Raphael Kay; www.raphaelkay.com

Summary

I grow single-celled slime molds to develop **more resilient cities** and I study microscopic sea creatures to design **zero-energy buildings**. The related, published research that I've led has been featured by **100+** media outlets, journals, and advisory toolkits worldwide like **Nature** and **Bloomberg**, while earning me **30+** prestigious awards/distinctions/fellowships in renewable energy and sustainability.

I've been invited to speak about my work on a range of podcasts/radio shows like **CBC** and **Learning from Nature**, and to design/research teams at places like **NASA**. In addition, I have been **commissioned** to write about the implications of my research by international magazines, and I have been asked to **develop policy** with international governments and speak to **Presidential/Prime Ministerial** delegations worldwide. As a manager, I have mentored over **two dozen students**, from undergraduate design projects to award-winning global sustainability proposals.

Education

2023/28 **Ph.D.,** Materials Science & Mechanical Engineering, Harvard University, Mentored 10+, 4.0/4.0, 7 Awards/Distinctions
2020/22 **M.A.Sc.**, Mechanical Engineering, University of Toronto, Mentored 10+, 4.0/4.0, 10+ Awards, *Top Thesis*, Rank: ***1/89***
2016/20 **B.A.**, Architectural Technology**,** University of Toronto**,** 3.95/4.0; 15+ Awards, *Top Graduate*, Rank: ***1/230***

Selected Awards/Honors (*30+, >$1M USD total (offered awards)*)

2024 **Department of Defense** Graduate Fellowship (~$300k, ***top ~4%*** of applicants)
2024 **Link** Energy Fellowship (~$70k, ***top ~4%*** of applicants)
2024 **Canada** Graduate Scholarship, Doctoral (~$120k, declined)
2024 **Trudeau** Scholarship (~200k, top national humanities doctoral fellowship, ***top ~3%*** of applicants, declined)
2024 **Chen** Harvard Graduate Fellowship (***top ~0.5%*** of faculty)
2024 **NSERC** Postgraduate Scholarship (~120k, pending acceptance)
2023 **Stanford** Graduate Fellowship ($300k, declined, ***top ~0.8%*** of applicants)
2022 **Berkeley** Fellowship ($70k, declined, ***top ~1%*** of applicants, *singular recipient*)
2022 **Top graduate thesis** in department (***top ~1%*** of class, *singular recipient*)
2022 **Hatch** Sustainability Scholarship, Institute for Sustainable Energy ($10k)
2022 **MITACS** Research Award ($6k, declined)
2022 **Hogg** Energy Fellowship ($10k/year, renewable for three years, declined)
2021 **Canada** Graduate Scholarship ($17.5k, ***top ~0.4%*** of national graduate student body)
2021 **Ontario** Graduate Scholarship ($15k, declined, ***top ~1%*** of provincial graduate student body)
2021 **Bowman** Energy/Environment Scholarship, Centre for Global Engineering ($5k)
2021 **Wasmund** Sustainable Energy Fellowship ($1.2k)
2020 **Top Faculty Prize** (***top ~0.4%*** of class, ranked first in graduating faculty)
2019 **Leaders of Tomorrow** Award ($2.5k, ***top ~0.4%*** of class, *singular recipient*)
2019 **U of Toronto** Scholar ($1.5k, ***top ~4%*** of undergraduate class)

Selected Fellowship Finalist Distinctions

2024 **Hertz** Fellowship *Finalist* (selected as ***top ~5%*** of applicants)
2023 **Knight Hennessey** Scholarship *Finalist* (selected as ***top ~2%*** of applicants)
2022 Governor General's **Gold Medal** *Nominee* (selected as ***top ~0.1%*** (*~30/20 000*) of graduate student body)
2020 Governor General's **Silver Medal** *Nominee* (selected as ***top ~0.03%*** (*~20/15 000*) of undergraduate student body)
2019 **Rhodes** Scholarship *Finalist* (***top ~0.01%*** (*13/~100 000*) of provincial student body, *sole nominee* (*1/~15 000*) from university)

