# Technical Bulletin
# Durability of Heat Mirror® Film
# February, 2007

## Background

Extensive work has gone into verifying the performance and durability of the polyester substrate used for Heat Mirror® film. Important substrate properties include:

- Water white color
- High visible light transmission
- Ultraviolet (UV) screening
- Compatibility with the insulated glass mounting system
- Vacuum coating processability
- Film handling

Polyethylene terephthalate (PET) is well known for its superior optical properties and compatibility with vacuum deposition processing. Special ultraviolet-stabilized grades of PET are used in demanding outdoor applications. Southwall has considered PET suppliers throughout the world and has selected the most durable UV-stable PET film that meets all of the requirements above.

To demonstrate that Heat Mirror® suspended film meets the life expectancy requirement of the glass industry, it is important that the optical and mechanical durability of the film surpass the service life of representative commercial insulating glass unit (IGU) edge seals. The most important metric for long term optical quality is measured by the film's Yellowness Index (YID) and its change over time. Mechanical durability is measured by determining the ultimate strength of the film. Ultimate strength provides a measure of resistance to force without breakage addressing the film over a limited area. Solar radiation, specifically UV radiation, is the primary cause of change in optical properties and mechanical durability in units which have maintained the integrity of their seals and thus have not failed due to moisture intrusion in the IGU.

## Testing

Accelerated weathering of suspended window films at Southwall consists of accelerated exposure in a QUV Weather-o-meter produced by the Q-Panel Corporation. The QUV Weather-o-meter is widely used to evaluate materials response to UV radiation.

Conditions include:

- Continuous exposure to UV-A light
- Continuous 60 °C temperature
- Suspension in an IGU using low iron (extra clear) high transmission glass
- Dry desiccated air environment

Southwall calibrates the QUV accelerated weathering test by correlating QUV results to rooftop testing results. Note that tilted rooftop testing conditions in Palo Alto, California are accelerated over the ordinary, vertically-mounted conditions found in residential applications. The results of rooftop testing and correlation to QUV results are not adjusted for this increased level of exposure, as the incremental level of exposure is an unknown.

Southwall has compared the yellowing rates after indoor accelerated UV (QUV) exposure and outdoor (Palo Alto) rooftop exposure. Both figures indicate that the yellowness index (YID) change is linear with time. Note that low iron glass is primarily used for artificial accelerated testing. Low iron glass is used as it has the highest UV transmittance characteristics of standard commercial glass products used in residential and architectural applications.

Based on the compared tests, a correlation factor can be calculated to be:

| 1000 hours of QUV-A exposure (low iron glass) | = | 5 years of Palo Alto Rooftop exposure (clear glass) |
|---|---|---|

The tables below show how Heat Mirror® film changes over time, when exposed to QUV-A and elevated temperatures.

## Mechanical Properties, Heat Mirror® Film

| Hours Exposure | % Elongation at break | Ultimate Strength (psi) |
|---|---|---|
| 0 | 105 | 29,400 |
| 1544 | 104 | 30,400 |
| 3200 | 103 | 29,800 |
| 4800 | 109 | 29,800 |

## Optical Properties, Heat Mirror® Film (in an IGU)

| Hours Exposure | % Tvis | % HAZE | YID (yellowness) |
|---|---|---|---|
| 0 | 73.8 | 0.87 | 0.63 |
| 1544 | 73.8 | 0.70 | 0.53 |
| 3200 | 73.8 | 0.69 | 1.25 |
| 4800 | 73.9 | 0.60 | 1.22 |
| 8700 | 72.5 | 0.60 | 1.66 |

Results are based upon testing of air-filled units. Southwall recommends minimum oxygen levels within gas-filled units if double-coated film (e.g., TC88) is specified. After 8700 hours of light and heat exposure Heat Mirror units show a nominal 1 unit YID change (1.03). YID values less than 8 are not typically visible to most observers.

## Conclusion

Unit testing after extensive exposure in the QUV weatherometer demonstrate that after extended exposure to UV radiation and elevated temperature Heat Mirror films show minimal change in yellowness and minimal change in mechanical strength. These tests are verified by correlation with units that are tested on Southwall's rooftops. These results verify Southwall's assertion that units made with Heat Mirror film will seldom, if ever show film-related failures during an IGU's expected service life.

**Disclaimer**

Southwall Technologies reserves the right to change the product design. The tests were conducted on Southwall's standard Heat Mirror substrate which was introduced in 1990, and is used exclusively on all Heat Mirror films. The claims above are typical test values for comparison purposes and do not constitute a warranty. While 1000 hours of QUV A exposure at 60C has been demonstrated to correspond to 5 years of passive roof top testing in Palo Alto, solar and thermal exposure levels may vary in service from those in Palo Alto, Ca. Hence it should not be inferred that Southwall is indicating a unit which shows minimal change in 8700 hours of QUV A testing, will show no visible changes or have no reduction in mechanical strength after 40 + years of service life in any or all markets. Similarly this test is a measure of film durability, and should not be used to determine the full service life on an insulating glass unit. Field service life is determined by a number of factors, with major impacts from the integrity of the unit's seal over time and the quality of manufacture of individual insulating glass units.