



**Exponent<sup>®</sup>**  
Engineering & Scientific Consulting

**George Dimitrakopoulos, Ph.D., P.E., CFEI, CVFI**

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## Professional Profile

Dr. Dimitrakopoulos has a degree in mechanical engineering and works in Exponent's Thermal Science Practice. His core areas of expertise include fluid mechanics, heat-transfer, mass-transfer, combustion, thermodynamics, reaction kinetics, computational fluid dynamics (CFD), energy storage, electrochemistry, catalysis, electrocatalysis, material synthesis and characterization. He consults on the following areas:

1. Compartment and vehicle fire and explosion investigations (determination of origin and cause)
2. Consumer product review (performance and safety evaluation of prototype and in-production devices, CPSC matters, etc.)
3. Combustible dust hazard analysis (inspection of facilities handling/producing combustible dust, dust testing based on applicable standards, etc.)
4. Green hydrogen and ammonia (fuel cells and electrolyzers, process system review and safety, etc.)
5. Energy storage (li-ion battery failure investigation, cell-, pack-, and device-level thermal runaway testing and evaluation, etc.)
6. HVAC system review and analysis
7. Exhaust aftertreatment and emissions systems
8. Oil and gas (reactor design and characterization, system safety, process evaluation, catalyst characterization etc.)
9. Intellectual property cases

Prior to joining Exponent, Dr. Dimitrakopoulos was a Ph.D. candidate in the Reacting Gas Dynamics Laboratory at the Massachusetts Institute of Technology (MIT), Department of Mechanical Engineering. He obtained his Ph.D. in Mechanical Engineering in 2017, with a thesis in Mechanical Engineering and Computation. During his Ph.D., he investigated the production of added-value chemicals using ceramic membrane reactors. Through a novel experimental setup, transport and kinetic parameters were obtained and used to provide insight into the material properties and to develop 3D reactive flow CFD algorithms that would assist the design of optimized reactor modules for the conversion processes of interest. In 2014, Dr. Dimitrakopoulos completed a 3-month internship program at ExxonMobil's Upstream Research Company in Houston, TX, working on the development of computational models for process stratigraphy applications.

After his graduation, Dr. Dimitrakopoulos remained at MIT as a post-doctor and was later promoted to a Research Scientist. During this period, he worked on improving the performance of solid oxide fuel/electrolysis cells for green hydrogen and ammonia production by careful tuning of material properties. His research was both applied and fundamental with the aim to translate advances in the science of ceramic materials into real solid oxide cell devices. To this end, he investigated the concept of catalyst exsolution to produce nanoparticle-sized, well dispersed, and long-term stable catalysts on the surface of

perovskite oxide electrodes grown in-situ from the bulk of the material. He also experimented with proton-conducting electrolysis cells toward the production of green/blue ammonia from steam/methane and renewable electricity.

In 2021, Dr. Dimitrakopoulos was awarded the prestigious Kavanaugh Fellowship offered by the Department of Materials Science & Engineering at MIT. As a Kavanaugh Fellow, he investigated the oxidative coupling of methane to produce ethylene using thermochemical and electrochemical routes. He also conducted techno-economic analyses to evaluate the conditions under which these technologies could compete with the current industrial ethylene production routes (steam cracking of ethane or naphtha).

Dr. Dimitrakopoulos has extensive experience in synthesizing materials from raw precursors as well as characterizing materials using ex-situ (XRD, SEM, TEM, EDS, BET, XPS, XAS, TGA, DSC etc.) and in-situ (NAP-XPS etc.) techniques. He is an expert in the sintering of ceramic materials, the fabrication and testing of lab-scale solid oxide cells and the manufacturing of large-scale ceramic oxide devices. He is proficient in electrochemical characterization methods (I-V, electrochemical impedance spectroscopy, battery cycling etc.) and the analysis/quantification of gaseous mixtures.

