Radiative Sky Cooling from Visibly Transparent High-Emissivity Glass Window

Antonio Trujillo, Mechanical Engineering
Mentor: Liping Wang, Associate Professor
School for the Engineering of Matter, Transport, and Energy (SEMTE)

Research question

What is the cooling potential of a visibly transparent, high-emissivity, glass window constructed from commercially available materials?

Methodology

Construct visibly transparent, high emissivity glass window by coating soda lime glass in a dual layer consisting of indium tin oxide (ITO) and polyvinyl fluoride (PVF) film.
Measure the inner air temperature within building models where upper surface of the model is constructed from glass sample.

Experimental Setup

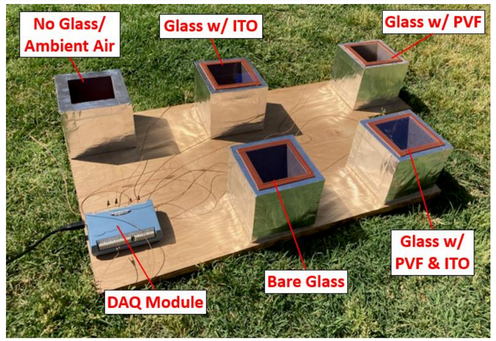

Figure 1: Outdoor testing setup consisting of DAQ and building models. Experiments conducted in Florence, AZ.

Results

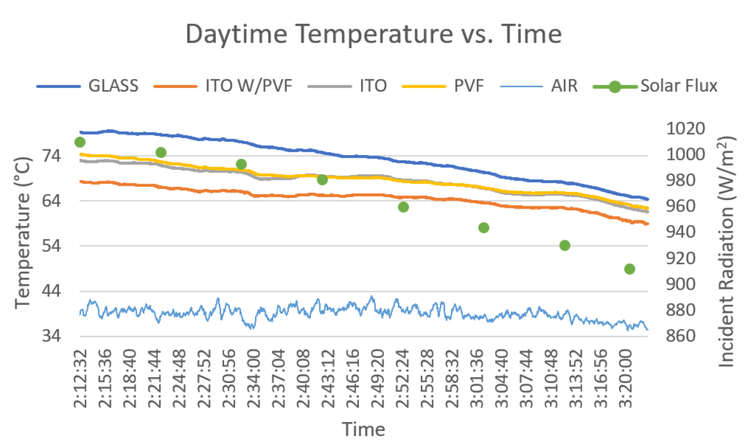

Figure 2: Daytime temperature and solar irradiation measurements taken on April 6th, 2022, during clear skies and no wind conditions.

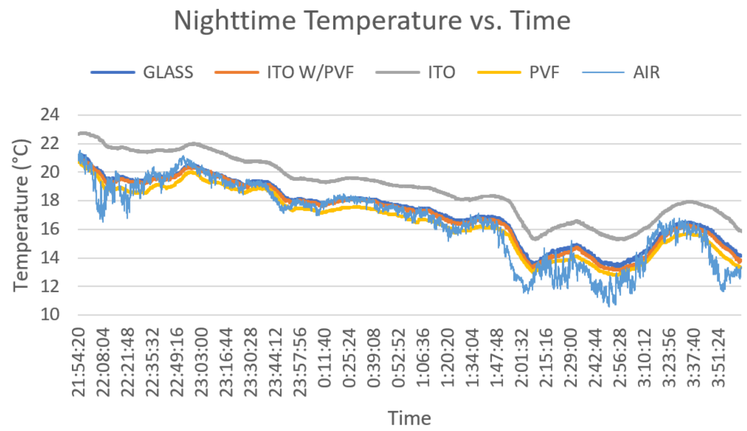

Figure 3: Nighttime temperature measurements taken on April 9th, 2022, during clear skies and mild wind conditions.

Discussion

It is expected that the glass window coated with ITO and PVF will achieve the lowest inner air temperature. This is because it can reject solar heat in the near-IR due to the highly reflective ITO, and it can dissipate infrared heat via radiative sky cooling due to the highly emissive PVF film. The superior cooling capability and high visible transparency make the window coated in ITO and PVF the best choice of those tested. The superior cooling performance of this window is supported by the inner air temperature measurements taken during the daytime. The inner air temperature in the building model with glass coated in ITO and PVF was consistently cooler than its counterparts.

Future Work

Future work aims to develop a visibly transparent window with tunable properties in order to minimize cooling effect when the ambient air is cold and maximize cooling effect when the ambient air is hot.

Acknowledgments

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