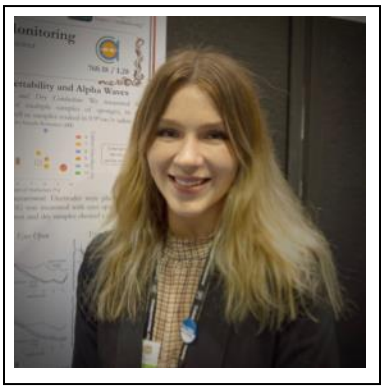
Making the Connection

Recent grad Kalee Rozylowicz enjoys solving electrical problems via materials innovation



Kalee Rozylowicz *(B.S. 2021)* came to Carnegie Mellon with an interest in mechanical engineering, but quickly realized that materials science was a better fit.

"Mechanical engineering problems are large, and they have been tackled for years," Rozylowicz notes. "I love the ability to focus on real-world problems at a much smaller scale. It seems very hands-on and practical to me. Studying materials problems is genuinely fun — but it's also useful and gives you the opportunity to make a meaningful impact on society."

Better EEG Results via Materials Improvements

With a double major in Biomedical Engineering, Rozylowicz conducted honors research that has the potential to provide more accurate electroencephalogram (EEG) results for all patients, regardless of race or ethnicity, via materials innovation. This idea was first introduced by Arnelle Etienne, a Black student researcher who graduated from Carnegie Mellon in 2019.

Electroencephalography monitors electrical activity in the human brain via small electrodes that are firmly attached to patients' scalps. This technique is critical for diagnosing epilepsy and other neural conditions. As interest in understanding the brain increases, the market for portable EEG devices is growing fast — and is expected to reach $1.83 billion by 2028.

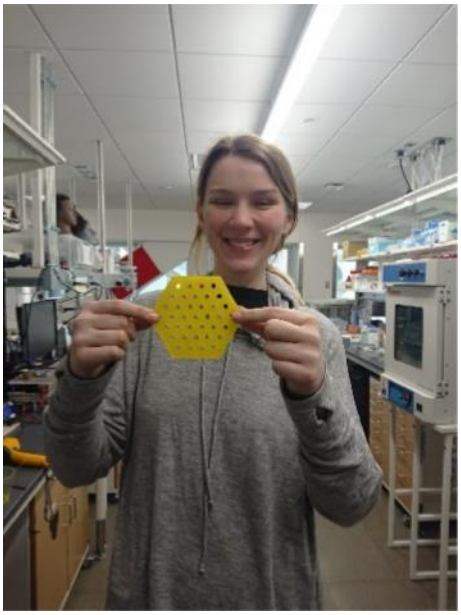
However, current EEG electrode contacts have some significant limitations. "Because of the traditional, rigid materials used for this application, it was challenging to attach electrodes to the scalp of patients with curly hair, including Black patients," Rozylowicz explains. "As a result, signal quality was being degraded. A better, more flexible material was needed to ensure good contact and higher-quality EEG results."

Working with Professor Pulkit Grover of Electrical and Computer Engineering, Rozylowicz developed a conductive carbon fiber based sponge that can be used to more effectively apply EEG electrodes. Made of hydrophilic polyurethane, the sponge also incorporates carbon nanofibers that make it conductive. "Because the sponge is flexible, it enables increased contact with the scalp of a curly-haired patient," Rozylowicz notes. "In my tests, the sponge-based electrode design had an impedance over 13 times lower than standard, metal-based electrodes on coarse and curly hair."

Pulkit, Rozylowicz, and other members of the research team have applied for a patent for the conductive sponge. Rozylowicz also presented her research findings at CMU's annual Meeting of the Minds student summit. "I love presenting my research and talking about it with other people," says Rozylowicz. "Often you receive feedback that makes you think about your topic in a new way, which only leads to greater innovation."

Exploring the Next Generation of Electronics

Rozylowicz will continue focusing on electrical materials innovation as a Ph.D. student at Stanford University beginning in fall 2021. She is currently planning to work with Professor Alberto Salleo in the Department of Materials Science and Engineering, studying molecular electronics improvements.



Rozylowicz will continue to focus on new materials that drive improvements in electronics applications.

"I'm excited to be working at the leading edge of electronics, because we have a huge opportunity to replace traditional transistor materials and designs with more flexible organic alternatives that can more easily be interfaced with biological systems," Rozylowicz points out. "I also hope to explore materials for neuromorphic computing, which allows hardware to mimic the processes of the human brain. I have a lot of freedom in designing my doctoral experience, and I'm grateful for that."

Rozylowicz's first three years at Stanford will be fully funded by the National Science Foundation's Graduate Research Fellowship Program, which hosts a competitive application process each year. Rozylowicz will receive an additional three years of support from the prestigious Stanford Graduate Fellowship in Science & Engineering.

Eventually, Rozylowicz can see herself as a faculty member leading her own research team. As an undergrad, she spent a year working as a materials researcher at Sandia National Laboratories, so she can also envision a career at a national lab. "Wherever I end up, I want to continue solving small-scale, focused problems — because that's what drew me to materials science in the first place," Rozylowicz states. "Sometimes the largest impact begins at the smallest scale."