate

Early career
Activate Fellowship

NASA

Early applications
US Navy, NASA

CGS Center for Gas Separations

U.S. DEPARTMENT OF ENERGY | Office of Science

Basic science
DOE EFRC

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"The defense industry often has been the first customer."

Shovel Ready

<4 years

Translate nano-enabled technologies for immediate impact on climate change

Building momentum

Targeted

2050

Improved efficiencies within existing processes and infrastructure to achieve 2050 net zero carbon goal

Realizing Net Zero

Blue Skies

>2050

From basic research to transformative “blue sky” approaches

Beyond Net Zero

Blue Skies

>2050

From basic research to transformative "blue sky" approaches

Beyond Net Zero

Nanoscience and Climate Phenomena

Dr. Mike Kuperberg, Executive Director, U.S. Global Change Research Program

- How do we address molecular scale aspects of climate scale problems?
- DOE cloud/precipitation problem has persisted for long-time with no good solutions.
- Can nano help advance our understanding of nuclei formation, ice crystals, etc?

Targeted 2050

Improved efficiencies within existing processes and infrastructure to achieve 2050 net zero carbon goal

Realizing Net Zero

Optimizing Existing Materials, Processes, Infrastructure

Dr. Michele Ostraat, Chief Scientist, Pajarito Powder

Previously with Aramco and the National Energy Technology Laboratory (NETL)

- Hard to imagine out-performing mature industries like petro-chemical
- Focus on technologies to use energy more efficiently, especially for large-scale industrial processes
- Catalysts, membranes, and sorbents at the top of the list
- Consideration of environmental health and safety (EHS)

Shovel Ready – Tech on Shelves

Dr. Sally Benson, Deputy Director for Energy and Chief Strategist for the Energy Transition, Office of Science and Technology Policy, Executive Office of the President

- How do we expedite commercialization?
  - NSF I-Corps
  - DOD xTech
- Compress innovation cycle from 20-30 years to 5-10 years
  - Translational facilities
  - Stepping-stone markets
  - Innovation communities
- Support throughout innovation cycle – keep promising companies in the fight

Nano is Already Transforming Energy Tech

What's the hold up getting to market?

Carbon Nanotechnology Lowers Cost of Hydrogen Fuel Cell

Florida State University

To keep the world's growing army of cell phone towers constantly powered so mobile phone users can enjoy ubiquitous service, telecommunication providers are scrambling to find viable solutions to supplement unstable power grids or meet new r...

