

Weathering of ACRYLITE® acrylic resins



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Radiation

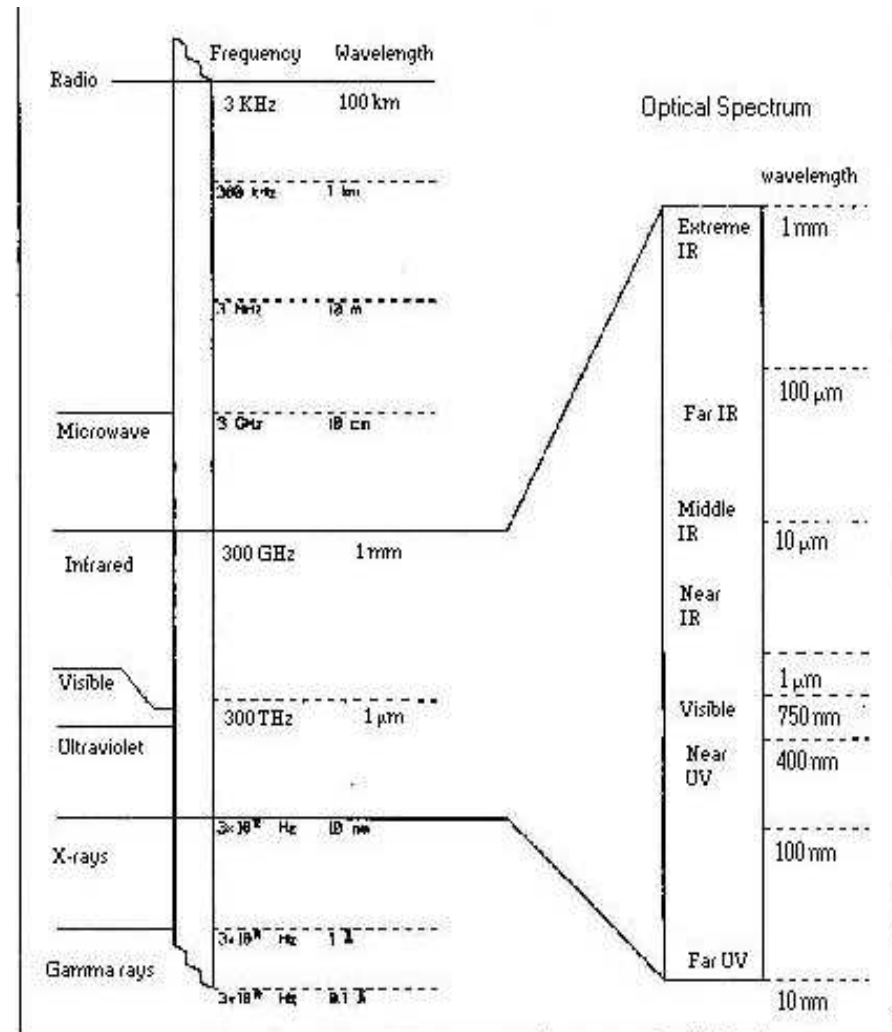
A form of energy

Small portion of electromagnetic spectrum

Light travels as photons

Photon energy is higher at shorter wavelengths

Ultraviolet very aggressive



Sources of Radiation



Solar radiation (Natural source)

- Approximate total annual UV radiant dosage
 - 275 MJ/m² (Miami, based on several year's data)

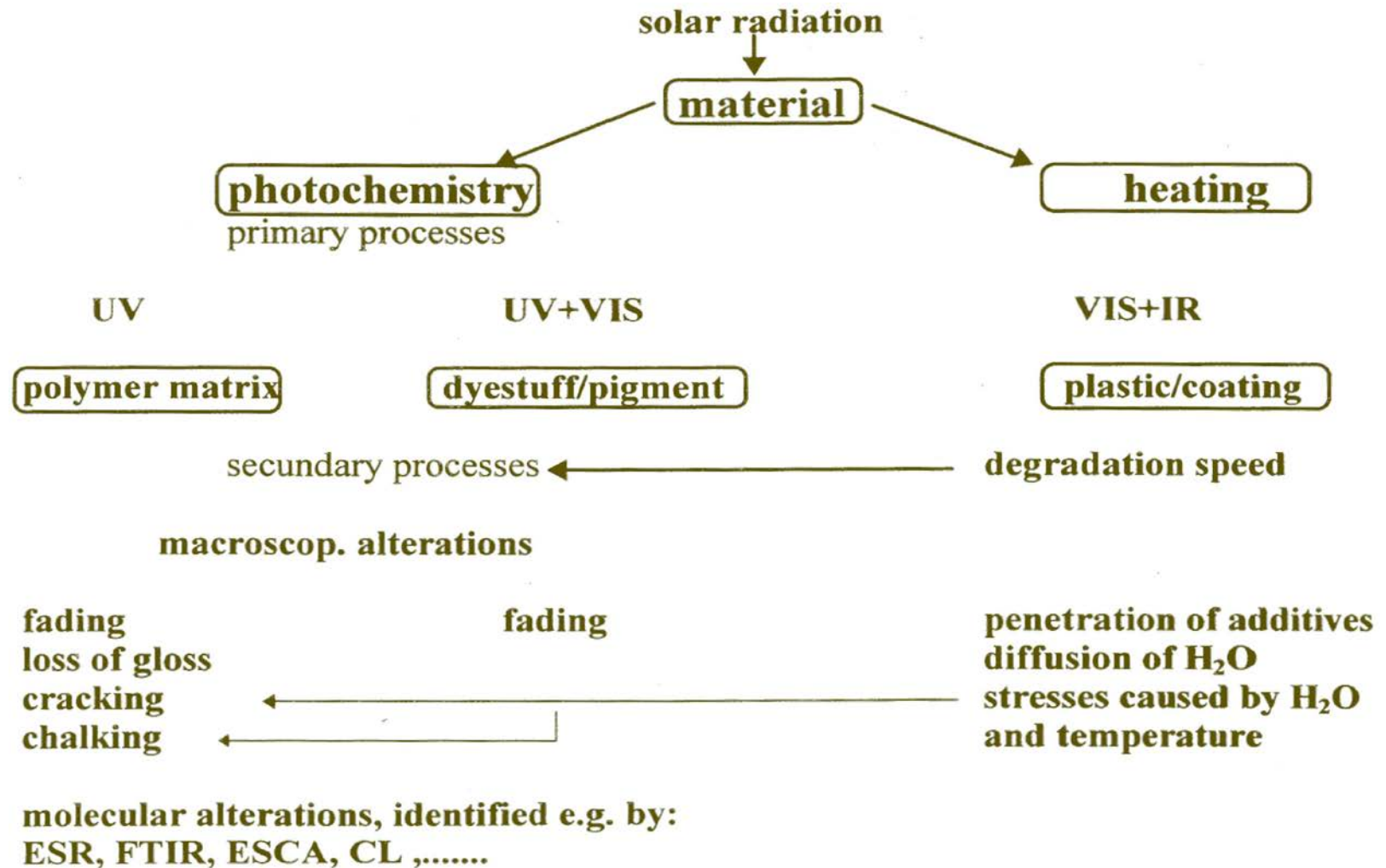
Xenon S/S @ 0.55 W/m² @ 340 nm (Artificial)

