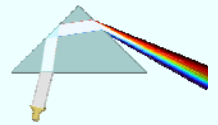




# SolSwitch for solar thermal collector and greenhouses



vrije Universiteit amsterdam

Martin Slaman and Ronald Griessen

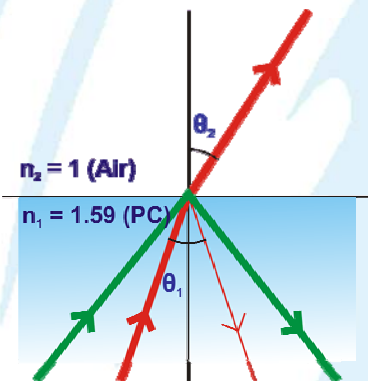
## SolSwitch: the cheapest and most efficient optical switch



VU University developed a low-cost optical switch. The switch consists of a panel which is transparent when filled with water and light reflecting when empty.

### Working principle:

#### Critical angle and total internal reflection:

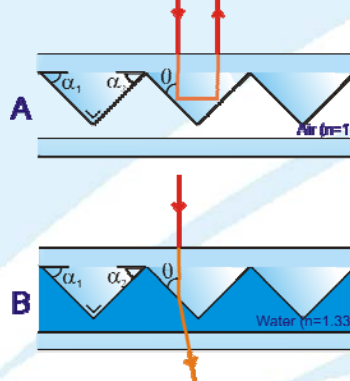


Light which travels through a medium such as polycarbonate (PC) at incidence angles larger than the so-called "critical angle" cannot escape from the medium. This effect is called "Total internal reflection".

$$\theta_c = \arcsin(n_2 / n_1) \quad [n_2 / n_1 < 1]$$

Polycarbonate to air interface  $\Rightarrow \theta_c = 39^\circ$   
 Polycarbonate to water interface  $\Rightarrow \theta_c = 57^\circ$

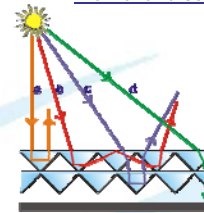
#### Total internal reflection in prisms:



A) Prismatic structure surrounded by air: The incidence angle on the prism interface ( $\alpha=45^\circ$ ) is larger than the critical angle  $\theta_c = 39^\circ$ . "Total internal reflection" occurs.

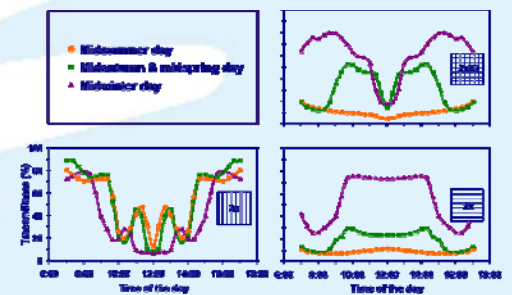
B) Prismatic structure surrounded by water: The incidence angle on the prism interface ( $\alpha=45^\circ$ ) is smaller than the critical angle  $\theta_c = 57^\circ$ . Light is transmitted through the panel.

#### Diurnal and seasonal changes

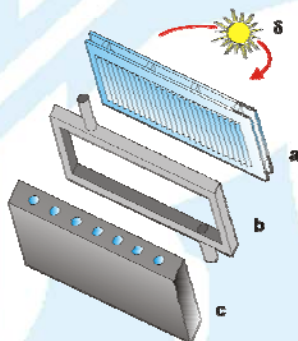


The effect of light reflection is optimal for light rays at or near normal incidence (a, b). However, in a double prismatic layer light is efficiently reflected for a wide interval of incidence angles.

Optimal configurations can easily be designed for various applications.



### Applications:



SolSwitch can be used in low-cost all-polymer solar collectors to prevent stagnation due to overheating. a) Thermally isolated prismatic structure. b) Switching fluid reservoir. c) Solar absorber with (optional) thermal fluid channels.



The great advantages of SolSwitch for greenhouses:

- Active protection of plants from sun burning (without cumbersome Shading Chalk Spraying)
- Optimal temperature control of the greenhouse by switching of individual roof modules.
- Thermal energy harvesting from the switching fluid
- No "light pollution" of greenhouses during nights.