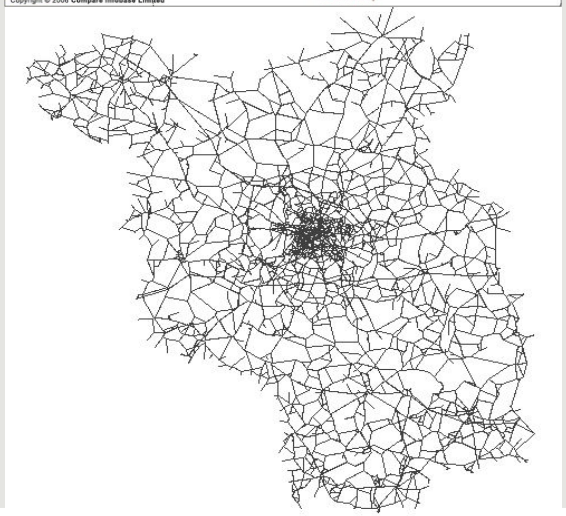
Nanocatalysts to solve energy and environmental problems

ALEXANDER ORLOV, STONY BROOK UNIVERSITY, USA

- Developing new methods for nanoparticle synthesis using He droplets
- Utilizing new nanocatalysts to produce sustainable energy from water and CO_2

Calibration of large-scale traffic simulators

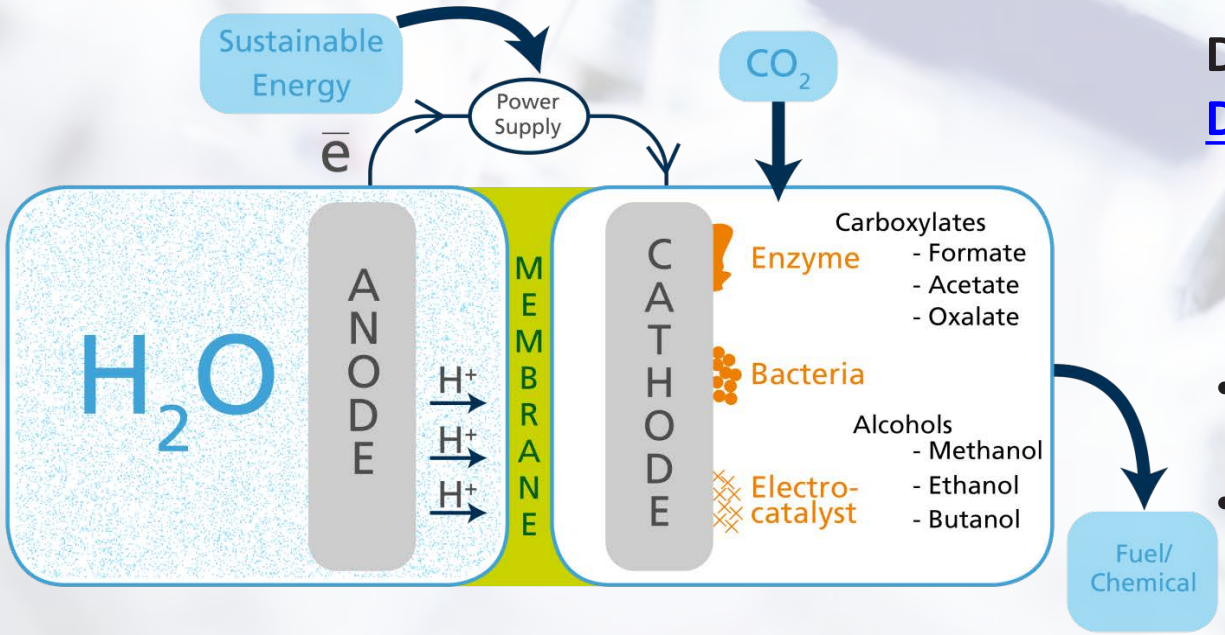


C. Zhang (MIT), C. Osorio (MIT), G. Flötteröd (KTH)

- Efficient estimation of demand and supply parameters of traffic simulators
- Large-scale networks: Berlin metropolitan network, with over 24,000 links, and 172,000 trips
- Algorithm reduces simulation runtime by 80%
- Of interest to transportation agencies around the world

cee.mit.edu/osorio

Bioelectrochemical CO_2 Reduction to Chemicals: Improved microbial Electrosynthesis using Gas Diffusion electrodes



Dr. Deepak Pant
Deepak.pant@vito.be

- Electricity-driven CO_2 reduction using biocatalyst
- Homoacetogenic bacteria

$2\ HCO_3^- + 9\ H^+ + 8\ e^- \rightarrow CH_3COO^- + 4\ H_2O$
$E = -0.28$ V vs SHE pH 7

CO_2 to chemicals/fuels

Chemical drivers

- A more sustainable local feedstock
- Utilize existing waste streams/exhaust
- Possibilities for new chemistry/materials

Energy drivers

- Peak shaving of renewable energy supplies
- Energy storage in fuels
- Less dependence on geographical location
- public acceptance