## Academic Credentials & Professional Honors

Ph.D., Mechanical Engineering, Massachusetts Institute of Technology (MIT), 2017

B.S., Mechanical Engineering, National Technical University of Athens, 2012

Kavanaugh Translational Innovation Fellowship, Department of Materials Science & Engineering, Massachusetts Institute of Technology, 2021

George and Marie Vergottis Presidential Fellowship, Massachusetts Institute of Technology, 2012-2013

Onassis Foundation Scholar, 2012-2016

National Hellenic Research Foundation Scholar, 2007-2012

## Licenses and Certifications

Professional Engineer Mechanical, California, #41768

Blasting Certificate of Competency (MA)

Certified Fire and Explosion Investigator (CFEI)

Certified Vehicle Fire Investigator (CVFI)

## Prior Experience

Research Scientist, Massachusetts Institute of Technology, Departments of Mechanical Engineering and Nuclear Science & Engineering, Cambridge, MA, USA, December 2019 – March 2022

Postdoctoral Associate, Massachusetts Institute of Technology, Departments of Mechanical Engineering and Nuclear Science & Engineering, Cambridge, MA, USA, January 2017 – December 2019

Research Assistant, Massachusetts Institute of Technology, Department of Mechanical Engineering, Cambridge, MA, USA, September 2012 – January 2017

Intern, ExxonMobil, Upstream Research Company, Houston, TX, USA, May 2014 – August 2014

## Professional Affiliations

National Association of Fire Investigators (NAFI)

National Fire Protection Association (NFPA)

## Languages

French

English

Greek

## Patents

Ahmed F. Ghoniem, B. Yildiz, G. Dimitrakopoulos. Methane Upgrade to Ethane and Ethylene Within Ceramic Membrane Reactors. US Patent Application 17/243,219, 2022.

## Publications

H. Kytömaa, A. Wechsung, G. Dimitrakopoulos, N. Cook, D. Jaimes, I. Hur, S. Faraji. Industry R&D needs in hydrogen safety. Applications in Energy and Combustion Science 18 (2024) 100271.

S. Koohfar, M. Ghasemi, T. Hafen, G. Dimitrakopoulos, D. Kim, J. Pike, S. Elangovan, E.D. Gomez, B. Yildiz. Improvement of oxygen reduction activity and stability on a perovskite oxide surface by electrochemical potential. Nature Communications (2023) 14:7203.

F. Orsini, D. Ferrero, S.F. Cannone, M. Santarelli, A. Felli, M. Boaro, C. Leitenburg, A. Trovarelli, J. Llorca, G. Dimitrakopoulos, A.F. Ghoniem. Exsolution-enhanced reverse water-gas shift chemical looping activity of Sr<sub>2</sub>FeMo<sub>0.6</sub>Ni<sub>0.4</sub>O<sub>6-δ</sub> double perovskite. Chemical Engineering Journal 475 (2023) 146083.

H.G. Seo, A. Staerz, G. Dimitrakopoulos, D. Kim, B. Yildiz, H.L. Tuller, Degradation and recovery of solid oxide fuel cell performance by control of cathode surface acidity: Case study – Impact of Cr followed by Ca infiltration. Journal of Power Sources 558 (2023) 232589.

M. Laqdiem, A.J. Carrillo, G. Dimitrakopoulos, M. Balaguer, J. Garcia-Fayos, A.F. Ghoniem, J.M. Serra, Impact of lattice properties on the CO<sub>2</sub> splitting kinetics of lanthanide-doped cerium oxides for chemical looping syngas production. Solid State Ionics 394 (2023) 116192.

F. Grajkowski, S. Chandra, G. Dimitrakopoulos, D. Kim, B. Yildiz, Exploring Stable and Selective Anode Materials for the Electrochemical Oxidative Coupling of Methane (EOCM): A Case Study of Doped Titanates. ECS Transactions, 111 (6) 2259-2270 (2023).

D. Kim, G. Dimitrakopoulos, B. Yildiz. Controlling the Size of Au Nanoparticles on Reducible Oxides with the Electrochemical Potential. Journal of the American Chemical Society 2022, 144, 48, 21926–21938.

W. Fan, B. Wang, R. Gao, G. Dimitrakopoulos, J. Wang, X. Xiao, L. Ma, K. Wu, B. Yildiz, J. Li. Anodic Shock-Triggered Exsolution of Metal Nanoparticles from Perovskite Oxide. Journal of the American Chemical Society 2022, 144, 17, 7657–7666.

G. Dimitrakopoulos, B. Koo, B. Yildiz, A.F. Ghoniem. Highly Durable C<sub>2</sub> Hydrocarbon Production via the Oxidative Coupling of Methane Using a BaFe<sub>0.9</sub>Zr<sub>0.1</sub>O<sub>3-δ</sub> Mixed Ionic and Electronic Conducting Membrane and La<sub>2</sub>O<sub>3</sub> Catalyst. ACS Catalysis 2021, 11, 3638–3661.