- Radiant dosage per hour = 169.4 KJ/m²
- Exposure time to produce 275 MJ/m² = 1620 h

QUV UVA 340 (Artificial)

- Radiant dosage per hour = 130.6 KJ/m²
- Exposure time to produce 275 MJ/m² = 2100 h

Effects of solar radiation on polymers



Florida Exposure Testing



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Florida outdoor testing



Florida outdoor testing



- Miami has a very harsh climate - ideal for testing outdoor durability

- High intensity sunlight
- High temperatures
- Abundant rainfall
- Very high humidity.

- Florida - excellent for testing mildew resistance

- Plastics may fade, lose strength, crack, peel, chalk or rust.

- Resistant plastics will retain a reasonable appearance and physical properties.

Florida outdoor testing



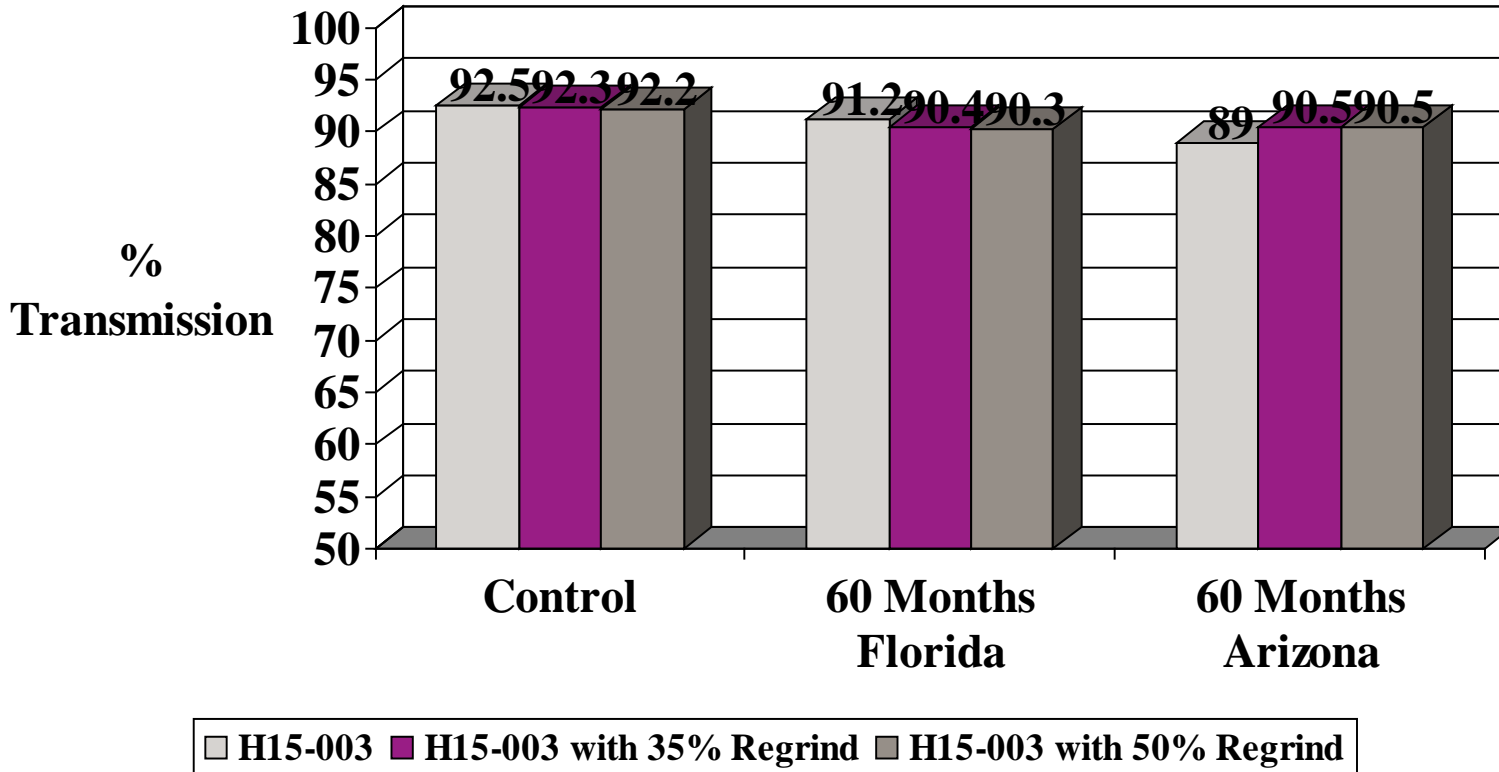
Latitude 25° 33' North	Longitude 80° 24' West	Elevation 12 foot	
Typical Annual Solar Energy Direct, 25° South (latitude angle):	TUV 280 MJ/m ²	Total 6,588 MJ/m ²	%Sun 69%
Temperature (Air)	C	F	
Average Summer Maximum:	32°C	90°C	
Annual Average Maximum:	28°C	82°C	
Annual Average Minimum:	21°C	70°C	
Average:	24°C	76°C	
Average Humidity	Rainfall	mm	inches
Summer Max: 93% RH	Monthly Max:	237	9.5
Maximum: 80% RH	Monthly Min:	46	1.8
Minimum: 61% RH	Monthly Avg:	152	6.1
Annual: 70% RH	Total/Year:	1420	56.8
Rain Days/Year: 111 days			

