

촉진 옥외 폭로 시험

Accelerated Outdoor Weathering Testing

Principles, Challenges and Case Studies

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[녹음하기](#)

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촉진 옥외 폭로 시험이란?

What is Accelerated Outdoor Weathering?

태양의 조도(irradiance) 를 근본으로 자연 환경에서 얻을 수 있는 하나 혹은 그 이상의 인자를 증가 함으로써 품질저하 현상을 촉진할 수 있는 옥외폭로 시험을 의미함.

... outdoor weathering using the sun as the source of irradiance, and where the rate of deterioration is accelerated by increasing one or more of the influencing parameters above a level obtained in the natural environment.

From ASTM G113 "Standard Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials"

촉진 옥외 시험 vs 실험실을 비교하는 이유

Why Accelerated Outdoor vs. Laboratory?

실제 환경은
가변적(variable)이다
Real world conditions
are **variable**

실제 환경은
복합적(complex)이다
Real world conditions
are **complex**

촉진속도(speed)와
현실성(realism) 사이의
최상의 균형
Excellent balance between
speed and realism



옥외 폭로시험에서의 일반적인 가속 형태

Common forms of Acceleration in Outdoor Testing

- 조도 증가
 - 태양 빛 집중 및 태양의 추적
- Increased Irradiance
 - Solar concentration and/or tracking the sun
- 온도 변화
 - 열(heat) 또는 냉각(freezing) 기간의 변화/추가
- Modified Temperature
 - Trapping/Adding heat or Freezing periods
- 수분 증가(Moisture)
 - 추가 수분 분사
- Increased Moisture
 - Supplementary water spray



Interior Materials Testing

AIM Box

TRUE-AIM Box

Outdoor Tests for Interior Components



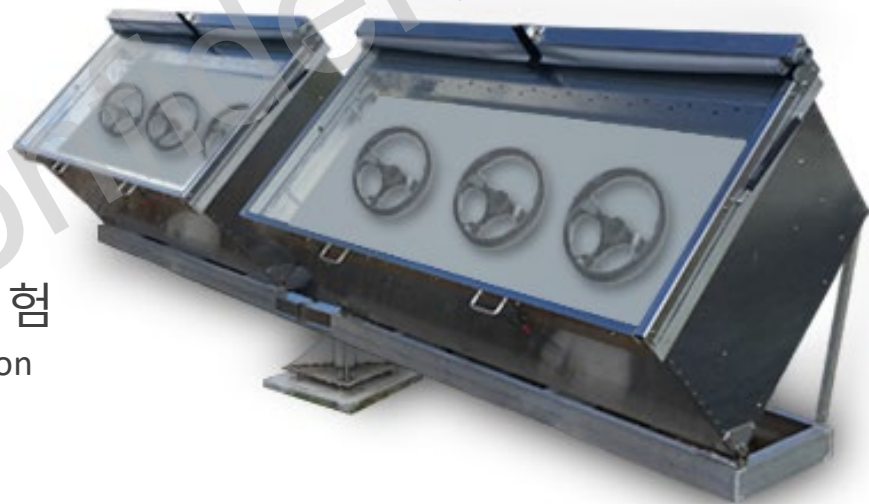
Speedometer
Bezels

자동차 내장부품 재현장치

Automotive Interior Materials

AIM Box

- 자동차 실내의 극한의 열(heat) 재현(up to 110°C) Reproduces extreme heat from automotive interior
- IP Module 시험 가능 Can test entire instrument panel
- 다양한 내장 부품의 서로 다른 열팽창 경험 Different plastics experience different thermal expansion
- 다양한 인테리어 부품 간의 서로 다른 스트레스(stress) 유발 Generates differential stresses between different interior plastics



AIM Box 구성

AIM Box Configurations

- 강화 유리 또는 접합 유리 Tempered clear or laminated glass
- 남향 45° 고정(static) 또는 남향 51° 추적(tracking)
Static 45° S or Tracking 51° S
- 과열(over-temperature)로 인한 음영 보호
Over-temperature shade protection

AIM Boxes



TRUE-AIM Box

- TRUE AIM Box 는 총 광량을 증가시킴
TRUE (Tracking Reflecting Ultra Exposure) AIM box
increases total solar radiation exposure
- 높은 반사율의 거울과 태양을 이중의
축(방위각과 고도)으로 추적하는
시스템을 사용하여 태양을 box
안쪽으로 더 집중화 함 Highly reflective
mirrors and dual-axis tracking (azimuth and
elevation) to focus more sunlight into the box
interior.
- 시편이 받는 광량을 약 두배
증가시킴 Approximately doubles total sunlight
received by specimens.



