



Two shots of one corridor: the yellowed diffuser only shows beside a new white reference. The onset depends on resin grade, exposure and optic temperature.

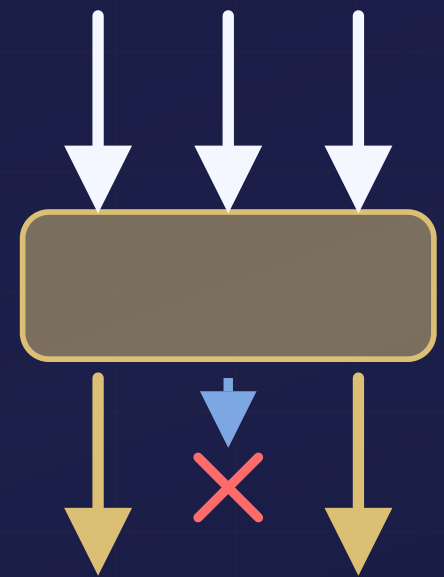
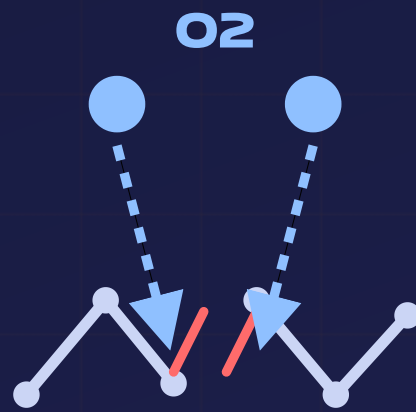
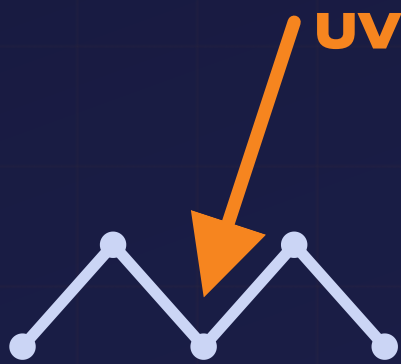
NLC Academy | Episode 10

Snow white at handover. **Amber years before its time.**

A diffuser never turns yellow overnight. UV and Gulf heat rework its polymer slowly, and you only see it beside a new fixture. This episode: the chemistry behind it, what suppliers warrant in writing, and the evidence to demand before you sign.

The chemistry

UV + heat = photochemical ageing.

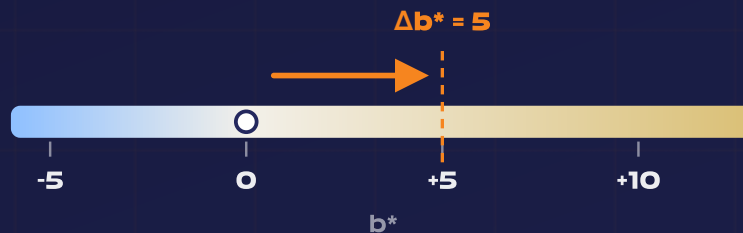


- 1** UV can break and rearrange polymer chains: chain scission and, in polycarbonate (PC), the photo-Fries route; which reaction leads depends on wavelength and oxygen. [1][2]
- 2** Broken and rearranged sites, many via reaction with oxygen, become new light-absorbing degradation products: chromophores. [1] [3]
- 3** Those groups absorb the blue end of the spectrum, so the optic transmits amber. [1]

Rule out dirt first. Confirmed bulk photoyellowing is a chemical change that no cleaning reverses.

The measurement

Yellowing has a number: Δb^* .



- 1 CIELAB colour space measures blue-to-yellow on the b^* axis; a new white diffuser sits near $b^* = 0$. [4]
- 2 Ageing pushes b^* positive. A shift of $\Delta b^* = 5$ is shown as a PROJECT-AGREED example of a clearly visible change, validated on the actual optic; no standard sets it. [5][6]



Example instrument: HunterLab UltraScan PRO spectrophotometer, configured for total-transmittance measurement of optical plastics.

