2020 Peter Mark Memorial Awardee: Rehan Kapadia - “For pioneering work in hot-electron emission and electrochemical devices”

The Peter Mark Memorial Award honors a special type of scientist – one under 35 years of age, who has already made significant scientific contributions in his/her field through outstanding theoretical or experimental work. This year, AVS honored a young scientist, Dr. Rehan Kapadia, University of Southern California, with the 2020 Peter Mark Memorial Award. Rehan’s work has earned him much recognition in his career, and we wanted to know more about him. So, we were excited when he granted AVS an interview.

Research on Rehan reveals professional excellence that began back during his time as a student. During his Ph.D. work in electrical engineering at University of California, Berkeley, he was a National Science Foundation Graduate Research Fellow, and also won the David J. Sakrison Memorial Prize for outstanding research. Additionally, in 2016, he was awarded an AFOSR Young Investigator Award. Since then, he has authored over 60 journal articles relating to electronic devices, photonic devices, nanomaterials growth and applications, and thin-film growth. Notably, he has developed new techniques for growing and integrating compound semiconductors with arbitrary substrates. Moreover, he holds multiple patents.

Rehan humbly acknowledged that he would not have achieved the things he has without “a string of fantastic professional mentors throughout my life, starting all the way back in high school, and continuing to this day. It is not an exaggeration to say that I definitely would not be where I am without the guidance I received from them through the years.” He specifically noted his Ph.D. advisor, Professor Ali Javey. Rehan had the wonderful opportunity to join Javey’s group only two years after Javey started it. So, “beyond learning how to do great science, I got a chance to see how to really build a group from the ground up.” What a group Rehan has built too at the University of Southern California.

Rehan runs a research lab there, where he works as an Assistant Professor in the Electrical and Computer Engineering Department. He teaches both undergraduate and graduate students, while also doing research in his field. Recently, his research group has been developing some interesting devices that are based on non-equilibrium or ‘hot’ electrons. “Unlike equilibrium or ‘cold’ electrons, which follow a well-established distribution versus energy in our materials, hot electrons can exist outside this distribution, with energies substantially higher than the cold electrons. Cold electron distributions just don’t have many electrons at higher energies, which means that if we want to drive processes which require larger electron energies, we need to apply significant voltages to our devices.” He explained further that this can cause many problems, from power consumption to device degradation and breakdown. His group has been focusing on mechanisms for generating hot electrons that can be easily fabricated and manufactured. Carrying out device design to enable those hot electrons to be immediately used to drive some useful process has proven difficult “because non-equilibrium electrons are just that, out of equilibrium with the material. That’s something nature hates, and therefore will immediately try to rectify. The consequence of this is that hot electrons only stay hot for a very short amount of time, even 10’s to 100’s of femtoseconds, depending on the material.” So, Rehan’s research group continues searching for different types of device structures that can deliver high performance. Rehan has found two areas where these devices could have big potential impacts, which excites him greatly. The first area is in electron photoemission devices, and the second is in electrochemistry. He had a whole lot more to say about these, and welcomes you to **contact him** to discuss his research further. This great work caught the attention of AVS awhile back.

Rehan became affiliated with AVS when he attended the 2011 AVS International Symposium in Nashville, Tennessee, as a contributing speaker. He was drawn to the Society, and continued to participate regularly after that. Eventually, he became involved with conference organization. He has now served as a Session Chair, a Technical Organizer, and a Member of the EMPD Committee. Rehan feels that "AVS is a fantastic Society that brings together scientists from a wide variety of different fields. It is a Society that has a wide-ranging focus from materials to processing to devices . . . just a great place for me to interact with experts in all of the domains in which my group operates." We look forward to Rehan's continued and valuable contributions to the AVS community.

Outside of his vibrant professional life, Rehan enjoys an active lifestyle. When asked about his leisure time, he joked, "Leisure? What's that?" Still though, living in downtown Los Angeles, and pre-coronavirus, he managed to attend weekly meetups with his local running club, biked outdoors, and participated in the occasional triathlon. He understands the importance of having a few activities outside of work "which you can fall back on, especially when our work becomes intense and stressful, which it always does." Rehan acknowledged the importance of a work-life balance. He also spoke about his evolving ideas about the future of the larger scientific community. When asked if he had advice for future generations:

> "I'm answering this in the backdrop of multiple unprecedented events, a nationwide and global pandemic, and the demonstrations that are taking place across the nation which are trying to shine a light on the vast systemic inequality that exists across so many aspects of our society. Normally, I would tell the younger generation to put their head down, work hard, and stay laser focused on their goals. That's what I did, and it has, for the most extent, worked for me. But I think that in society today, this is not enough. We also need to actively work to recognize and shine a spotlight on the systems which are in place that unfairly restrict the advancement and success of certain groups, and then work to correct them. It's a very large goal, and not one that can be achieved by any one person. However, if we can all work at this, I'm certain that we will improve science and engineering for all those who follow in our footsteps."

This penetrating and beautiful statement reveals just another reason why Dr. Rehan Kapadia is a deserving awardee, and we hope you will join AVS in congratulating him!