Q-Trac 태양 집중장치

Natural Sunlight Concentrators

Fresnel Concentrator
Solar Concentrator
Q-TRAC

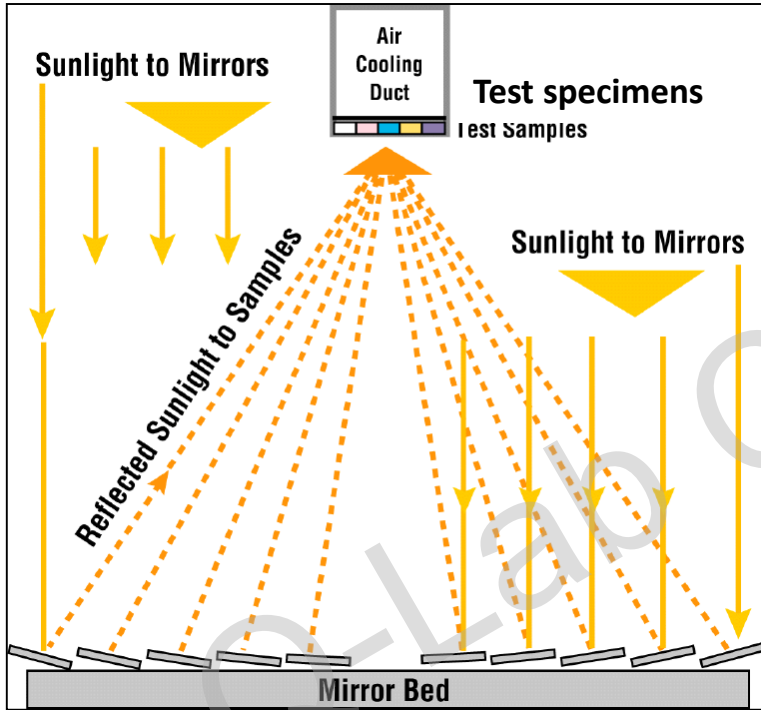






태양 집중 장치

Sunlight Concentrating Mirrors



햇빛을 반사하여 시편으로 집중

Mirrors Reflect Sunlight onto Specimens



평균적으로 80%의 UV가 반사 된다

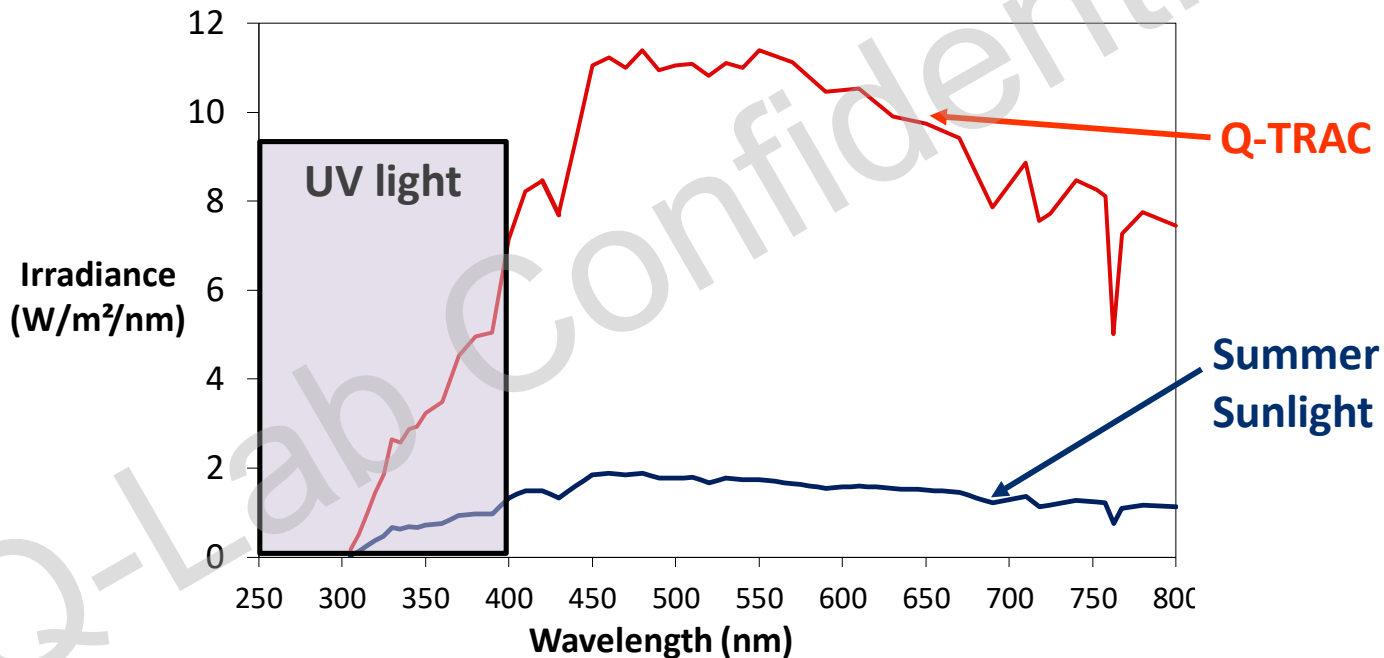
Mirrors on average reflect 80% of solar UV radiation