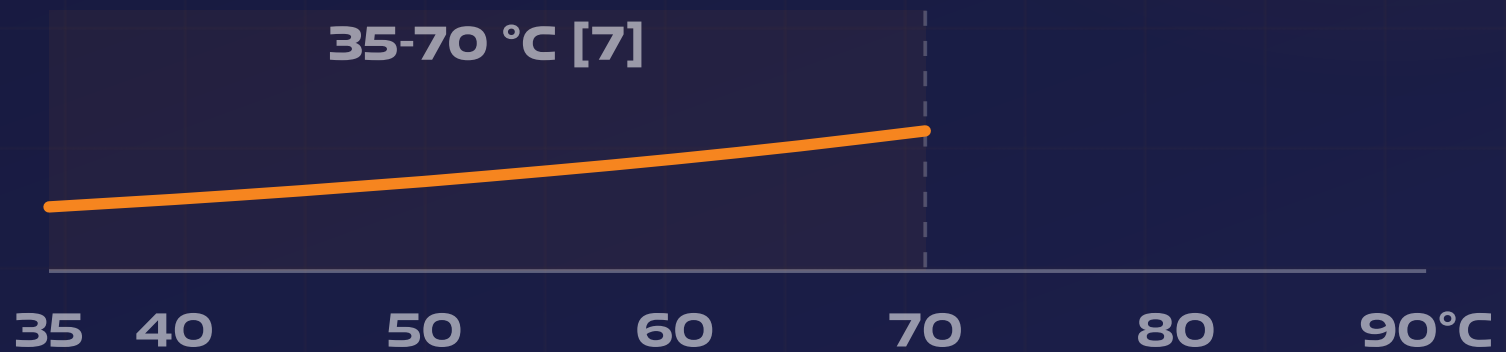


Portable field instrument: a handheld spectrophotometer for repeatable surface-colour and yellowing measurements.

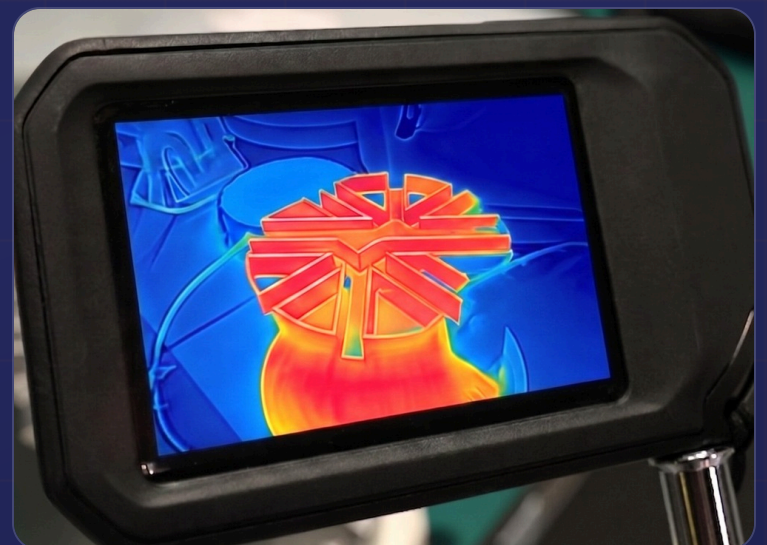
Track yellowing as the change in CIELAB b^* [4]. Yellowness Index is a separate metric per ASTM E313-20(2025), valid only for same-material comparisons [5]; ΔE_{00} follows ASTM D2244-25 [6].

The accelerants

Two accelerants: **UV dose and heat.**



-  Strong solar UV with high optic temperatures [9]: Riyadh clear-sky UVA averages about 21.6 W/m^2 , peaking near 29.5 W/m^2 instantaneous (315-400 nm). [10]
-  Hotter optics age faster: one UV-weathering study of aromatic thermoplastics found 20-30% more degradation per 10°C , validated 35-70 $^\circ\text{C}$. [7]



Thermal camera on the line: hot fins (red), cooler surroundings (blue). False colour, no scale shown.

