TECHNICAL BULLETIN LU-8007

Using the QUV to Simulate Behind Glass Exposures

Many materials are exposed not to direct sunlight, but to sunlight filtered through glass. Several examples of these are window blinds and interior textiles, caulking compounds used on the inside of windows, automotive interiors, and materials coated with transparent coatings or laminates. Testing for the damage caused by this type of sunlight requires an understanding of how the glass changes the sunlight spectrum and how this can best be simulated in the QUV® accelerated weathering tester.

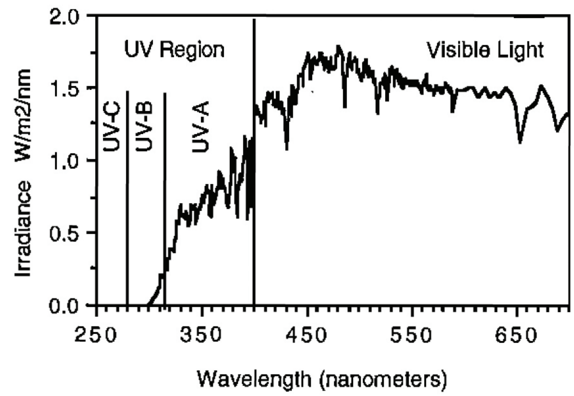

Figure 1 - The Sunlight Spectrum

Sunlight

The electromagnetic energy from sunlight is normally divided into ultraviolet light, visible light, and infrared energy. Figure 1 shows the spectral power distribution (SPD) of noon, midsummer sunlight (Solar Maximum). Infrared energy (not shown) consists of wavelengths longer than the visible red wavelengths and starts above about 760 nanometers (nm). Visible light is defined as radiation between 400 and 760 nm.

Ultraviolet light consists of radiation below 400 nm. The International Commission on Illumination (CIE) further subdivides the UV portion of the spectrum into UV-A, UV-B and UV-C as shown in Figure 1.

Filtering Effect of Glass

Figure 2 shows a diagram of the through glass measurement arrangement. The piece of glass is simply placed between the sun and the light measuring instrument (spectroradiometer). This instrument therefore measures the same light that a material behind glass would be exposed to.

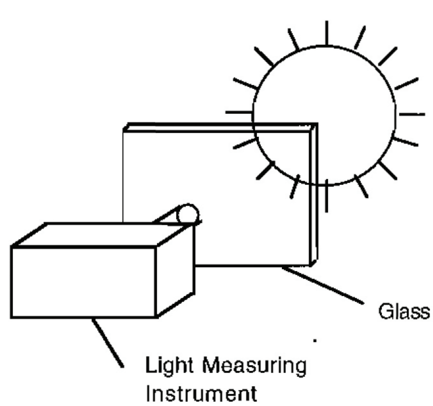

Figure 2 - Sunlight Through Glass Measurements

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Common Window Glass. Glass of any type acts as a filter on the sunlight spectrum. The shorter, more damaging UV-B wavelengths are the most greatly affected. Figure 3 shows direct summer sunlight compared to sunlight filtered through ordinary, single strength, untinted, 0.125 inch thick window glass.

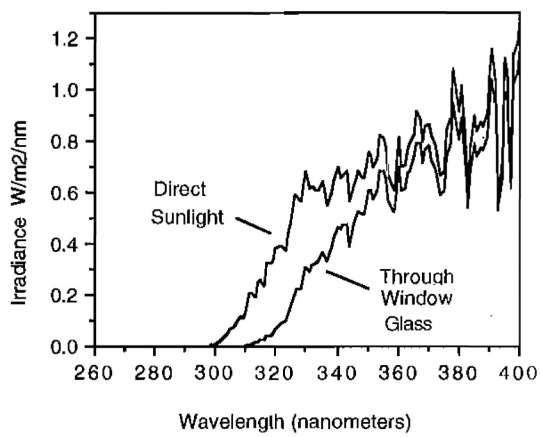

Figure 3 - Sunlight Through Window Glass

As the figure shows, ordinary glass is essentially transparent to light above about 370 nm. However, the filtering effect becomes more pronounced with decreasing wavelength. The most damaging wavelengths below about 310 nm are completely filtered out.

