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Engineering & Scientific Consulting

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Professional Profile

Dr. Leroy is a mechanical engineer in Exponent's Thermal Science Practice with a background in heat and mass transfer, thermodynamics, and fluid mechanics. He specializes in modeling and testing of energy systems with a focus on understanding and improving energy efficiency through heat and mass transfer. Dr. Leroy has extensive experimental and modeling experience with passive radiative and evaporative cooling devices, solar thermal systems, adsorption systems, and high-temperature energy conversion.

Dr. Leroy also has experience in assessing the design, implementation, and efficiency of HVAC systems. He has performed building-level simulations using EnergyPlus and MATLAB to estimate air conditioning energy consumption in buildings and the potential energy savings brought by passive evaporative and radiative cooling architectures when applied to buildings. Furthermore, Dr. Leroy's experience extends to 2D and 3D multiphysics modeling using COMSOL to estimate pressure drop, temperature gradients, heat losses, and combustion efficiency in various energy systems such as catalytic micro combustors, solar absorbers, heat exchangers, incandescent light bulbs, and radiative coolers.

Before joining Exponent, Dr. Leroy was a Ph.D. candidate in the Device Research Laboratory at the Massachusetts Institute of Technology. During his Ph.D., Dr. Leroy proposed and demonstrated a new passive cooling architecture targeting building cooling using an optimized infrared transparent and solar reflecting aerogel insulation and a hydrogel-based evaporative and radiative cooler. More specifically, his work included the fabrication of aerogels, optical characterization using UV-VIS and FTIR spectrophotometry, and optimization of the material by solving the radiative transfer equation. Among other works, Dr. Leroy also built several experimental setups including a guarded hot plate thermal conductivity setup, an outdoor cooling power characterization setup for passive radiative and evaporative cooling devices, a high-vacuum vacuum chamber for testing incandescent light bulbs, a high-temperature (>650°C) thermoelectric generator characterization setup, and propane a catalytic micro combustor.

Academic Credentials & Professional Honors

Ph.D., Mechanical Engineering, Massachusetts Institute of Technology (MIT), 2021

M.Sc., Mechanical Engineering, Massachusetts Institute of Technology (MIT), 2017

B.Sc., Mechanical Engineering, Polytechnique Montreal, Canada, 2015

Prior Experience

Postdoc, MIT 2021-2022

Research Assistant, MIT 2015-2021

Languages

French (Canada)

Patents

US Patent 2021/0123558 A1: High-Performance Sub-Ambient Radiative Cooling Enabled by Optically Selective and Thermally Insulating Polyethylene Aerogel, April 2021 (Leroy A, Bhatia B, Zhao L, Wang EN).

US Patent 2020/0025468 A1: Passive radiative cooling during the day, January 2020 (Soljačić M, Wang EN, Shen Y, Bhatia B, Leroy A)

Publications

Leroy A,* Lu Z,* Zhang L, Patil JJ, Wang EN, Grossman JC. Significantly enhanced sub-ambient passive cooling enabled by evaporation, radiation, and insulation. Cell Reports Physical Science. 2022 Sep 20:101068.

Li X, Wilson CT, Zhang L, Bhatia B, Zhao L, Leroy A, Brandt O, Orta-Guerra R, Youngblood JP, Trice RW, Wang EN. Design and modeling of a multiscale porous ceramic heat exchanger for high temperature applications with ultrahigh power density. International Journal of Heat and Mass Transfer. 2022 Sep 15;194:122996.

Leroy A, Bhatia B, Sircar J, Wang EN. Thermal transport in solar-reflecting and infrared-transparent polyethylene aerogels. International Journal of Heat and Mass Transfer. 2022 Mar 1;184:122307.

Leroy A, Bhatia B, Njike UT, Vaartstra G, Wang EN. Zinc sulfide-pigmented polyethylene aerogel covers for daytime radiative cooling. Journal of Photonics for Energy. 2021 Oct;11(4):042110.

