Combustion and Energy Research Laboratory (COMER)

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Mission/Purpose

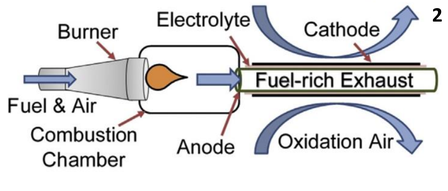
- Further the understanding and application of energy conversion and conservation
- Improve the way society utilizes energy while also building a more sustainable world
- Combine fundamental knowledge of thermodynamics, chemistry, heat transfer, and combustion

Scope

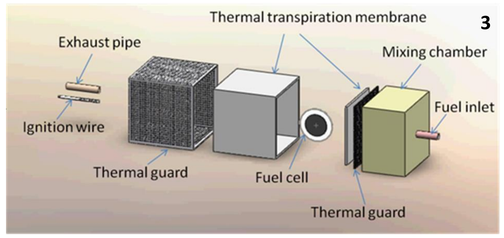
The COMER's research ranges from the development of novel solid oxide fuel cells to emission control and investigations of corrosion of medical implants. Major ongoing research areas include:

Advanced Manufacturing of Ceramics

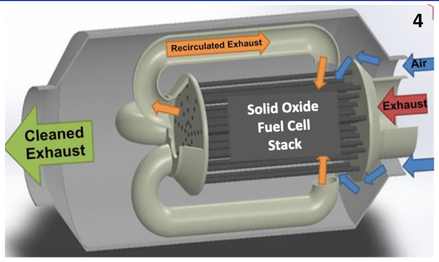
Cogeneration Systems



Propulsion and Pumping

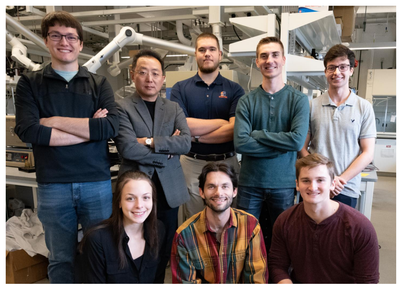


Emission and Corrosion Control



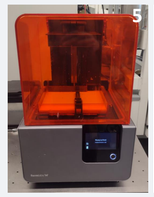
Team Members

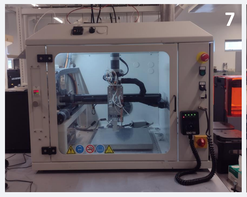
Dr. Jeongmin Ahn, Associate Professor, Director
Alexander R. Hartwell, Lab Manager, Ph.D. Candidate
Cole A. Wilhelm, Ph.D. Student
Aliza M. Willsey, Ph.D. Student
Alexander T. Metcalf, M.S. Student
Kassidy Fields, Undergraduate Student
Nathaniel P. Slabaugh, Undergraduate Student
Harrison Kayton, Undergraduate Student
Cody J. VanNostrand, Undergraduate Student

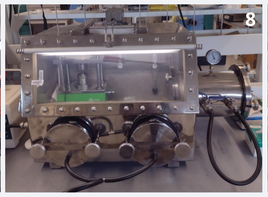


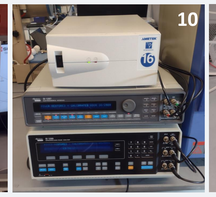
Capabilities

The COMER manufactures solid oxide fuel cells, batteries, reaction chambers, and other ceramic/organic devices. Gas characterization, performance testing, and electrochemical analysis are also carried out in the COMER. Key equipment includes: **5.** FormLabs 3D Printer **6.** High Temperature Sintering Furnace **7.** SonoTek Ultrasonic Spraycoater **8.** Glove Box **9.** Shimadzu Gas Chromatographer **10.** Solartron Electrical Impedance Spectrometer **11.** Smart Engine Test Stand **12.** VW Jetta Diesel Engine