Automotive Glass. Automotive glass is thicker than window glass. The thicker glass acts as a more efficient filter. In addition, auto glass windshields are often tinted and usually contain a layer of plastic for safety enhancement. Each of these factors adds to the filtering efficiency.

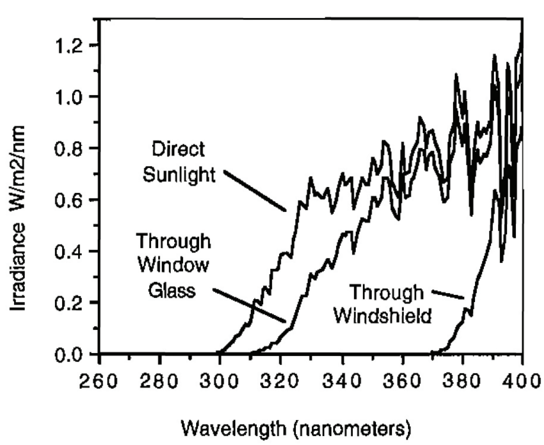

Figure 4 - Sunlight Through Windshield Glass

Figure 4 shows direct summer sunlight compared to sunlight filtered through tinted automotive windshield glass. Almost all of the most damaging ultraviolet light has been filtered out.

A = 0.128 inch thick, Clear
B = 0.228 inch thick, Clear
C = 0.159 inch thick, Lightly Tinted
D = 0.194 inch thick, Tinted

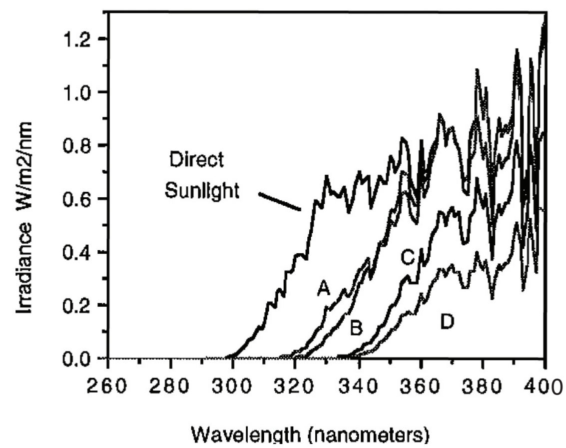

Figure 5 - Sunlight Through Auto Glasses

Figure 5 shows that various other types of auto window glass filter sunlight less than windshield glass but more than ordinary window glass.

QUV Lamps Filtered Through Glass

UV-B Lamps. UV-B lamp output, as the name implies, is concentrated in the UV-B portion of the electromagnetic spectrum. Because glass filters these short wavelengths most efficiently, very little light from this type of lamp will reach samples behind glass. Figure 6 shows the UVB-313 lamp directly, and through window glass, versus sunlight through window glass. The most evident observation from this comparison is the 80% drop in total energy a test sample would receive behind window glass. It can also be seen from the figure that the spectrum shifts towards the longer wavelengths. In fact, the short wavelength cutoff for both sunlight behind window glass and the UVB-313 lamp behind window glass is about 310 nm. Figure 7 shows the same effect for the FS-40, the other UV-B lamp.