J. Wang, J. Yang, A. Opitz, W. Bowman, R. Bliem, G. Dimitrakopoulos, A. Nenning, I. Waluyo, A. Hunt, J.-J. Gallet, B. Yildiz. Tuning Point Defects by Elastic Strain Modulates Nanoparticle Exsolution on Perovskite Oxides. *Chemistry of Materials* 2021, 33, 5021–5034.

G. Dimitrakopoulos, A.F. Ghoniem, B. Yildiz. In Situ Catalyst Exsolution on Perovskite Oxides for the Production of CO and Synthesis Gas in Ceramic Membrane Reactors. *Sustainable Energy & Fuels* 3 (2019) 2347–2355.

R.C. Schucker, G. Dimitrakopoulos, K. Derrickson, K.K. Kopeć, F. Alahmadi, J.R. Johnson, L. Shao, A.F. Ghoniem. Oxidative Dehydrogenation of Ethane to Ethylene in an Oxygen-Ion-Transport-Membrane Reactor: A Proposed Design for Process Intensification. *Industrial & Engineering Chemistry Research* 58 (19) (2019) 7989–7997.

A.F. Ghoniem, Z. Zhao, G. Dimitrakopoulos. Combustion Technologies for Low Carbon Energy: Fundamentals, Modeling and Reactors. *Proceedings of the Combustion Institute* 37 (2019) 33–56.

G. Dimitrakopoulos, R.C. Schucker, K. Derrickson, J.R. Johnson, K.K. Kopeć, L. Shao, F. Alahmadi, A.F. Ghoniem. Hydrogen and Ethylene Production Through Water-Splitting and Ethane Dehydrogenation Using BaFe<sub>0.9</sub>Zr<sub>0.1</sub>O<sub>3-δ</sub> Mixed-Conductors. *ECS Transactions* 80 (9) (2017) 181–190.

G. Dimitrakopoulos, A.F. Ghoniem. Developing a Multistep Surface Reaction Mechanism to Model the Impact of H<sub>2</sub> and CO on the Performance and Defect Chemistry of La<sub>0.9</sub>Ca<sub>0.1</sub>FeO<sub>3-δ</sub> Mixed-Conductors. *Journal of Membrane Science* 529 (2017) 114–132.

G. Dimitrakopoulos, A.F. Ghoniem. Role of Gas-Phase and Surface Chemistry in Methane Reforming Using a La<sub>0.9</sub>Ca<sub>0.1</sub>FeO<sub>3-δ</sub> Oxygen Transport Membrane. *Proceedings of the Combustion Institute* 36 (2017) 4347–4354.

G. Dimitrakopoulos, A.F. Ghoniem. A Two-Step Surface Exchange Mechanism and Detailed Defect Transport to Model Oxygen Permeation Through the La<sub>0.9</sub>Ca<sub>0.1</sub>FeO<sub>3-δ</sub> Mixed-Conductor. *Journal of Membrane Science* 510 (2016) 209–219.

A. Hunt, G. Dimitrakopoulos, A.F. Ghoniem. Surface Oxygen Vacancy and Oxygen Permeation Flux Limits of Perovskite Ion Transport Membranes. *Journal of Membrane Science* 489 (2015) 248–257.

A. Hunt, G. Dimitrakopoulos, P. Kirichen, A.F. Ghoniem. Measuring the Oxygen Profile and Permeation Flux Across an Ion Transport La<sub>0.9</sub>Ca<sub>0.1</sub>FeO<sub>3-δ</sub> Membrane and the Development and Validation of a Multistep Surface Exchange Model. *Journal of Membrane Science* 468 (2014) 62–72.

I.S. Kavvadias, E.M. Papoutsis-Kiachagias, G. Dimitrakopoulos, K.C. Giannakoglou. The Continuous Adjoint Approach to the k- $\omega$  SST Turbulence Model with Applications in Shape Optimization. *Engineering Optimization* 47(11) (2014) 1523–1542.

#### **Conference presentations:**

A. Wechsung, G. Dimitrakopoulos, K. Hashad, T. Myers, Are Power-to-Heat Technologies Ready to Transition Your Facility?, 2024 AIChE Spring Meeting, New Orleans, 2024

D. Kim, G. Dimitrakopoulos, B. Yildiz. Controlling the Size of Au Nanoparticles on Reducible Oxides with Electrochemical Potential. 23rd International Conference on Solid State Ionics, Boston, MA, USA, July 2022.

B. Yildiz, G. Dimitrakopoulos, J. Wang, W. Fan, V. Kyriakou, A.F. Ghoniem, J. Li. Controlling the Size and Dispersion of Exsolved Catalyst Particles By Electrochemistry and By Strain. Invited talk, 237th ECS Meeting, Montreal, Canada, May 2020.

