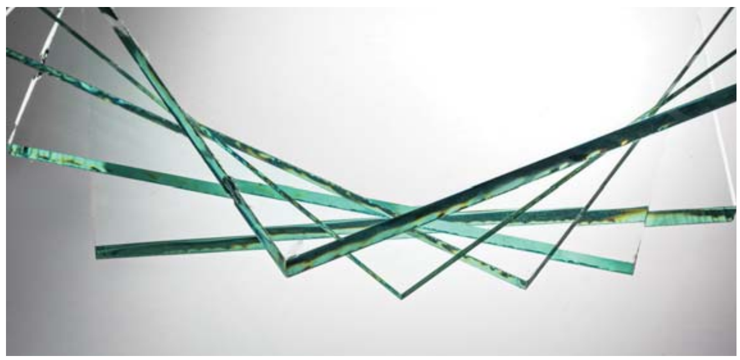
Determining the effects of angle on the infra-red reflectance properties of thin films in architectural glass using the Agilent Cary 630 FTIR

Application note

Materials



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Introduction

The glass used in buildings plays a key role in keeping the building energy efficient. Similar to walls and ceilings being insulated, glass can be coated to alter the reflectivity of infrared (IR) light. To control this level of reflection, thin film coatings can be placed on the building glass to (a) enable IR light to enter the building to heat up in colder climates or (b) reflect IR light to keep the building cooler in warmer climates. The angle at which the sunlight hits the glass and its coatings can have a significant effect on the ability of the glass to heat and cool.

FTIR spectroscopy can be used to measure the characteristics of the thin films across the IR spectral range. These measurements complement similar UV-Vis-NIR measurements and the ability to collect both types of data allows for a more complete characterization of the coating. Agilent offers solutions for both the IR and UV-Vis-NIR measurements.

In this paper we will demonstrate how the Agilent Cary 630 FTIR can be used to compare the reflectivity of coatings on a piece of coated architectural glass at 10° (near-normal) and at 45° (at-angle). Uncoated sheet glass was used as a reference.

Experimental

The Agilent Cary 630 FTIR was fitted with the 10 Degree Specular Reflectance Accessory. This accessory slides on to the front of the Cary 630 engine, and locks into place with no alignment required. The samples were also measured on a 45° accessory that drops into place inside the transmission compartment on the Cary 630 without requiring alignment. Both interfaces are shown below in Figure 1a and 1b.

The background was a gold coated slide to provide a 100% reflectance background. The sample and reference were measured at incident angles of 10° and

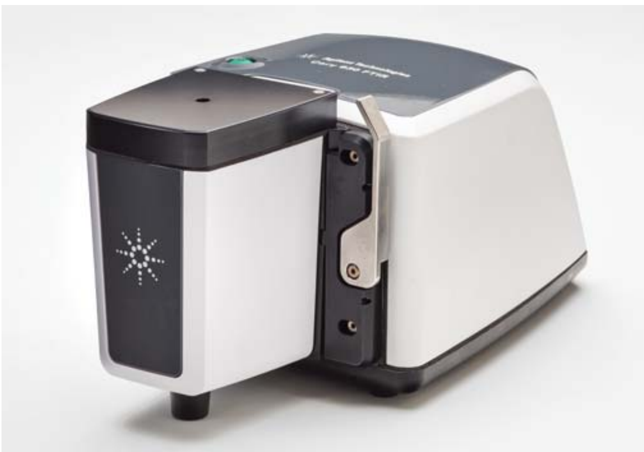

Figure 1a. The 10 degree Specular Reflectance Accessory

45°, 64 scans at 4 cm^{-1} resolution. The samples were measured in % reflectivity versus wavenumber.

The reflectance of building glass at a near normal angle (10°) was measured. The same glass was then measured at 45° to determine how the angle of incidence may affect the reflective properties in the MidIR spectral region.

Figure 1b. The 45 degree Specular Reflectance Accessory sits within the Cary 630 transmission module.

Results

When the reflection (%R) data versus wavenumber (cm^{-1}) was graphed, an angular dependence on the %R was found, as shown in Figure 3.

As expected, the uncoated sheet glass overlays almost perfectly at 10° and 45°. When looking at the sample, good overlap over 400–600 cm^{-1} can be seen, however at higher wavenumbers – further into the MidIR range – the reflectance decreases as the angle is increased from 10° to 45°. This is most pronounced at around 1000 cm^{-1}. What we draw from this is that the position of the sun can influence how much heat enters the building and therefore coatings on architectural glass play a big part in regulating the heat within a building

The sample and reference measured above were of witness samples of glass which could be accommodated by the Cary 630 FTIR. However, under some circumstances, it may be necessary to measure much larger glass samples, in some cases, those that are part of the building. To do so, Agilent has a range of mobile FTIR solutions that can be used to measure architectural glass that cannot be brought to the lab. The Agilent 4100 Exoscan is a hand-held FTIR that uses the same technology as the Cary 630 FTIR – enabling you to obtain the same high quality of results measuring the sample out of the lab, as you do the witness sample in the lab. Having both in-lab and mobile solutions can improve your efficiency and lower costs, providing the ideal solution for both research and QA/QC.

