

# Palladium Based Microactuators for Next-Generation Microrobotics

**Dr Hanyu Alice Zhang**

Department of Applied Physics  
Cornell University, USA.

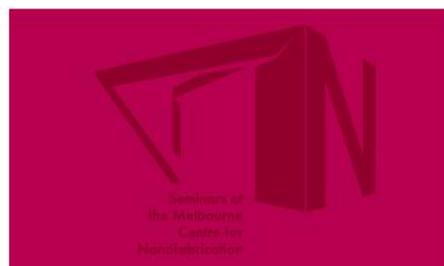
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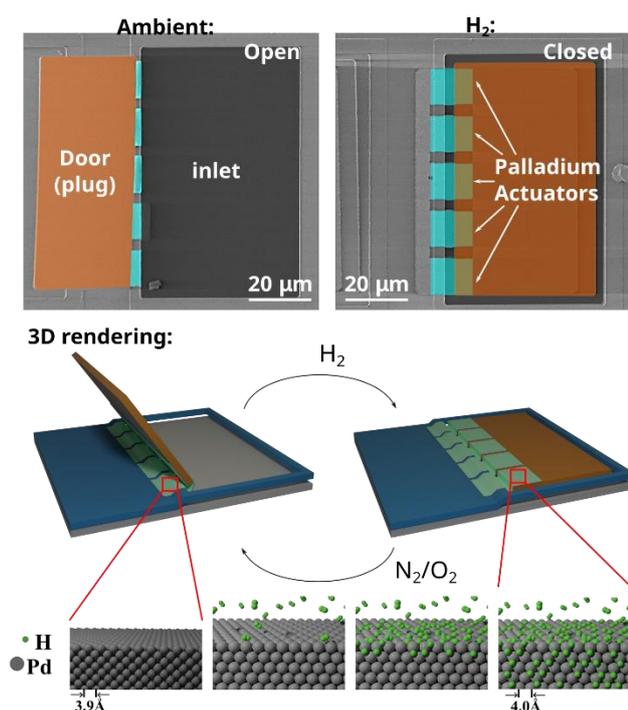
Dr Hanyu Alice Zhang  
Department of Applied Physics  
Cornell University  
Email: hz496@cornell.edu



**Abstract:** The field of microrobotics has seen significant development over the last decade, with the potential to revolutionize medicine, materials science, and microfluidics. By making use of the chemical and physical properties of different materials, microscale actuators today can respond to various chemical, thermal, magnetic, and electrical stimuli, making them versatile to various applications.

In this talk, I will give an overview of microactuators by our collaborators and focus on a new microscopic palladium-based system that convert chemical fuel into mechanical work (i.e., micro-chemomechanical systems (MCMSs)). This system uses hydrogen gas as fuel and the  $\alpha$  to  $\beta$  phase transformation of palladium hydride to drive microactuation. The microactuators, fabricated as 40 nanometer-thick palladium/titanium bimorphs, exhibit reversible changes of curvature of 0.7 inverse micrometers at room temperature, changes that are orders of magnitude superior to previous systems that utilize phase transformations to drive actuation. However, initial experiments in hydrogen and nitrogen show slow actuation response times at  $\sim 100$ s. To mediate this problem, we turned to density functional theory calculations and found that the addition of oxygen would lower energy barriers to the actuation, which we then confirmed experimentally and showed that the same actuators can respond an order of magnitude faster.

Our findings provide general, atomic-scale design principles for MCMSs with rapid dynamics, enabling development of active three-dimensional structures by chemically triggered folding of two-dimensional photolithographically printed devices for applications in circuit blocks, antennae, metamaterials, and microrobotics.



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**About the speaker:**

Hanyu Alice Zhang received a B.S.E. degree in Engineering Physics in 2018 and an M.S.E. degree in Material Science in 2019 from Case Western Reserve University, M.S.E. and Ph.D. degrees in Applied Physics from Cornell University in 2022 and 2025, respectively. She is now a research scientist working on finishing projects from her PhD degree, and traveling around the world to explore opportunities for academic research and science communication.