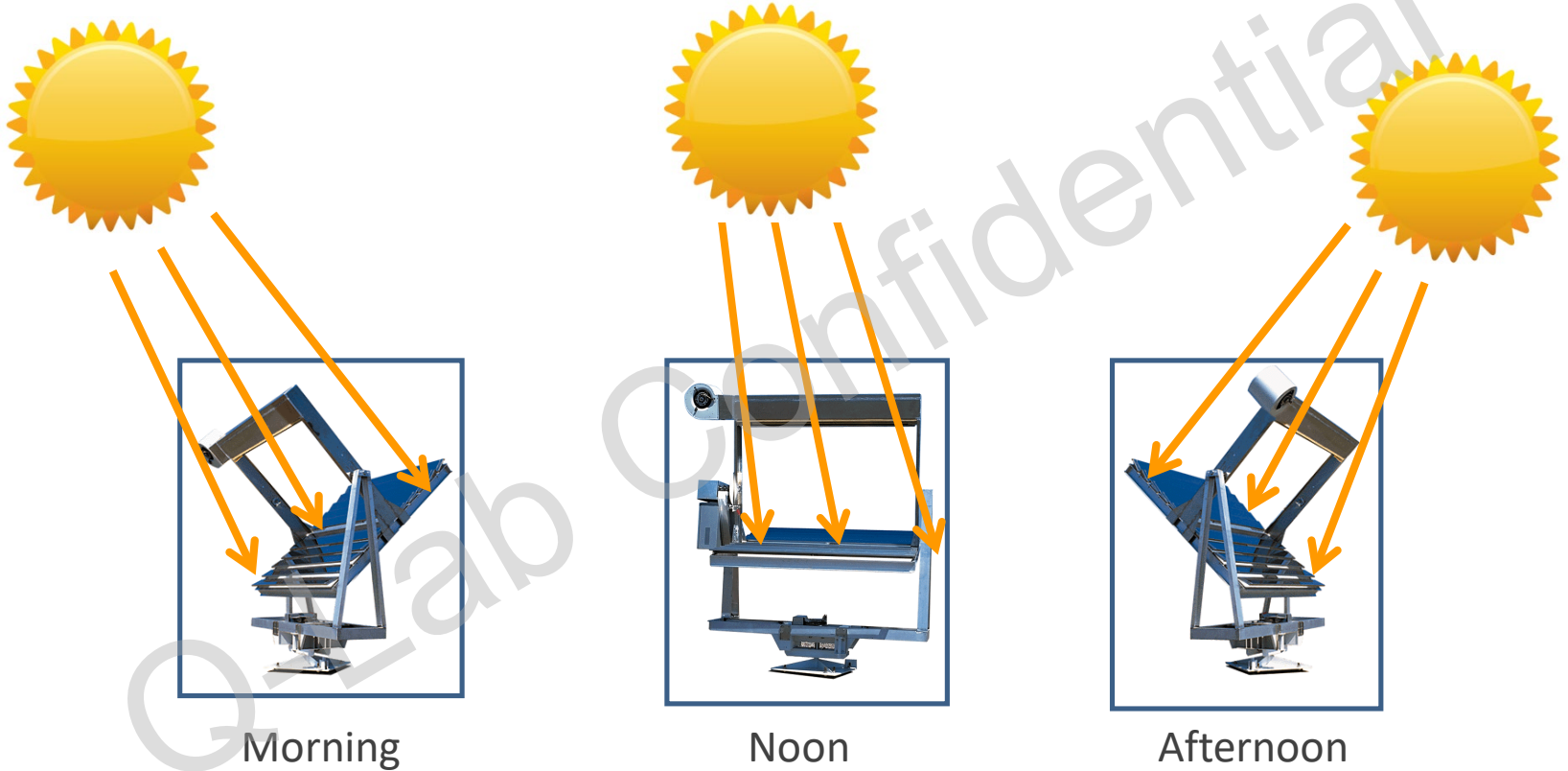
Summer Sunlight vs. Q-TRAC

자연 상태 대비 약 5 배의 UV

~5× UV Irradiance of Natural



태양 추적 Following the Sun...



Arizona Only

- 집광을 하기 위해서는 태양추적이 필요 Tracking is required for concentration to work
- 빛이 확산(diffuse)될 때는 작동되지 않음 (구름 낀 날씨)
Doesn't work when light is diffuse (cloud cover)
- 악천후에서는 효과가 없음
Doesn't work in inclement weather!



복사 노출 Radiant Exposure



×



단위 면적당 일정 시간동안 떨어지는 복사 에너지 [MJ/m²]

The accumulated light energy falling on a surface over a period of time, per unit area [usually MJ/m²]

