RENEWABLE ENERGY INTEREST REINFORCED BY POSTDOC RESEARCH

When Wesley Chang first trained as a chemical engineer at Stanford University, he discovered different renewable energy technologies and their importance in the energy transition. But it wasn't until after he spent years in a consulting role for the utilities sector and then as an electrochemist for a battery startup that he became convinced of his future career plans and decided to pursue a PhD in mechanical engineering to research new battery technologies and focus on lithium metal.

"It became clear to me that we need better, longer lasting batteries," explained Chang, "and we need more people working on rechargeable battery technologies."

During Chang's PhD, the lab he was in relocated from Princeton to the newly formed Columbia Electrochemical Energy Center, a move that opened opportunities for collaboration with many battery researchers and enabled him to work on exciting projects with both battery startup and large automobile companies.

"After, I spent a year as a Beckman Postdoctoral Fellow at Caltech," he shared. "I sought to strengthen my background in electrochemical applications for batteries with a stronger grasp of electrochemical fundamentals. Taking these

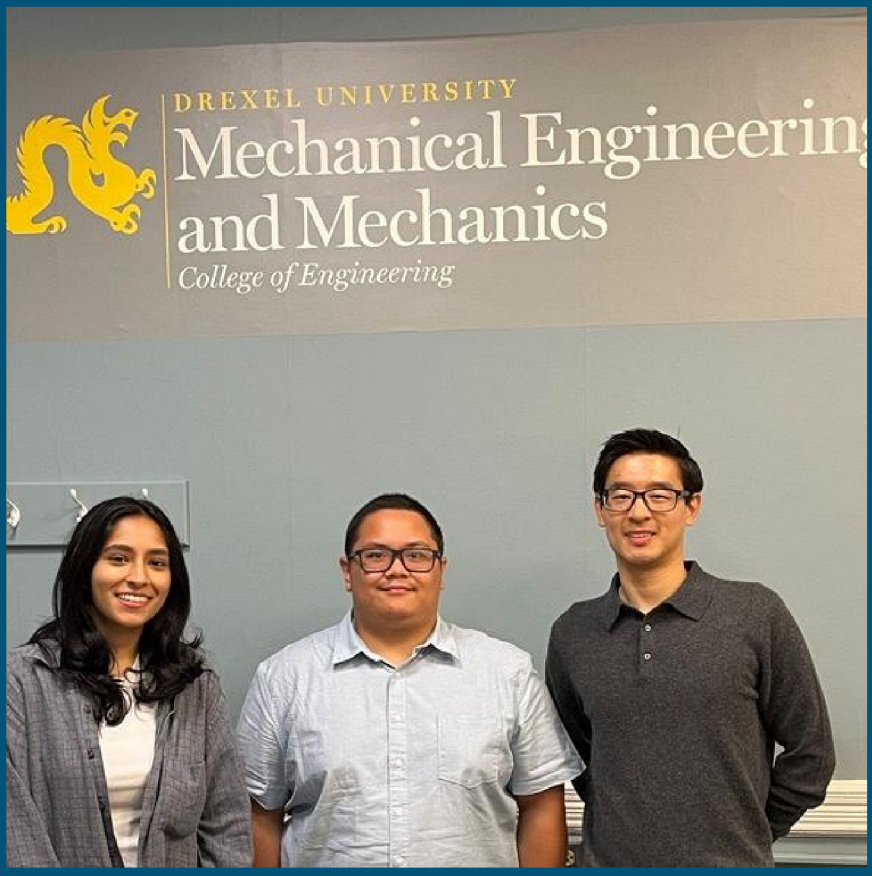
Above: Wesley Chang, PhD was awarded the Arnold O. Beckman Postdoctoral Fellowship in 2022.

"complementary skillsets into the future, I am now starting my own research group at Drexel University where our main goal is the understand relationships between material properties and cell-level behavior."

The Arnold O. Beckman Postdoctoral Fellowship is a merit-based program that supports advanced research by postdoctoral scholars within the core areas of fundamental chemistry or the development and build of chemical instrumentation. As a Fellow, Chang worked with and learned from Professor Karthish Manthiram's research group at the California Institute of Technology, focused on the understanding of fundamental electrochemical behavior of lithium-mediated nitrogen reduction. The goal was to build upon prior experience working on all types and sizes of batteries.

"Toward the end of my PhD, I became curious about the ongoing energy-intensive processes for making industrial fuels such as ammonia and was fascinated by reports demonstrating the electrochemical production of ammonia through lithium-mediated nitrogen reduction, with renewable electricity as the driving force for the reaction rather than burning fossil fuels in the conventional Haber-Bosch process," stated Chang.