Novelty

Gas diffusion electrode (GDE) instead of submerged electrode

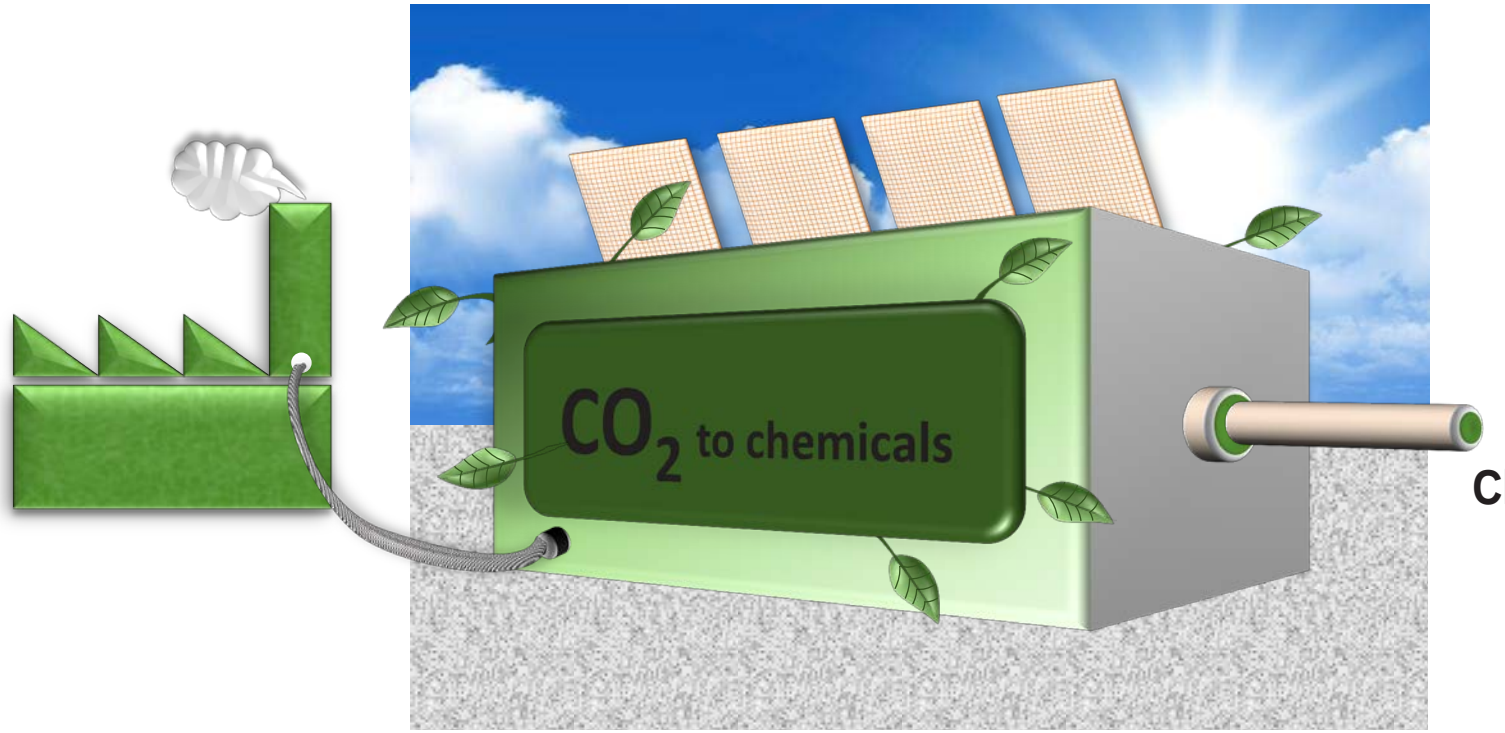
To enhance CO_2 mass transfer

For direct CO_2 capture and conversion form waste gas

To provide reducing equivalents at active sites

- Biocatalyst can access adsorbed CO_2, dissolved CO_2 and HCO_3^-

ElectroRefinery



Acetic Acid

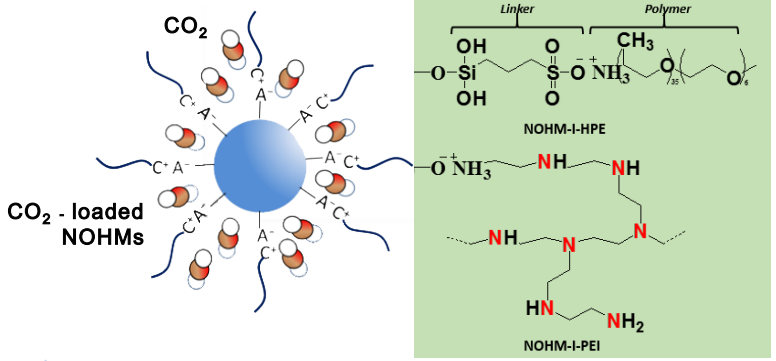
Formic Acid

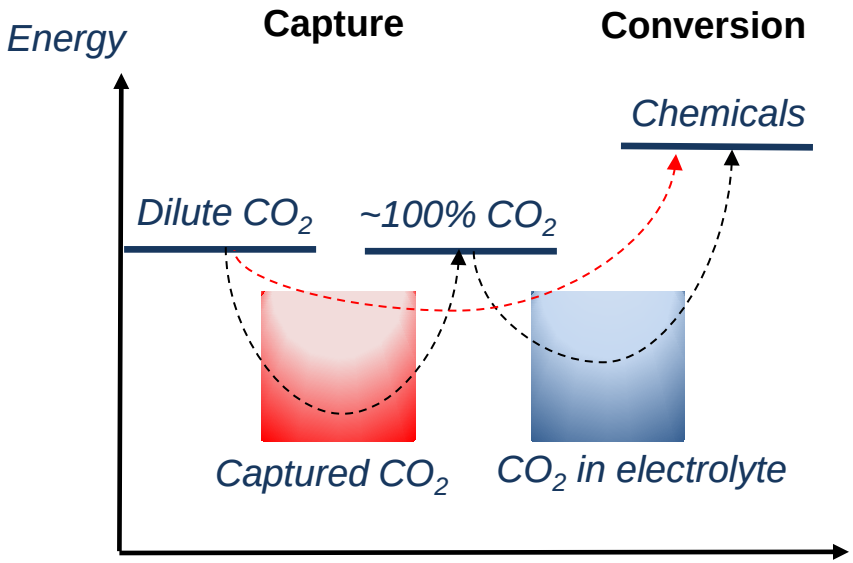
Base Chemicals

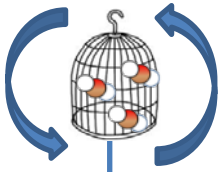
Novel Liquid-like NOHMs-based Electrolyte for Combined CO_2 Capture and Conversion