Transmission

60 months real time weathering



ACRYLITE H15 003

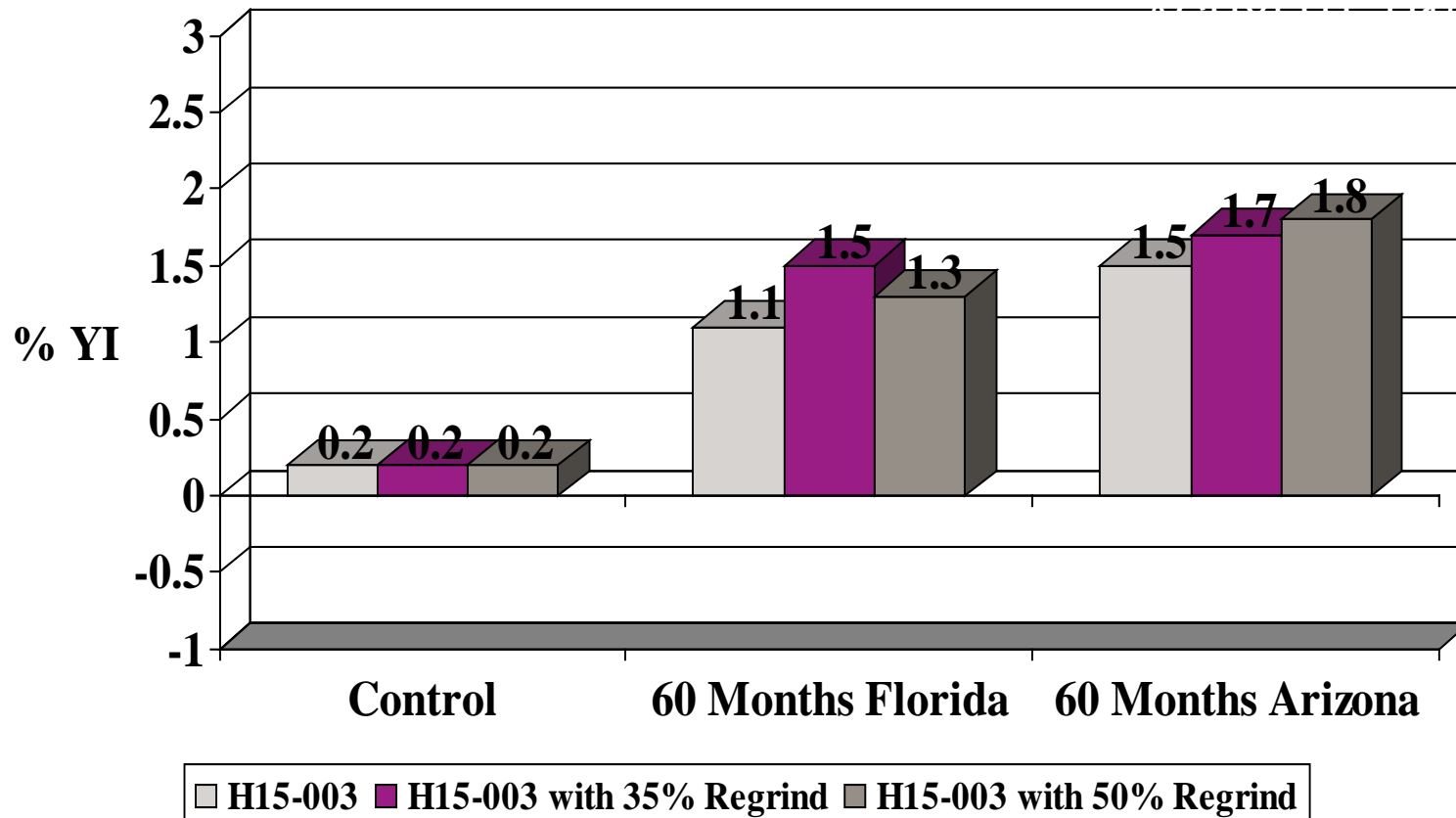


ASTM -D1003 1987 - 1989 Lab Request #15222 Shiely

Yellowness index 60 months real time weathering



ACRYLITE H15-003

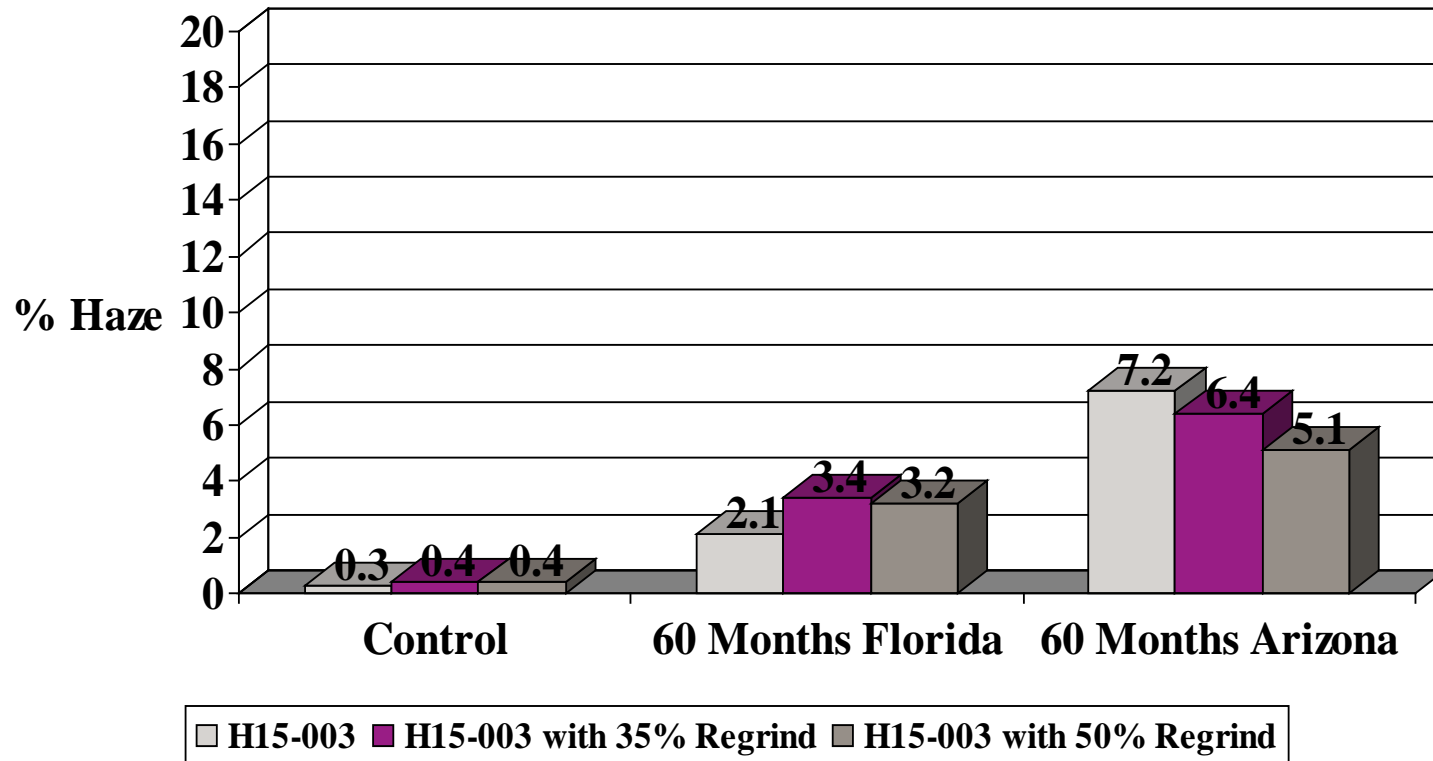


Haze

60 months real time weathering



ACRYLITE H15-003



Arizona Exposure Testing



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Arizona outdoor testing

- The hot, high UV conditions in AZ produces faster deterioration than any other location.
- AZ weather affects: color and gloss, coatings, color stability, physical properties
- More sunlight than Florida (20%)