See Full Story

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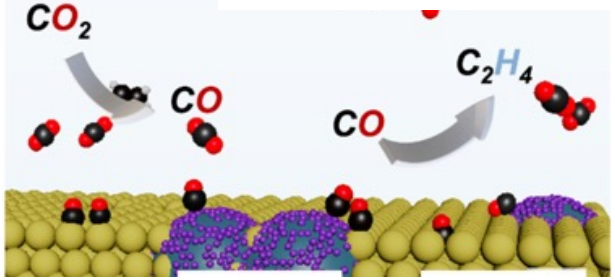
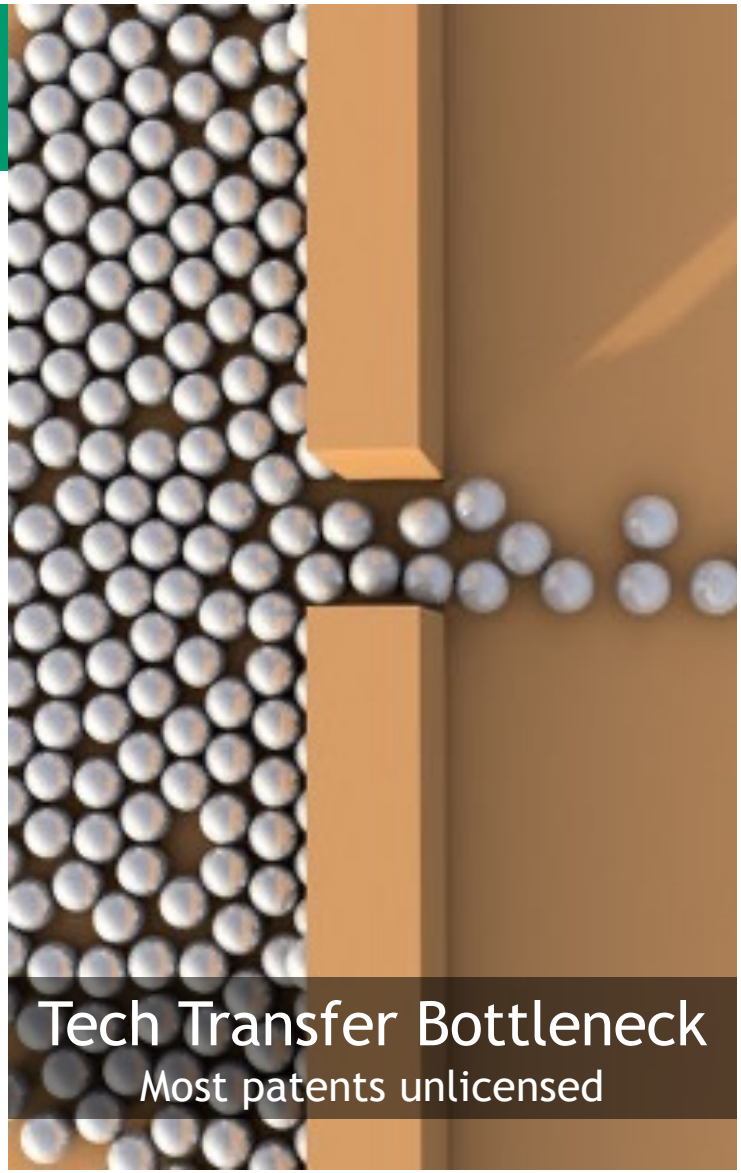
Stanford University

Metal catalysts for CO_2 conversion



"a novel and specific photocatalyst" Nano?