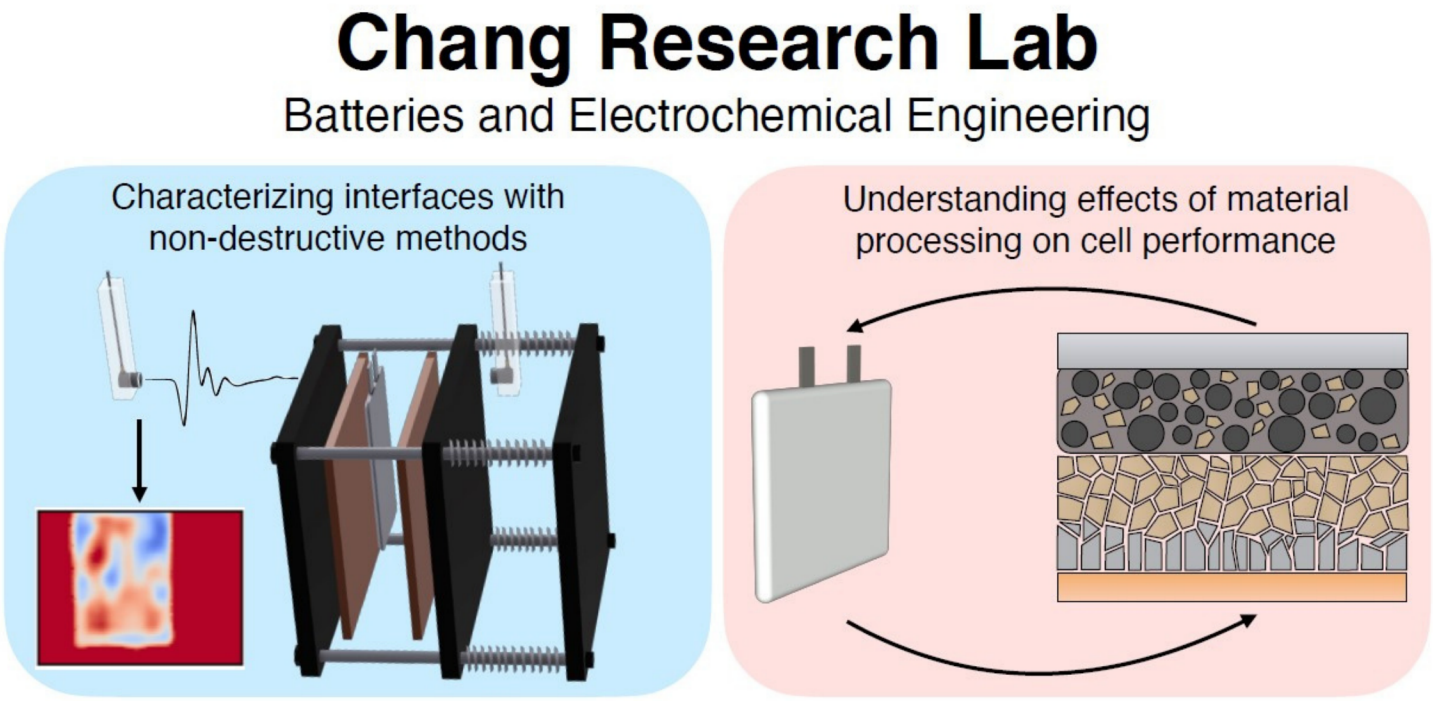
His Beckman-funded research was focused on applying concepts and chemistries known in the lithium battery field to the field of lithium-mediated electrocatalytic nitrogen reduction. It was during that work he conducted tests on a series of known battery electrolytes with varying physical properties to study their effects on ammonia generation. For this he chose a series of material characterization techniques with distinct advantages and sensitivities in order to measure how the electrochemical cells behaved. An example of this would be electrochemical quartz crystal microbalance, which can measure how much the sample mass changes down to nanograms. Another would be solid-state nuclear magnetic resonance spectroscopy, a technique using magnetic fields that can readily detect the presence of lithium metal.



Above: Wesley Chang, PhD (right) stands with members of his group, PhD students Fatima Tariq (left) and Andre Tayamen (center)

"As we deploy more solar and wind," posited Chang, "the changes to the energy generation sector will have significant effects on renewable energy storage and electric transportation. However, perhaps less spoken about in the public forum is the use of this renewable electricity to power the production of common chemical and fuels. While still in its infancy, commercialization of electrochemical reactors for making chemicals such as ammonia could have significant global impact in industrial decarbonization."

Chang understands that this means there is still a lot of work left to be done; to make enough product to justify commercial applicability, reactors would need to apply much higher electric currents and last for much longer than they currently do in



Above: The Chang lab at Drexel University conducts research on batteries and electrochemical engineering, seeking to understand how local material properties (e.g., electrode microstructure and surface chemistry, electrolyte conductivity) affect cell-level behavior (e.g., cycling performance and dynamics, gas formation, changes in mechanical stiffness). Schematic courtesy of Wes Chang, PhD.

research and development. He's undaunted by the prospect of a long road ahead. In fact, he's got an excitement and passion for it that appear to be contagious.

"I was one of the first members of the newly formed group at Caltech, having joined shortly after my Postdoctoral advisor moved there from MIT," he said. "During the past year, I had the privilege of watching the lab grow from 5 to nearly 20 members, and as the senior postdoctoral researcher in the nitrogen-related subgroup, have worked directly with four graduate students and several master's students on the lithium-mediated ammonia project. Our work will soon be published in several peer-reviewed journals. I'm looking forward to continuing research at the interface of batteries and electrochemical synthesis with my first two PhD students at Drexel."

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