복사 노출로 측정된 Q-TRAC 으로 측정된 복사 에너지는 여름철이 겨울철 보다 높다 Q-TRAC tests are measured in radiant exposure – higher during summer months than winter

Q-TRAC 테스트는 일반적으로 누적 복사량으로 측정함

Q-TRAC Tests Are Usually Timed by Accumulated Radiant Dosage

Exposure Angle	1 Year Florida Energy (MJ/m ² TUV)
0° South	322
5° South	339
26° South	345
45° South	320
90° South	170

Q-TRAC 은 연간 최대 **1400 MJ/m²** 를 전달 한다 – Florida 연평균의 **5배** *
Q-TRAC delivers ~**1400 MJ/m²** annually - ~**5x** a typical year in Florida*

True or False?

5배의 태양광(sunlight)은
5배의 품질저하(degradation)를 의미한다

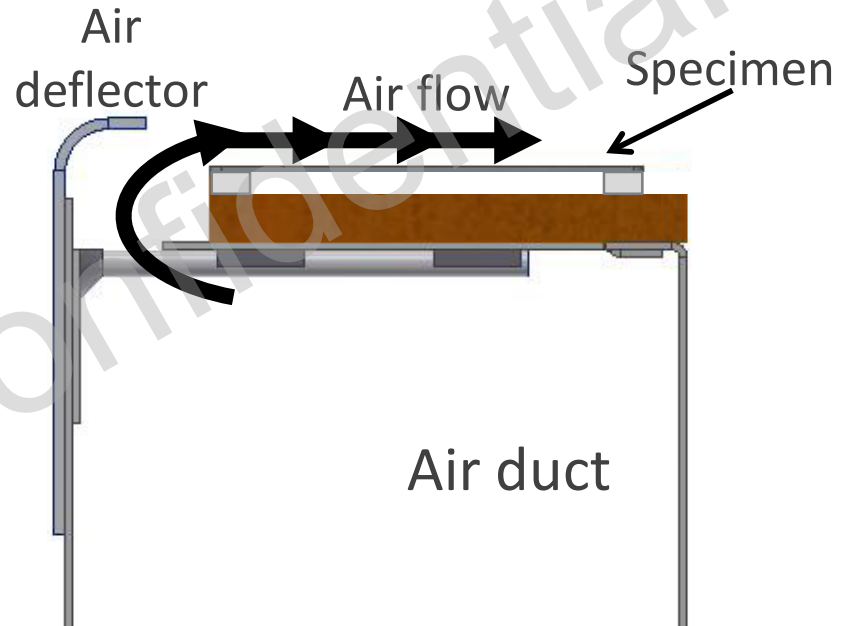
5× the sunlight means 5× the degradation

