Physical Sciences

Technology Available for Licensing

DARTMOUTH
Technology Transfer

2020-014

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US PATENT APPLICATION 17/766,121

Handheld, Inexpensive, Side-by-side Transmission Probe

PRINCIPAL INVESTIGATOR: Paul M. Meaney, Professor of Engineering, Dartmouth
CO-INVENTORS: Timothy Raynolds, Lead Senior Systems Engineer, Dartmouth | Dr. Robin Augustine, Associate Professor of Electrical Engineering, Uppsala University

VIEW PUBLICATION

DESCRIPTION

- Critical to clinical diagnosis and monitoring of conditions such as lymphedema, edema and skin wound is an **accurate picture** of all the diseased and injured tissues.
- Current technologies such as commercial reflection-based dielectric probes include **inadequate penetration** for interrogating deeper tissues and **high sensitivity** to movement during measurements, rendering them less suitable for dynamic or point-of-care applications.
- This **handheld, inexpensive, side-by-side transmission dielectric probe** builds upon the principles of **oversized coaxial probes and transmission techniques**, combining deeper signal penetration with reduced susceptibility to artifacts and improved clinical usability.
- The probe operates using an **"open-circuit" coaxial interface**, where a signal fringes out from one open-circuit coax and is coupled to an adjacent receiving open-circuit coax, propagating through the intervening tissue for interrogation.

ADVANTAGES AND BENEFITS:

- **Enhanced penetration:** This technology achieves penetration depths of **several centimeters**, far surpassing the sub-millimeter range of existing probes.
- **Motion artifact reduction:** Its transmission-based design is far **less susceptible to cable motion artifacts** than current technologies.
- **Improved clinical applicability:** The **side-by-side layout mitigates multi-path signal corruption**, enhancing clinical versatility.
- **Broadband capability:** An "open-circuit" coaxial interface enables **very broad bandwidth** and rich spectral content for diagnosis at varying tissue depths.
- **Portability and cost:** The probe pairs with emerging **handheld Vector Network Analyzers (VNAs) operating up to 3 GHz for under $500**.
- Prototypes have been fabricated using **advanced CAD and metal 3D metal printing**, showing strong early promise. The design has evolved from earlier concepts, now potentially using **elliptical coaxes** to better confine fields and focus the interrogation zone.

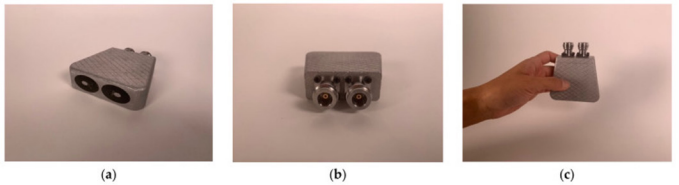

Figure. 1: Preliminary design of the probe.

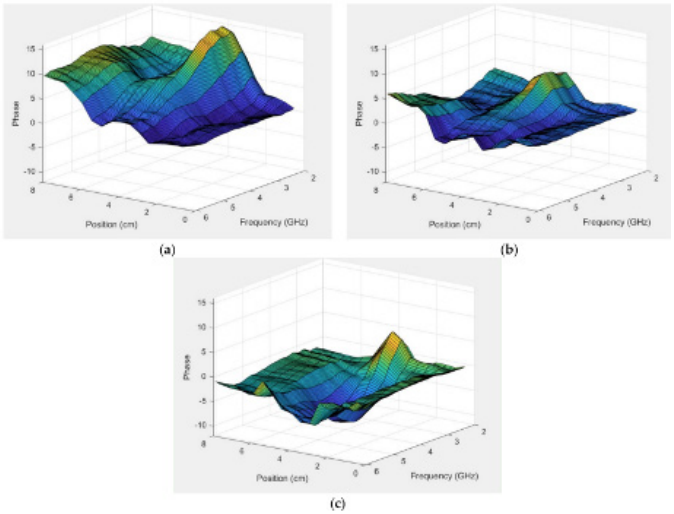

Figure. 2: Normalized phase plots as a function of horizontal position above muscle phantom for all frequencies: (a) 4.32, (b) 2.54, and (c) 1.78 cm diameter. The fat rod was clearly visible for a relatively large frequency range (2-4 GHz).

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2020-039

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PCT/US2020/067713
US PATENT APPLICATION US18/709,497

Novel Cathode Material to Improve Capacity & Life Span of Li & Na Batteries

PRINCIPAL INVESTIGATOR: Dr. Weiyang (Fiona) Li, Professor of Engineering

VIEW PUBLICATION

INVENTION OVERVIEW

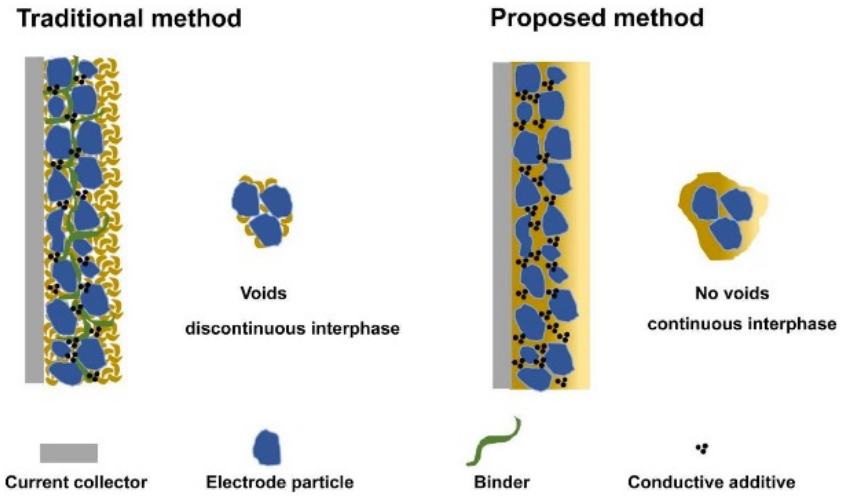
- The invention provides **a metal-sulfur battery, where the cathode/catholyte is a metal-phosphorothioate**.
- The melt phase can be used as a binder and ion-conducting buffer for battery electrodes.
- Synthesis is a simple two-step mixing process; forming a metal polysulfide followed by mixing with phosphorus pentasulfide to form the metal phosphorothioate. Compatible with both Li- and Na-Sulfur batteries.
- Cathode is formed from a combination of the metal phosphorothioate, electroconductive carbon black, and a salt.

ADVANTAGES

- **Improved Performance:** Use of Li or Na Phosphorothioate improves energy density, diffusion rate and electrochemical kinetics by creating a continuous interphase and removing voids.
- **Superior electrochemical performance:** 25% greater initial capacity with significantly greater Coulombic efficiency compared to conventional metal-sulfur battery.
- **Cost-effective:** The raw materials of sodium phosphorothioates are inexpensive and the fabrication method uses a scalable and time-saving process.

MORE DETAILS

- The core innovation is a complexation-precipitation method to produce sodium/lithium phosphorothioates by reacting sodium/lithium sulfide, phosphorus pentasulfide, and sulfur powders in a solvent such as diglyme.
- The solid-state electrolyte (P_2S_5-Na_2S_8) exhibits an ionic conductivity of **3.04×10^{-2}** mS cm^{-1}, while its melt phase shows a conductivity of **5.70×10^{-3}** mS cm^{-1} and maintains this conductivity even after cooling as measured using electrochemical impedance spectroscopy (EIS).
- Low temperature battery performance shown down to −60°C with long-term operability down to −40°C.