Mirvakili SM, Leroy A, Sim D, Wang EN. Solar-Driven Soft Robots. Advanced Science. 2021 Apr;8(8):2004235.

LaPotin A, Zhong Y, Zhang L, Zhao L, Leroy A, Kim H, Rao SR, Wang EN. Dual-stage atmospheric water harvesting device for scalable solar-driven water production. Joule. 2021 Jan 20;5(1):166-82.

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Zhao L, Strobach E, Bhatia B, Yang S, Leroy A, Zhang L, Wang EN. Theoretical and experimental investigation of haze in transparent aerogels. Optics Express. 2019 Feb 18;27(4):A39-50.

Zhao L, Blackman M, Zhang L, Bhatia B, Leroy A, Strobach E, Wang EN. Plasmonic absorption-induced haze suppression in random scattering media. Applied Physics Letters. 2019 Jun 24;114(25):251102.

Bhatia B, Leroy A, Shen Y, Zhao L, Gianello M, Li D, Gu T, Hu J, Soljačić M, Wang EN. Passive directional sub-ambient daytime radiative cooling. Nature communications. 2018 Nov 27;9(1):1-8.

Leroy A, Bhatia B, Zhao L, Wang EN. Specular side reflectors for high efficiency thermal-to-optical energy conversion. Optics Express. 2018 May 14;26(10):A462-79.

Leroy A, Bhatia B, Wilke K, Ilic O, Soljačić M, Wang EN. Combined selective emitter and filter for high performance incandescent lighting. Applied Physics Letters. 2017 Aug 28;111(9):094103.

Leroy A, Bernier M. Development of a novel spiral coil ground heat exchanger model considering axial effects. Applied Thermal Engineering. 2015 Jun 5;84:409-19.

Presentations

Leroy A, Bhatia B, Kelsall CC, Castillejo-Cuberos A, Di Capua H M, Zhao L, Zhang L, Guzman AM, Wang EN. Polyethylene Aerogel Covers for Subambient Radiative Cooling. The 2nd Pacific Rim Thermal Engineering Conference, Maui, HI, 2019.

Leroy A, Bhatia B, Wilke K, Ilic O, Soljačić M, Wang EN. High performance incandescent light bulb using a selective emitter and nanophotonic filters." SPIE Conference 10369: Thermal Radiation Management for Energy Applications, San Diego, CA, 2017.

Leroy A, Bhatia B, Zhao L, Wang EN. Optimizing Optical and Thermal Properties of Polyethylene Aerogels for Radiative Cooling. Materials Research Society Fall Meeting, Boston, MA, 2019.

Leroy A, Bhatia B, Kelsall CC, Castillejo-Cuberos A, Di Capua H M, Zhao L, Zhang L, Guzman AM, Wang EN. Infrared-Transparent Thermally-Insulating Polyethylene Aerogels for Radiative Cooling. Mechanical Engineering Research Exhibition, Cambridge, MA, 2019.

Bhatia B, Leroy A, Shen Y, Zhao L, Gianello M, Li D, Gu T, Hu J, Soljačić M, Wang EN. Passive directional sub-ambient daytime radiative cooling. Primer workshop en nuevas tecnologías híbridas de conversión de energía solar y térmica: Desafíos para un desarrollo sustentable. Santiago, Chile, 2018.

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Leroy, A, Bhatia B, Bierman D, Ilic O, Soljačić M, Wang EN. "High performance incandescent light bulb." Gordon Research Conference – Solar Energy Conversion, Hong Kong, China, 2016

Leroy, A, Bhatia B, Bierman D, Ilic O, Soljačić M, Wang EN. High performance incandescent light bulb. Mechanical Engineering Research Exhibition, Cambridge, MA, 2016

Peer Reviews

Joule

Science

Nature Communication

ACS Nano

Applied Physics Review

Optics Express