COLUMBIA ENGINEERING
The Fu Foundation School of Engineering and Applied Science

A.-H. Alissa Park, Columbia University, New York







Waste gas
5 ~ 30% CO_2

CO_2 capture

Power

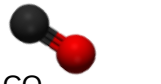
Cement

Steel

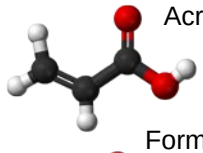
Carbon-free electrons and H_2

CO_2 conversion (e.g. electrochemical,…)

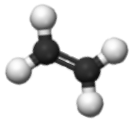
Chemicals & Fuels



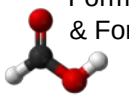
CO



Acrylic Acid & Acrylates



Ethylene & Higher Hydrocarbons



Formic Acid & Formates

Taking electrons out of bioelectronics: from bioprotonic transistors to shark's electrosensors

Marco Rolandi, *Department of Electrical Engineering*

University of California Santa Cruz

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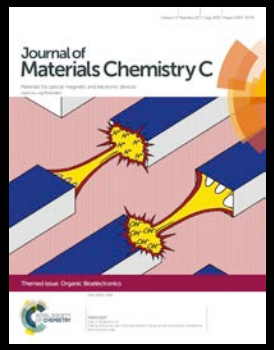
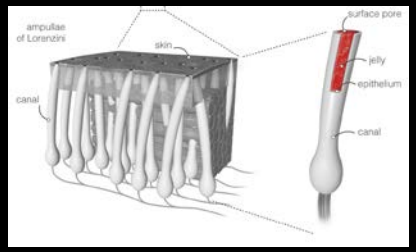
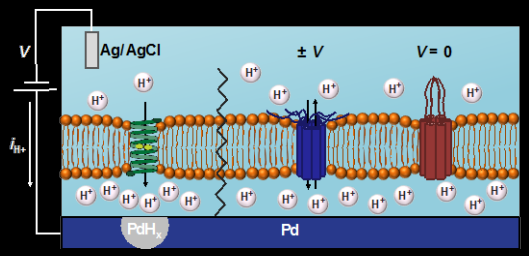




The New York Times, Washington Post, IEEE Spectrum, The New Scientist, Materials 360, Materials Views, Santa Cruz Sentinel, EnGadget, Popular Science, MIT Review (Chinese), Le Scienze (Italy), Cosmos (Australia), Inovacao Technologica (Brazil)

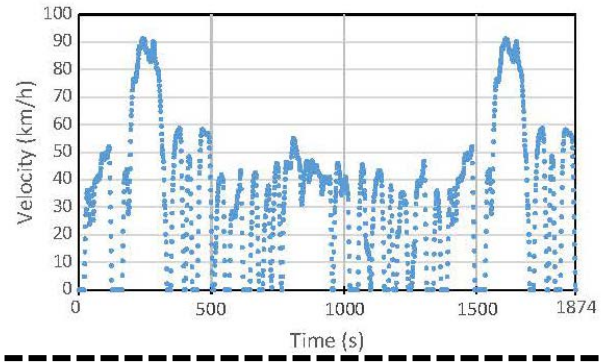


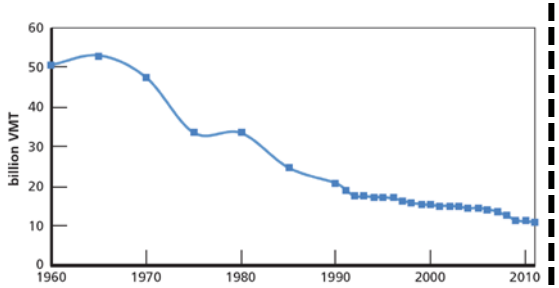
Modeling to inform the transition to automation

Costa Samaras
Carnegie Mellon University

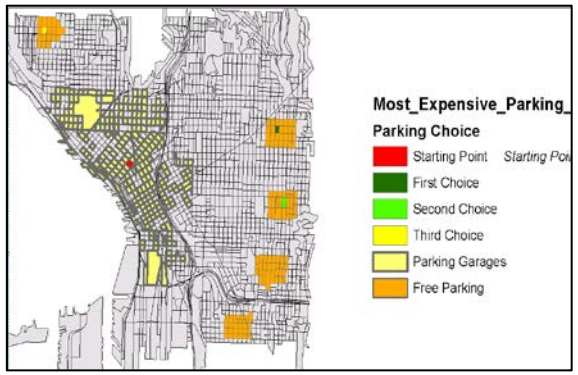
Modeling & simulation of how automation

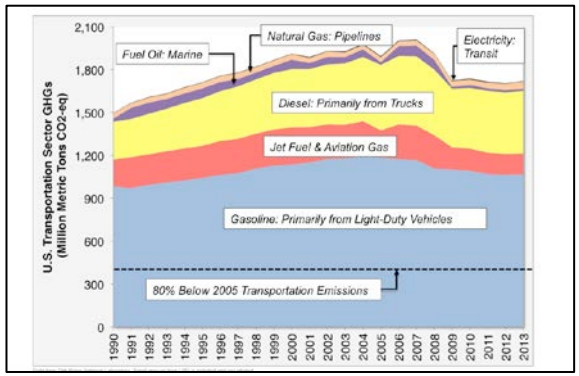
affects vehicle-level energy, emissions, and safety outcomes,





affecting larger-scale outcomes and infrastructure decisions,





which can inform vehicle and engineering decisions and policy

- **Mixed methods for systems engineering models under uncertainty**
- **Assessment along automation progression spectrum for passenger and freight mobility**
- **Inform robust and resilient decisions**

traffic21 a transportation research institute of Carnegie Mellon University

CERCA Center for Engineering and Resilience for Climate Adaptation

CEDM

Technologies for Safe and Efficient Transportation
A U.S. DOT UNIVERSITY TRANSPORTATION CENTER

