Investigating contemporary pre-primed artist canvases

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Introduction

Commercially pre-primed canvases are a popular choice for contemporary artists. This poster reports on a collaborative project between the Queensland Art Gallery | Gallery of Modern Art, Brisbane and the Heritage Conservation Centre, Singapore to investigate the materials and properties of contemporary pre-primed canvases.

Sample set

53 different pre-primed artist canvases were sourced, representing 19 brands manufactured in Europe, China, Australia, USA, India and Mexico. Brands included Artfix, Claessens, Belle Arti, Frederix, Winsor and Newton, Caravaggio, Sydney Canvas Company, Art Spectrum, Clairefontaine, Mont Marte, National Art Materials, Jasart, Overjoyed, Pebeo, Semco, Francheville, Phoenix, Talens and Colorpro. Analysis included cross sectional and surface microscopy, ATR-FTIR, Py-GC/MS, XRF, Raman and SEM-EDX to identify binder, pigment and fibre types. In addition, uniaxial tensile strength testing was undertaken. 17 artworks on pre-primed canvases dating 1990–2018 were also investigated for correlation.

Results: Canvas Samples

Binder

Priming layers were characterised as oil, acrylic, PVAc or PVAc/acrylic copolymers with and without styrene (fig.1). No two canvas samples showed identical formulation except some of the same brand.

Styrenated acrylic copolymers were most common (41.5%) — in combinations of 7 different acrylic monomers. The most prevalent acrylic copolymer was styrene-BA, followed by BA-MMA. PVAc copolymers were also common. No alkyd binders were found (Osmond et al 2018).

Styrene was found in 64% of binders. It is used to modify copolymer properties but is associated with yellowing (Standeven 2011) as well as chalking and cracking with UV exposure.

Priming layer thickness ranged from 30µm to 300µm. Multiple priming layers specified by suppliers were not always discernible. Layer combinations included acrylic over styrenated acrylic (fig.6) and oil over acrylic.

Pigments + fillers + additives

All samples contained Ti or Ca as major elements with Zn, Ba, S, Mg, Al, Si, K, Fe, Mn or Sr. Titanium dioxide and chalk predominated in synthetic primings, typically in combination but sometimes singly (fig.2). Other pigment combinations including barium sulfate with titanium white and/or zinc white were found in 9% of samples, primarily in oil priming. ATR-FTIR revealed amorphous and crystalline zinc carboxylates at the surface of two samples from two different brands of oil primed canvases, which may pose a risk to paint adhesion (Osmond 2019).

Additives included VeoVa and glycol dibenzoate plasticiser.

Fibre + weave pattern

Cotton was the most prevalent fibre, followed by linen, polyester (PET) and PET/cotton blends (fig.3).

Three weave patterns were identified: 57% of samples were plain weave (1 x 1), 37% were half basket (2 x 1) and 6% were full basket (2 x 2). Cotton was typically found as half basket, while linen, PET and PET/cotton blends were mostly plain weave. 25% of cotton samples had a thread count of 10 x 30 threads/cm, otherwise thread counts varied.

Tensile strength

Uniaxial tensile strength testing indicated that the type or number of priming layers did not significantly affect tensile strength. Force at max measurements ranged from 56N-258N for cotton and cotton/PET samples. These were generally lower than measurements for linen and PET samples at 191N-514N. These results align with research by Young et al 2012 where fibre type, thread count and weave pattern of raw canvas were the dominant factors affecting tensile strength. Further investigation is required to compare results to a study of hand-primed canvases, where strength values increased with the number of priming layers (Penava et al 2015).

The modulus of elasticity varied. Samples generally showed a lower modulus of elasticity for the warp than for the weft. Higher thread count in the warp direction showed lower modulus of elasticity, indicating increasing resistance to deformation with higher number of threads.

Results: Artwork samples

Pre-primed canvases from 17 paintings dated 1990–2018 were analysed. These paintings exhibited unusual condition or response to conservation treatment including loss of canvas tension over time ('creep'), 'stretchiness' of canvas, puckering of unstretched canvas, priming layer tolerance to heat above 45°C, unpredictable response to humidification, priming discolouration or delamination of paint.