Tech Transfer Bottleneck

Most patents unlicensed

Tech Transfer is Challenging

"Rich in Ideas, Poor in Resources" –E. Cave, Twelve

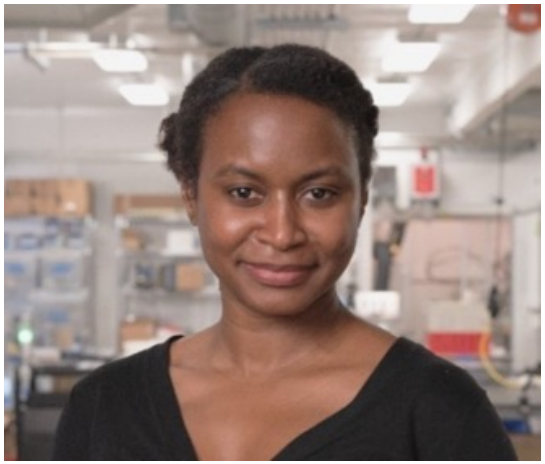
Smart Material Solutions

SBIR/STTR, Army xTech, RTNN User Facilities

Dr. Nichole Cates
Smart Material Solutions

twelve

DOE Activate CRADA



Dr. Etosha Cave
Twelve

CHAIN REACTION INNOVATIONS
Entrepreneurship at Argonne

Fellowships for innovators focused on clean energy

Dr. Dick T. Co
Chain Reaction Innovations, Argonne National Laboratory

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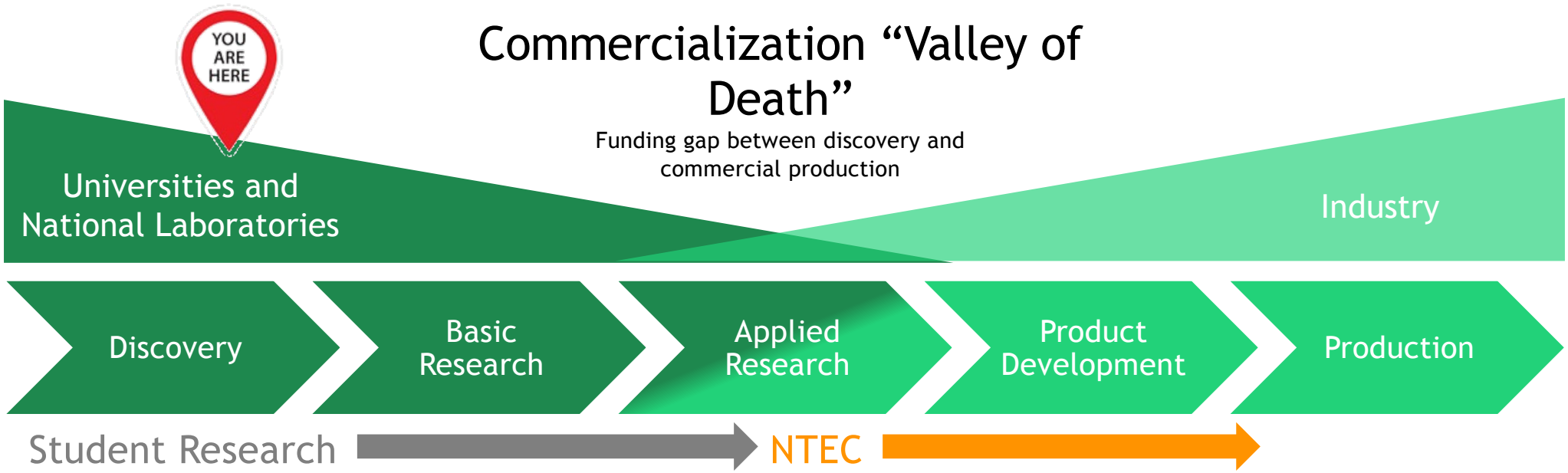
How Can We Better Serve Promising Nano4EARTH Entrepreneurs?

NNCI NTEC – Support Shovel-Ready Nano4EARTH Ideas



NTEC provides funds and mentorship to help NNCI undergrads/grads/post-docs translate nano-enabled solutions from the lab to the market.

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Easy to Apply!

Win $500 to $1,000 to translate nano-enabled tech for climate

1. Complete 1 page application (right)
2. Email it to mahull@vt.edu

Due February 28th

Extended for Nano4EARTH

Don't have an idea? Check out your university tech transfer office.

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Title:	
Student Leader (name/email) and Level (BS, MS, PhD):	
Faculty/Staff Mentor (name/email):	
NNCI Site Affiliation (more info):	
Award Type (pick one):	*1) Regular ($500) OR 2) Diversity Award ($1,000)*

1. Briefly describe your innovative idea *OR* the technology you wish to license from an NNCI site.

2. What customer/societal problem are you attempting to address? How does your idea offer a solution?

3. How does nanotechnology offer a competitive advantage in addressing the problem noted above?

4. Briefly describe the initial market(s) for your idea, the market size, and the target customer.

5. Budget: Briefly describe what you plan to accomplish with the award and complete the table below.

6. Complete the budget table

Budget Item	Amount	Brief Description
Materials & Supplies	$ -	
Analytical (e.g., NNCI node)	$ -	
Travel (Diversity Award only)	$ -	

7. Faculty mentorship statement: Briefly describe the nature of your support for the proposed project.

Key Takeaways and Synthesis

- Look closely at DOE opps – connect with an EERC
- Nano as a tool in the toolbox - *"you don't necessarily need a lot of nano to get the benefits"*
- Shovel Ready – Focus on the **4** in Nano**4**EARTH
  - Inventory IP at universities, government labs (nano not obvious)
  - Be aggressive with small-scale seed funds (e.g., NTEC)
  - Keep promising start-ups in the fight
- Top innovators, entrepreneurs often have a day job

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Continue the Conversation

March 22-24, Washington, D.C.

…brings together experts from different technical disciplines and professional communities to think about America's energy challenges in new and innovative ways.

May 17, 2023, Alexandria, VA

…facilitate partnerships between businesses and federal laboratories, universities, and private-sector innovators—including government-funded startups—offering a wide range of green energy technologies for licensing, including green hydrogen, energy storage, and wind energy.

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