Comparison of electrode preparation for solid-state batteries in traditional method and proposed method. Note that the P2S5-Na2S8 melt works as binder and ion-conducting buffer. (patent no. 63/278,700)

Prototype test results and comparisons for NaS battery

	NaS catholyte w/ Na anode	Conventional NaS battery
Cyclic Retention	80% over 400 cycles	n/av
Coulombic Efficiency	> 95% over 200 cycles	< 50% over < 50 cycles
Initial Capacity	440 mAh/g active sulfur	350 mAh/g active sulfur

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2020-039

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US PATENT APPLICATION US17/790,245
US PATENT APPLICATION US18/709,497

Novel Cathode Material to Improve Capacity & Life Span of Li & Na Batteries

PRINCIPAL INVESTIGATOR: Dr. Weiyang (Fiona) Li, Professor of Engineering

VIEW PUBLICATION

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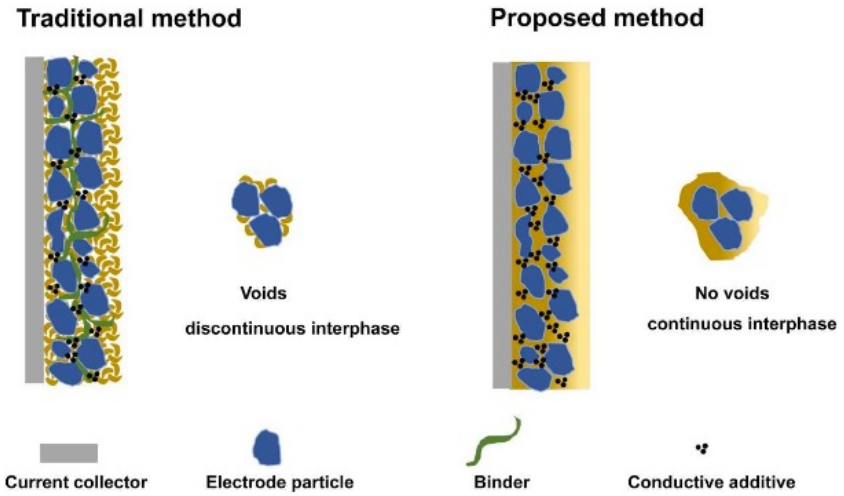

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2020-075

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Acyclic/cyclic ether-based electrolyte that outstretches the low temperature limit of sodium metal anode

PRINCIPAL INVESTIGATOR: Dr. Weiyang (Fiona) Li, Professor of Engineering

VIEW PUBLICATION

INVENTION OVERVIEW

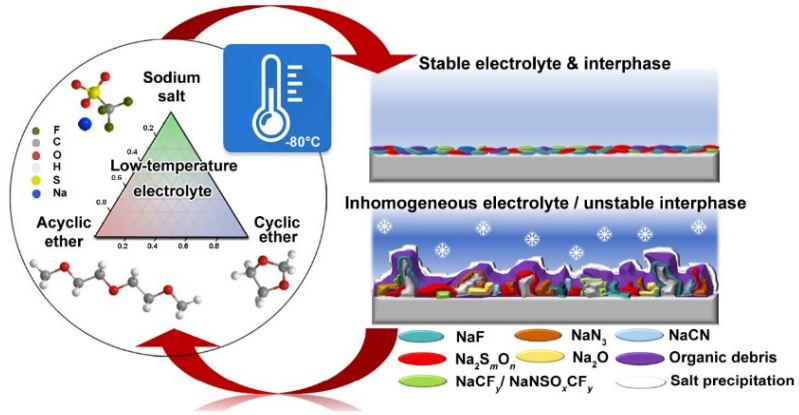
- Novel **low-temperature electrolytes** designed for sodium metal batteries using acyclic and cyclic ether solvents.
- Compatible with Na, Li and K based batteries.
- Customizable electrolyte composition for efficient operation at ranges between **–20°C and –150°C**.
- Lithium-ion batteries (LIBs) suffer from significant energy losses below 0°C, with commercial LIBs delivering only 5% of their energy density and 1 .25% of their power density at –40°C.
- There is a need for alternative battery technologies that can operate effectively at extreme low temperatures.

ADVANTAGES

- **Low temperature performance:** Stable operation of sodium metal batteries at temperatures below –80°C without salt precipitation or solvent freezing.
- **Enhanced stability:** Reduced dendrite formation = lower incidence of battery failure.
- **Improved efficiency:** Low electrolyte resistance and high ion transfer/migration at low temperatures, showing small overpotentials of less than 50 mV and stable cycling for more than 2000 hours in Na/Na symmetric cells.
- Broad applications: Applicable to portable devices, scientific tools in polar regions, or space exploration where temperatures can drop to –125°C.

MORE DETAILS

- The electrolytes consist of sodium conducting salts such as sodium trifluoromethanesulfonate (NaOTf) and/or sodium hexafluorophosphate (NaPF6) combined with organic ether-based solvents.
- The use of a binary solvent electrolyte consisting of 0.5M NaOTf in DEGDME/DOL (was shown to enable stable sodium plating and stripping with a low overpotential of 50mV even at a temperature of **–80°C** for over **2000** hours.



Low-temperature electrolytes consist of sodium conducting salts and unary/binary solvent including acyclic ethers and/or cyclic ethers in a range of mixing ratios. (patent no. PCT/US2021/045,949)

Comparisons between acyclic/cyclic ether-based electrolyte battery against existing battery solutions

	Acyclic/Cyclic ether-based	Standard Li-ion	Low-Temp Li-ion
Temp Range (°C)	–150 to –20	–40 to 0	–50 to –10
Capacity Retention	>95% @–40°C	5% @–40°C	80% @–40°C
Low-Temp Efficiency	<50mV overpotential	>200mV polarization	100-150mV polarization
Dendrite Formation	Low	High	Low

Source: Benzo energy, Sunpower, UFine battery, Wang et al. (2022)

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2021-026

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US PATENT NO 11,771,323
US PATENT APPLICATION 18/229,086

Optical time-of-flight imaging methods and systems for surgical guidance and fluorescence depth estimation in tissue

PRINCIPAL INVESTIGATORS: Dr. Brian W. Pogue, Adjunct Professor of Engineering | Dr. Petr Brůža, Assistant Professor of Engineering

VIEW PUBLICATION

DESCRIPTION

- Critical information about the depth and shape of targets in florescence-guided surgery procedures is limited by the **one-millimeter visualization** barrier that hampers objectivity and utility.
- This invention introduces an **optical imaging system** that leverages time-of-flight data to precisely determine the depth and shape of fluorescence-tagged targets, such as tumor tissue, embedded within scattering media like healthy tissue.
- The technology addresses limitations in current surgical tumor guidance by **enabling subsurface imaging through diffuse radiation transport**.

ADVANTAGES AND BENEFITS:

- **Enhanced visualization:** The technology provides surgeons with crucial information about the depth and shape of fluorescent targets in vivo or ex vivo, offering guidance during procedures like fluorescence-guided surgery.
- **Improved accuracy:** By integrating multi-wavelength time-of-flight data, the invention calculates the target's surface topology, optical properties, and fluorophore depth, enhancing the precision of depth localization and shape evaluation.
- **Signal discrimination:** The technology reliably distinguishes the primary fluorescence signal from reflected secondary signals using time-of-flight information.

