BERKELEY LAB

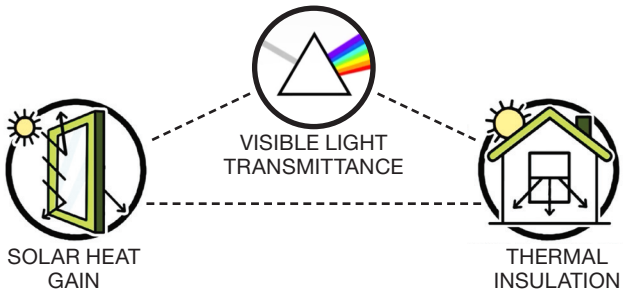
BUILDING TECHNOLOGY & URBAN SYSTEMS DIVISION

Energy Technologies Area

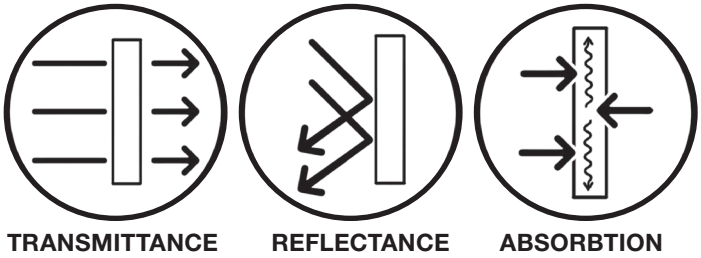
WINDOWS 101: EPISODE FIVE FACT SHEET

Optical Properties of Windows

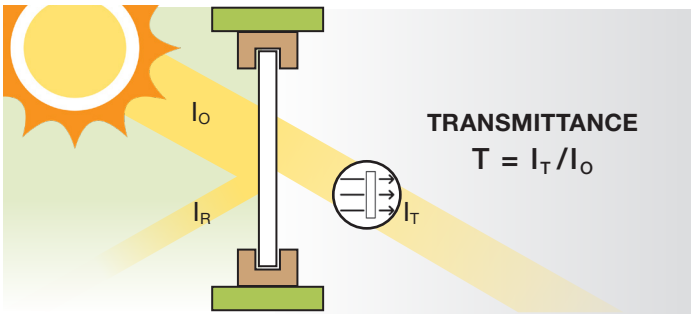
1 Controlling visible light transmittance, solar heat gain and thermal insulation of a window is key for making it energy efficient. These properties are **COUPLED** and to understand that coupling is helpful to look at the optical properties of window materials.

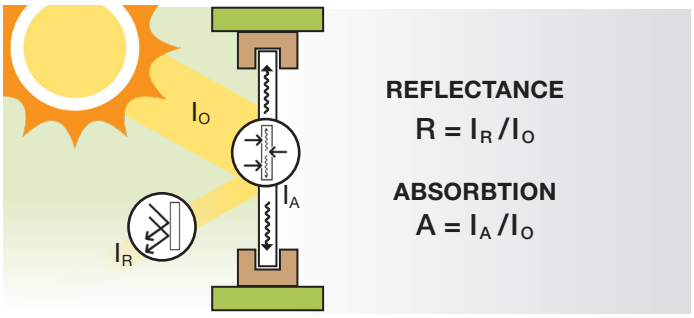


2 Light interacts with matter according to three main pathways:

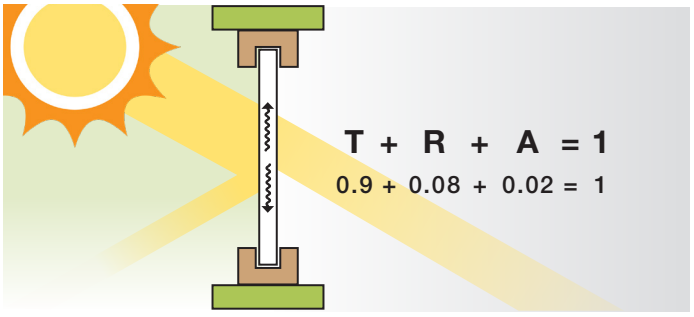


3 Transmittance, reflectance and absorption are material properties defined as the **FRACTION OF INCIDENT LIGHT** that is transmitted, reflected or absorbed.

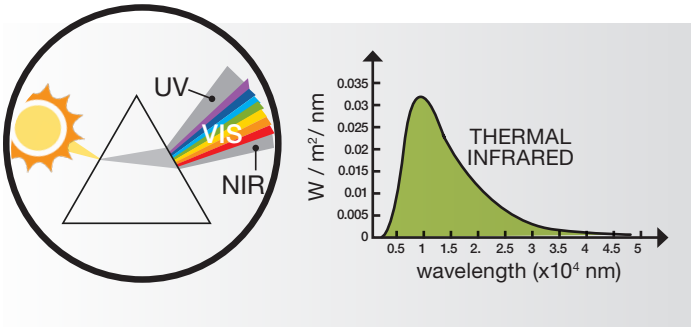




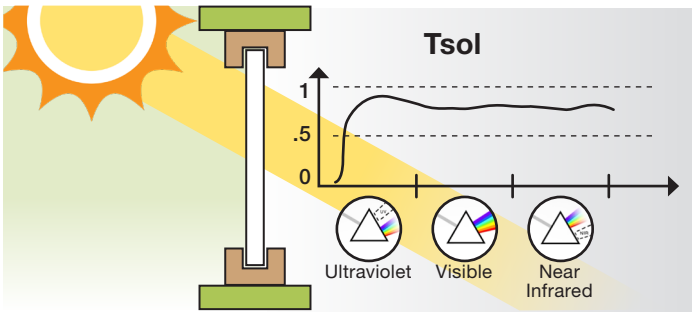
4 For each wavelength energy must be conserved, which means that **T+R+A=1**. The goal of modern window design is to have control over T, R, and A in the different wavelength ranges.