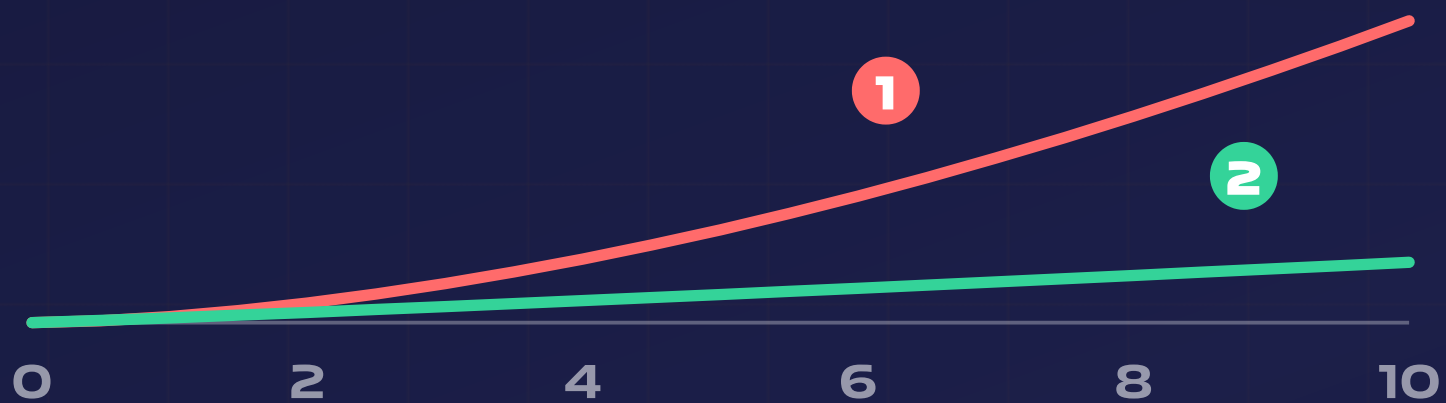
Vertical axis: relative ageing rate, illustrative, drawn across the cited study's validated range only. Acceleration depends on resin, stabiliser, spectrum and stress; a 90-120 $^\circ\text{C}$ blue-LED regime measured far steeper. [7][8]

The fix is dual: **a UV-stable optic AND a cooler-running fixture**, better heatsinking, lower drive current.

The pattern

Ten years, **two very different optics.**

⚠ Illustrative trend, not measured product data



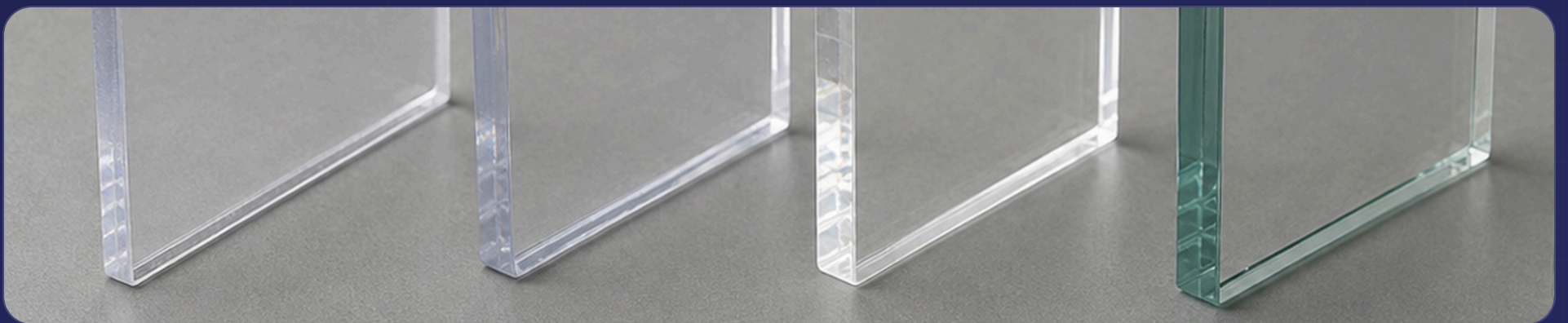
- 1** Unstabilised polycarbonate (PC) loses optical quality under UV: transmission drops, haze rises, the colour drifts amber. [25]
- 2** A well-protected optic can hold its colour for many years: qualified PMMA carries 30-year no-visible-yellowing guarantees; qualified co-extruded PC, 10-year transmission-based warranties. [19][20]

Curve shapes are illustrative; no grade, thickness, cycle or sample data behind them. The coupon photo is an illustrative studio render.

The gap between the two curves **was decided the day the resin was chosen.**

The trade-off

PS, PC, PMMA or glass: **pick your trade-off.**



Left to right: **PS · PC · PMMA · tempered glass**. Sample panels; edge tint and thickness vary by sample and grade.

PS

The one to avoid

Yellows and embrittles fastest; keep out of UV-exposed specs. [27]

PC

Tough, yellow-prone

Needs a real UV package outdoors [2] [25]. Best impact. [26]

PMMA

Whiter for longer

Better colour stability than unstabilised PC [20][25]; weaker on impact. [26]

Glass

No polymeric yellowing

No polymer to yellow; solarization and soiling still shift looks. [24]

PC absorbs impact by deforming; PMMA and glass resist by hardness (Episode 07).