Q-TRAC Acceleration

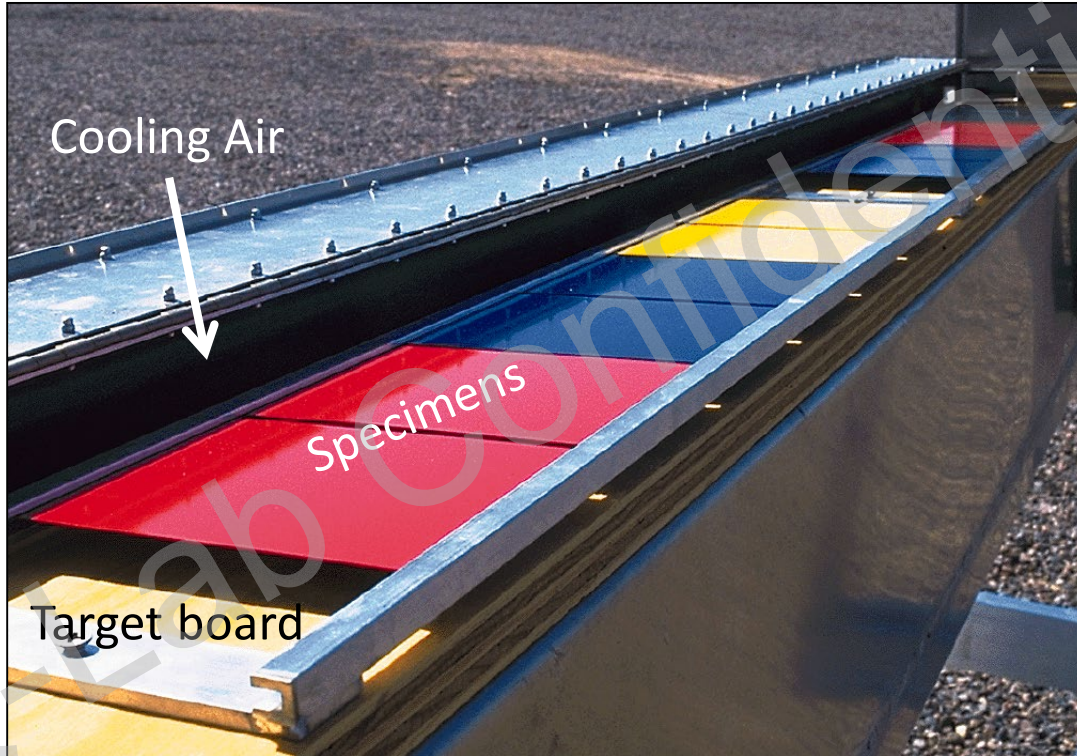
- 5 배의 UV ~5 times more UV
- Florida 1년 일조량의 5배 ~5 years Florida sunlight in 1 year
- 빛의 강도(intensity)는 단지 하나의 스트레스 요인이다
However: Light intensity is only one stressor

Q-TRAC Specimen Mounting

- Flat Specimens
 - Backed or unbacked
- 폭 Width < 14 cm (5.5 in)
 - 타겟 보드의 길이에 따라 요금 부과
Tests are charged by length along target board
- 두께 Thickness < 2.5 cm (1 in)
 - 모든 시편의 두께가 비슷해야 함
All specimens should be similar thickness