- Summer temperatures are hotter ((15° F)
- Arizona summer air = 46 °C.



Arizona outdoor testing

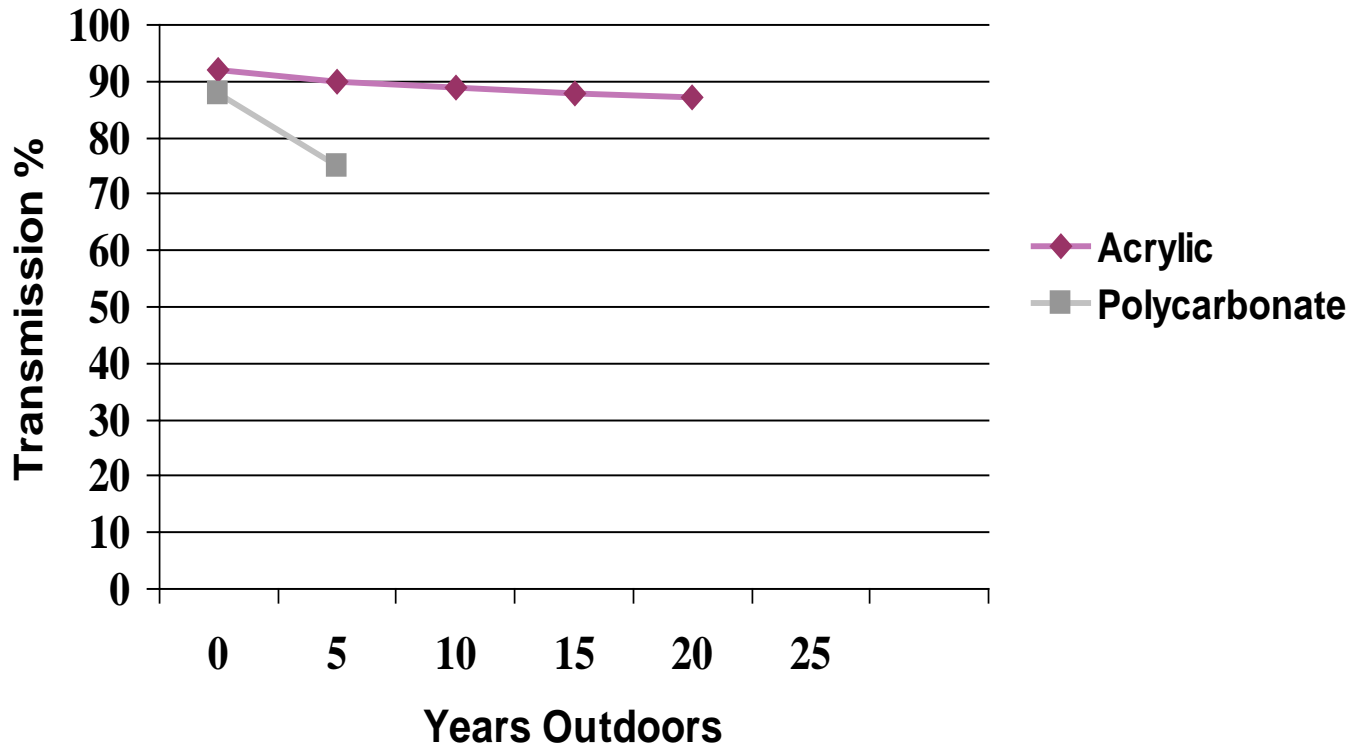


Latitude 33° 23' North	Longitude 112° 35' West	Elevation 1055 foot	
Typical Annual Solar Energy Direct, 33° South (latitude angle):	TUV 334 MJ/m ²	Total 8,004 MJ/m ²	%Sun 85%
Temperature (Air)	C	F	
Average Summer Maximum:	40°C	105°C	
Annual Average Maximum:	30°C	86°C	
Annual Average Minimum:	13°C	56°C	
Average:	21°C	70°C	
Average Humidity	Rainfall	mm	inches
Summer Max: 28% RH	Monthly Max:	28	1.1
Maximum: 49% RH	Monthly Min:	2	0.1
Minimum: 21% RH	Monthly Avg:	16	0.6
Annual: 35% RH	Total/Year:	186	7.4
Rain Days/Year: 32 days			

