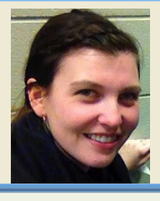

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# Face-lifts for Face-Mounting: *Fill Materials and Methods for Scratch Repair on Poly(methyl methacrylate) Used in Face-Mounted Photographs*

## INTRODUCTION:

- A primary conservation issue for the sustained use of face-mounted photographs (FMP) is the long-term stability and inherent susceptibility of the poly(methyl methacrylate) (PMMA) surface to abrasions.
- A scratch on a smooth acrylic surface is composed of a trough, with a depressed center, and ridges, created by the displaced acrylic material. (see Fig. 1)
- When light is reflected by the raised ridges the scratch becomes disturbing visually, therefore by smoothing these ridges, the visibility of the scratch should be reduced.
- This paper examines surface modification methods (scratch-flattening and scratch-scraping) as well as the choice of fill material (an acrylic co-polymer, a UV-curing adhesive, or an epoxy resin) in decreasing the visibility of scratches on the PMMA surface of face-mounted photographs.

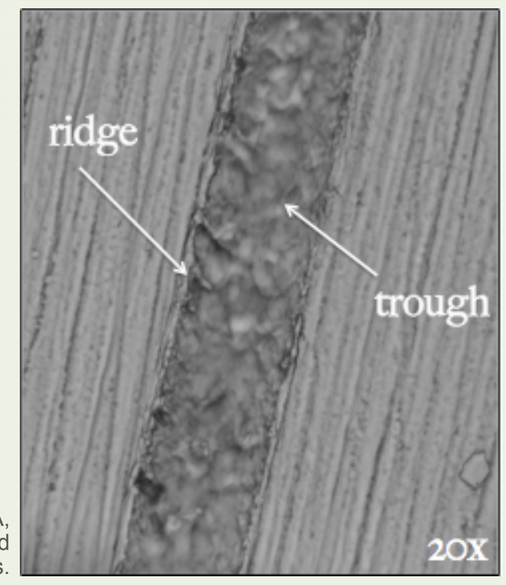


Figure 1: 20x scratch on PMMA, illustrating depressed trough and raised ridges.

## EXPERIMENTAL

### Step 1: Scratching and Surface Modification

- PMMA surfaces degreased with mineral spirits
- Coupons scratched by 80 granite sandpaper with rub-test machine (Fig. 2)
- Select coupons were subject to flattening treatment (F) with microscopy roller, scraping treatment (S) with razor blade, or were left as is for fill material application.

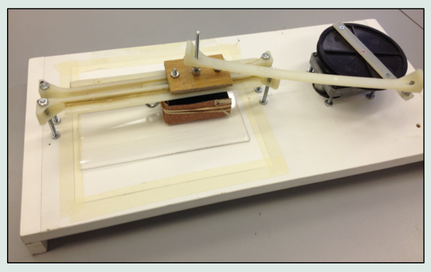

Figure 2: Rub-test machine used for creating scratches.

### Step 2: Material Application

- Fill materials were applied manually with syringe/brush and leveled out naturally and with silicon wedge to ease adhesive into scratch troughs
- Curing time varied by material

I) Acrylic Co-polymer : 20% Paraloid B72 in 1:4 hexane: toluene
>highest viscosity and n=1.49

II) UV-Curing adhesive: Dymax 4-20638
>longest cure time and n=1.504

Epoxy Resin: Hxtal NYL-1
>lowest surface tension and n=1.52

### Step 3: Accelerated Aging

After coupons were able to fully cure (over 2 months undisturbed) they were subjected to thermal and radiated light to simulate extended storage and exhibition conditions.

Thermal: Samples aged separately

- B72 (B)→ 4.53 hrs and 85°C - 50%RH
- Hxtal (H)→ 47 hrs and 95°C - 50% RH
- Dymax (D)→12.15 hrs and 95°C – 50% RH

Light: Samples aged simultaneously

- Exposure to 100,000 lux for a continuous 438 hrs
- 39-43°C - 25-40% RH

## RESULTS & DISCUSSION

### Color Change, Surface Gloss & Visual Examination

- B-72 fills held the greatest shift to –b* (more blue) values compared with the PMMA control surface (displaying the greatest potential for ΔE color change)
- Hxtal samples had the smallest shift to –b* values (and the smallest potential ΔE shift)
- Dymax held a mid-level –b* shift and potential ΔE change