Q-TRAC Target Board



촉진 옥외폭로 시험

Outdoor accelerated testing

Temperature Effects



사막에서 발생하는 고온과
집중 광

High temperatures from both desert
conditions and concentrated irradiance

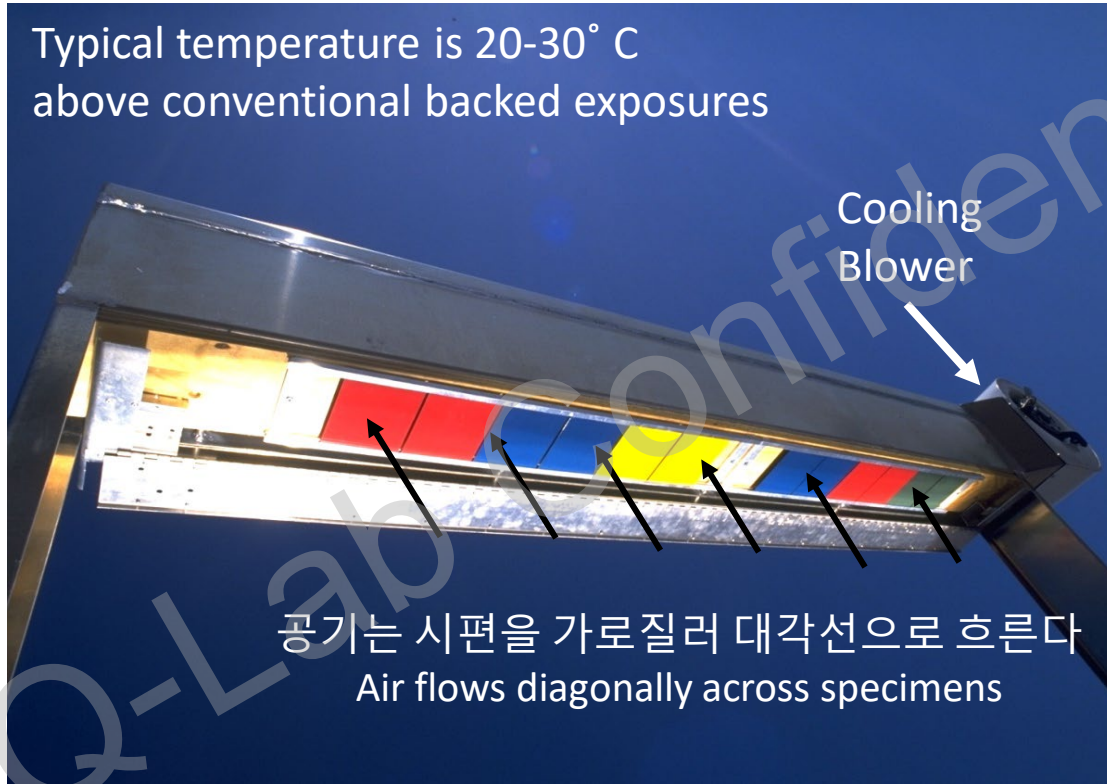
거치 방식에 따른 온도 효과

Temperature Effect of Mounting

	Open / Mesh	Plywood Backed	Black Box	Natural Sunlight Concentrator	
				Conventional	Temp controlled
Black Panel (°C)	50	70	80	100	70
White Panel (°C)	40	50	60	80	50

Q-TRAC Specimen Cooling

Typical temperature is 20-30° C
above conventional backed exposures



촉진 옥외폭로 시험

주간 스프레이(daytime water delivery)



- 주간 스프레이는 빨리 건조되고 열충격을 야기함
Daytime spray dries quickly, causes thermal shock
- *코팅은 수분을 흡수하지 않는다*
Coatings do not absorb any water!