Match the material to the real site risk first, **then buy colour stability at grade level**, with evidence.

The written record

Not folklore: **what suppliers warrant in writing.**

Polystyrene (PS) optics

No outdoor weathering guarantee comparable to the rows below; PS yellows and embrittles fastest. [27]

none found

Co-extruded UV polycarbonate (PC) sheet

Transmission loss $\leq 6\%$ over 10 years (DIN 5036). European scope; structured and thermoformed excluded; pro-rata after year 5. [19]

10-year warranty

PLEXIGLAS clear PMMA sheet

No visible yellowing and retained transmission over 30 years; climate-zone allowances; hard-coated surfaces excluded. [20]

30-year guarantee

Glass optics

No polymeric yellowing to warrant; solarization and soiling remain application checks. [24]

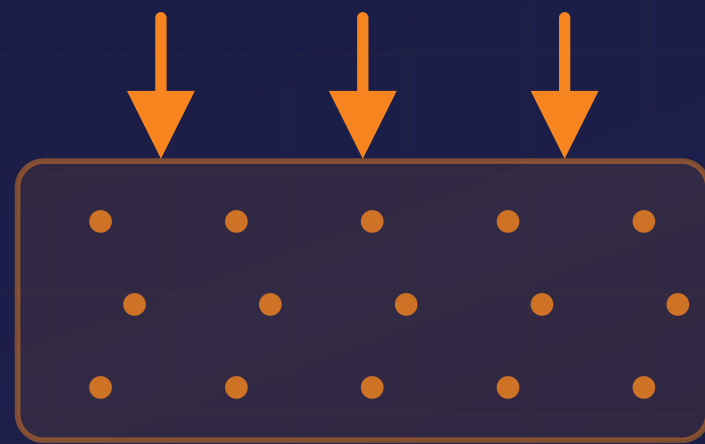
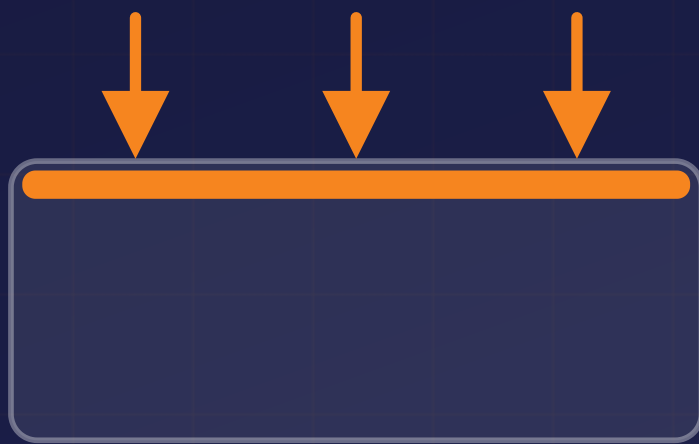
n/a (polymeric)

Warranty examples for specific products under their own published conditions, not universal material lifetimes. Confirm scope, exclusions and Gulf applicability with the manufacturer.

Ask every supplier the same question: **what colour change do you warrant, for how long, measured how?**

The protection

Surface layers or bulk stabilisation: both must prove themselves.



- 1** Co-extruded UV cap layers and hardcoats concentrate absorbers at the surface; qualified CO-EXTRUDED systems carry 10-year outdoor warranties. Layer thickness, absorber package and an intact surface decide performance: abrasion belongs in the qualification. [19]
- 2** Bulk-stabilised resin spreads the UV package through the full thickness; it too is grade-specific and needs validation for the real exposure, not assumption.

Specify by **validated evidence, warranty scope and abrasion performance**, not by protection category.

