

# Self-Tracking Solar Concentrators

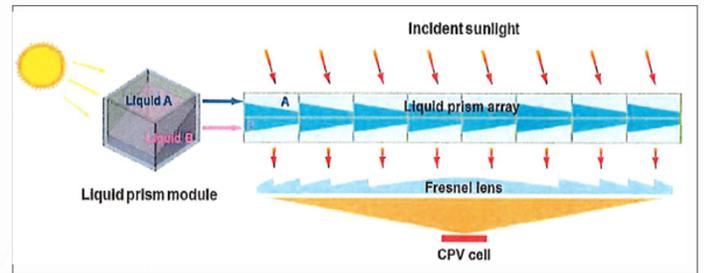
VTIP 20-056: “Self-Tracking Optofluidic Solar Concentrators Controlled by Bistable Electrowetting”

## THE CHALLENGE

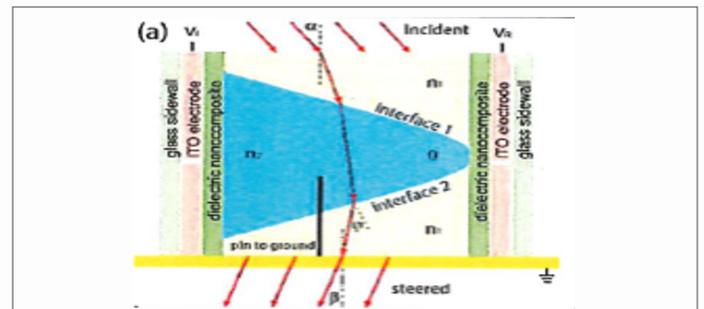
The US and global energy markets are being forced to embrace renewable energy sources. The most promising solution is solar energy. State of the art solar energy harvesting devices are currently too expensive to achieve widespread adoption so improvements that make solar energy affordable are much needed. There are two ways this can happen: a decrease in cost or an increase in harvesting efficiency. Both of these are necessary for a brighter future with renewable energy.

## OUR SOLUTION

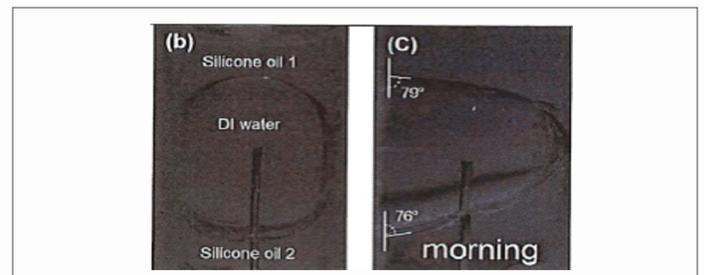
Virginia Tech’s professor Jiengtao Cheng has developed a concentrating photovoltaic (CPV)-solar thermal (CPV/T) hybrid system for full spectrum harvesting of solar energy through electrowetting-driven liquid prisms. This CPV/T system is based on electrowetting- on-dielectric (EWOD), which controls the contact angle between an electrolyte and a dielectric surface through the application of a potential difference between them. With two immiscible fluids filled in a transparent cuvette, we can actively control the contact angle along the fluid-fluid-sidewall tri-junction line and hence the orientation of the fluid-fluid interface via EWOD. Wide-range tracking and agile steering enables the liquid prism work as a solar tracking module. Without mechanical moving parts, this liquid prism allows the device to adaptively track both the daily and seasonal changes of the Sun's orbit. This invention reduces capital costs of CPV and increases operational efficiency by eliminating power consumption of mechanical tracking.



The solar energy harvesting system is based on an optofluidic solar concentrator comprised of an array of liquid prism modules on a Fresnel lens. Sun is adaptively tracked by tuning the orientations of the fluid-fluid interfaces inside each liquid prism module via EWOD and sunlight throughout the day is refracted toward the Fresnel lens with a CPV cell located on its focus surrounded by thermal receivers.



(a) Optical path inside a dual prism cell. Dual fluid-fluid interfaces can achieve a large steering angle ( $\alpha > 80^\circ$ ).



(b) Profile and structure of triple layers of fluids in a dual prism module with no voltage applied. (c) A dual liquid prism was formed with proper voltages applied on sidewalls.



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