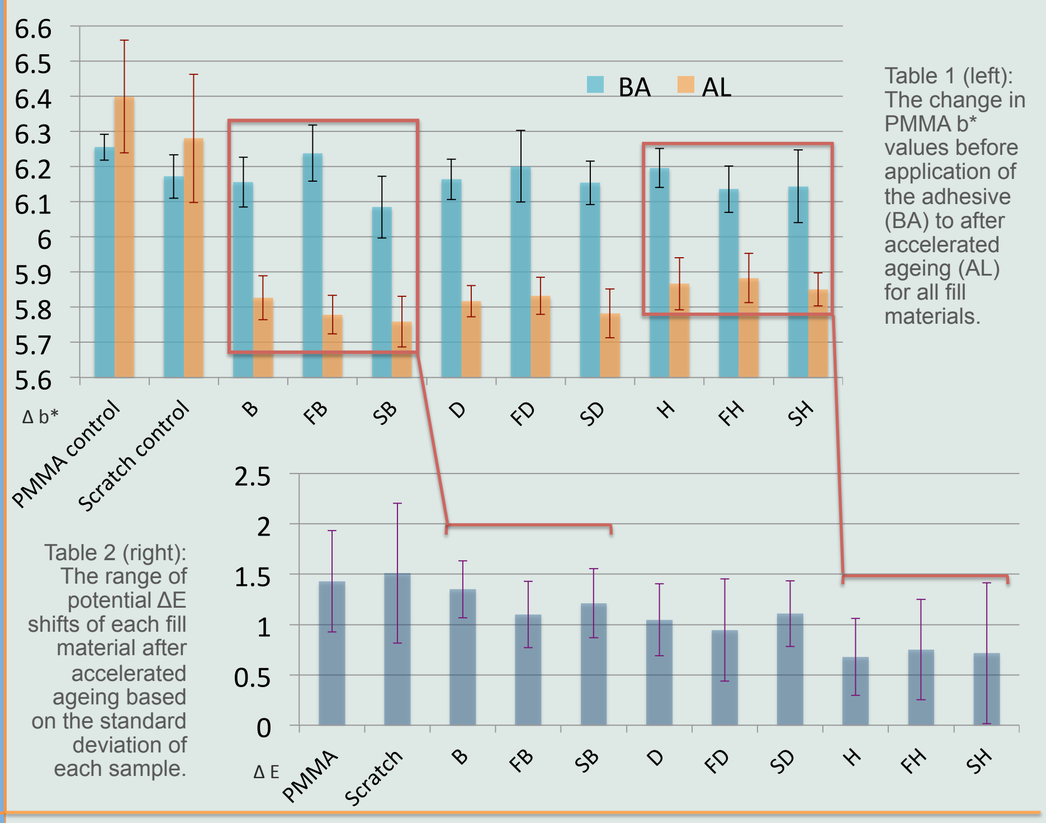


Table 1 (left): The change in PMMA b* values before application of the adhesive (BA) to after accelerated ageing (AL) for all fill materials.




Table 2 (right): The range of potential ΔE shifts of each fill material after accelerated ageing based on the standard deviation of each sample.

- Application of B-72 created the most matte surface while Hxtal made a surface glossier than untouched PMMA
- While Dymax cured to a glossy surface, too many dust particles were present from the long cure time to be an effective fill


Table 3 (above): The change in PMMA surface gloss before application of adhesive (BA) to after accelerated ageing (AL) for all surface modification methods.

- An observational study of 12 participants voted that the scraped Hxtal NYL-1, and the scratched Paraloid-B72 coupons were the most visually effective in reducing the prominence of surface scratches.


Table 4 (right): Surface gloss measurements for scratch modification techniques. Scratching PMMA severely reduces gloss while flattening increased it and scraping does not.




Table 5: 20x raking light photomicrographs detailing scratch reduction capabilities of fill materials. Scratched PMMA (uncovered) for reference at right of each red-dotted line. Under normal viewing conditions many of the minor scratches are not visible.

## CONCLUSION

Paraloid B-72 had the greatest color change and produced the most matte surface. Hxtal NYL-1 had the least color change and produced a surface glossier than unscratched PMMA. While these two fill materials represent the best and worst analytical data sets, an observational study chose both the scratched B-72 and scratch-scraped Hxtal as the most effective in visually reducing surface scratches. Dymax was not as effective as a fill material. With further experimentation on adhesive application methods, the information obtained in this study can be applicable in attempts to fill deep surface scratches on FMP. Further testing to completely obscure surface scratches still needs to be explored. It is important to note that the light source, viewing angle and image content of a FMP will always affect the prominence, and inherent visibility, of surface scratches.

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