V. Kyriakou, G. Dimitrakopoulos, J. Wang, D. Neagu, M.N. Tsampas, B. Yildiz. In-Situ Exsolution of Metal Nanoparticles in Solid Oxide Cells for Efficient Syngas Generation from Steam and Carbon Dioxide. Invited talk, 237th ECS Meeting, Montreal, Canada, May 2020.

G. Dimitrakopoulos, J. Wang, R. Rothman, B. Yildiz. Comparison Between Thermochemical and Electrochemical Exsolution of Catalysts from Perovskite Oxides for Efficient Hydrogen Production Through Steam Electrolysis. Materials Research Society Conference, Boston, MA, USA, December 2019.

Y. Chen, X. Wu, G. Dimitrakopoulos, A.F. Ghoniem. Fabrication of Novel Janus Membrane for High Temperature Oxygen Separation and Water Thermochemical Reduction. Materials Research Society Conference, Boston, MA, USA, December 2019.

G. Dimitrakopoulos, A.F. Ghoniem, B. Yildiz. In situ Exsolution of Nickel Catalyst on Perovskite Oxides for the Production of CO and Synthesis Gas in Ceramic Membrane Reactors. 22nd International Conference on Solid State Ionics, PyeongChang, Korea, June 2019.

J. Wang, A. Opitz, R. Bliem, W. Bowman, X. Yao, A. Nenning, G. Dimitrakopoulos, I. Waluyo, A. Hunt, J.-J. Gallet, B. Yildiz. Uncovering Biaxial Strain Effect on Nanoparticle Exsolution for Thin-Film Perovskites. Bulletin of the American Physical Society, Boston, MA, USA, March 2019.

G. Dimitrakopoulos, A.F. Ghoniem, B. Yildiz. In-situ Exsolution of Nickel Nanoparticles for Efficient Carbon Dioxide Splitting and Methane Conversion to Syngas in Ceramic Membrane Reactors. Materials Research Society Conference, Boston, MA, USA, December 2018.

G. Dimitrakopoulos, A.F. Ghoniem, B. Yildiz. Catalyst Exsolution in Carbon Dioxide Splitting and Methane Conversion to Syngas Using Ceramic Membrane Reactors. Gordon Research Conference on Solid State Studies in Ceramics, Mount Holyoke College, South Hadley, MA, USA, August 2018.

G. Dimitrakopoulos, Z. Zhao, A.F. Ghoniem. Combustion Technologies for Low Carbon Energy: Fundamentals, Modeling and Reactors. Plenary lecture, 37th International Symposium on Combustion, Dublin, Ireland, August 2018.

G. Dimitrakopoulos, A.F. Ghoniem. Methane Partial Oxidation and Dry Reforming to Syngas Using the  $\text{La}_{0.9}\text{Ca}_{0.1}\text{FeO}_{3-\delta}$  Mixed-Conductor. 2017 AIChE Annual Meeting, Minneapolis, MN, USA, November 2017.

G. Dimitrakopoulos, R.C. Schucker, J.R. Johnson, K.K. Kopec, L. Shao, F. Alahmadi, K. Derrickson, A.F. Ghoniem. Hydrogen and Ethylene Production Through Water-Splitting and Ethane Dehydrogenation Using  $\text{BaFe}_{0.9}\text{Zr}_{0.1}\text{O}_{3-\delta}$  Mixed-Conductors. 232nd ECS Meeting, National Harbor, MD, USA, October 2017.

G. Dimitrakopoulos, Z. Zhao, M. Uddi, N. Tsvetkov, B. Yildiz, A.F. Ghoniem. Enhanced Intermediate-Temperature  $\text{CO}_2$  Splitting Using Nonstoichiometric Ceria and Ceria-Zirconia. 232nd ECS Meeting, National Harbor, MD, USA, October 2017.

G. Dimitrakopoulos, A.F. Ghoniem. Methane Partial Oxidation/Dry Reforming Using Nickel Catalyzed  $\text{La}_{0.9}\text{Ca}_{0.1}\text{FeO}_{3-\delta}$  Oxygen Transport Membranes. Invited talk, 13th International Conference on Catalysis in Membrane Reactors, Houston, TX, USA, July 2017.

G. Dimitrakopoulos, X. Wu, A.F. Ghoniem. Enhancing Syngas Production During Methane Reforming Using a  $\text{La}_{0.9}\text{Ca}_{0.1}\text{FeO}_{3-\delta}$  Ion Transport Membrane. Materials Research Society Conference, Boston, MA, USA, December 2016.