촉진 옥외폭로 시험

야간 스프레이 (nighttime water delivery)



Test Cycle	Daytime			Nighttime		
	Spray duration	Dry duration	Cycles	Spray duration	Dry duration	Cycles
1 "Spray 1"	8 min	52 min	1 / hr	8 min		3 per night: 21:00, 00:00, 03:00
3 "Spray 2"		none		3 min	12 min	4 per hour (40 total) 19:00-05:00

- 잦은 야간 스프레이 사이클 = 높은 습기 시간 (time of wetness) Frequent nighttime spray cycles = high Time of Wetness
- 코팅의 수분 흡수 증가 – 보다 현실적인 테스트 Increased water uptake of coatings – more realistic test



Applications

자연 태양광 집중장치는 내구성 높은 고온 재료에 유용하다

Natural sunlight concentrator particularly useful for durable, high-temperature materials

- Coil Coatings
- Powder Coatings
- Some Plastics
- Roofing

Natural Sunlight Concentrator Cycles

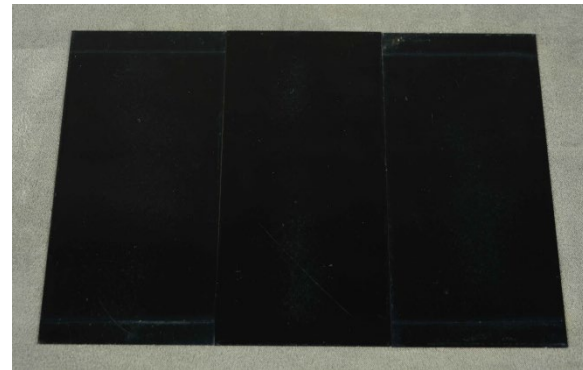
Cycle	Application	Day	Night
Desert	Plastics, Coatings, Inks, Textiles, Building Materials	Sunlight only	Ambient
Spray-1	Plastics, Coatings, Sealants, Textiles, Building Materials	Sunlight Spray 8 min/hr	8 min water 3 times a night
Spray-2	Plastics, Coatings, Sealants, Textiles, Building Materials	Sunlight only	3 min water every 15 min <i>(ToW like Florida)</i>
Interior (behind glass)	Auto Interior, Textiles, Inks, Indoor Products	Sunlight only	Ambient

Q-TRAC Test Examples

Q-Lab Confidential

Q-TRAC Control Specimens

- 42 day Q-TRAC exposures
- Center panel is control
- High-performing coatings from ASTM D7869 study