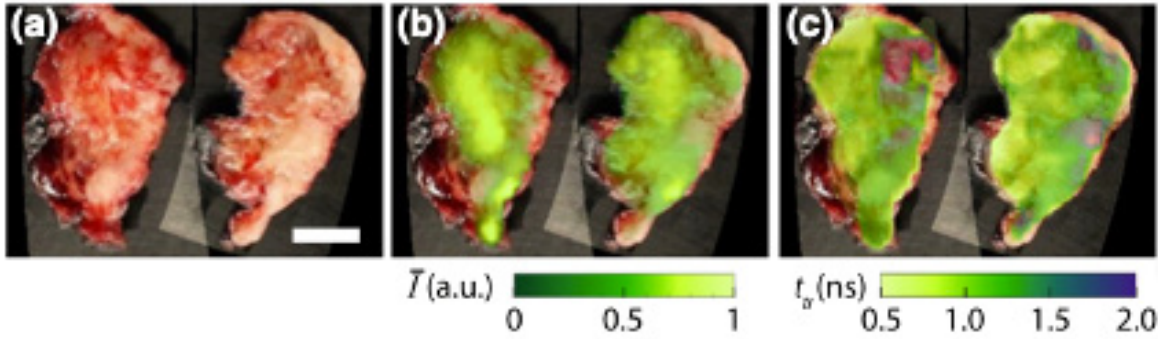

Figure 1: *In vivo* fluorescence LiDAR imaging of a resected head and neck tumour using time of flight data reveal picomolar ABY 029 fluorescence and map margins beneath the surface.

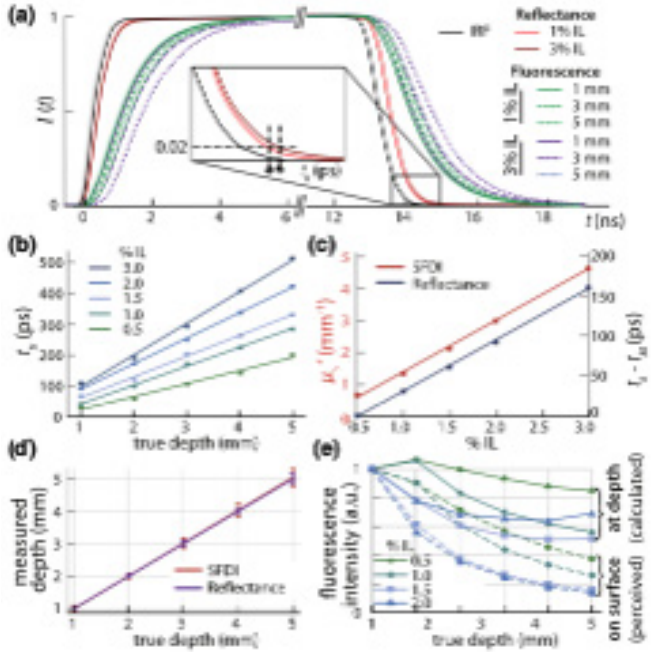

Figure 2: (a) shows depth dependent fluorescence/reflectance traces; (b) converts rising edge delay into a linear depth ruler; (c) retrieves tissue scattering and kernel width; (d) validates depth estimates within ≈0.3 mm across 1–5 mm; and (e) corrects surface measured intensity to the true subsurface fluorophore signal.

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2022-020

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US PATENT APPLICATION 18/849,436

Clay Minerals to Sequester Carbon from the Ocean Surface

PRINCIPAL INVESTIGATOR: Dr. Mukul Sharma, Professor of Earth Sciences

VIEW PUBLICATION

DESCRIPTION

Current atmospheric CO_2 removal technologies **lack the scale and cost-effectiveness** needed to accelerate the transition to a low-carbon economy. The marine biological pump processes significant atmospheric carbon (~25 Pg/year as DOM and 5–12 Pg as POM), but over 90% is oxidized back to CO_2 in the upper ocean.

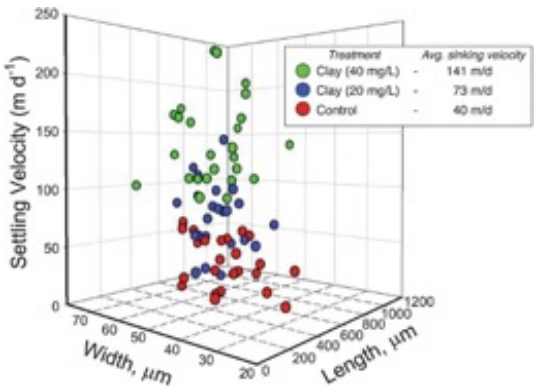
By promoting organoclay floc formation and rapid export, the process greatly increases the fraction of bloom-captured carbon that is sequestered in the deep ocean rather than being rapidly returned to the atmosphere.

FEATURES AND OPERATING PRINCIPLES

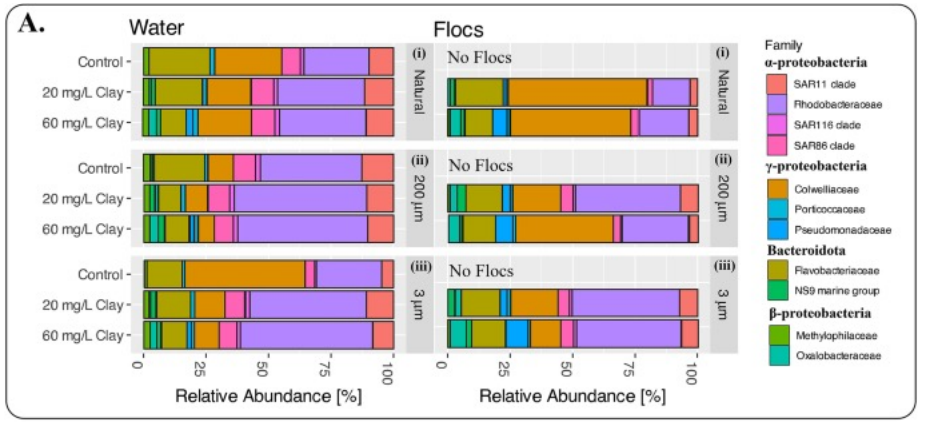
- A mixture of clay minerals (e.g., palygorskite) is applied to surface waters at the end of phytoplankton blooms, acting as ballast and increasing the density and sinking velocity of organic matter.
- Experiments show that clay addition leads to sticky organoclay flocs, which are consumed by zooplankton and repackaged into dense fecal pellets that sink rapidly during diel vertical migration, enhancing the biological pump.
- The Scientific Reports study quantitatively confirms this pathway: in Gulf of Maine bloom microcosms, adding clay at experimentally relevant concentrations removed 15–42% of phytoplankton organic carbon from the surface layer (up to ~52% in some treatments) by packaging it into rapidly settling organoclay flocs

ADVANTAGES AND BENEFITS

- **High-impact, scalable CDR:** Clay minerals could remove **>1 billion metric tons of atmospheric CO_2 per year** by sprinkling ~10 million tons of clay, leveraging existing natural ocean processes.
- **Demonstrated mechanism:** Peer-reviewed lab and mesocosm experiments show that clay enhances flocculation and carbon export without harming marine bacteria or phytoplankton.
- **Low-cost, abundant feedstocks:** Clay minerals are inexpensive, widely available, and can be sourced from mining and phosphate-processing by-products, turning waste streams into climate assets.
- **Deployment-ready logistics:** Clay can be deployed using existing aerial application infrastructure (e.g., crop-dusting aircraft). Field trials off Southern California will test real-world performance.



Sinking velocity of fecal pellets produced by *Calanus finmarchicus* following feeding on a diet comprising algae Rhodomonas salina supplemented with varying concentrations of clay for control and treatment groups.



Relative abundance and beta diversity from the 16s rRNA gene amplicon sequencing of bacterial communities in water and floc samples. Clay supplementation leads to floc formation with no change in bacterial population.