ACRYLITE weatherability



Real time - Arizona



Automotive SAE - testing

QUV Accelerated Weathering



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QUV accelerated weathering

Reproduces the damage caused by sunlight, rain and dew

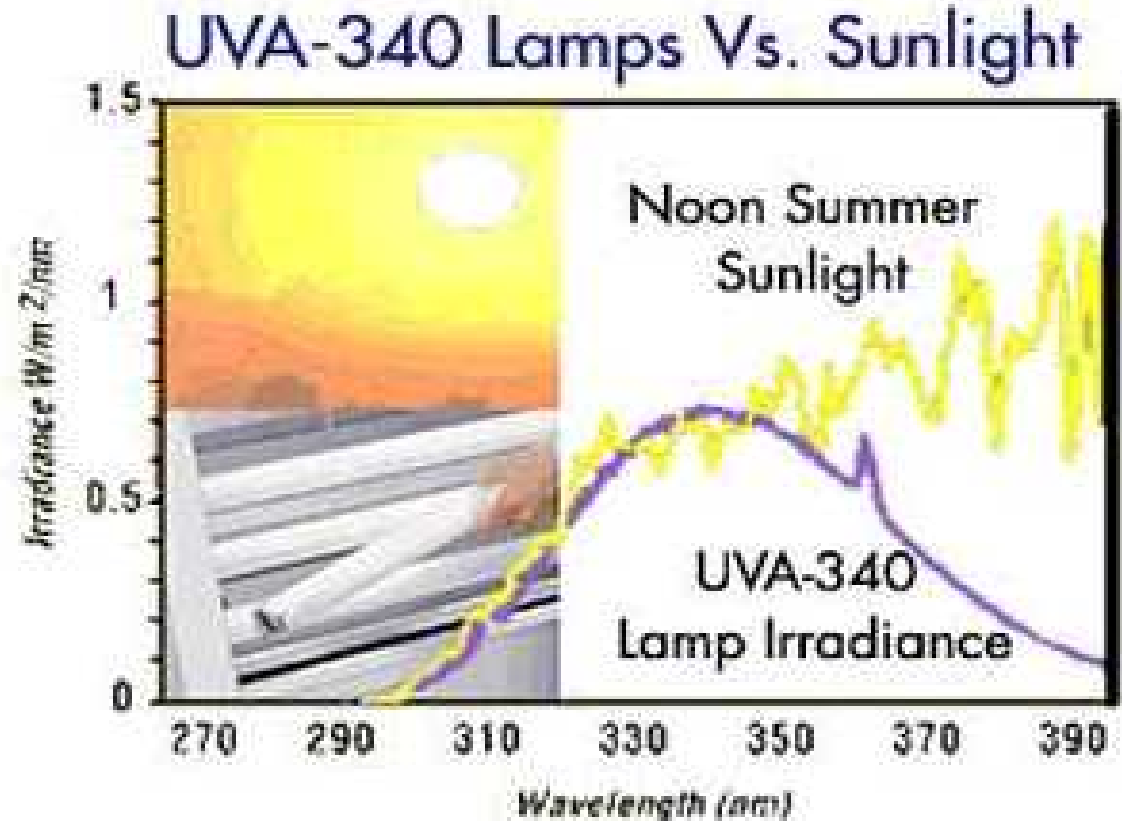
- Exposes materials to alternating cycles of light and moisture at controlled, elevated temperatures.
- Sunlight is simulated with fluorescent UV lamps.
- Dew and rain is simulated with condensing humidity and water sprays.
- Exposure conditions can be varied to simulate various end-use environments

QUV accelerated weathering



- QUV reproduces damage such as color change, gloss loss, hazing, cracking, etc...
- UVA-340 lamp - best simulation of solar UV.
- Simulates the short wave UV of sunlight from 365 nm to 295 nm.
- One year of sunlight = 2100 h of QUV exposure (approx)

QUV vs Sunlight



UVA-340 lamp:

- best simulation of solar UV

- simulates the short wave UV of sunlight from 365 nm to 295 nm.

- 1 year of sunlight = 2100 h of QUV exposure (approx)

Test procedures



QUV Accelerated Weathering Tester:

- ASTM G151 (Gen. Weathering),
- ASTM G154 (Fluorescent UV/Condensation Test Apparatus),
- SAE J2020 (Automotive Exterior Materials),
- ASTM D4587 (Coatings),
- GM 9125P(Automotive Material),
- ASTM C1442 (Sealants),
- ASTM D904 (Adhesives),
- **ASTM D4329 (Plastics),**
- ASTM D5208 (Plastics),
- ISO 4892 (Plastics),
- ASTM D4799 (Roofing),
- AATCC Test Method 186 (Textiles)

Xenon Accelerated Weathering



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Xenon Arc accelerated weathering



Weathering

- water spray simulates the effect of moisture on materials exposed outdoors.
- the spray periods are programmable
 - can operate during light or dark periods.
- water spray cycle is useful for introducing thermal shock and mechanical erosion.
- 1 year of Florida exposure equivalent to 1620 h of Xenon Arc exposure.