Carnegie Mellon University
Civil and Environmental Engineering

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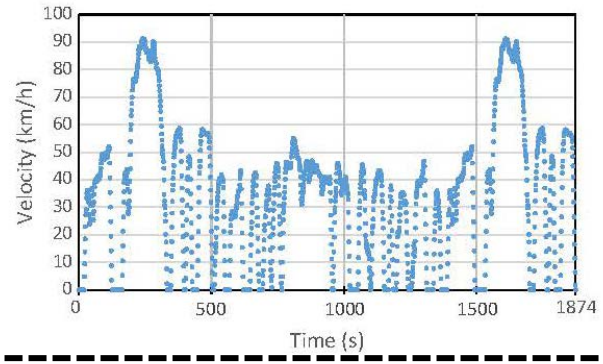

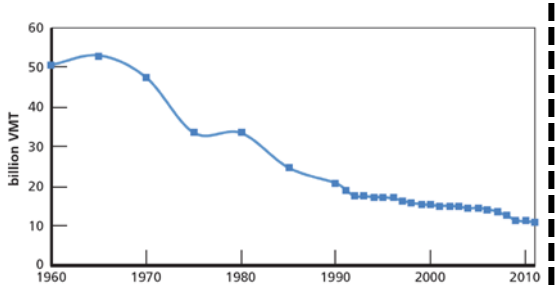

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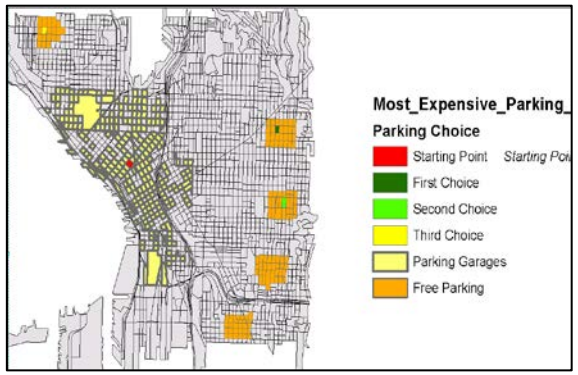

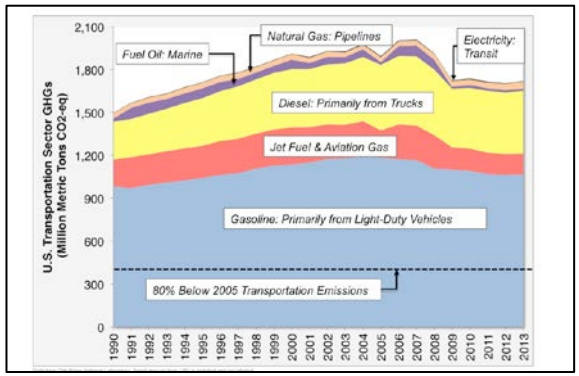

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Carnegie Mellon University
Civil and Environmental Engineering