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2023-006

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PENDING APPLICATION PCT/US23/077930

Nitrogen and Sulfur co-doped MXene compounds for improved hydrogen evolution reaction

PRINCIPAL INVESTIGATOR: Dr. Will Scheideler, Assistant Professor of Engineering

VIEW PUBLICATION

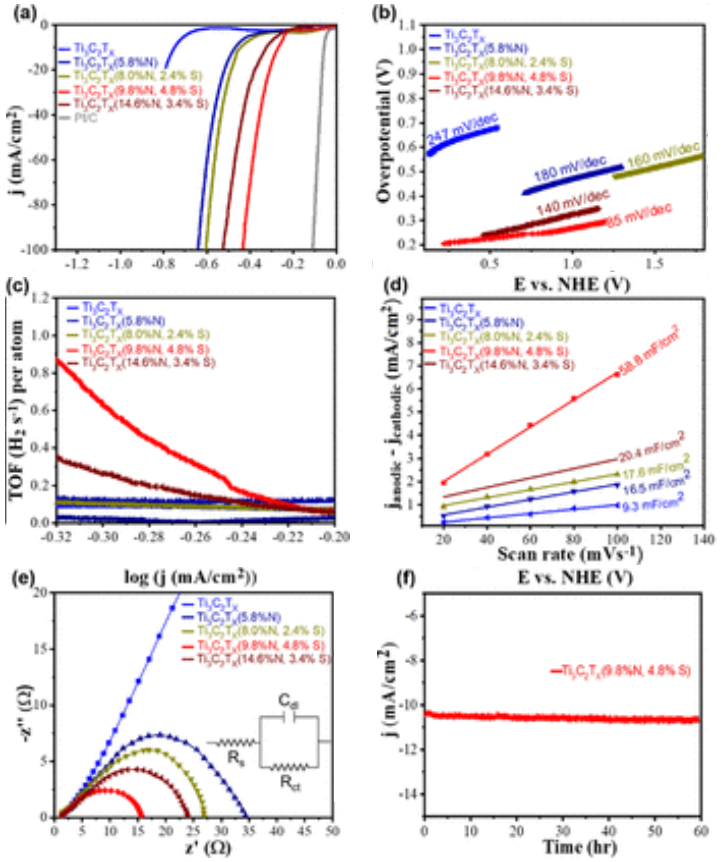
INVENTION OVERVIEW

- N- and S- co-doped MXene compounds offer improved performance and stability in hydrogen evolution reaction compared to existing MXene materials which are limited by poor intrinsic chemical activity and limited active site densities
- Simple thermal annealing process using solid thiourea at 300-700°C for 1-3 hours; allows for controlled surface modification of MXenes and the creation of new chemical bonds.

MXene	Standard Li-ion	Low-Temp Li-ion
Co-doped Ti3C2Tx	260mV	85mV/dec
Pristine Ti3C2Tx	~770mV	247mV/dec

ADVANTAGES AND SCOPE

- **Enhanced performance:** This technology overcomes the limitations of poor intrinsic chemical activity and the limited active site densities of pristine MXenes by tuning the interfacial chemical co-doping with anions and is more stable than Mxenes with metallic electron donors (Fe, Ni, and Co).
- **Improved electrocatalytic activity:** The modified MXenes show significantly reduced overpotential for the hydrogen evolution reaction, achieving 260 mV at 10 mA/cm² which is three times lower than pristine Ti3C2Tx (-770 mV).
- **Broad applicability:** The technology is generally applicable to electrocatalytically accelerating hydrogen evolution activity and could be extended to other MXenes and to enhance their performance in other electrochemical device applications such as supercapacitors and fuel cells.



Electrocatalytic performance of pristine and doped MXene

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2023-035

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PCT/US2024/025537

Novel Soil Amendment to Remove Atmospheric Carbon Dioxide

PRINCIPAL INVESTIGATOR: Dr. Mukul Sharma, Professor of Earth Sciences

VIEW PUBLICATION

INVENTION OVERVIEW

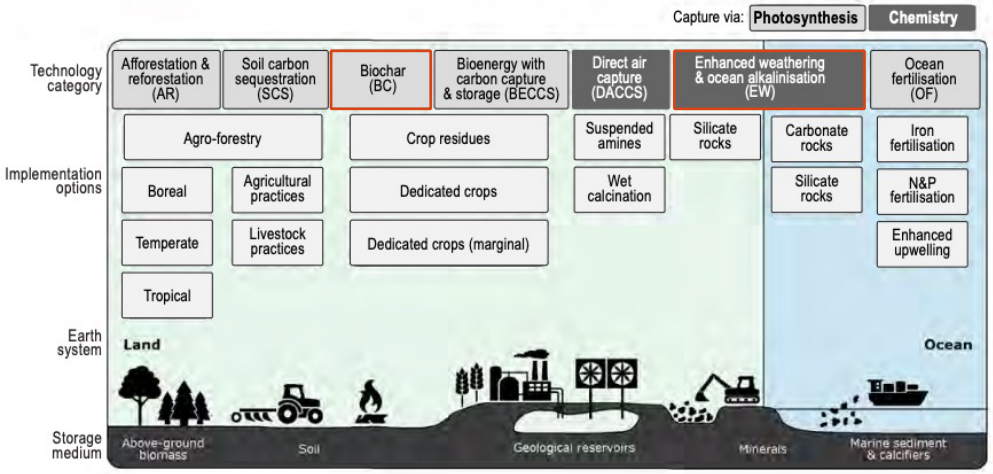
- Two current approaches to carbon dioxide removal (CDR) — enhanced silicate rock weathering (EW) and the application of biochar (BC) — **both have individual limitations**.
- **A novel soil amendment**, Altered Basalt with Fortified Biochar (ABFB), is a composite material consisting of both biochar and basalt that can simultaneously **reduce atmospheric CO_2 and increase soil fertility**.
- This technology **addresses the limitations of EW** by accelerating basalt weathering kinetics and also **mitigates the drawbacks of BC** by minimizing the release of CO_2 during production and avoiding the synthesis of pollutants.

FEATURES / OPERATING PRINCIPALS

- ABFB consists of generating an altered basalt through heating and mixing it with BC, which can be derived from various biomass sources.
- This new material becomes a pool of recalcitrant carbon that can reduce atmospheric CO_2 and increase soil fertility by sequestering mineral bound refractory carbon in soil and producing soluble bicarbonate ion (HCO_3^-) that has a mean residence time of 10,000 years in the environment.

ADVANTAGES / SCOPE

- **Reduced Material Usage**: The invention requires about 100 times less basalt than traditional EW.
- **Enhanced CO_2 Removal**: ABFB is projected to remove 0.3-0.5 tons of CO_2 per ton of ABFB per year.
- **Soil Health**: ABFB improves soil fertility by providing nutrients, decreasing soil acidity, and increasing soil carbon and water content.
- **Reduced Pollutants**: ABFB does not contain harmful organic pollutants that can be present in BC.
- **Scalability**: The reduced material requirements and enhanced reaction rates make the technology more scalable than traditional EW.
- **Cost Efficiency**: The technology is estimated to cost less than $100 to remove a ton of CO_2.
- **Resource Utilization**: The process utilizes waste heat and liquid from BC production, increasing efficiency.



Proposed technologies to get to net-zero. This invention proposes the combination of both Biochar (BC) and Enhanced Weathering (EW).