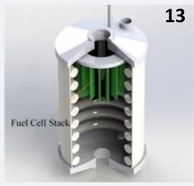


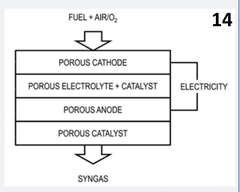


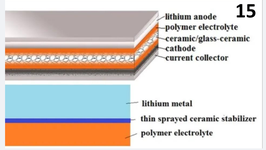


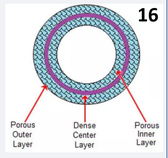
Ongoing/Active Projects

- Combine internal combustion engines with solid oxide fuel cells to improve overall system efficiency **12**.
- Combine solid oxide fuel cells with heating systems to produce resilient, high-efficiency combined heat and power systems **13**.
- Use planar solid oxide fuel cells modified with infiltrated nanocrystals to reduce nitric oxide emissions as a replacement for precious metal catalytic converters **4**.
- Use porous solid oxide fuel cells (PSOFCs) to improve combustion efficiency by co-generating syngas and electricity from a mixed hydrocarbon fuel and air flow through a porous structure **14**.
- Produce a solid-state battery which resists Lithium dendrite formation **15**.
- Use ceramic membranes to remove carbon dioxide from exhaust streams **16**.
- Form complex ceramic structures via 4D printing **1**.
- Utilize thermal transpiration (flow manifested by a thermal gradient across a pipe) in a 3-dimensional setup to provide propulsive power to a micro unmanned aerial vehicle (micro-UAV) **3**.
- Investigate rapid degradation of medical implants caused by external electromagnetic signals.
- Integrate mycelium (mushroom root network) into batteries, solid oxide fuel cells, and thermal transpiration membranes.









Major Contributions/Output

Patents:

- Jeongmin Ahn, Ryan J. Milcarek, and Kaoru Maruta, "Microcombustion Microtubular Flame-assisted Fuel Cell for Power and Heat Cogeneration without Soot Formation", U.S. Provisional App. No. 62/789,463 (2019).
- Jeongmin Ahn, and Ryan J. Milcarek, "Flame-assisted Fuel Cell Integrated Rich Burn, Quick Mix, Lean Burn Combustion for Reduced NOx", U.S. Provisional App. No. 62/551,961. (2017).
- Jeongmin Ahn, and H. Ezzat Khalifa, "Furnace with an Integrated Flame Assisted Fuel Cell for Combined Heating and Power", US 10170780 B2 (2019).
- Jeongmin Ahn, Ryan J. Milcarek, Kang Wang, and Pingying Zeng, "Electricity and Syngas Co-Generation System Using Porous Solid Oxide Fuel Cells (PSOFCs)", US 10283794 B2 (2019).

Publications:

- Thomas S. Welles, and Jeongmin Ahn, "Comparison of In Vitro Corrosion Products on CoCrMo generated via Oscillatory Electric Fields Before and After Removal of Proteinaceous Layer", Materialia, Vol. 22, pp. 101400 (2022).
- Thomas S. Welles, and Jeongmin Ahn, "Driving Electrochemical Corrosion of Implanted CoCrMo Metal via Oscillatory Electric Fields without Mechanical Wear", Nature-Scientific Reports, Vol. 11, pp. 22366 (2021).
- Alexander R. Hartwell, Thomas S. Welles, and Jeongmin Ahn, "The Anode Supported Internal Cathode Tubular Solid Oxide Fuel Cell: A Novel Cell Geometry for Combined Heat and Power Applications", International Journal of Hydrogen Energy, Vol. 46, Issue 75, pp. 37429-37439 (2021).
- Thomas S. Welles, and Jeongmin Ahn, "Novel Investigation of Perovskite Membrane Based Electrochemical Nitric Oxide Control Phenomenon", Nature-Scientific Reports, Vol. 10, Issue 1, pp. 18750 (2020).
- Ryan J. Milcarek, Vincent P. DeBiase, and Jeongmin Ahn, "Investigation of Startup, Performance and Cycling of a Residential Furnace Integrated with micro-Tubular Flame-assisted Fuel Cells for Micro-Combined Heat and Power", Energy, Vol. 196, pp. 117148 (2020).
- Ryan J. Milcarek, Hisashi Nakamura, Takuya Tezuka, Kaoru Maruta, and Jeongmin Ahn, "Investigation of Microcombustion Reforming of Ethane/Air and Micro-Tubular Solid Oxide Fuel Cells", Journal of Power Sources, Vol. 450, Issue 29, pp. 227606 (2020).

Sponsors

American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE), US Department of Energy (DOE), Institute of Fluid Science (IFS) Collaborative Research Project, Korea Fuel Cell Energy, NEXUS-NY, National Science Foundation (NSF), New York State Energy Research and Development Authority (NYSERDA), Empire State Development's Division of Science, Technology and Innovation (NYSTAR), SyracuseCOE