

Dr. Mostafizur Rahman's visit to the University of Western Cape from May 15 to May 23, 2024, under the University of Missouri and South Africa Faculty Exchange program, focused on enhancing collaboration between UMKC and UWC through joint research, curriculum development, and facility management. The visit included a series of meetings, tours, and research activities, during which new research opportunities in sensor device integration were identified, and potential paths for joint publications were explored. As a direct outcome of this collaboration, a PhD student from the Sensor Lab, Teboho N. Moeketse, is scheduled to intern in Dr. Rahman's lab in the spring of 2025 for three months. This visit built on the ongoing relationship between Dr. Rahman (UMKC), Dr. Christopher Arendse (UWC), and Dr. Priscilla Baker (UWC), who previously submitted a joint proposal to the U.S. Department of State in 2022, with plans for resubmission. Dr. Rahman had also hosted Dr. Arendse at UMKC during his visits in 2022 and 2023, further strengthening this collaboration.

### **Research Thrusts and Activities During the UMSAEP Visit**

The collaborative research efforts between the University of Missouri Kansas City (UMKC) and the University of Western Cape (UWC) focused on advancing the field of optoelectronic devices, with a particular emphasis on exploring innovative device architectures. UMKC's expertise in device configuration, led by Dr. Mostafizur Rahman, was complemented by UWC's deep knowledge of perovskite materials, guided by Dr. Christopher Arendse and Dr. Priscilla Baker. This collaboration aimed to push the boundaries of perovskite-based technologies, particularly in the areas of energy harnessing and storage.

#### **Research Thrusts:**

The primary research thrust centered on the development of optoelectronic devices utilizing three-dimensional (3D) organic–inorganic halide perovskite (OIHP) materials. These materials have been recognized as transformative in electronic and optical applications due to their exceptional power conversion efficiency. Perovskite thin films, in particular, have shown remarkable potential in applications ranging from indoor solar cells to optical sensors used in medical diagnostics and environmental monitoring. The collaboration explored the potential of low-pressure chemical vapor deposition (CVD) as a scalable and controllable method for fabricating multi-dimensional perovskite layers with enhanced environmental stability and phase control.

A key focus of the research was the development of an innovative device configuration that could leverage the phenomenon of Crosstalk—typically viewed as noise—to harness and store electrical energy. This device configuration involved sandwiching perovskite layers between electrodes, with a dielectric layer and patterned electrodes enabling charge induction through Crosstalk. The approach aimed to convert captured light into voltage, which could then be stored as electrical energy in capacitors. Dr. Rahman's extensive background in Crosstalk devices and circuits, including his pioneering work on utilizing noise for computation, played a crucial role in driving this research forward. The ultimate goal was to develop novel perovskite-based optoelectronic devices that could efficiently capture and store energy.

### **Curriculum Development and Facility Management:**

In addition to research, the collaboration also focused on curriculum development and facility management. A joint effort was made to create a nanomanufacturing course at UWC, designed to provide students with hands-on experience in micro and nanofabrication. Dr. Rahman, who teaches a similar course at UMKC, contributed his expertise to the course development at UWC, ensuring that the curriculum would equip students with the necessary skills for cutting-edge research and industry applications.

On the facility management front, Dr. Rahman shared his experience in cleanroom-based fabrications to optimize resource usage and enhance the productivity of UWC's new microfabrication facility, which was scheduled to open in Fall 2023. His insights were aimed at ensuring that the facility would be capable of supporting advanced research in micro and nanotechnology, benefiting both the university and the broader research community.

### **Activities During the UMSAEP Visit:**

During his visit to UWC from May 15 to May 23, 2024, funded by the University of Missouri South Africa Education Program (UMSAEP), Dr. Rahman engaged in a series of strategic meetings, tours, and research activities designed to deepen the collaboration between UMKC and UWC. On May 15, he met with Dr. Christopher Arendse at the National Microbial Monitoring Facility (NMMF), followed by a facility tour, an off-campus lunch, and meetings with faculty members. The following day, May 16, involved a detailed tour of the physics and chemical vapor deposition facilities, accompanied by Dr. Arendse and James.

On May 17, Dr. Rahman participated in discussions and lab setup activities with Dr. Arendse, James, and Sihle, focusing on the practical aspects of their research collaboration. Research activities continued on May 20, allowing for in-depth exploration of ongoing projects. On May 21, Dr. Rahman contributed to a session that featured presentations by students Teboho, Rezaan, and Mia, followed by one-on-one meetings and planning for future collaborative work.

The visit also included significant academic contributions. On May 22, Dr. Rahman delivered lectures on his research, the ongoing collaboration between UMKC and UWC, and the integration of electrochemical sensors with electronic devices. These lectures were attended by students, postdocs, and interested staff, fostering knowledge exchange and sparking discussions on potential future research directions. The visit concluded on May 23 with a faculty presentation organized by Dr. Arendse, which was attended by all members of the SensorLab, marking a successful end to a productive visit that laid the groundwork for future collaboration.

Table 1: Schedule during Dr. Rahman's visit to UWC

DATE	TIME	ACTIVITY	HR
May 15, 2024	10h00 – 11h00 11h00 – 12:h00 12h00 – 14h00 14h00 – 16h00	- Meet Chris Arendse at NMMF - Tour of NMMF - Lunch – off campus - Meeting with faculty	Chris, Priscilla
May 16, 2024	10h00 – 16h00	- Physics tour - Chemical vapor deposition facilities	Chris, James
May 17, 2024	10h00 – 16h00	- Project discussions - Lab setup of low-current photoconductivity system	Chris, James, Sihle
May 20, 2024		Research activities	Chris
May 21, 2024		<b>Session 1</b> – printed electrode presentations by Teboho (10 min), Rezaan (10 min) and Mia (10 min) Break+ catering <b>Session 2</b> – Dr. Rahman one on one with Nastaran/Keagan (30 min) Francis/Dhielnawaaz (30 min)	Keagan/Francis/Dhielnawaaz + Physics? Book presentation venue Chemistry boardroom? Or 3 <sup>rd</sup> floor lecture room? Catering with Ms. Jackson
May 22, 2024		<b>Lecture 1:</b> Dr. Rahman Research overview, UMKC/UWC partnership, context of collaboration (40 minutes) <b>Lecture 2:</b> Research specific response to electrochemical sensors	All PGLB PG students and postdocs + Physics? Interested staff - SensorLab

		integration with electronics for devices (40 mintues) Q & A and discussion	Time to be confirmed: Venue? Catering with Dr. Rahmans J
May 23, 2024		Faculty presentation and catering	Organizer – Prof Chris All campus All SensorLab to attend