Figure credit: Baker S.E. et al., 2020, Lawrence Livermore National Lab.(LLNL), Livermore, CA (United States). Retrieved: https://gs.llnl.gov/sites/gs/files/2021-08/getting_to_neutral.pdf

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2023-036

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PENDING APPLICATION PCT/US24/33807

Micro-lattice transition metal oxide materials and structures for efficient electrocatalysis

PRINCIPAL INVESTIGATOR: Dr. Will Scheideler, Assistant Professor of Engineering

VIEW PUBLICATION

INVENTION OVERVIEW

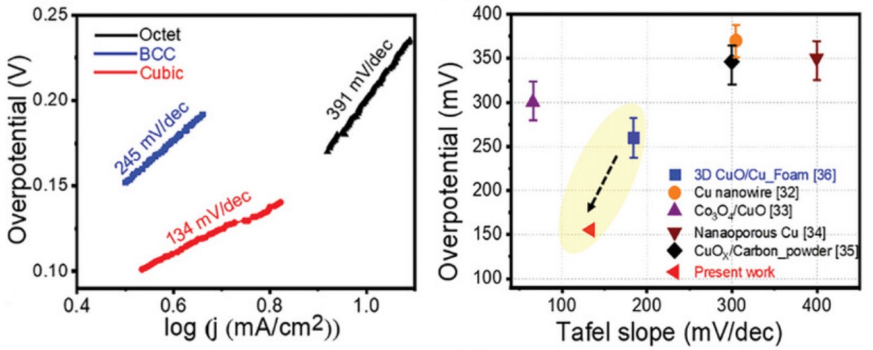
- Novel materials, structures and fabrication processes for highly stable and efficient electrocatalysts for hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) processes.
- Current nickel- and transition metal oxide-based electrocatalysts in alkaline media suffer from sluggish kinetics, stability issues, and low active site density, severely limiting their efficiency. Platinum group metal electrocatalysts are efficient and stable but expensive.

FEATURES

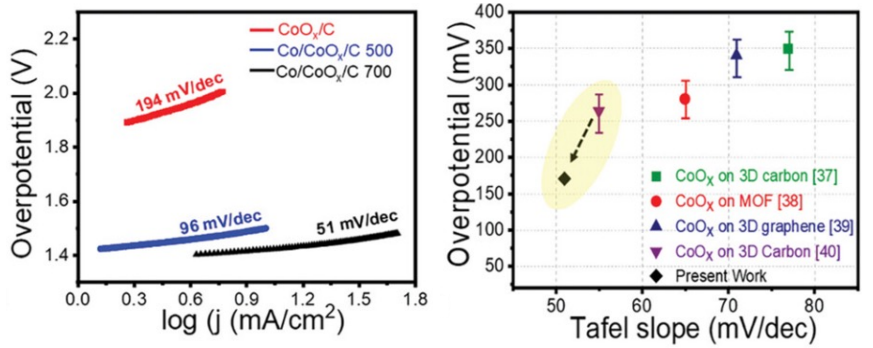
- The innovation uses 3D-printed, lattice-based mesoporous electrodes that provide a high density of electrochemically active sites, facilitate reactant transport, and enhance stability via efficient bubble evolution. The electrodes are fabricated using a polymer infusion additive manufacturing (PIAM) technique.
- The 3D electrodes showed promising performance metrics: an overpotential of **155 mV at 10 mA/cm² for HER and 1.42 V at 10 mA/cm² for OER**.
- The electrodes also exhibit superior durability, with up to 240 hours of continuous hydrogen evolution without significant performance changes.

ADVANTAGES AND SCOPE

- **High stability:** This invention overcomes the limitations of low stability and activity of traditional earth-abundant electrocatalysts through 3D structuring and chemical modification via a simple heat treatment.
- **Scalability and cost:** 3-D printing manufacturing methods are low-cost and use earth-abundant materials, offering a significant cost advantage over precision metal catalysts.
- **Improved performance:** Superior overpotential for OER and HER compared to existing solutions and benchmark noble metal-based electrocatalysts; improved stability over 3D catalysts and powder electrocatalysts.
- **Design flexibility:** The process allows for greater design freedom in electrode architecture and the mixing of multiple transition metal precursors to form complex alloys for various catalytic reactions (HER, OER, CO2 reduction, etc). The pore structure facilitates bubble release, preventing blockage of active sites.



Electrocatalytic performance for HER of different microlattices in 1.0 M KOH solution. Left: Tafel plots. Right: Comparison of overpotential at 10 mA cm−2 and Tafel slopes between 3D microlattices of Cu/CuOx/C and other 3D structured electrocatalysts



Electrocatalytic performance for OER of Co/CoOx/C and CoOx/C cubic microlattices catalysts in 1.0 M KOH solution. Left: Tafel plots. Right: Comparison of overpotential at 10 mA cm−2 and Tafel slopes between 3D microlattices of Co/CoOx/C and other 3D structured electrocatalysts.

DARTMOUTH
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2024-004

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US PATENT APPLICATION 18/883,022

Enhanced magnetic performance of Manganese Aluminum alloy via Titanium addition

PRINCIPAL INVESTIGATOR: Dr. Ian Baker, Professor of Engineering

VIEW PUBLICATION

INVENTION OVERVIEW

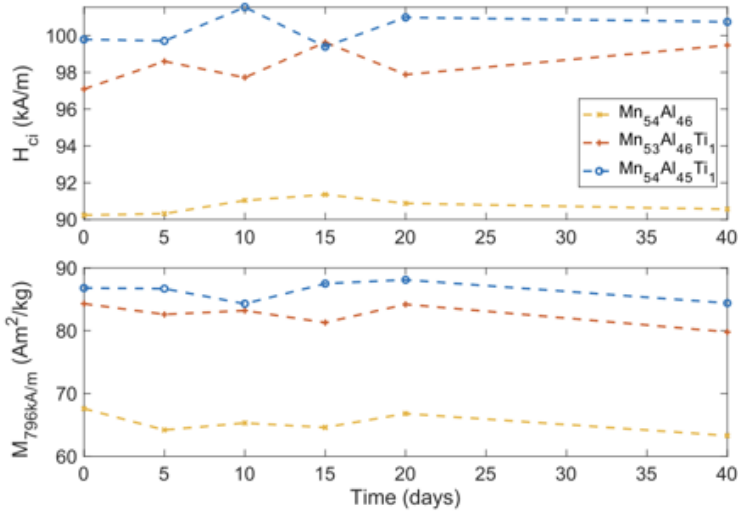
- This invention is a permanent magnet (PM) composed of a manganese-aluminum-titanium (**Mn-Al-Ti**) alloy, designed to improve upon existing magnet technology.
- Current permanent magnets with the highest performance are based on neodymium-iron-boron (Nd-Fe-B) and samarium-cobalt (Sm-Co), which have high raw material costs, scarcity, and require extractive mining.
- Manganese and aluminum are cheaper and more abundant, but current Mn-Al PMs do not perform as well as rare-earth magnets due to limitations in achieving both high coercivity and remanence, and issues with anti-phase boundary (APB) defects.

FEATURES AND OPERATING PRINCIPLES

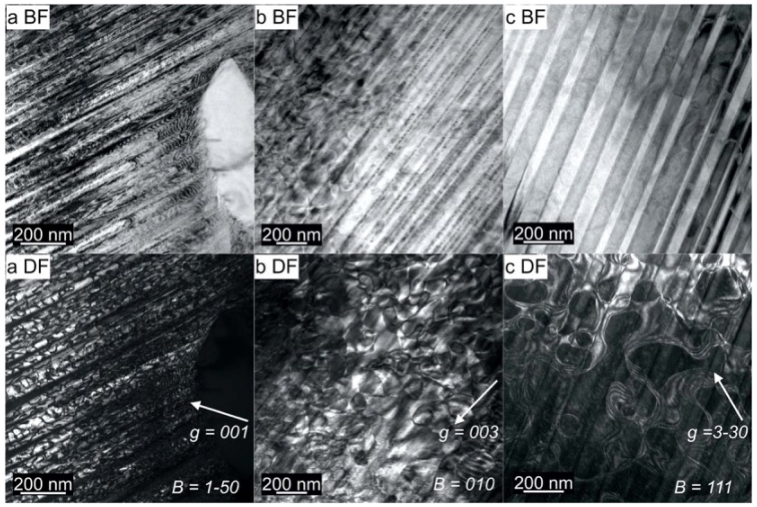
- The core of the innovation is a Mn-Al-Ti alloy, with a targeted composition of about **1% of titanium**, which is found to preferentially sit on APBs to enable better ferromagnetic pairing across the APB.
- Experimental results demonstrate that a composition of $Mn_{54}Al_{45}Ti_1$ exhibits a **33% improvement** in the base magnetic performance factor (BHmax), as well as increased remanence and equivalent or greater coercivity compared to the standard $Mn_{54}Al_{46}$ alloy.