Selected Grants (*~$75k USD total, only grants I led as primary contact/contributor are included)*

2024 **Director's Fund**, Harvard Wyss Institute ($50k, ***lead contact/contributor***)
2023 **Salata Seed Grant**, Harvard Salata Institute (~$25k, ***lead contact/contributor***)

Selected Research Activities *(5+ labs in 3 countries)*

2023- PhD Student, leading team of 5+ to develop **0-energy building skin** using mostly **water**, Harvard University, Prof. Aizenberg.
2022/23 Research Fellow, developed **first material to universally manipulate a beam of sunlight**, Harvard University, Prof. Aizenberg.
2022/22 Visiting Researcher, helped develop bacteria **living solar panels**, Hub for Biotechnology in the Built Environment, Dr. Sawa.
2022/22 Visiting Fellow, fused fluidics + photonics to develop class of **low-energy liquid windows**, Harvard University, Prof. Aizenberg.
2020/22 MASc Student, led team of 4 to develop new **fish-inspired platform** for **0-energy buildings**, U Toronto, Prof. Hatton.
2020/21 Researcher, led team of 3 to develop **slime-mold-inspired city design tool**, U Toronto, Prof. Hatton.
2020/20 NSERC Research Award, used **75-cent oil** to make **self-regulating**, sustainable **liquid window**, U Toronto, Prof. Hatton.
2019/20 Undergrad researcher, designed project to address **diff between** perceived/measured **air quality**, U Toronto**,** Prof. Robinson.
2019/20 Undergrad researcher, co-designed autonomous **robot self-propelled by humidity**, U Toronto + U Waterloo, Prof. Correa.
2019/19 Selected Student, **chosen to represent Canada** in multinational **water resiliency program**, Delft University of Technology.
2019/19 NSERC Research Award, developed the idea to integrate **light-guiding veins** in **windows**, U Toronto, Prof. Hatton.

2018/19 NSERC Research Award, assisted filter forensics experiments to **rethink air quality measurements**, U Toronto, Prof. Siegel.
2017/17 Volunteer, led outreach for **social-impact environmental design**, Public Architecture, San Francisco (remote work).

First-Author Publications *(*indicates lead, corresponding author)*

2023 **Kay**. What color-changing crustaceans can teach us about designing efficient buildings. **Invited/commissioned article**. *Ar. Aktl.*
2023 **Kay** et al., *Multilayered optofluidics for sustainable buildings. *PNAS*, 30+ features/interviews.
2022 **Kay** et al., *Decapod-inspired pigment modulation for active building facades. *Nature Comm.*, 30+ features/interviews.
2022 **Kay** et al., *Stepwise slime mould growth as a template for urban design. *Scientific Reports*, 25+ features/interviews.
2022 **Kay** et al., *Shape-programmable fluid bubbles for responsive building skins. *J. of Building Engineering*.
2022 **Kay** et al., *Programmable droplets: Leveraging digitally-responsive flow fields to actively tune liquid morphologies. *PLoS One*.
2020 **Kay** et al., *The bio-inspired design of a self-propelling robot driven by changes in humidity, in *eCAADe*, 5 features/interviews.

Selected Intellectual Property

2024 **Kay** et al. A fluidic system for climate control. PCT filed May 10, 2024.
2022 **Kay** et al. System for control of optical properties of light. U.S. Patent filed November 29, 2022. U.S. 18071496.
2022 **Kay** et al. Fluidic device for regulating light transmission through the device. PCT Filed November 29, 2022. CA2022/051747.