Dr. Sebastian Teir
VTT Technical Research Centre of Finland Ltd

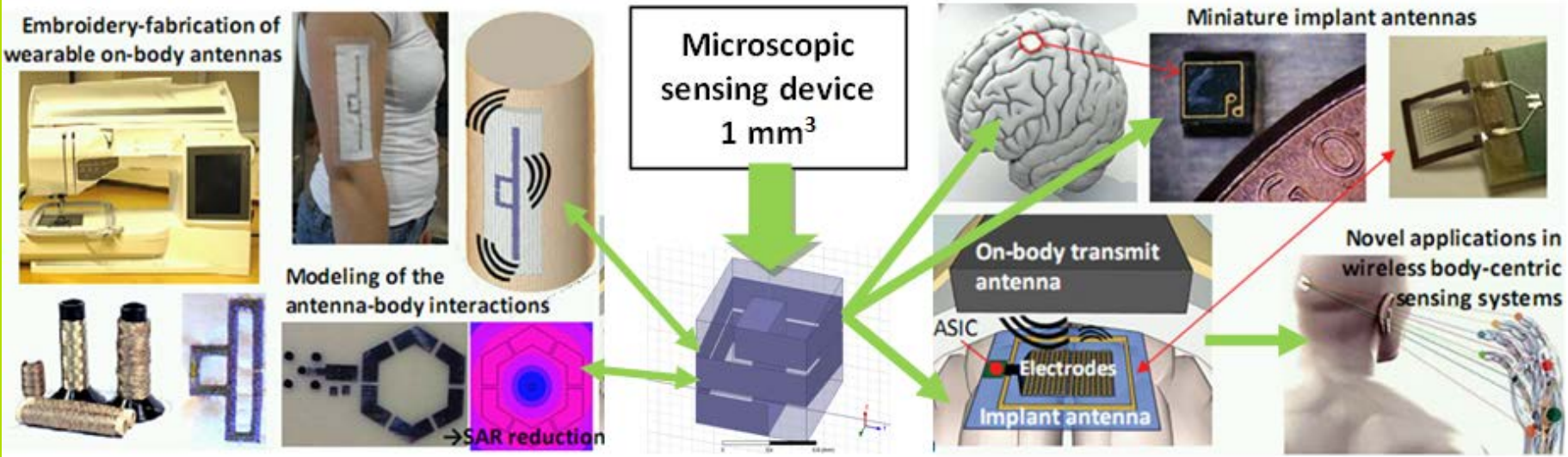
Negative CO_2 emissions by bio-CLC

TECHNOLOGY FOR BUSINESS

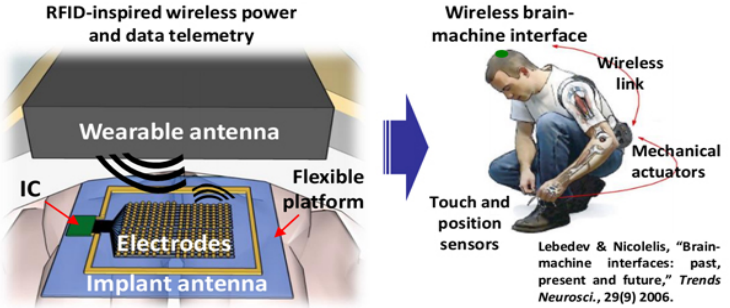
- Chemical looping combustion (CLC) a promising technology for bio-CCS
  - Lowest energy requirements of known CO_2 capture technologies
  - No high-temperature corrosion risk → improves efficiency for biomass combustion
- CLC at 20 kWth scale for biomass successfully tested at VTT Bioruukki

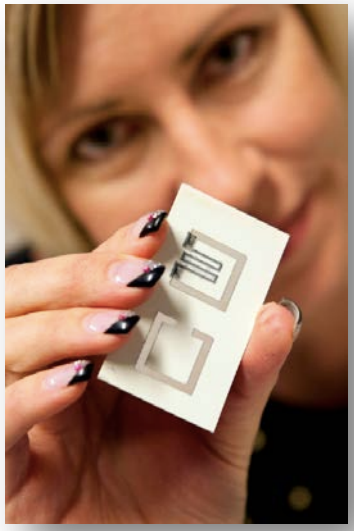
Wireless Identification and Sensing Systems

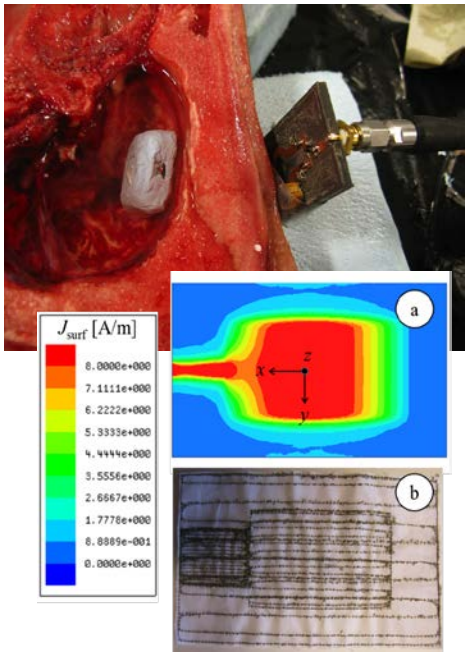
Prof. Leena Ukkonen



- Wireless Implantable Biomedical Systems and Sensors
- Novel Materials for Wireless Identification and Sensing