Single-Stage Paint

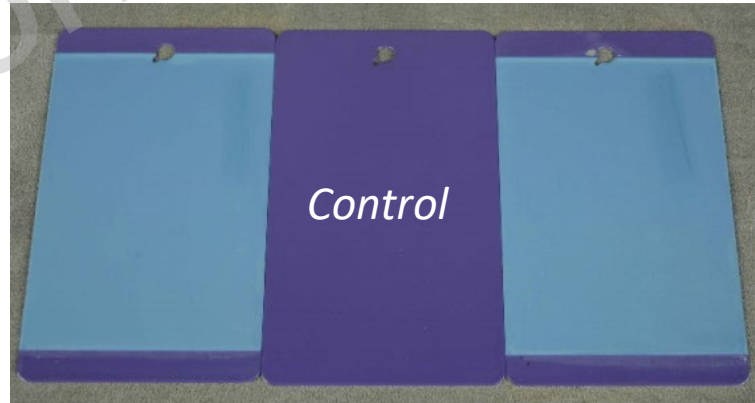
Direct Exposure: 90 Days



Q-TRAC Exposure



29 Days



42 Days

Single-Stage Paint

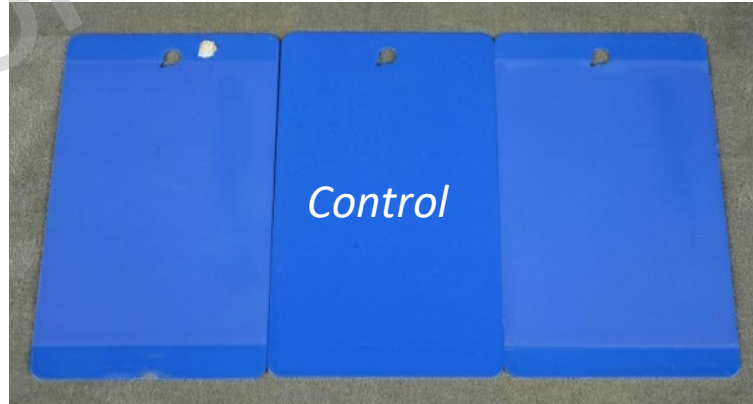
Direct Exposure: 90 Days



Q-TRAC Exposure



29 Days



42 Days

Wood Coating

Direct Exposure: 90 Days

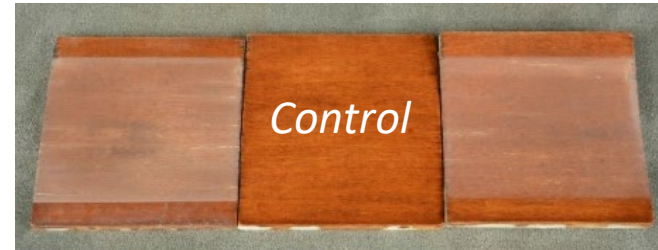


115 MJ/m² TUVB

Q-TRAC Exposure



29 Days
106 MJ/m²



42 Days
153 MJ/m²

Wood Coating

Direct Exposure: 90 Days

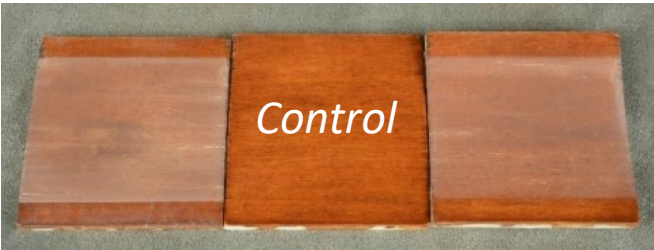


115 MJ/m² TUVB

Q-TRAC Exposure



Freeze/thaw
42 Days
136 MJ/m²



42 Days
153 MJ/m²

Single-Stage Paint Black "A"

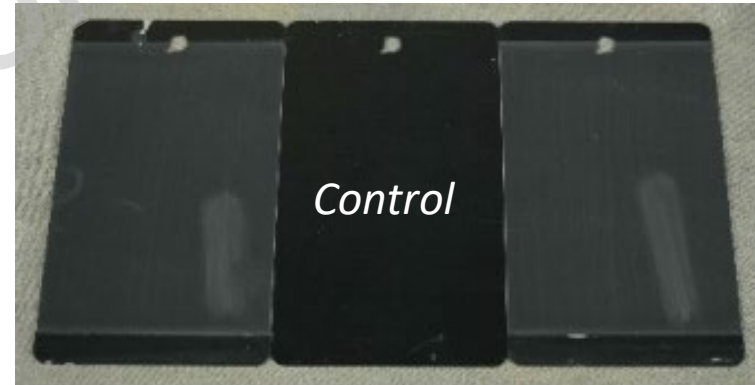
Direct Exposure: 90 Days



Q-TRAC Exposure



29 Days



42 Days

Single-Stage Paint Black "B"

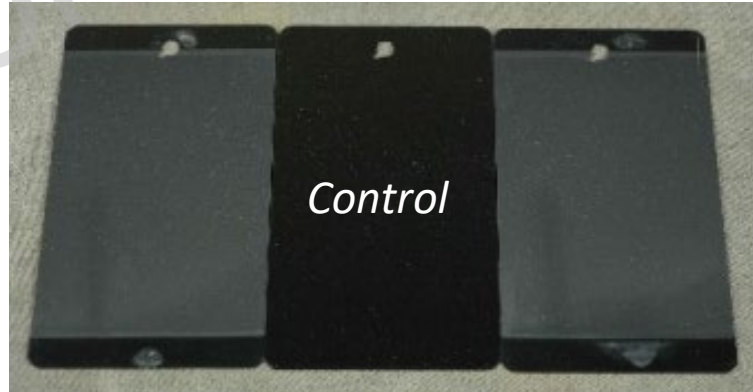
Direct Exposure: 90 Days



Q-TRAC Exposure



29 Days



42 Days

Q-TRAC Natural Sunlight Concentrator

- 빠른 결과 Fast Results
- 태양광 풀 스펙트럼
Full-spectrum natural sunlight
- 고온 (온도 조절 가능)
High temperature
(temp control available)
- 다양한 물 분사 사이클 가능
Multiple water spray cycles available
- 야간 결빙 옵션
Nighttime Freezing option



Thank you for your attention!

Questions?

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