ADVANTAGES

- **Improved performance:** The Mn-Al-Ti magnet exhibits higher magnetic remanence, equivalent or greater coercivity, and more stable coercivity at high temperatures compared to the standard Mn-Al alloy.
- **Reduced defects:** The invention significantly lowers the density of APB defects and increases the size of anti-phase domains, leading to improved properties.
- **Enhanced stability:** The titanium stabilizes the coercivity of the magnet at high temperatures and enables high temperature processing without losing coercivity.
- **Cost-effective alternative:** The Mn-Al-Ti alloy provides a potential replacement for expensive rare-earth magnets by utilizing cheaper and more abundant materials such as manganese and aluminum.



H_{ci} and M as a function of time at 250ºC in air. Samples were not demagnetized corrected, so M values are relative and not absolute.



TEM BF and DF images of Mn-Al-Ti alloys showing how the density of APBs decreases with Ti addition. (a) $Mn_{54}Al_{46}$ (b) $Mn_{54}Al_{46}$ Ti1 (c) $Mn_{54}Al_{45}Ti_1$. *B* is the beam direction and g is the diffraction vector.

DARTMOUTH
Technology Transfer

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2024-046

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US PATENT APPLICATION 63/688,132

A New Class of Stable and Earth-Abundant Thin Film PV Materials

PRINCIPAL INVESTIGATOR: Dr. Geoffroy Hautier, Hodgson Family Professor of Engineering

VIEW PUBLICATION

INVENTION OVERVIEW

This technology introduces a new class of Zintl-phosphide materials (AM_2P_2 family) for thin-film solar applications that combine earth-abundant compositions, high efficiency potential, and exceptional stability. A flagship compound, $BaCd_2P_2$, was discovered by high-throughput first-principles screening of ~40,000 inorganic compounds and then experimentally validated as a promising solar absorber.

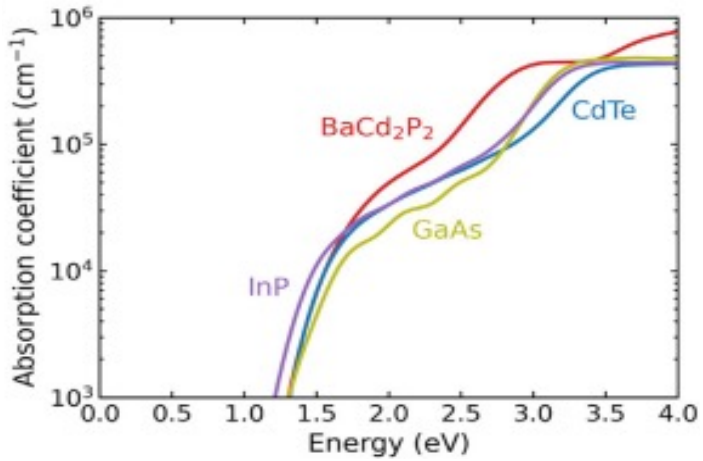
The invention covers this Zintl-phosphide platform and its use in thin-film photovoltaics, with opportunities to extend to cadmium-free analogs such as $CaZn_2P_2$ and related compositions.

FEATURES AND BENEFITS

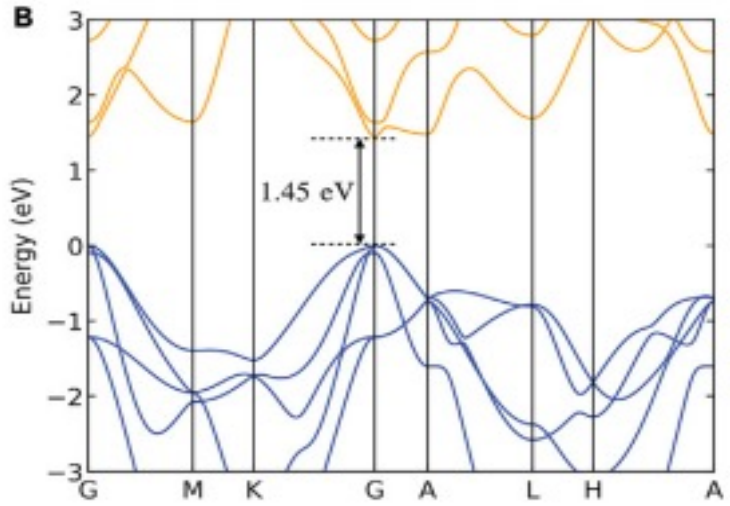
- **High-Efficiency Potential:** Near-optimal band gap (~1.45 eV), strong photoluminescence, and long carrier lifetimes (~30 ns) observed even in unoptimized powder indicate substantial efficiency headroom. Performance trends approach GaAs despite low material purity, demonstrating strong intrinsic optoelectronic quality.
- **Defect tolerance and transport:** Calculations and measurements show no dominant deep nonradiative defects. Favorable electron and hole effective masses support efficient thin-film carrier transport.
- **Environmental Stability:** Structurally stable for months in air and after water or alkaline exposure; degradation occurs only in strong acids. This reduces encapsulation demands relative to many emerging absorbers.

ADVANTAGES

- New material class, not an incremental tweak: Opens an AM_2P_2 Zintl-phosphide family for PV, rather than a single experimental compound.
- Device-ready direction: Stability and optoelectronic properties make $BaCd_2P_2$ and analogs strong candidates for thin-film or tandem top cells.



Improved optical absorption of $BaCd_2P_2$



Optimal Electronic band structure

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2024-049

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US PATENT 18/776,887

A Dynamic Framework for Managing an Integrated Energy System Under Uncertainty

PRINCIPAL INVESTIGATOR: Dr. James E. Smith, Professor in Decision Science

VIEW PUBLICATION

INVENTION OVERVIEW

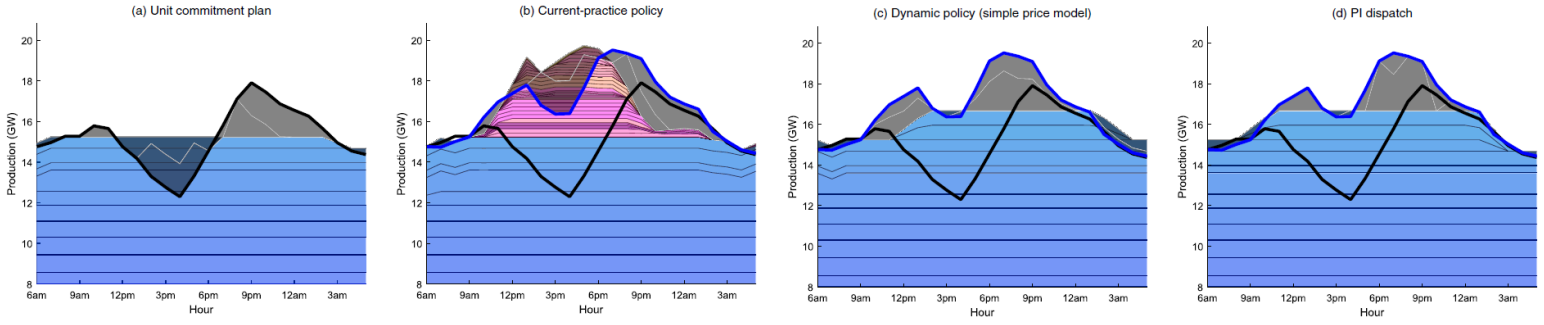
- This invention provides a **dynamic framework for managing an integrated energy system** using a novel approach based on weakly coupled stochastic dynamic programming.
- Current practices in energy management involve solving "unit commitment" and"economic dispatch" optimization problems, which, while complex, do not explicitly **incorporate uncertainty**.
- The increasing use of renewable energy sources has exacerbated issues related to variability and uncertainty in power systems, creating a need for better management techniques.