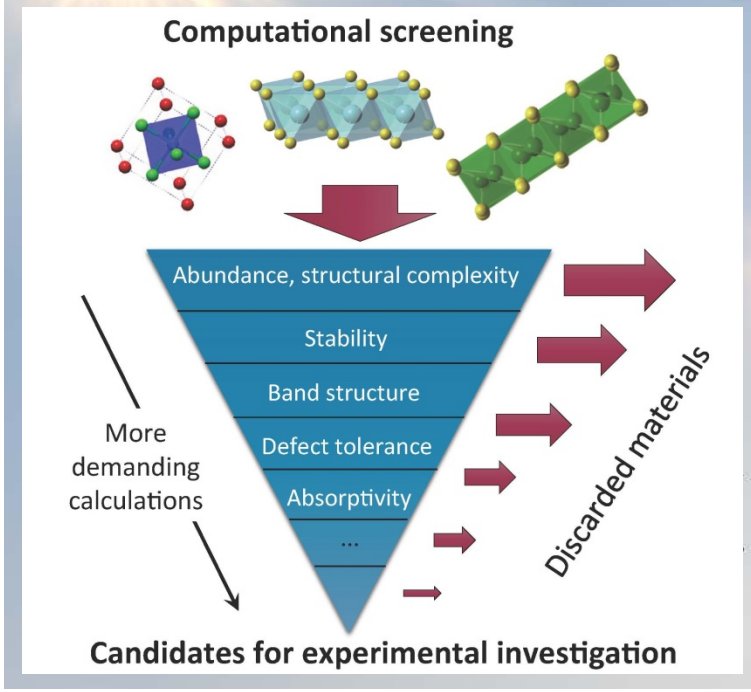
TAMPERE UNIVERSITY OF TECHNOLOGY

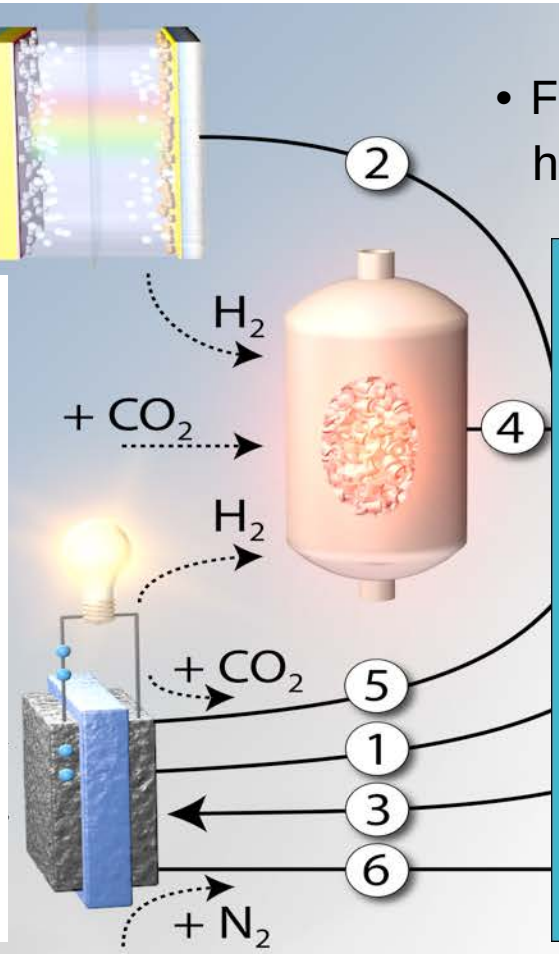
From CO_2 to Sustainable Fuels and Chemicals

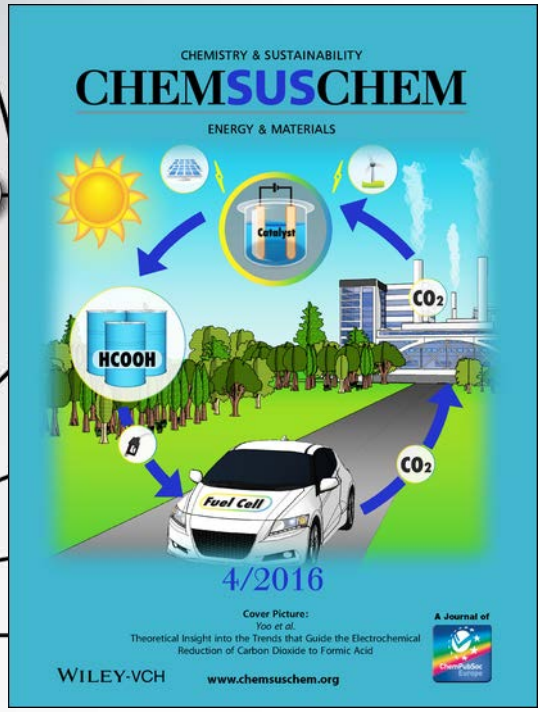
- Prof. Tejs Vegge – Technical University of Denmark (DTU)
- Computational method development for accelerated materials design
- Predicting electrocatalysts with high activity and selectivity

Solarfuels and chemicals

- From CO_2 to fuels and high-value chemicals





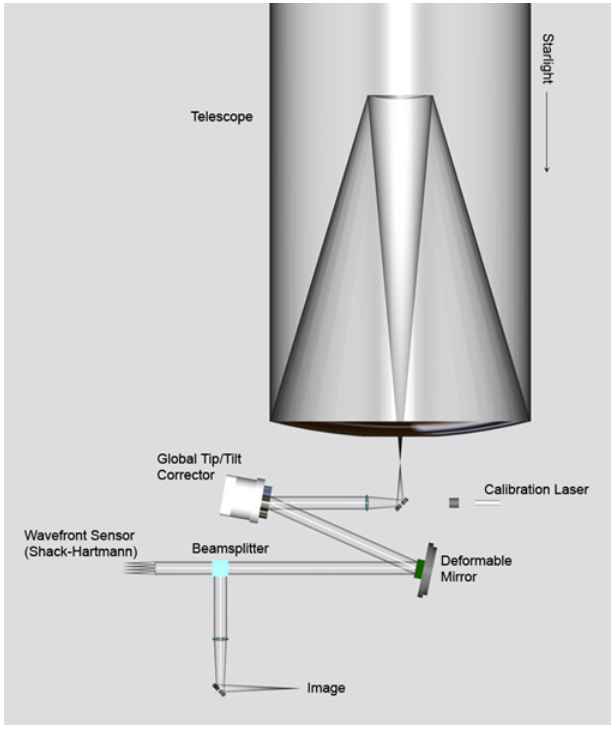


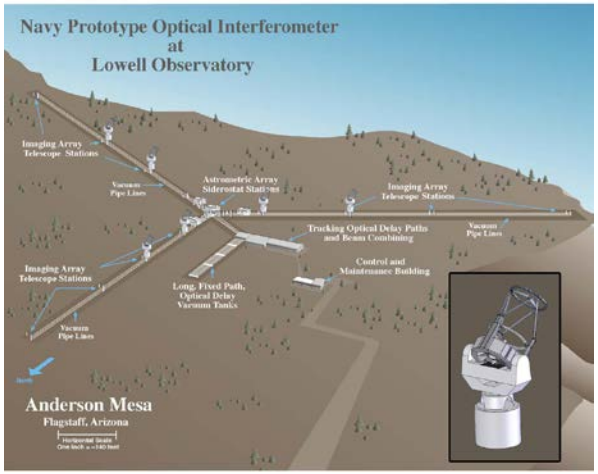
Light-Weight Telescopes and Adaptive Optical Systems

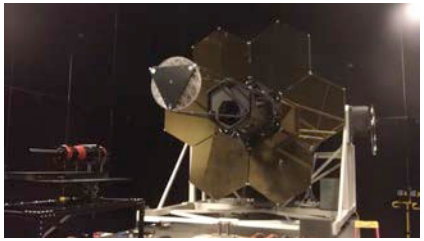
Christopher C. Wilcox, PhD

US Naval Research Laboratory

- Light-Weight Telescopes
- Adaptive Optics for Astronomy
- Atmospheric Turbulence Studies
- Optical Interferometry
- Segmented Mirror Telescope