Figure 2. The handheld Agilent Exoscan can be used to measure architectural glass that cannot be brought into the lab.

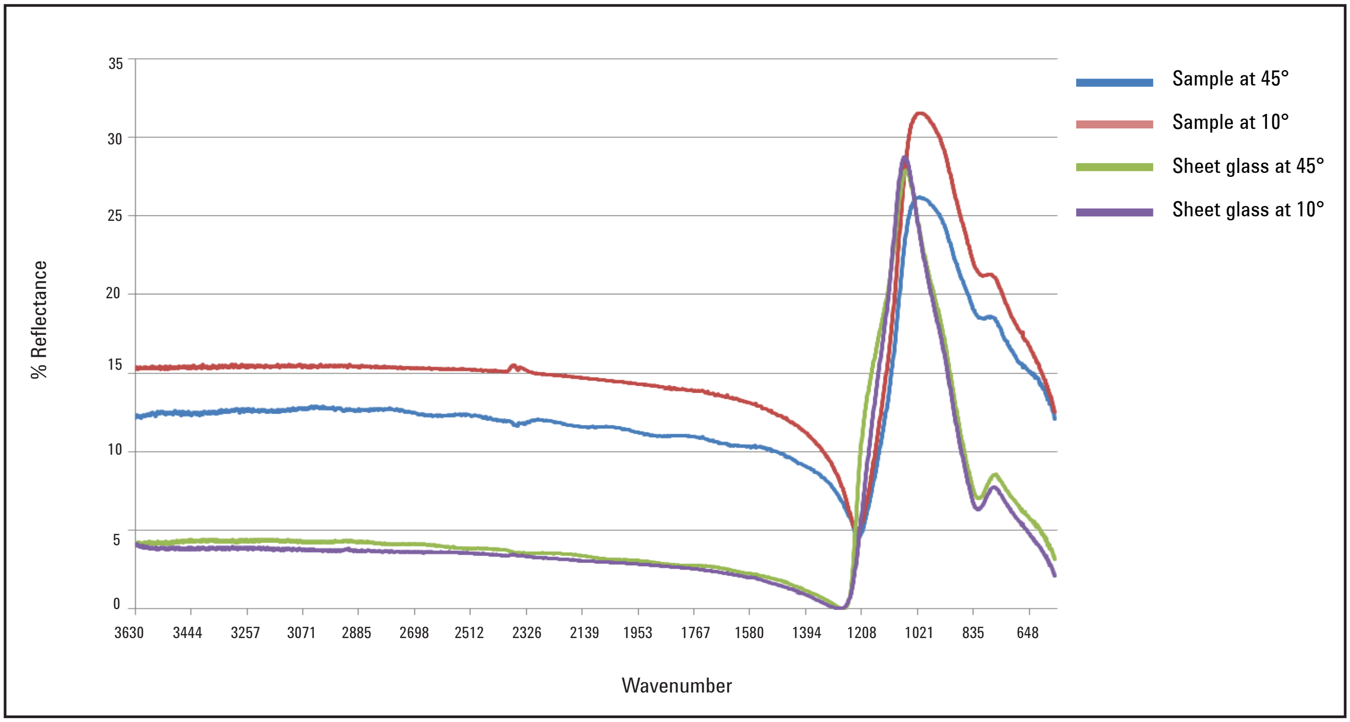

Figure 3. Percent reflectance plotted against wavenumber

Conclusion

When considering the 'greenness' of a building, glass can make a considerable difference to its energy efficiency. Coatings on the glass alter the reflectivity of the IR light, in some cases enhancing the reflectance and in other cases lowering it. Angular dependence of the incident radiation also plays a key role in how effectively the coating can reflect or absorb IR light. While these experiments were carried out in the MidIR region, the same measurements taken in the UV-Vis-NIR region could be used to determine the amount and type of light that enters a building, enabling you to optimize coatings and provide superior quality products. With a complete range of UV-Vis-NIR, in-lab FTIR and mobile FTIR solutions for measuring architectural glass, Agilent provides a complete solution for the glass manufacturer. For more information on the range of Agilent molecular spectroscopy products visit www.agilent.com/chem/molecularspec

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