Cal Poly Senior Physics Major Works with Professor Palffy-Muhoray Developing a Liquid Crystal Generator During Winter Break

Back in 2002, when Jake Fontana asked his college professor if he knew of any summer work he could do, he probably never imagined he would be spending his winter break in Kent, Ohio two years later. He also probably didn't think he would be taking part in a unique experiment developing a liquid crystal generator. But, fortunately, that is exactly what happened.

After completing his sophomore year at Cal Poly in 2002, Jake Fontana, now a senior physics major, was looking for summer work. So, he asked his college professor, Dr. Ron Zammit, if he knew of any summer work. Zammit introduced Fontana to a former student and friend, Dr. Bahman Taheri. Fontana then spent the summer working for Taheri at AlphaMicron, based in Kent, Ohio.

Meeting Dr. Palffy-Muhoray

That summer he was introduced to Professor Peter Palffy-Muhoray, who along with Dr. Taheri and Dr. Tamas Kosa founded AlphaMicron. Fontana has continued working for AlphaMicron for the past two years.

This past summer, Palffy-Muhoray, a professor of Chemical Physics at Kent State University's Liquid Crystal Institute, came up with the idea to explore the possibility of using liquid crystals to generate electric power for personal electronic devices, much like the heel-strike generator studied by SRI International's Dr. Ron Pelrine and Dr. Roy Kornbluh. Naturally, Fontana was interested. So, Palffy-Muhoray arranged for Fontana to work with him at the LCI during Cal Poly's winter break this past December.

Jake Fontana

The Liquid Crystal Generator

Inspiration for the project came while thinking about improving more conventional generators. SRI International, a nonprofit organization, had developed a heel-strike generator for the U.S. Department of Defense in an effort to develop an alternative means of producing electrical energy from mechanical work. They have integrated the idea into the sole of a shoe, so as a soldier walks around he or she can produce electrical energy just by walking.

In the case of SRI's heel-strike generator, as the soldier walks, the compression of the sole of his/her shoe increases the distance between capacitor plates built into the heel. If the capacitor is charged, the voltage between the plates increases, producing electricity.

The idea of the liquid crystal generator is to use a liquid crystal between the capacitor plates, and change the capacitance by mechanically reorienting the liquid crystal molecules to produce electricity.

"In the normal operation of liquid crystal displays, one places a voltage on the liquid crystal cell (which can be thought of as a capacitor)," Fontana said.

This in turn creates a torque which reorients the liquid crystal molecules, and thus changes the dielectric constant as well as other properties of the liquid crystal.

"In our case we want electrical energy out, not in. So we have to run a display cell in reverse. We put in mechanical work and want electrical energy out," Fontana explained.

They did this by making a Hele-Shaw cell so that the alignment of the liquid crystal molecules was perpendicular to the glass. "When we pumped liquid crystal in or out of the cell, doing mechanical work, the orientation of the liquid crystal changed to parallel to the surface during the flow. This decreased the dielectric constant, increasing the voltage across the cell, and transforming mechanical work into electrical energy."

The result of the study

The preliminary results indicated that the project was a success. "It is great to see an idea go from idea to reality in three weeks," Fontana said. "Working with Dr. Palffy-Muhoray on this project was fun. I had a great time. This is what I want to do. You play with an idea and it actually works out. You can't ask for more. I've kept a positive attitude since the beginning of the project."

If you ask Jake why he would leave sunny California to spend his winter break in chilly Ohio, he'll tell you: "it was fun; this is exactly what I want to do!" "I want to be an experimental physicist and get my hands dirty," he said.

"This is just Phase 1," Fontana explained. "We would really like to work with elastomers. This is just the starting point, but the future looks bright."

Support for Fontana's work was provided through the US Department of Education grant to Kent State University's Liquid Crystal Institute for a Center for Liquid Crystal Science and Education and the National Science Foundation Grant DMR-0132611.

Fontana plans to graduate from Cal Poly in March and hopes to attend Kent State in the fall as a graduate student in the Chemical Physics Interdisciplinary Program while continuing to work at AlphaMicron.

--Jim Maxwell, PR Coordinator
KSU Liquid Crystal Institute