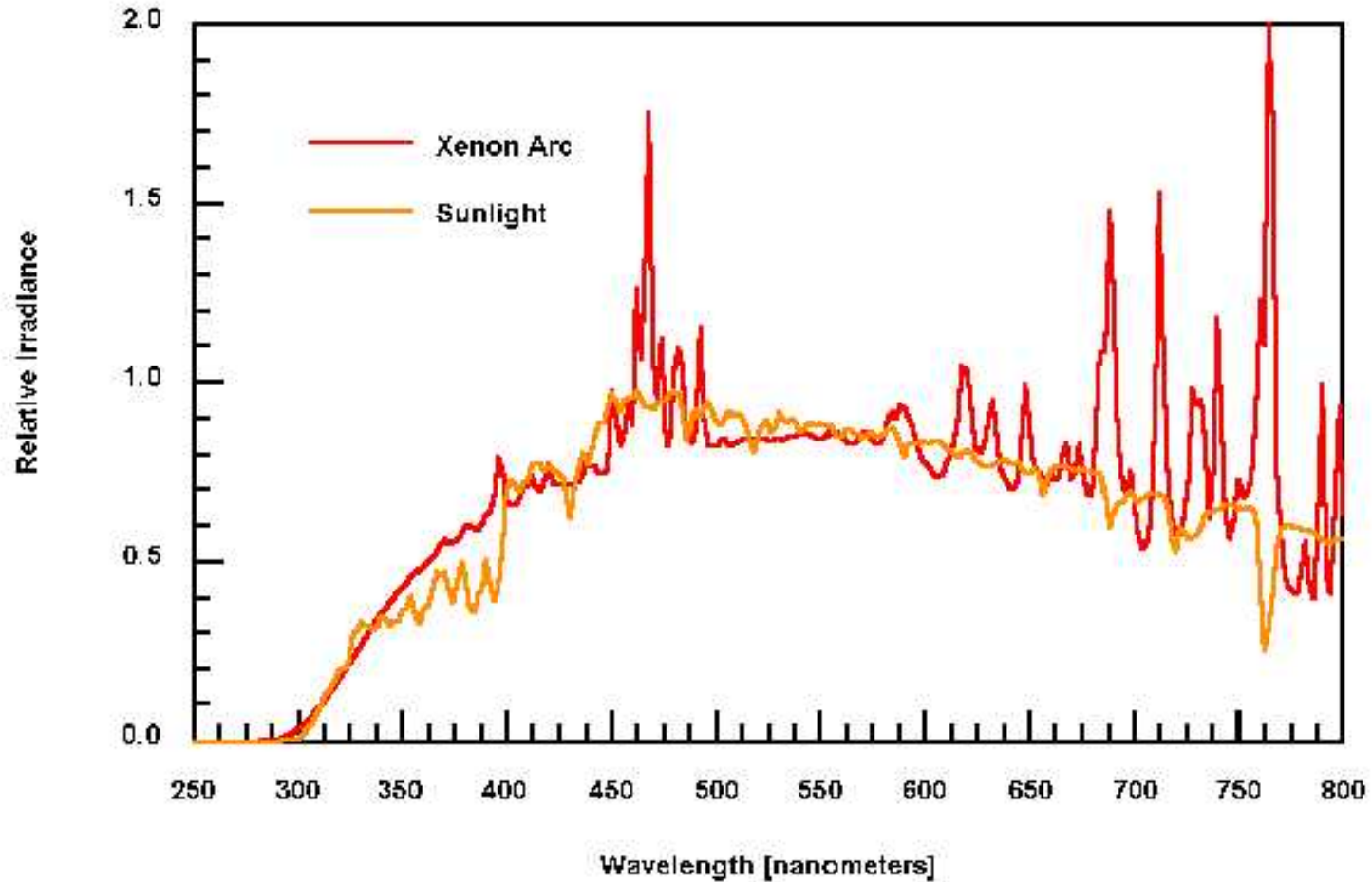
Xenon Arc accelerated weathering

Full Spectrum Sunlight Simulation

- materials exposed to UV, visible, and IR light
- filtered Xenon arc light correlates the full spectrum of sunlight
- Xenon light is filtered to obtain appropriate spectrum.
 - E.g. It can be filtered to correlate direct daylight or sunlight behind a window-glass.
- The exposure application dictates which filters should be used.

Xenon vs. sunlight

FILTERED XENON ARC vs. SUNLIGHT



Test procedures



Xenon Arc test chamber:

- ASTM G155 (Xenon-Arc Test Apparatus),
- **ASTM D2565 (Plastics - Outdoor Applications),**
- ASTM D4459 (Plastics - Indoor Applications),
- ASTM D5071 (Photodegradable Plastics),
- ISO 4892-2 (Xenon- Arc - Plastics),
- ASTM D3424 (Printing Inks)