The datasheet

LM-80 answers for the LED, **not for the optic.**

LM-80 / TM-21

LM-80-21 measures flux and colour maintenance of solid-state light sources (LED packages, arrays, modules); TM-21 projects long-term FLUX maintenance from that data. Neither observes the diffuser ageing in front of them. [15][16]

The optic's own evidence

The exact resin grade on the resin datasheet, a FULL weathering report with conditions and measured colour results (ISO 4892-2 xenon arc, ASTM G154 fluorescent UV), and luminaire-level maintenance (LM-84 / TM-28), which shows system light loss without isolating the optic. [11][12][17][18]

 **Resin datasheet: exact grade**

 **ISO 4892-2 / ASTM G154**

 **LM-84 / TM-28**

If the brochure answers "LM-80" when you asked about yellowing, **your question has not been answered.**

The design levers

Two design levers: **thermal design and serviceability.**



Thermal design

Degradation is thermally activated: a better heatsink and a lower drive current slow the ageing directly, on top of whatever resin you chose. [7]

Replaceable optics

On transit, stadium and other critical installs, spec a field-replaceable diffuser: replacing the optic instead of the fixture can cut lifecycle cost and waste. Run the numbers with replacement interval, optic price, labour, access, downtime and spares. [22]

On the bench: the diffuser lifts out as a part, the luminaire stays.

Specify the resin for the UV, **design the thermals for the heat**, and keep the optic serviceable.

From the NLC range

Four materials, straight from the catalogue.

TRIO

Tri-proof linear luminaire



IP65

22-40 W

PC · UV

Housing: extruded polycarbonate with UV protection; no optic row listed.

STONY

High bay luminaire

IP65

100-240 W

PC · UV



Optics: polycarbonate UV-resistant. High-bay heat works the package hard.

VEIL

Cylindrical bollard



IP65

6-7 W

PMMA

Optics: PMMA. Bollards sit at eye level; tint shows early.

VALLEY

Spike flood light

IP65

9-72 W

Glass



Light window: ultra-white tempered glass; no polymer to yellow.

Material rows quoted from each catalogue page, verified 2026-08-24; application notes are ours. No page names a resin maker or grade. [23]

Before you sign

Five lines that keep **white optics white**.

- ☐ Name the exact **resin grade and its UV package** on the resin datasheet; a brand name alone says nothing about outdoor performance. [21]
- ☐ Ask **how the optic is protected**, bulk-stabilised, co-extruded cap layer or hardcoat, and for the validation and warranty scope behind it. [19][20]
- ☐ Write a **measured colour spec**: metric, instrument geometry, SCI/SCE, illuminant and observer, specimen thickness and backing, baseline, cleaning procedure, measurement locations and sample count, permitted change, warranty period. [5][6]
- ☐ Demand a **full weathering report** with conditions and measured results; a bare "ISO 4892-2", "ASTM G154" or "G155" name proves nothing alone. [11][12][13][14]
- ☐ On critical installations, spec a **field-replaceable optic** and confirm the spare stays available. [22]

The sources

Every claim on these slides, **sourced.**

- [1] Rivaton 1995, PDS 49:163 · [2] Diepens, Gijsman 2007, PDS 92:397
[3] Factor, Chu 1980, PDS 2:203 · [4] ISO/CIE 11664-4:2019, CIELAB
[5] ASTM E313-20(2025), yellowness · [6] ASTM D2244-25, colour diff.
[7] Pickett et al. 2019, PDS 166:135 · [8] Gandhi et al. 2019, PDS 164:69
[9] Al-Dhafiri 2000, JAWMA 50:1045 · [10] Maghrabi 2021, TAC 146:631
[11] ISO 4892-2:2013/Amd 1:2021 · [12] ASTM G154-23 · [13] ASTM G155-25
[14] ASTM G151-26 · [15] ANSI/IES LM-80-21 · [16] ANSI/IES TM-21-21
[17] ANSI/IES LM-84-20 · [18] ANSI/IES TM-28-20
[19] Exolon UV 10-yr warranty MFO016 · [20] PLEXIGLAS 30-yr guarantee
[21] Covestro Makrolon portfolio · [22] IEA 2026, LED lighting
[23] NLC catalogue, 4 product pages · [24] SCHOTT TIE-35, glass
[25] Tjandraatmadja 1999, DBMC 8:884 · [26] Plaskolite TUFFAK GP PDS
[27] Yousif, Haddad 2013, SpringerPlus 2:398 (PS photodegradation)

Short forms (PDS = Polym Degrad Stab; JAWMA, TAC, DBMC = the cited journals). Full citations with DOIs, URLs and access dates (2026-08-24) ship in the episode reference document; standards cited in their current active revisions.

PRACTICAL LIGHTING ENGINEERING

**Save this. Send it to a
colleague.**



Read the full episode article

<https://nlc.com.sa/academy/yellowing.html>



Next episode
Green, Magenta Shift