Development of Solar Indoor Lighting Systems

PROJECT TEAM

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PROBLEM STATEMENT

Researchers have found that around 30% of electricity consumption is due to conventional lighting systems in building sector. Furthermore, utilizing natural sunlight is eco-friendly which According to researchers, sunlight is a healthier approach when it comes to indoor lighting as sunlight increases people's ability to concentrate and improves human memory. Moreover, it could reduce pollution and encourage indoor activities such as planting, and it could help in reducing 30% of the electricity consumption.

PROJECT GOAL

The main purpose of the project is to reduce the high lighting power consumption caused by the usage of conventional lighting systems. An electrowetting-driven indoor solar lighting system was developed which contain four different components. They are: multiple voltage sources, a liquid prism, a white light source, and a programmed controller.

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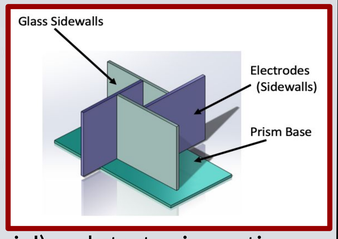
FABRICATION

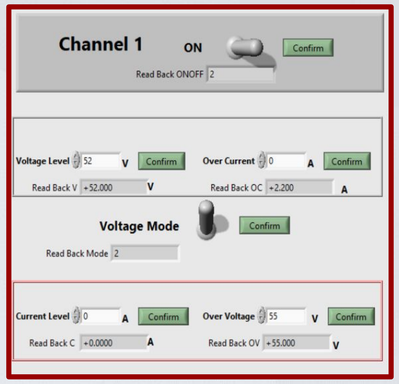


The fabrication process utilize the use of a NanoFabrication Lab. The process of fabricating an electrode sidewall starts with covering a small area of the glass with the kapton tape after cleaning it and placing it on the spin coating machine.

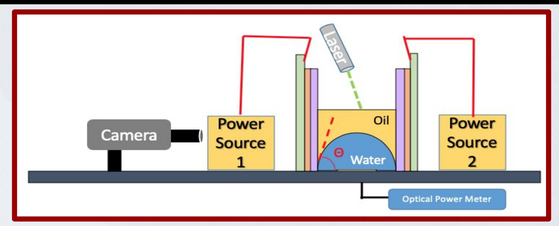
Second, dispense the Ion Gel (dielectric material) and start spin coating at 2000-3000 rpms. Third, the glass shall be left on a hot plate under 75°C for 24 h to dry. Fourth, spin coat the Fluoropel at 1000-1500 rpm and leave it for 12 h to dry under 65-75°C. The same process shall be done for the glass sidewalls and the base but without the Fluoropel 800 coating. Fifth, the walls shall be attached together using adhesive to f orm the cubic shape of the prism. Lastly, the prism shall be filled with two immiscible liquids, water and silicon oil.

CONTROL SYSTEM

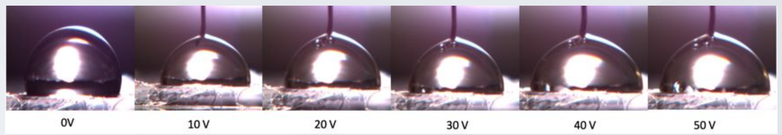
The team used LabVIEW to program the power supplies. The control system shall command the voltage sources to provide the desired amount of voltage to each side of the liquid prism walls. The system has a simple panel to allow the user to easily manage to control the amount of voltage applied from each power supply.



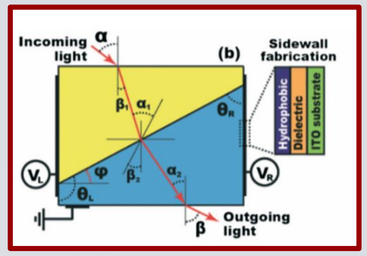
WORKING MECHANISM



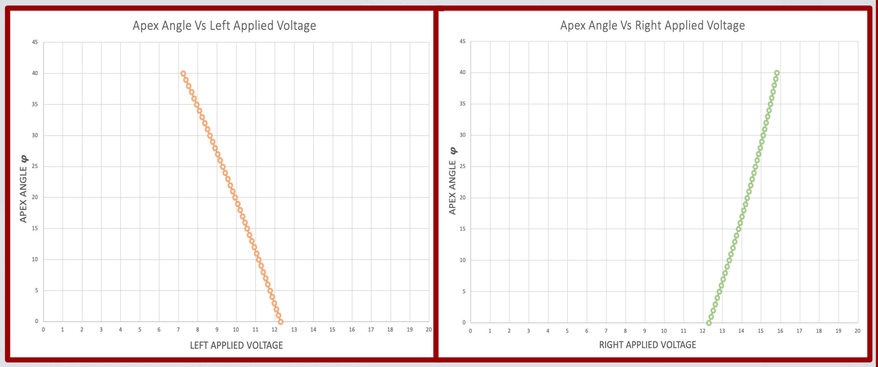
The working principle of the liquid prism is based on the electrowetting phenomenon. When the Voltage is applied on the electrodes, the prism angle shall be changed based on the tension between the wall layers, water and the silicon oil. The more voltage you apply on one side, the more light shall be transmitted through the prism. The prism angle θ is around 116°-120° in air. The angle decreases when voltage is applied as shown below.



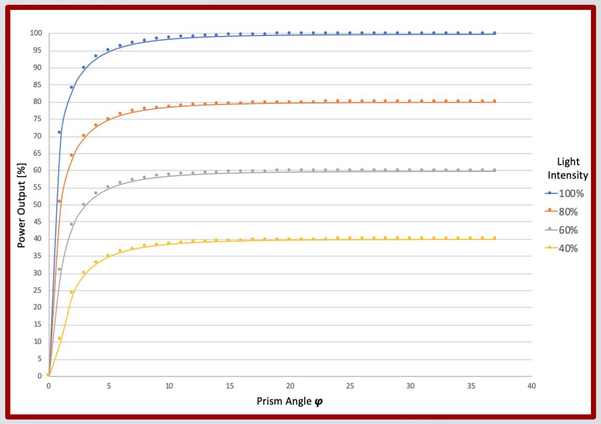
ENGINEERING ANALYSIS



The working principle of the liquid prism is based on the electrowetting phenomenon, which is well described by the Young–Lippmann theory to control the left angle θ_L and right angle θ_R of the prism. The following graphs present the theoretical results which conclude relationship between the prism (apex) angle φ and θ_L and θ_R of the prism.



Moreover, The liquid prism main purpose is to transmit light for indoor lighting. The equations governing transmittance of power are Snell's' law and Fresnel equations. With a fixed incident angle, a theoretical study was made to understand the performance of prism in transmitting light with the change of the prism angle φ and the results were shown in the graph below. The graph demonstrate how the change in the prism angle φ can affect the intensity of the light passing through the prism .



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