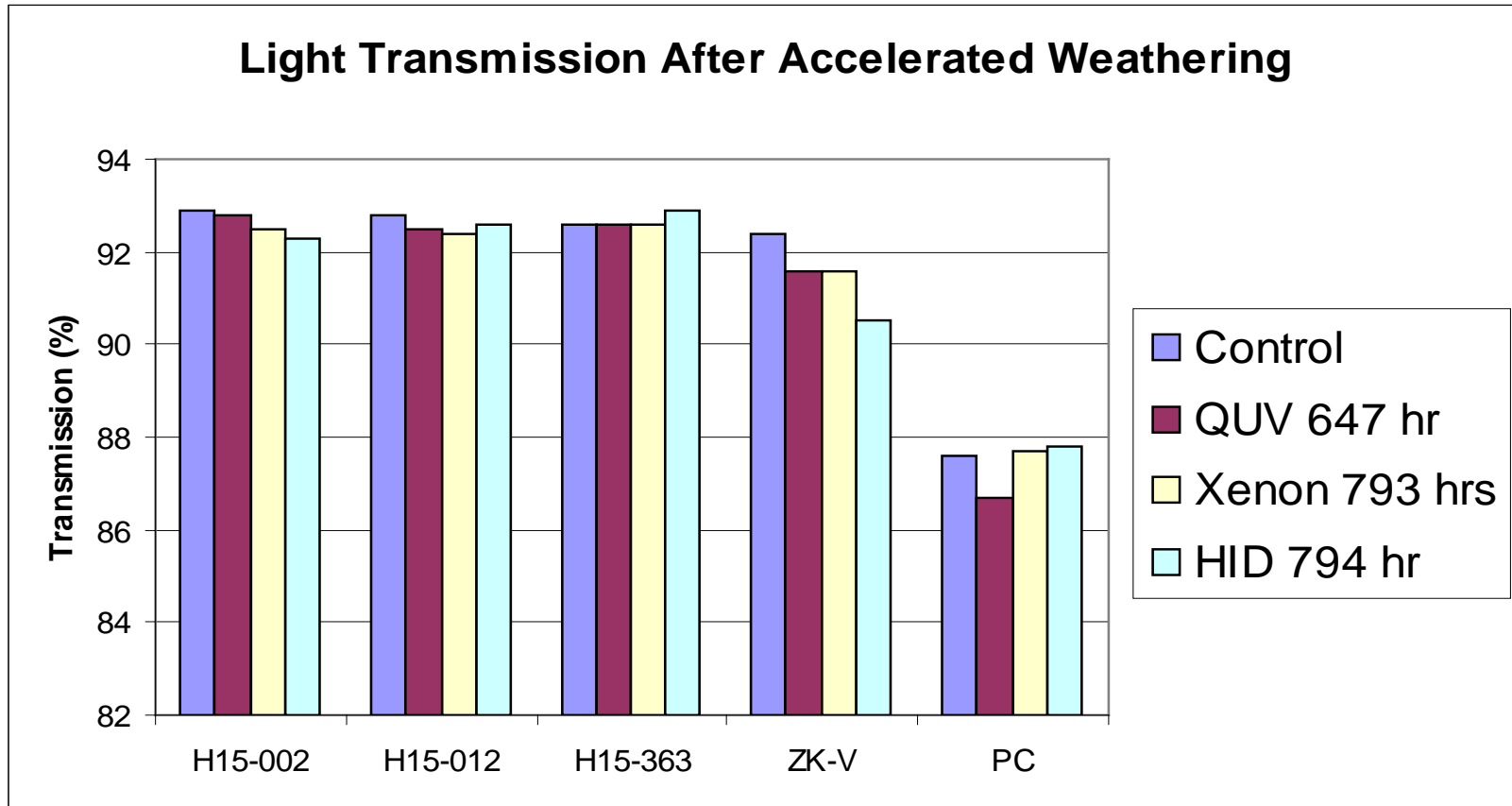
Results of accelerated weathering



Following materials were exposed to QUV and Xenon for approximately 700 h

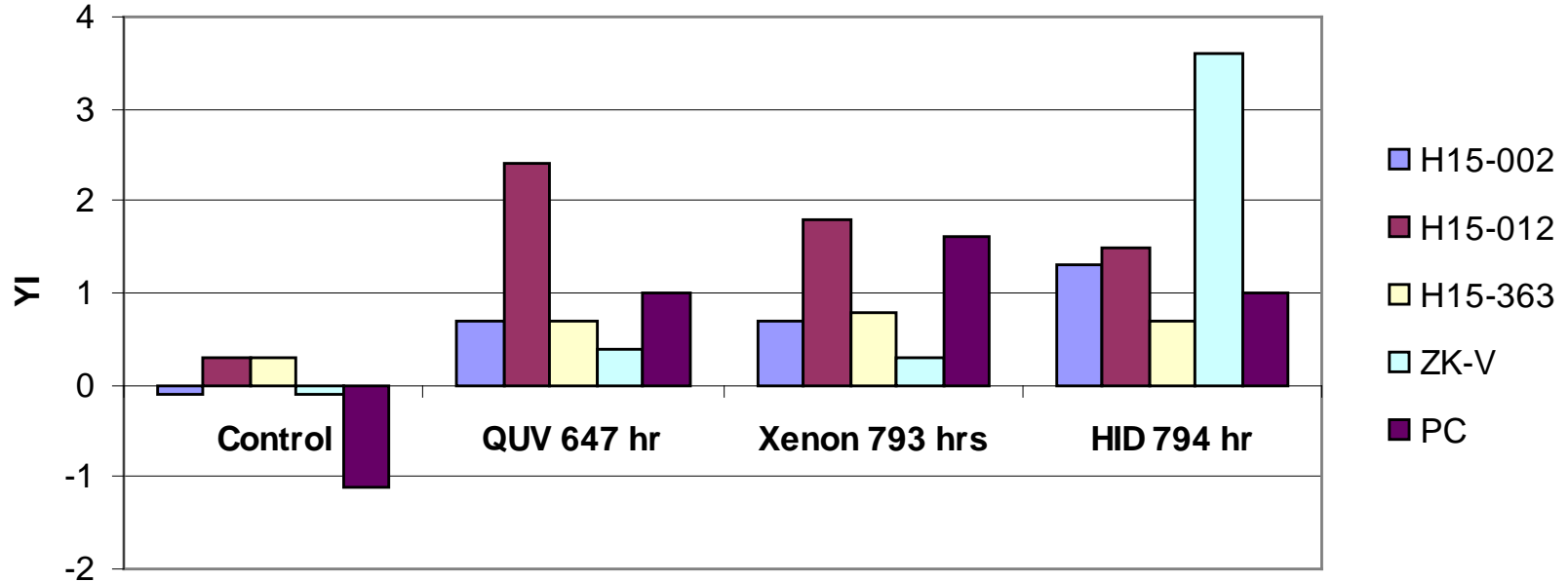
- ACRYLITE H15-002 (LOW UVA)
- ACRYLITE H15-012 (UVT)
- ACRYLITE H15-363 (HIGHEST UVA)
- ACRYLITE PLUS ZK-V (LOW UVA)
- POLYCARBONATE (POSSIBLY HIGH UVA)