FEATURES AND OPERATING PRINCIPLES

- The model decomposes an integrated energy system across its various units, then uses a price model to describe the marginal value of energy production, allowing each unit to maximize its expected profit given uncertain prices.
- The system operator can start up or shut down slow-start units and deploy storage as desired, and the ramping constraints are fully respected in this dynamic approach. The unit-specific value functions from the dynamic program are used to incorporate longer-term effects in dispatch decisions.

ADVANTAGES

- **Addresses uncertainty:** This dynamic programming method incorporates uncertainty in energy demand and renewable supply, enabling more efficient energy system operation.
- **Improved efficiency:** The dynamic approach can reduce operational costs by ~2% on average in the present Duke Energy Carolinas system and can reduce costs by 4–5% on average in a future system with increased solar and storage capacity.
- **Near-optimal performance:** The dynamic approach performs, on average, within 0.2–0.3% of production plans based on perfect foresight about future net demands.
- **Scalability:** This method is computationally feasible at an industrial scale and can solve the Lagrangian dual problems on a desktop computer in seconds to minutes.



Unit commitment plan to meet deterministic demand forecast (shown with black line).

Given this plan, system response to higher than expected demand (shown with blue line); the unexpected peak is covered using peaking units. Costs are 12.4% more than with perfect information (PI).

Dynamic plan adjusts forecasts mid-morning and starts slow-start units and uses storage to cover unexpected peak. Costs are 0.3% more than PI.

With perfect information about demand. It is optimal to start slow-start units earlier and use less storage in the morning.

Key:

Blue = production from slow-start units
Pink = production from fast-start units (peakers)
Gray= into storage (dark gray) or from storage (light gray)

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2025-023

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PCT PATENT APPLICATION:
PCT/US2025/057931

Development of Porous Heterogeneous Catalysts for Energy-efficient & Sustainable Industrial Synthesis

PRINCIPAL INVESTIGATOR: Dr. Miguel Gonzalez, Assistant Professor of Chemistry

INVENTION OVERVIEW

- 80% of industrial catalytic processes rely on heterogeneous catalysts, but they are **unable to precisely control** reaction outcomes, leading to significant **waste** and **costly** purification steps.
- This invention describes a surface-bound porous catalyst platform for heterogeneous catalysis in industrial and fine-chemical synthesis, allowing for **recoverable catalysts with high activity and improved selectivity**.

KEY ADVANTAGES

- **Eliminates Trade-Offs:** Enables highly reactive, precise and recoverable catalysts, **reducing** expensive purification and replacement **costs**.
- **Adaptable across catalyst metals/reactions:** Readily adaptable to different supported metal catalysts.
- **Unlocks new High-Value Production:** Enables solid catalysts to access lucrative **new markets** where they currently fail to perform in, such as chiral pharmaceuticals and premium polymer feedstocks.
- **Platform for Catalyst Design:** Provides a modular, tunable system to rapidly develop optimized catalysts for specific high-value reactions, **de-risking R&D**.

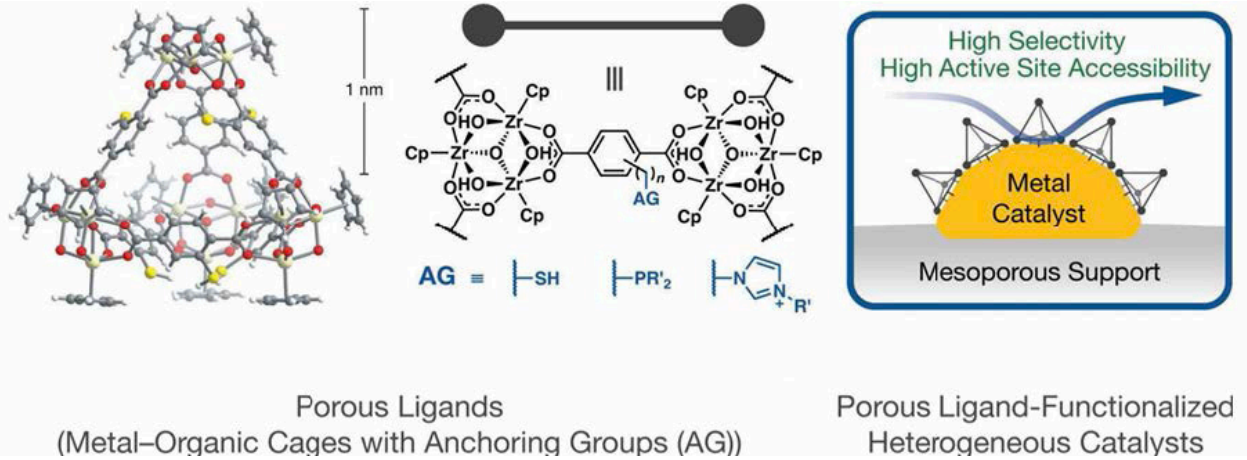
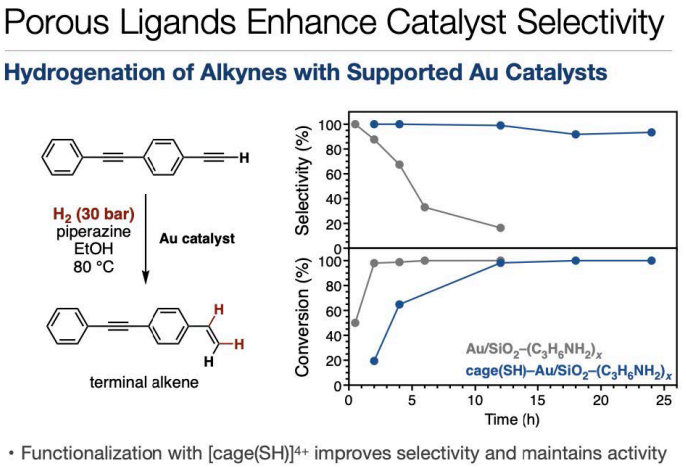


Figure 1 (left):
The invention uses a metal-organic cage as a porous ligand, which anchors to the catalyst surface, allowing reactant access while maintaining a selective microenvironment.

Figure 2 (right):
Porous cage functionalization improves selectivity while maintaining activity (supported Au catalysts).