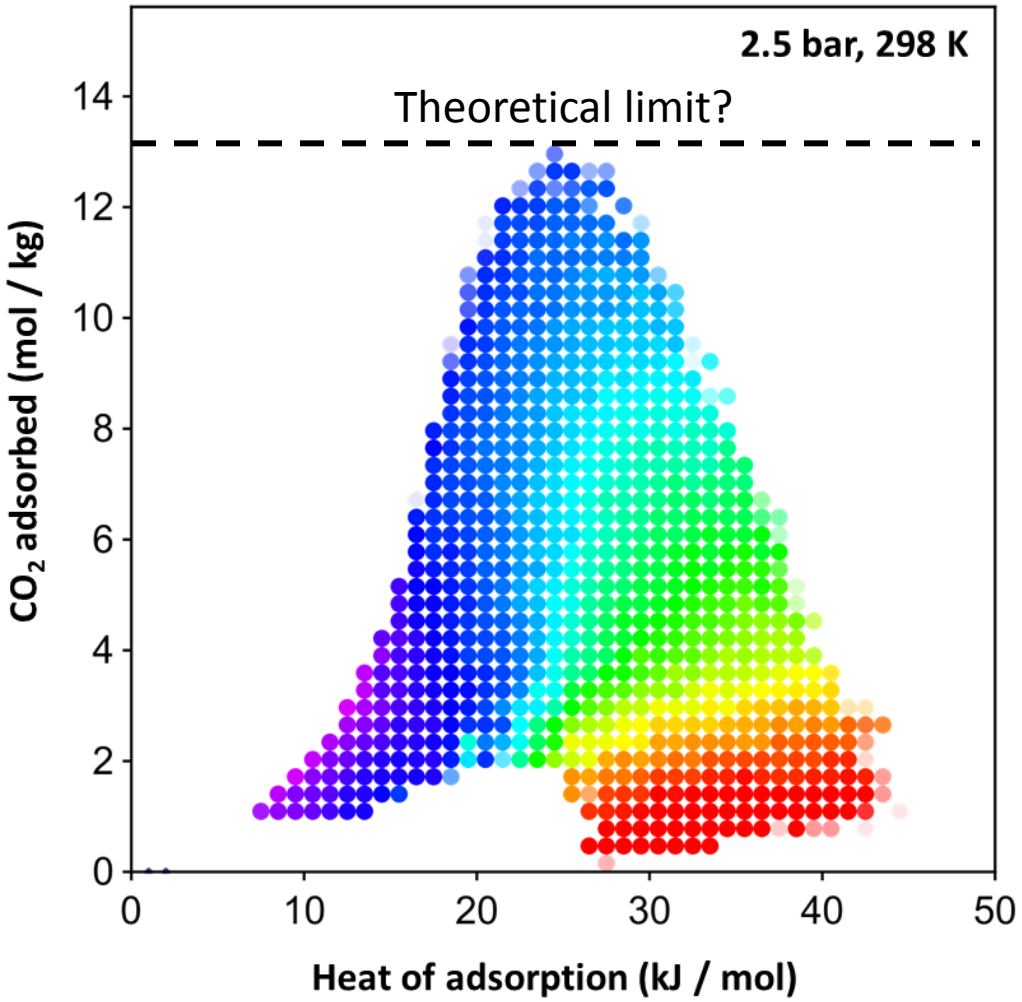


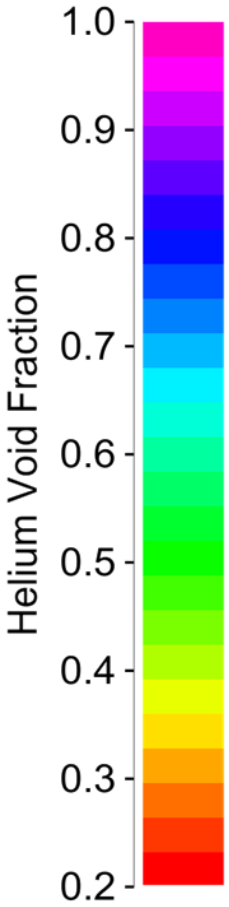




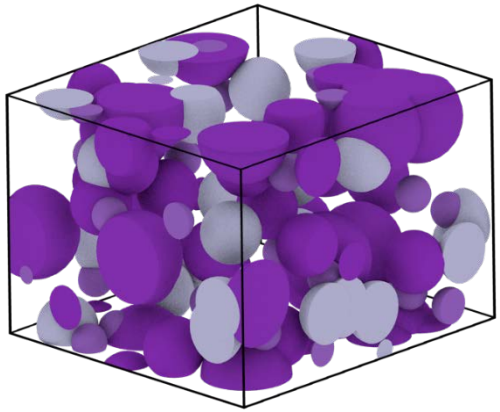
Hypothetical Materials Screening

High throughput screening of all
conceivable porous materials
for gas adsorption/separations applications,
such as CO_2 capture