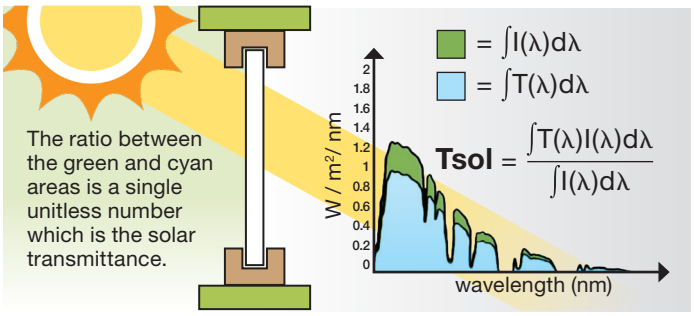
5 Sunlight is often divided in three bands: UV, visible, and near-infrared (NIR). Room temperature heat radiation is contained between 5000 to 50000 nm and that band is called **THERMAL INFRARED**.



6 **SOLAR TRANSMITTANCE (Tsol)** is a number that represents the fraction of sunlight transmitted – and a way to represent the spectral curve as a single number.



7 The total incident energy is visualized by the green area under the **SOLAR INTENSITY CURVE**. The total energy passing through a clear glass is the cyan area.



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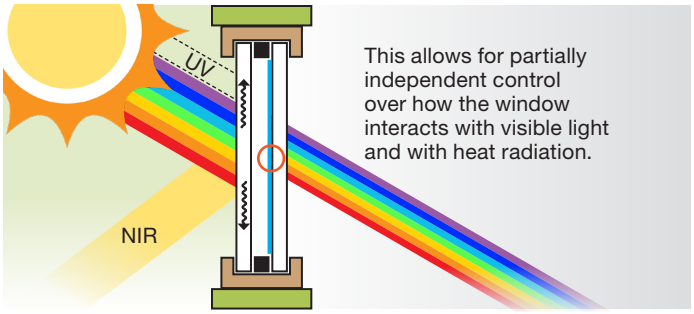
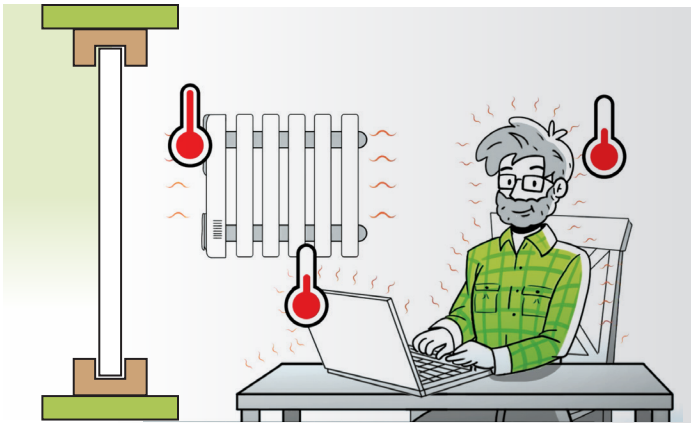
8 Energy efficient window innovations such as **LOW-E GLASS** have taken into account these important optical properties of glass to optimize energy efficiency. A glass pane gets a very thin metal coating on top to produce a pane which is transparent to visible light, but still reflects near-infrared and thermal infrared light.*



** This is true for low-solar gain low-e glass, most beneficial for hot climates. In cold climates, we can use high solar gain low-e glass, which allows NIR through while reflecting thermal IR.*

9 The optical property that impacts the U-value the most is the **THERMAL INFRARED EMISSIVITY**. All objects emit thermal radiation, with its wavelength distribution dependent on the temperature of the object.



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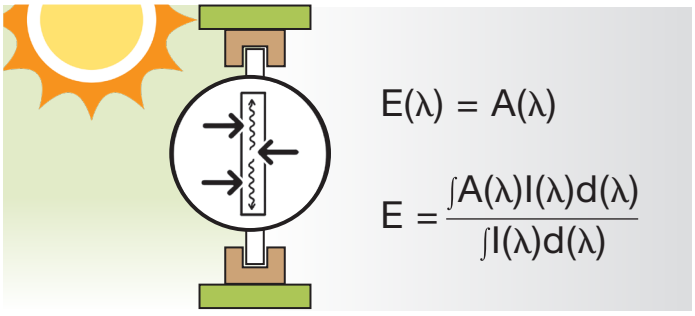
10 The mechanism in the material that radiates light **IS THE SAME** that absorbs light, so if you know the absorption at a given wavelength you also know the emissivity as they are the same.



11 Tailoring a window's wavelength properties allows for **GREATER CONTROL** over visible transmittance, solar heat gain coefficient and U-value of a window. These values enable us to rank and simulate window performance in different buildings and climates.

At Berkeley Lab we maintain the International Glazing Database of glass properties storing transmittance and reflectance as a function of wavelength for more than 5,000 glass products.
https://windows.lbl.gov/software/igdb