G. Dimitrakopoulos, A.F. Ghoniem. Role of Gas-Phase and Surface Chemistry in Methane Reforming Using a  $\text{La}_{0.9}\text{Ca}_{0.1}\text{FeO}_{3-\delta}$  Oxygen Transport Membrane. 36th International Symposium on Combustion, Seoul, Korea, August 2016.

G. Dimitrakopoulos, A.F. Ghoniem. Detailed Surface Kinetics and Charged Species Diffusion to Model the Impact of H<sub>2</sub> and CO Oxidation on Oxygen Permeation Through La<sub>0.9</sub>Ca<sub>0.1</sub>FeO<sub>3-δ</sub> Mixed-Conductors. The 14th International Conference on Inorganic Membranes, Atlanta, GA, USA, July 2016.

#### **Invited Seminars:**

A. Hunt, G. Dimitrakopoulos, P. Kirchen, A.F. Ghoniem. Experimental Surface Characterization of Oxygen Ion Transport Membranes for Flux Model Development Under Oxy-Fuel Combustion Conditions. Inorganic Membrane Conference, Valencia, Spain, September 2013.

G. Dimitrakopoulos, A. Hunt, A.F. Ghoniem. A Multistep, Thermodynamically Consistent and Constraint by Material Properties Reaction Mechanism for the La<sub>0.9</sub>Ca<sub>0.1</sub>FeO<sub>3-δ</sub> Hydrogen Oxidation. Materials Research Society Conference, Boston, MA, USA, December 2015.

G. Dimitrakopoulos, A.F. Ghoniem, B. Yildiz. Improving the Production of Valuable Chemicals Using Ceramic Oxides Optimized Based on Advanced Catalysis Methods and Detailed Computational Models. Air Liquide - Paris Innovation Campus, Paris, France, January 2020.

G. Dimitrakopoulos, A.F. Ghoniem, B. Yildiz. The Concept of Catalyst Exsolution for Efficient Catalysis of Methane Partial Oxidation to Syngas and Carbon Dioxide Splitting to Carbon Monoxide. DuPont Research Center, Marlborough, MA, USA, December 2018.

G. Dimitrakopoulos, A.F. Ghoniem. Experimental Study and Modeling Analysis of Perovskites for Methane Partial Oxidation and Oxyfuel Combustion. Robert Borsch Research Center, Cambridge, MA, USA, November 2017.

G. Dimitrakopoulos, A.F. Ghoniem. Materials, Reactors and Systems for the Production of Hydrogen, Syngas and Chemicals. SABIC, Sugar Land, TX, USA, July 2017.

G. Dimitrakopoulos, A.F. Ghoniem. A Multistep Surface Exchange Mechanism and Detailed Defect Transport to Model Oxygen Permeation Through La<sub>0.9</sub>Ca<sub>0.1</sub>FeO<sub>3-δ</sub> Perovskites. Schlumberger Research Center, Cambridge, MA, USA, March 2016.

G. Dimitrakopoulos, A.F. Ghoniem. Modeling the Interaction of Gas Phase Chemistry with Surface Reactions on Ion Transport Membranes for Oxyfuel Combustion. Comsol Inc., Burlington, MA, USA, January 2015.

G. Dimitrakopoulos, A.F. Ghoniem. Carbon Capture Using Ion Transport Membranes and Oxyfuel Combustion Techniques. Exxon Mobil Upstream Research Company, Houston, TX, USA, June 2014.

#### **Editorships & Editorial Review Boards**

Guest Editor, Solid State Ionics, Special Issue Title: "Proceedings of 23rd International Conference on Solid State Ionics (SSI-23)", Elsevier, July 2022.

Organizer of the "Energy and Fuels Conversion" Symposium, 23rd International Conference on Solid State Ionics, Boston, MA, USA, July 2022.

#### **Peer Reviews**

Combustion and Flame

Fluids

Proceeding of the Combustion Institute

Chemical Society Reviews

ACS Catalysis

Journal of Materials Chemistry A

Journal of Power Sources

Journal of Membrane Science

Acta Materialia

Renewable Energy

Journal of Materials Chemistry C

ACS Applied Energy Materials

Batteries

Scripta Materialia

Ceramics International

Catalysts

Langmuir

Solid State Ionics

Materials

Catalysis Letters

Energies

Processes

Chemical Engineering Journal

Materials Horizons

Applied Sciences