Christopher E. Wilmer
U. Pittsburgh
Chemical Engineering



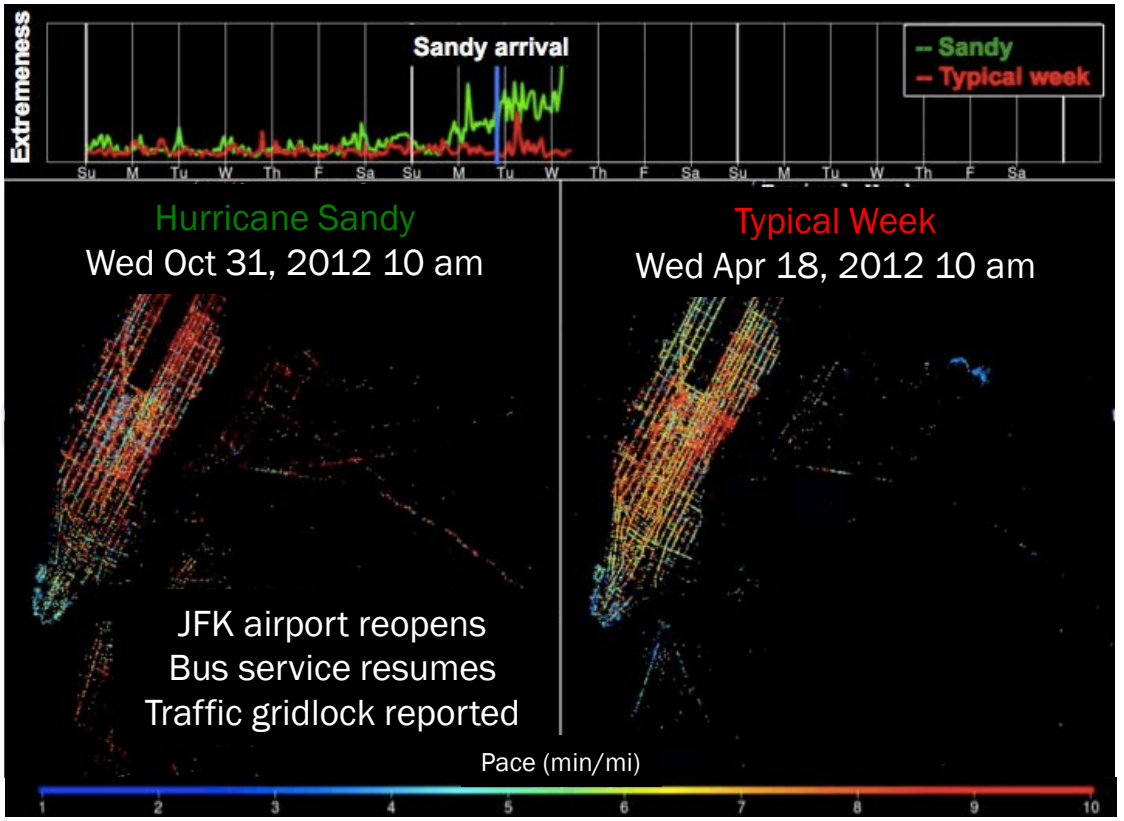
Randomly generated porous "pseudomaterial"

Quantifying city-scale transport disruptions

Daniel B. Work

University of Illinois at Urbana Champaign

- Use 700 million taxi trips in New York City to measure traffic patterns.
- Events quantified in terms of duration and peak disruption.
- Uncovers new pre- and post-disaster traffic dynamics.

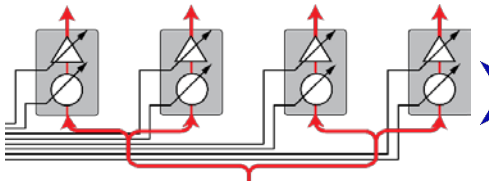


[research sponsors: NSF & NCSA]

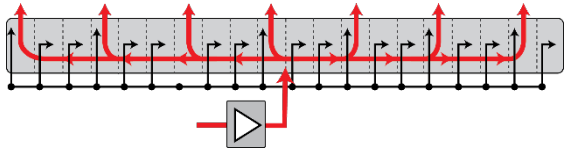
MESA

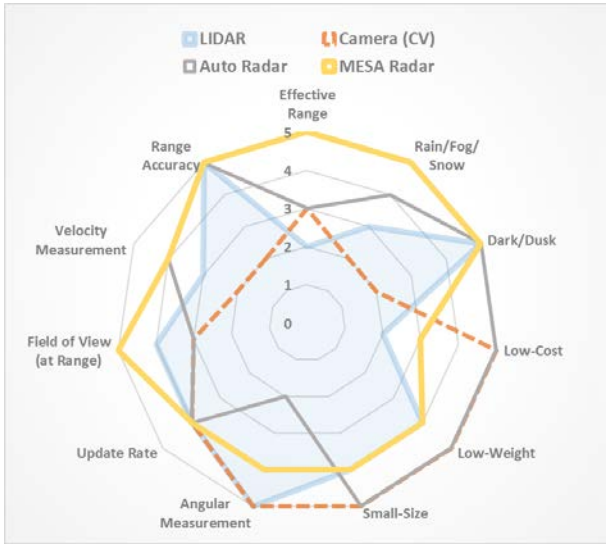
Metamaterials Based Radar for Commercial Detect and Avoid Applications, A New Design Paradigm for Scanning Antennas

Traditional Phased Array



Metamaterial Electronically Scanned Array



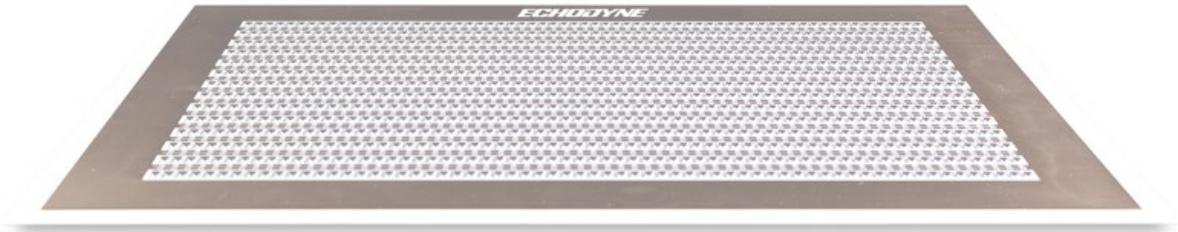


Low-SWAPC MESA Radar

Robert T. Worl

Echodyne Corporation

- Fast Beam Scanning Radar without T/R modules
- Metamaterial Antenna Research & Production
- Focused on Bringing LIDAR like performance to Radar



ECHODYNE