CERIS Civil Engineering Research and Innovation for Sustainability

Thermal, luminous, energy and environmental performance of smart glazing in building facades

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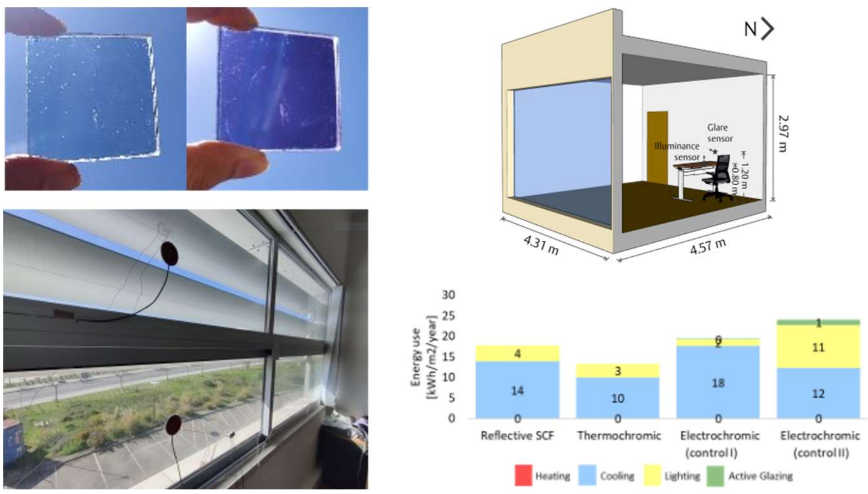
Summary

The building and construction sectors are essential to promote decarbonization and energy efficiency since they are accountable for 36% of global energy use. A building's facade has a significant impact in the energy performance and indoor comfort of the building. This impact is more notorious for the glazed elements of the facade due to the poor performance of conventional glazing. Modern and innovative glazing technologies that can dynamically alter their properties and/or convert energy have been developed and investigated in recent years. Even though these smart glazing technologies have the potential to increase indoor comfort and the energy efficiency due to their solar control properties, holistic studies that simultaneously assess the thermal, luminous, energy and environmental performance of these technologies are scarce, particularly for the Mediterranean climate. Consequently, this PhD thesis aims at filling the existing research gaps and improve the knowledge on the topic through the experimental and numerical investigation of the thermal, luminous, energy and environmental performance of different smart glazing technologies on the Mediterranean climate.

A comprehensive literature review on the topic has been conducted to identify passive and active state-of-the-art solar control glazing technologies and assessment methodologies. Also, an extended experimental campaign has been carried out under real occupancy conditions to monitor outdoor and indoor temperature, illuminance, irradiance and heat fluxes in two offices, one with a photochromic film and another used as reference with the original clear glazing without film. Furthermore, the field experimental data was used to calibrate a computer simulation model of the office rooms to assess the global performance of the photochromic film and its impact on indoor comfort. In addition to this, a second numerical simulation model was created to assess the second case study that is constituted by an office room with double clear glazing with and without a solar control film southeast oriented. In this case study, the global performance of thermochromic and electrochromic glazings have been evaluated against the original clear glazing with and without a static solar control film. The performance of the different smart glazing technologies covered in this thesis is also assessed considering climate change scenarios and from a building to city scale. Finally, the viability of the application of these smart glazings is evaluated through a multicriteria decision analysis that includes energy performance, environmental impact, costs and comfort decision criteria.

Keywords

Smart glazing, thermal performance, luminous performance, energy performance, environmental performance, indoor comfort, in-service monitoring, numerical simulation.



Photochromic film and experimental campaign, computer simulation model of the second case study and energy performance results.