The most prevalent artwork priming was acrylic/PVAc copolymer (29.5% — a higher ratio than the canvas samples at 23.1%), followed by acrylic (23.5%). Only 17% of artwork priming contained styrene compared to 64% of the canvas samples tested.

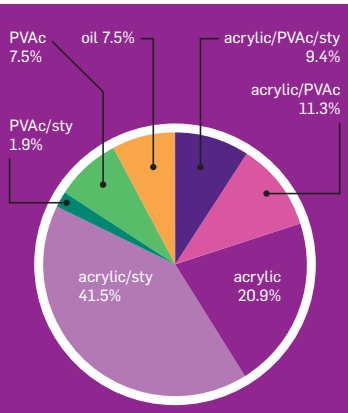

Figure 1. **Binder** type distribution in pre-primed canvas samples (ATR–FTIR)

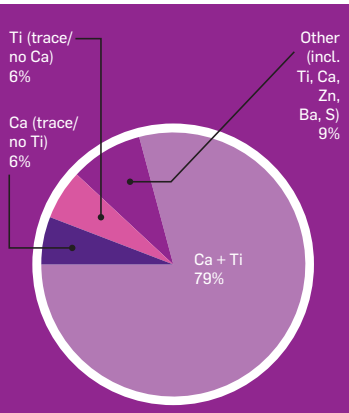

Figure 2. **Pigments and fillers** elemental distribution in pre-primed canvas samples (XRF)

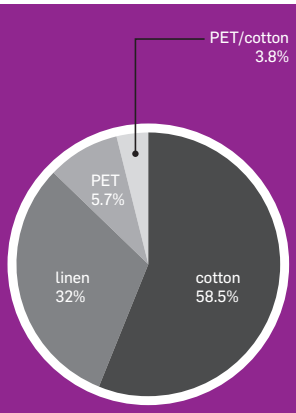

Figure 3. **Fibre** type distribution in pre-primed canvas samples (ATR–FTIR)

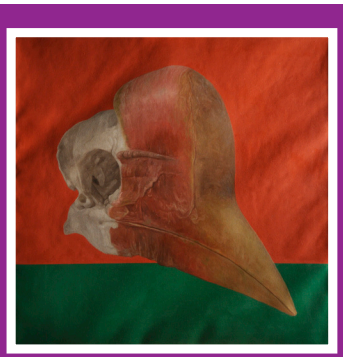

Figure 4. *Voices of Hope* by Tan Wei Kheng, 2013, Collection of the Singapore Art Museum. Raking light image showing undulations. Size: 91 x 91cm. Cotton canvas half basket weave (12 x 32 threads/cm). Priming is acrylic (EA) with chalk and titanium white.

Chalk and titanium white predominated in acrylic artwork priming. Two of the three primings which showed tolerance to heat above 45°C contained high $CaCO_3$ content (trace TiO_2), with a binder not able to be determined, possibly due to its low content. A tear and fast response to humidification was also reported in a painting with a similar priming.

Delamination of subsequently applied oil paint was noted over an oil priming containing crystalline zinc carboxylates and $BaSO_4$ on linen.

64% of artworks were on cotton canvases. The rest were linen with a few on cotton/linen, cotton/PET or PET canvas. Weave patterns were either plain (52%) or half basket across fibre types. Artworks exhibiting undulations, loss of canvas tension over time (fig.4) and/or stretchiness of canvas during treatment were associated with cotton canvases of half basket weave with thread counts of 11–12 x 30–32 threads/cm.

Conclusion

Pre-primed canvas

There was significant variety in canvas and priming formulation, even within brands, with no immediate trend linked to price point. This variety implies there is no standard for pre-primed canvases, even within brands.