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2025-031

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US PROVISIONAL APPLICATION 63/820,802
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High-Speed Event Cameras for Extreme Motion and High-Dynamic-Range Scenarios

PRINCIPAL INVESTIGATOR: Adithya Pediredla, Assistant Professor, Computer Science, Dartmouth
CO-INVENTORS: Ziyuan Qu, PhD Student, Computer Science, Dartmouth | Vivek Boominathan, Assistant Research Professor, Computer Engineering, Rice University
Praneeth Chakravarthula, Assistant Research Professor, Computer Science, University of North Carolina | Zihao Zou, PhD Student, Computer Science, University of North Carolina

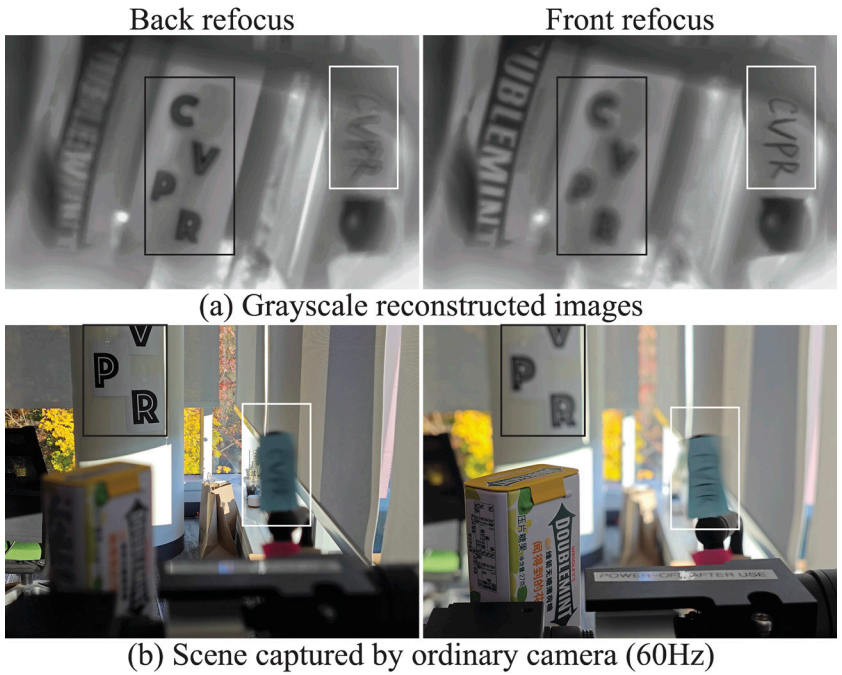
VIEW PUBLICATION

DESCRIPTION

- Capturing high-speed visual objects in real-time in science and engineering applications has become a necessity. Traditional high-speed cameras are noteworthy, but they are **bulky, expensive and can only record for a short time**.
- This invention proposes leveraging **a complementary setup of event cameras**, which allows for post-capture manipulation of high-speed video, rapid refocusing on fast-moving objects, real-time true depth estimation and high-dynamic light field capture.
- The technology compared with traditional high-speed cameras provides continuous streaming, reduces bandwidth requirements and is more affordable while enabling robust imaging in **high-speed, high-dynamic-range scenarios**.

ADVANTAGES AND BENEFITS

- **Affordability:** The technology lowers the cost of high-speed cameras, making high-speed cameras more broadly affordable and available.
- **Angular Capture:** The technology extends current event camera capabilities introducing angular capture allowing for post-capture manipulation of the high-speed video, which was not possible in prior setups.
- **Ultra Capture:** The technology captures light fields with unprecedented speed, resolution, and dynamic range resulting in high-speed, low-latency imaging with post-capture refocusing, depth estimation, and HDR capabilities.



Using our galvanometer design at 250 Hz, we capture a scene with a rotating fan marked-with "CVPR", spinning at 300 rpm. (a) Using prior knowledge of the scanned mirror's location, we refocus on the background or the rotating fan in the foreground. (b) An ordinary camera captures the scene at 60Hz, focusing on the background and foreground from different viewpoints. The camera lacks refocus ability and causes motion blur on the fan due to the slower shutter speed.

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Dartmouth Health

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2026-036

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US PROVISIONAL APPLICATION : 63/949,926

Anti-ferroelectric Weberite-type Materials

PRINCIPAL INVESTIGATOR: Dr. Geoffroy Hautier, Hodgson Family Professor of Engineering

INVENTION OVERVIEW

- Antiferroelectrics (AFEs) are valuable for applications in energy storage, cooling, and non-volatile memory but are rare, and current **R&D is limited** to small sets of material families, **limiting the available performance** and slowing discovery of new solutions.
- This invention introduces a new AFE material and a broader weberite-type family, with a **simpler** distortion **mechanism** and a **smaller volume change** during the AFE to FE phase transition.

KEY ADVANTAGES

- **High-field robustness:** The La_3NbO_7 AFE displays a much **higher breakdown strength** than currently optimised AFEs, enabling **operations at higher fields** especially in energy storage.
- **Lower mechanical stress when switching:** The newly developed AFE yields very **small volume change** upon switching, preventing cracking and resulting in **better cycling durability and overall yield**.
- **Demonstrated switchable AFE behavior:** The invention is the first demonstration of a switchable Kittel-type AFE, with a **simpler** AFE to FE switching **process** allowing for a **more controllable** engineering knob-set.

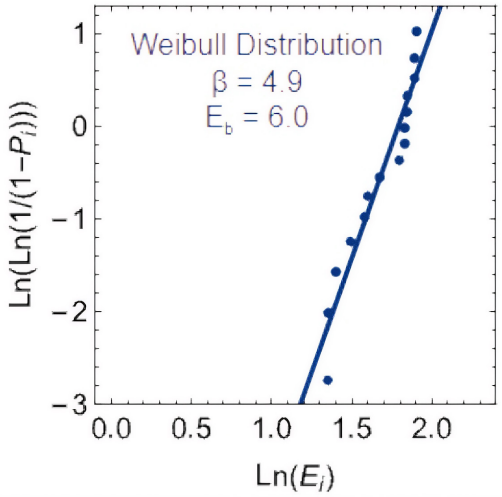

Figure 1:
Weibull analysis across 15 devices gives a characteristic breakdown field of ~6 MV/cm, significantly higher than many optimized AFE thin films currently being used

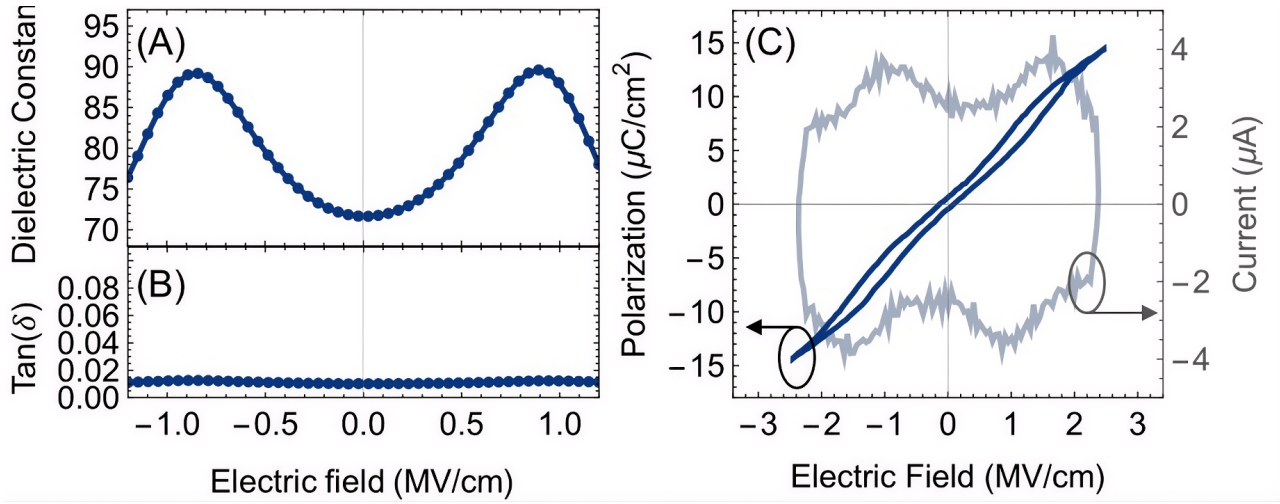

Figure 2:
Capacitor measurements show double peaks in dielectric constant vs electric field and double-hysteresis / four switching-current peaks, confirming field-driven antiferroelectric switching

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