Light transmission

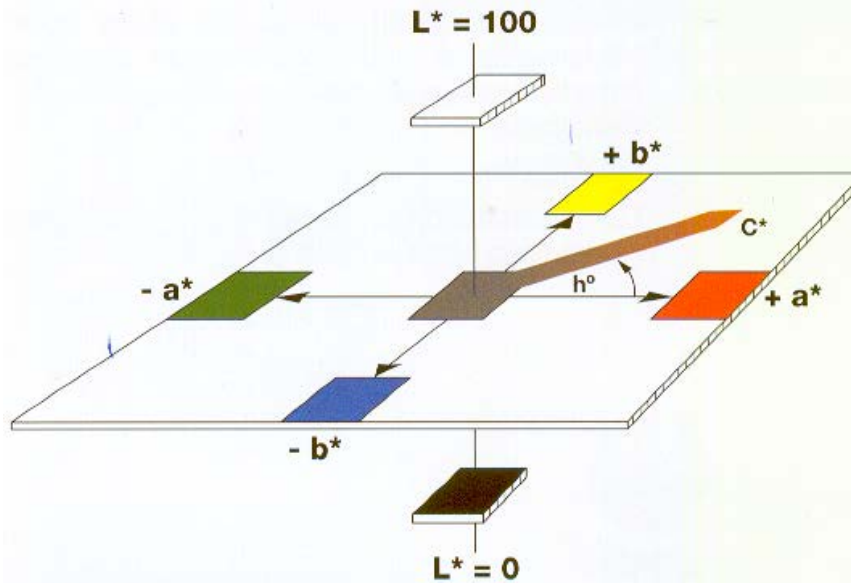


Yellowness index

Yellowness Index After Accelerated Weathering



CIE L*a*b*-System



L^* = Lightness

a^* = + red/- green

b^* = + yellow/- blue

C^*_{ab} = Chroma
unsaturated/saturated

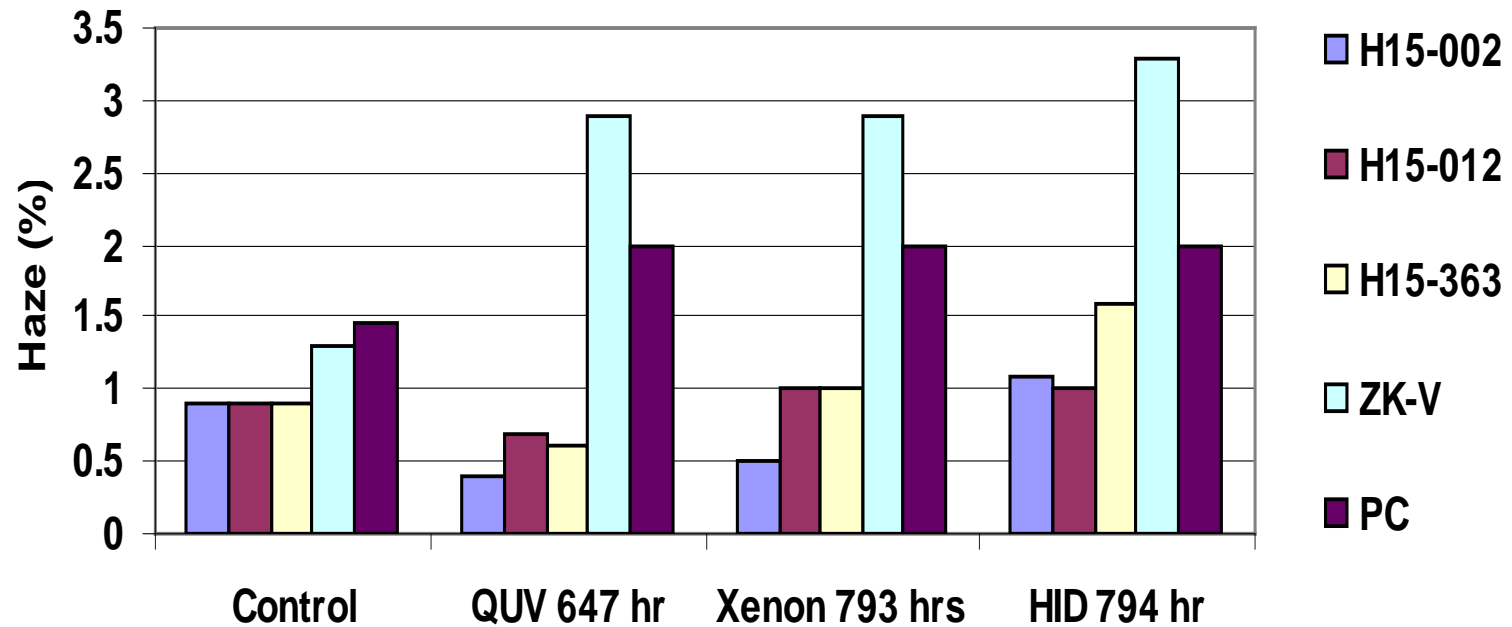
h°_{ab} = hue angle
 0° - 360°



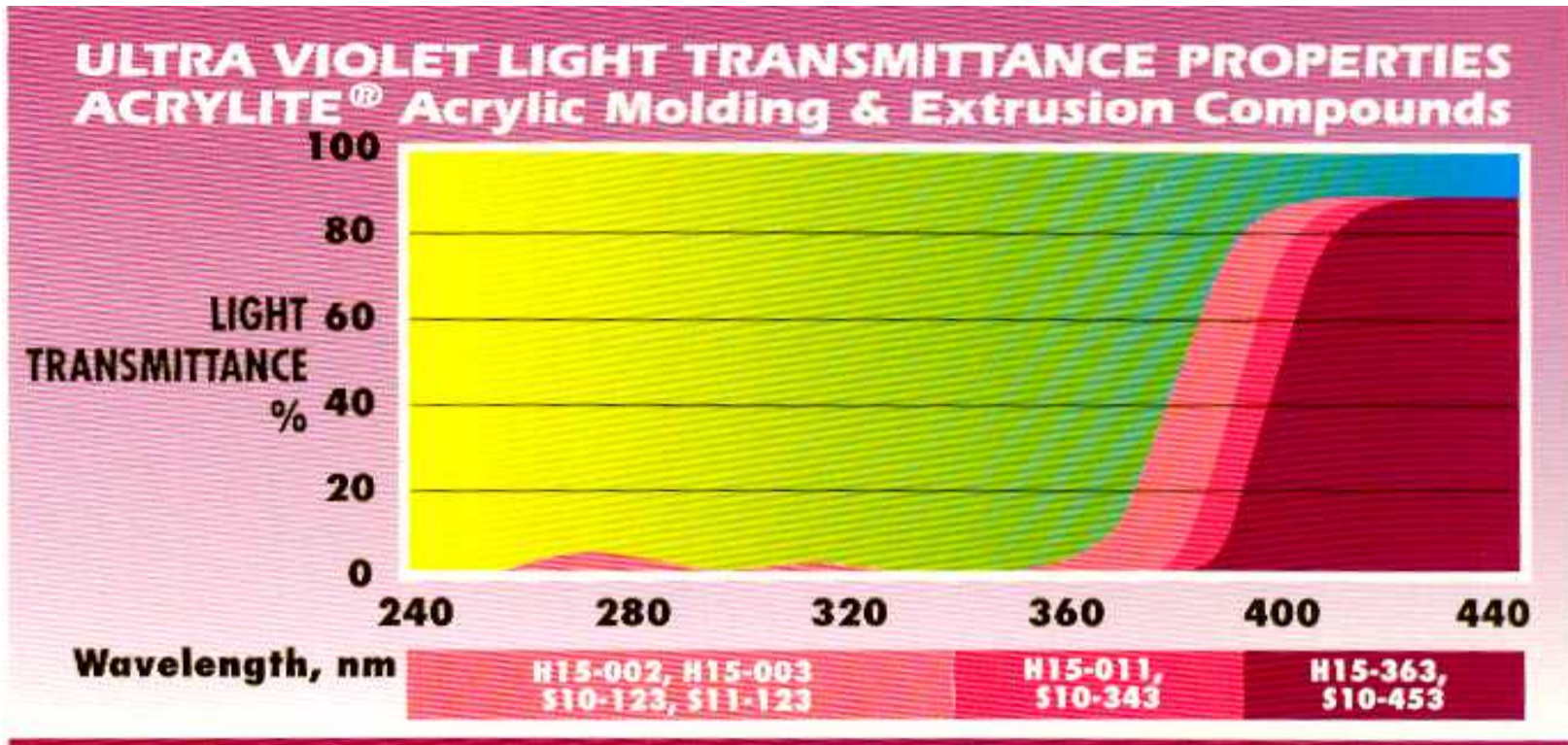
Gardner

Percent haze

Percent Haze



UV light transmittance



Low UVA: H15-002, H15-003, 8N-123, Medium UVA: H15-011, 8N-343

High UVA: H15-363, 8N-453

S10 now 8N; S11-not offered

ACRYLITE 8N-343

- Excellent UV resistance
 - 400 Watt, metal halide bulb at 90 °C for up to 2100 hours.
- Color stability outperforms many competitive products.
 - measured by yellowness index