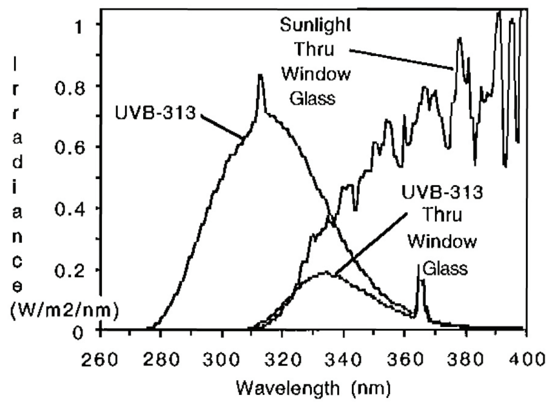

Figure 6 - UVB-313 Through Window Glass

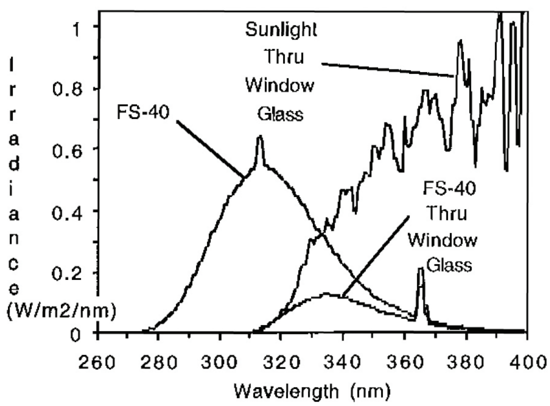

Figure 7 - FS-40 Through Window Glass

UV-A Lamps. There are two types of fluorescent UV-A lamps that are useful for simulating behind glass exposures, UVA-340 and UVA-351. UV-A lamp output is concentrated in the UV-A portion of the spectrum. Glass does not filter these longer UV-A wavelengths as much as it does the shorter UV-B wavelengths. In contrast to the UV-B lamps, most of the light emission from UV-A lamps is able to pass through glass to reach test samples mounted there.

Figure 8 compares sunlight filtered through window glass, UV-A 340 through window glass, and direct (unfiltered) UVA-340. The spectra of the UVA-340 lamp through glass and sunlight through glass are an exceptional match from the short wavelength cutoff, up to about 365 nm. This would be expected because unfiltered UVA-340 emission is an excellent simulation of unfiltered sunlight (not shown).

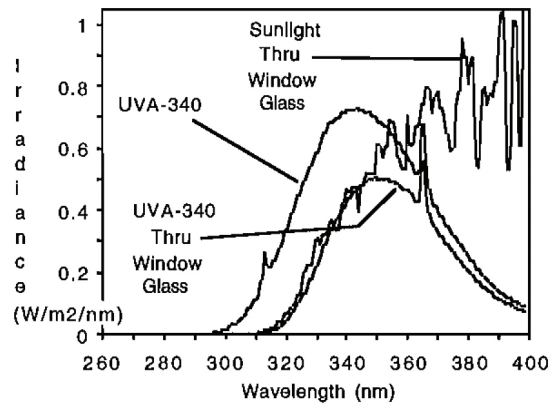

Figure 8 - UVA-340 Through Window Glass

Figure 9 compares sunlight through glass, UVA-351 through glass, and direct (unfiltered) UVA-351. Unfiltered UVA-351 is a good simulation of sunlight behind window glass. Therefore, the effect of sunlight through glass can be simulated with the UVA-351 without actually mounting test samples behind glass. If, however, test samples must be mounted behind glass (sealants, window films, etc.), UVA-340 is the preferred light source.

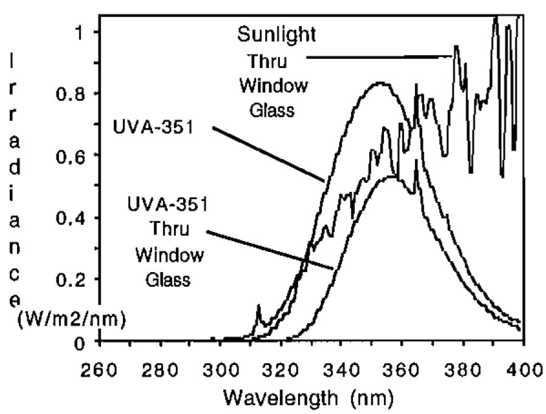

Figure 9 - UVA-351 Through Window Glass

Summary

Only UV-A lamps are recommended for testing materials which see sunlight through glass.

The UVA-351 lamp is the most convenient to use because it directly matches sunlight through window glass. Materials can therefore be mounted in the QUV tester without window glass filters being used.

The UVA-340 lamp is recommended for testing those materials in which glass is an integral part of the material (e.g. safety glass with a polyester film bonded between layers of glass or sealants and adhesives mounted directly to glass). The UVA-340 lamp is also recommended for materials which see sunlight through special glass rather than ordinary window glass. For these applications the test sample must be mounted behind actual glass in the QUV tester.

UV-B lamps should not be used to test materials which see sunlight through glass. Direct exposure to UV-B lamps is much too severe a test when compared to sunlight through glass. Yet on the other hand, exposure to UV-B lamps behind glass is too mild a test because the majority of the lamp's energy is filtered out by the window glass.

References

Brennan and Fedor, "Sunlight, UV and Accelerated Weathering," *SPE Automotive RETEC*, 1987.

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