Selected *Invited* Academic/Governmental Presentations

2024 Fish-inspired buildings & slime-inspired cities. **Invited speaker**, Tau Beta Pi Engineering Honor Society, City College of NY, NYC.
2024 Fish-inspired buildings & slime-inspired cities. **Seminar speaker**, Yonsei University, Seoul.
2024 Fish-inspired buildings & slime-inspired cities. **Invited conference speaker**, Bioinspired Materials and Design Conf., Toronto.
2024 Slime City. **Invited guest/presenter** to highlight my slime-inspired city design tool, **World Governments Summit**, Dubai.
2022 Could the future be fluidic? **Seminar speaker** to share my 0-energy liquid window concept, **Yale University**.
2022 Unicellular city planners for the moon. **Invited speaker** to ignite collaborative pilot-study, Lunar Habitat Design Team, **NASA**.

Selected Academic Presentations

2024 Transforming fluid instabilities into smart materials, in *Smart & Living Materials for Adv. Eng. Syst.*, 2024 MRS Fall Meeting.
2023 Optofluidic skins for sustainable buildings, in *Soft Optics*, 2023 MRS Fall Meeting.
2021 Slime mould networks as a template for the design of cities, in *Sustainability and Water*, U Toronto Eng. Research Conf.
2021 Biological microfluidics for smart buildings, in *Functional and Emerging Materials*, Canadian Materials Science Conf.
2020 From pinecones to robots, in *Cognizant Architecture - What if Buildings Could Think?*, eCAADe Conference.

Selected Interviews and Radio Show/Podcast Appearances *(40+, more here)*

2023 Could seafood-inspired skins slash emissions from buildings? Interviewed for: *CBC What On Earth with Laura Lynch.*
2023 How Does Nature Modify Light and Color? With Raphael Kay. *Learning from Nature: The Biomimicry Podcast. Apple. Spotify.*
2023 "The future of construction is liquid," claims a Harvard researcher. *Habitability*.
2023 'Liquid windows' inspired by squid skin could help buildings react to changing environments. *University of Toronto.*
2023 'Liquid windows' could be the answer to more sustainable buildings. *Fast Company.*
2023 Using Fluids to Control Energy Use in Buildings. *American Society of Mechanical Engineers.*
2023 Chameleon Skins Slash Building Energy Use. *IEEE Spectrum.*
2022 A Green Building Technique, Inspired by Fish Food. *Bloomberg News.*
2022 One Solution to the Climate Crisis is a Pane in the Glass. *H2O Radio.*
2022 These color-changing, energy-saving windows are inspired by an unlikely sea creature. *Fast Company.*
2022 Skin: the next frontier? *Novae Res Urbis, Toronto Edition.*
2022 What slime mould can teach us about optimizing the TTC. *The Varsity, University of Toronto.*

Selected Research Features in Academia/Popular Media *(75+, more here)*

2023 Optofluidics-based climate control in buildings. Research Highlight, *Proceedings of the National Academy of Sciences.*
2023 Squid-inspired smart windows could slash building energy use. *Anthropocene.*
2023 Optical tuner for sustainable buildings. Research Highlight, *Nature Communications Engineering.*
2023 Pigmented fluids. Included in the Biomimicry Design Toolkit, *bioSEA*.
2022 Sea creatures' sunshades inspire low-cost 'smart' windows. Research Highlight, *Nature*.
2022 The Krill Building. *Bloomberg Navigator*.

Selected Mentoring and Coaching *(35+ students)*

2022- High-school level: Germantown Friends School; St. John the Baptist High School; Undergraduate level: Carnegie Mellon University, Boston University, Harvard University; Graduate level: University of California; Rajk College for Advanced Studies.

Selected Academic Review Positions

2022- Environment and Planning B: Urban Analytics and City Science.

Leadership Activities and Achievements

2013- High-school: Appointed **captain** of junior, **co-captain** of senior basketball team; **most valuable player** of junior basketball team; volunteer basketball **coach**; senior basketball **counselor**/**coach**, **provincial** basketball player, culture club **president**. Undergraduate/graduate: faculty orientation **leader**, recruitment **leader**, intramural basketball, dodgeball team **captain**.