- Variety in formulation, high incidence of styrene and PVAc, and no alkyd priming contrasts with a study by Ormsby et al (2008) possibly reflecting changing formulation trends
- Styrenated acrylic copolymers were the most common binders
- Chalk and titanium white were major pigments
- Amorphous and crystalline zinc carboxylates were found at the surface of oil priming
- Cotton canvas, in half basket weave, predominated
- Synthetic canvases were not common however showed greatest tensile strength

Artwork priming

Correlations between canvas and priming formulation and treatment observations were not clear, although some patterns emerge:

- Acrylic/PVAc copolymer binders were most prevalent, with styrene copolymers less common than in canvas samples. This indicates a possible increase in the use of styrene in commercial priming formulations, with uncertain long-term implications
- Higher heat tolerance was observed in artwork priming with high chalk and low binder concentration
- Crystalline zinc carboxylates at the surface of artwork oil priming may be associated with delamination of applied oil paint
- Stretchiness, puckering and loss of canvas tension over time were associated with half basket weave cotton canvases

Figure 5. Sample QAG 6 — Sydney Canvas Company, 10oz cotton duck. Top left: reverse showing cotton canvas, half basket weave (11 x 30 threads/cm). Top right: front showing priming surface. Bottom: cross section showing canvas and priming layer of acrylic (BA/MMA)/PVAc with chalk and titanium white, thickness 144 µm.

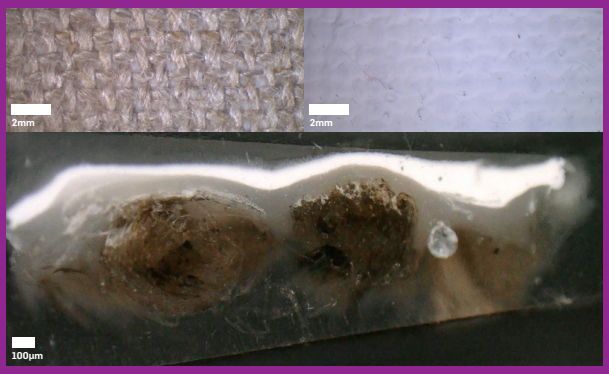

Figure 6. Sample QAG 26 — Caravaggio. Top left: reverse showing linen plain weave (11 x 12 threads/cm). Top right: front showing priming surface, micro-cracks noted in priming. Bottom: cross section showing canvas and two priming layers: top layer — acrylic (EA/EHA/EMA/MMA) with titanium white (no chalk), thickness 41.30 µm; bottom layer — styrenated acrylic (EA/MMA) with kaolinite, thickness 96.90µm.

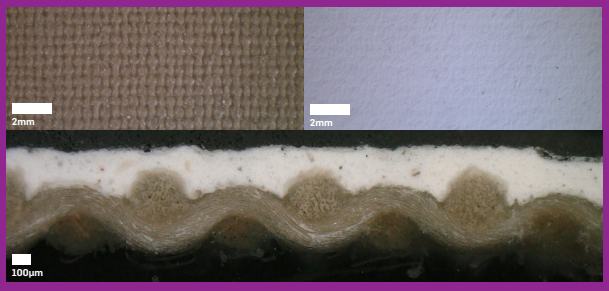

Figure 7. Sample QAG 44 — Artfix. Top left: reverse showing PET canvas plain weave (20 x 22 threads/cm). Top right: front showing priming surface. Bottom: cross section showing canvas and priming layer of PVAc (VeoVa)/acrylic (BA, MMA)/styrene with titanium white, chalk and talc, thickness 103.25µm.

Acknowledgement

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Experimental

ATR-FTIR — Thermo Scientific iN10 microscope with DTGS room temperature detector coupled to an iZ10 diamond ATR bench accessory. 16 scans over 4000–400 cm^{-1} range at 4cm^{-1} resolution.

Py-GC/MS — Shimadzu GC/MS QP2020 combined with a Frontier PY3030D pyrolyser unit with autosampler AOC-20i. Pyrolysis conditions: 600°C for 0.2 min; GC conditions 40°C for 5 min, ramped to 300°C at 10°C/min, hold 5 min. Oil-containing samples were derivatised with 3 µl of 25% TMAH in methanol. MS conditions: EI mode (70 eV), scan range: 50–600 m/z.

Uniaxial testing — 500N Zwick/Roell with 10mm sample width and 10mm gauge length, and speed of 100mm/minute at 55 ±5% RH and 22±3°C. Samples were tested in warp and weft with a tensile load of 500N. The average value of Force at max [Fmax/N] and the average value of Young's modulus [Emod/GPa] was measured.

XRF — Bruker Tracer 5i with Rh excitation anode, silicon drift PIN diode detector, no vacuum, Geo-Exploration mode calibration, spot size 8mm.

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