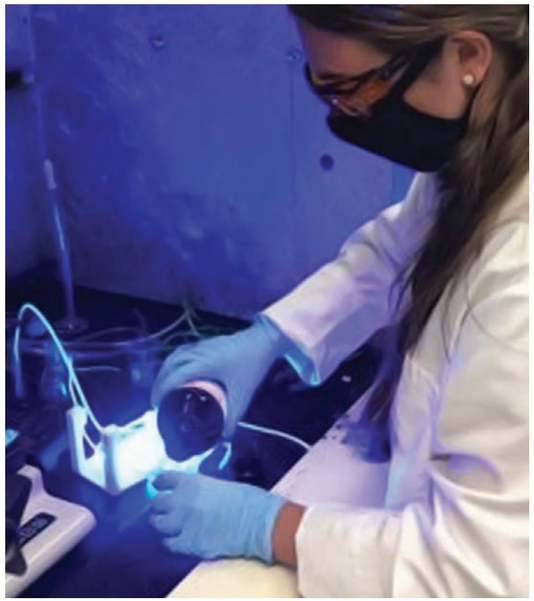

Biochemistry student **Brooke Pakech** prepares to conduct a chemical reaction with blue LED light in a 3D-printed flow chemistry device.

Putting Light to Work

Jefferson researchers are using light in new ways: using blue light to drive chemical processes, and creating products that illuminate in ultraviolet light. Their work reflects a convergence of disciplines such as physics, chemistry, textile engineering and nanotechnology that is driving applications with practical benefits for people and the environment.

John Milligan, PhD, assistant professor of chemical and biological sciences, is leading development of environmentally sustainable ways to spur chemical reactions using blue LED light. The work is an example of the "photoredox" subfield of organic chemistry, which has proven to be an increasingly effective method for building organic molecules. In the new approach, blue LED light activates innocuous catalysts to carry out useful reactions. The LED light-driven process could obviate the need for the currently used chemical reagents that produce harmful waste.

In one promising project, Dr. Milligan is working with Jefferson design experts to create 3D printed devices that enable LED light-triggered chemical reactions. Unlike traditional chemistry reactors, light-triggered 3D printed devices could be an inexpensive, easily adaptable and portable method for on-demand preparation of molecules used in medicine or agriculture. The researchers' eventual objective is to synthesize indole alkaloids, which are used in treatments for conditions ranging from cancer to neurological diseases.

"One of the first questions we are trying to answer is whether copper salts can be used with the blue light to make amides, which form the chemical backbone of peptides and proteins," explains Dr. Milligan. "Because copper is abundant, non-toxic and can readily share its electrons with organic molecules to spur reactions, it could be a very environmentally friendly ingredient for synthesizing useful organic molecules."

Another team—including textile engineering and science doctoral candidate **Abdur Sk**, assistant professor of physics **Brian Yust, PhD**, and associate professor of engineering **Brian George, PhD**—is creating ceramic nanoparticles that illuminate under UV light. Then the researchers are incorporating the particles into fabrics and other materials that could be used for a variety of purposes, such as clothing, tools or vehicles.

"To date, nearly all fundamental and applied research on persistent luminescent nanoparticles focused on the visible region of the light spectrum," Dr. George says. "That works well in standard situations—like viewing a watch face in the dark—but not when searching for someone who is lost in a forest or has fallen off a boat."

However, when exposed to UV lights, the new materials can store that energy and then, slowly, emit infrared light that can be easily detected with night vision goggles in low-light situations. The research team's goal is to create materials that exhibit luminescence for a period of hours, which could be life-saving. "Beyond the novelty of incorporating UV-responsive particles in regular products, we believe there will be an array of real-world applications that only begin with search-and-rescue situations," Dr. Yust observes. ■