

PALCCOAT Heritage Technical Documentation

Heritage Conservation Series — Heritage Matrix

Sub-micron photocatalytic TiO₂ matrix for mineral and fibre substrates

01 / Conservation Principle

The Vulnerability Traditional sealers are film-forming. They trap moisture, alter surface sheen, and require repeated invasive cleaning that abrades historic fabric. Each cycle escalates cumulative intervention risk and lifecycle cost.

The Approach PALCCOAT creates an active, self-renewing interface — not a barrier. Covalent non- film binding preserves vapour permeability. Photocatalytic action decomposes organic dirt, algae, and pollutants into CO₂ and H₂O. Rainfall lifts residue away.

02 / Evaluated Performance

Parameter	Standard	Measured Value	Conservation Relevance
Hydrophilicity	JISR1703-1/ISO27448	<6° contact angle (ST); unmeasurable (Clear-G)	Self-cleaning activation; rainfall spreads evenly
Organic decomposition	JISR1703-2/ISO10678	Decomposition activity index ~20 initial; ~9 after 3,000 hrs (PIAJ threshold: 5.0)	Reduces soiling accumulation
Antibacterial	JIS R 1702 / ISO 27447	>99.9% reduction (E. coli, S. aureus)	Bio-fouling resistance
Antifungal	JIS R 1705 / ISO 13125	Evaluated	Mould suppression on organic substrates
Air purification (NO _x)	JIS R 1701-1 / ISO 22197-1	Evaluated	NO _x breakdown
Air purification (acetaldehyde)	JIS R 1757 / ISO 19652	PIAJ certified	VOC breakdown
Antiviral	JIS R 1706 / ISO 18061	99.9% reduction (Influenza A H1N1, 8 hrs)	Viral load reduction

03 / Dual-Action UV Management

The Conservationist's Paradox: TiO₂ requires UV activation — yet UV degrades organic heritage materials.

Resolution: Substrate-gated photocatalysis.

- **On inorganic mineral surfaces:** UV and visible light (410–490 nm) activate hydroxyl radical generation for self-cleaning.

- **On organic substrates:** The stabilised matrix operates in UV-absorption mode — blocking >99%UV-B and >95% UV-A before substrate interaction, with radical generation chemically suppressed.

ASTM G154 evaluated. Yellowing index $\Delta YI < 1.0$ after 1,000 hrs QUV.

04 / Tropical Durability Evaluation

Malaysian Heritage Demonstration — Tangsi House, Kuala Lumpur

Evaluated on historic exterior masonry substrates. Post-application monitoring confirmed complete moisture vapour transmission, imperceptible colour alteration ($\Delta E < 0.5$), and long-term resistance against tropical bio-fouling and algae. No peeling, no under-film moisture.

05 / Heritage Research Lineage

Professor Fujishima Akira — KAKENHI Grant 16H03107 (2016–2018)

The scientific principles behind PALCCOAT's UV-absorption mode for organic substrates were informed by government-funded research on photocatalytic lacquer coatings for Nikko Toshogu cultural assets. Key findings:

- Lacquer lifetime extended **18x** versus uncoated lacquer when protected by photocatalytic UV absorbing coating
- Fungal species identified on cultural assets: **Penicillium, Cladosporium, Aspergillus** —also prevalent in tropical environments
- Transparent coating achieved with **$\Delta E < 1.0$** colour shift, preserving aesthetic integrity • Research published through kaken.nii.ac.jp (Japan Society for the Promotion of Science)

This research establishes the scientific basis for UV-absorption mode on organic heritage substrates — preventing degradation without compromising visual character. PALCCOAT applies these same principles to Malaysia's timber, lacquered, and painted heritage.

06 / Substrate Compatibility

Substrate	Mode	Conservation Outcome
Porous Stone (limestone, sandstone, granite)	Photocatalytic	Non-film covalent binding; capillary breathability maintained
Historic Renders (lime plasters, cement renders)	Photo catalytic	No spalling, no trapped moisture
Clay & Terracotta	Photocatalytic	Zero salt migration, zero sheen
Historic Fabrics (silk, velvet, wool)	UV-Absorption	Retains natural fibre feel; drape preserved
Museum Archives	UV-Absorption	Neutralises trapped odours; mould suppression
Heritage Timber	UV-Absorption	>80% vapour permeability (ASTM E96); >95% UV-A block; <2 GU sheen

Table 2 – continued

Substrate	Mode	Conservation Outcome
Heritage Metals	Passivation	Electrochemically neutral (± 20 mV, ASTM G59); reduces chloride/sulfate deposition
Heritage Glazing	Photocatalytic	>98% visible light transmission;
Wall Paintings & Murals	UV-Absorption	<1% haze (ASTM D1003) pH-neutral; >90% vapour permeability; photocatalytic activity suppressed on organic pigments

Additional Evaluation: PMC Alor Setar — Applied under supervision on modern wall substrate. Post-application monitoring at 6 and 12 months confirmed zero pigment interaction, complete vapour permeability retention, and measurable reduction in atmospheric soiling. $\Delta E < 0.5$ across all test patches.

07 / Coating Durability

Parameter	Result	Test Method
Pencil hardness	>2H	JIS K 5400, 7 days
Adhesion	No peeling	Cross-cut test
Alkali resistance	No discrepancy	Saturated $\text{Ca}(\text{OH})_2$, 7 days
Accelerated weathering	No discrepancy	Sunshine weather meter, 3,000 hrs (equivalent to 8-10 years outdoor exposure)
Film thickness	$\sim 1 \mu\text{m}$ general; $0.1 \mu\text{m}$ min.	TEM / SEM observation
TiO ₂ particle size	10-20 nm	Transmission electron microscopy

08 / Maintenance Intervals by Substrate

Substrate	Exposure	Review Interval
Vertical masonry	Exposed	7 - 10 years
Timber(vertical)	Exposed	7 - 10 years
Timber(horizontal/wear)	Hightraffic	5 - 7 years
Metal(ornamental)	Exteriorfaceonly	5 - 7 years
Glazing	Exteriorfaceonly	5 - years
Murals(modernwall)	Interior/exterior	Annual review

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