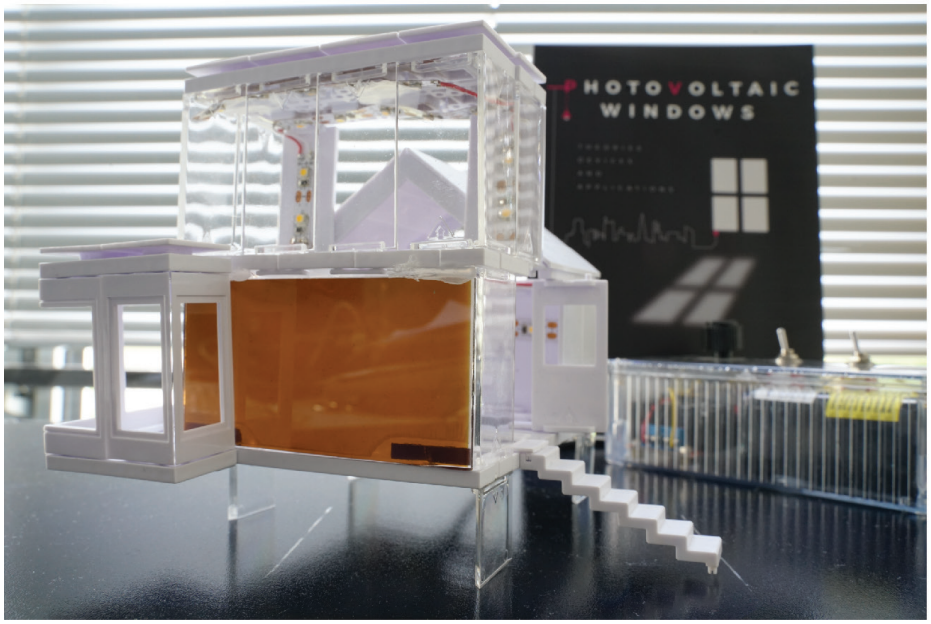
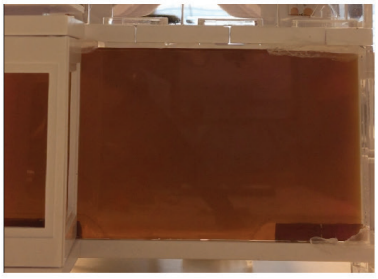
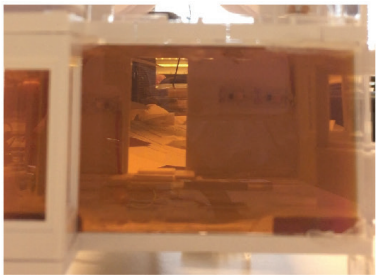
(a)



(b)



(c)



(a) A demonstration house model of STPV-PDLC system. The window dimensions are around 10 * 5 cm. (b) The STPV-PDLC window reveals opaque in the 'off' state when no voltage is applied to the PDLC film. (c) The STPV-PDLC window turns semi-transparent when an AC voltage is applied to the PDLC film

Harvesting energy from your windows

Globally, more than a third of energy consumption is attributable to the building sector. Reducing the consumption of building energy generated from fossil fuels helps alleviate the air pollution and global warming. Some European countries regulate that all new buildings shall be nearly zero energy buildings (ZEBs) by the end of 2020. Apparently, local energy harvesting is required to realize this goal. Among all realistic strategies, building-integrated photovoltaic (BIPV) is an obvious choice for those regions with adequate solar radiation. In congested urban areas, high-rise modern buildings possess more potential for harvesting solar energy around the window areas than roofs. Therefore, innovative design is required from the cell level to the system level regarding window-integrated photovoltaics.

Dr. Yuan Gao proposed, together with prof. Miro Zeman, prof. Kouchi Zhang, dr. Olindo Isabella and dr. Jianfei Dong, an innovative approach to collecting solar energy from window areas in buildings and meanwhile creating comfortable daylighting. This idea is realized by designing and fabricating a semi-transparent photovoltaic (STPV) glazing window combined with a polymer-dispersed liquid-crystal (PDLC) film. The semi-transparent amorphous silicon solar cell shows an average transmittance of 20.04 % with a power conversion efficiency (PCE) of 6.94 %. According to the climate data of Delft, such a PCE is sufficient to power an equal-area PDLC film, which can switch from an opaque to a transparent state in a second by applying an alternating-current (AC) voltage. The prototype of a house model, containing the STPV-PDLC system, has been built to demonstrate the feasibility of such a combination.

The PhD research work of Yuan Gao was performed under the joint supervision of Delft University of Technology in the Netherlands and State Key Laboratory of Solid State Lighting in China. Yuan Gao succeeded in defending his thesis on 25 June 2019, at Delft University of Technology. The title of his thesis is 'Photovoltaic Windows: Theories, Devices and Applications'.

The thesis can be found at:
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