

New Coating Techniques in Photoelasticity

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1.0 Introduction

Photoelastic Stress Analysis (PSA) has stood the test of time as one of the most broadly applied full-field stress analysis techniques.[1] Innovations in polariscope design[2][3], rapid prototype modeling and capable user-friendly software are proving to rejuvenate the technology. Even with these advancements, use of PSA is limited by coating technology. Surely, new polymers such as ultraviolet curing epoxies will in time yield easy spray, same-day cure coatings. But, until these coatings are available and proven, there is need to develop new ways of applying traditional polymers. The grey-field polariscope with automatic thickness measurement capability [3], or alternatively, the advent of hand held coating thickness measurement devices, open new opportunities of simplified direct application of partially set polymers to the surface of most components. This paper describes developments in a new application method dubbed TACTS, Thermally Activated Conformable Transfer Sheets.

2.0 Application method

TACTS is a simple clean method for applying traditional photoelastic polymers. It uses a rubber sheeting to form a pliant mold of the object and provide a backing for handling the coating during application. The simplest method for explaining the use of TACTS is to step through a sample application. The example below illustrates coating an ordinary adjustable wrench.

Step 1 Specimen preparation

Prepare specimen with silver backing to reflect polarized light (Fig. 1). Options include buffed silver paint, high index retroreflective beads sprinkled on silver paint or in the case of metallic components, simple sandblasting.

Softer materials should be blasted with beads and not sharp abrasives; dimpled surfaces minimize multiple reflections and therefore retain polarization better than rough surfaces. Each type of backing has different polarization integrity. In grey-field polariscopes, the measurement is independent of the source light intensity so the differences in polarization integrity is compensated for.



Fig. 1 Prepare Specimen

Step 2 Create a mold or positive pattern of coating

First, a mold or positive pattern is made of the part. This is done by laying a rubber sheet over the area to be coated and heated with a hair dryer to conform the sheet to the surface. Trim the sheet so that the area can be covered without overlaps. Fit the rubber to surface trying to avoid wrinkles. This step not only serves to define the transfer sheet mold but also provides practice and insight on how the coating itself will be applied to the part. If the positive pattern sheet can easily conform to the geometry so will the coating transfer sheet. Trim positive pattern on component to define final area to be coated (Fig. 2).



Figure 2 Positive Pattern coating or mockup

Step 3 Create transfer sheet mold

The next step is to create the negative pattern or the transfer sheet mold (Fig. 3). The transfer sheets are a 2-ply nonstick rubber. The positive pattern or mold is flipped face down and traced with a knife and the second ply is removed. There is texture on the bottom surface to avoid trapping air when placed on hot plate. Trapped air can cause bumps in the rubber resulting in inconsistent thickness. The top surface of the bottom sheet has a matte surface texture which will define the coating's external surface.



Fig. 3. Negative pattern Rubber mold dam

The coating replicates the matte finish on this rubber sheet. The second ply of rubber is the coating dam.

Step 4 Fill mold with coating

Pour in coating and level off with scraper if desired (Fig. 4). Retain some coating to be used later as the adhesive. If room temperature curing is used then the retained coating must be refrigerated to retard its curing. An alternative method is to skip specimen preparation and glue the transfer sheet coating to the component with silvered epoxy.

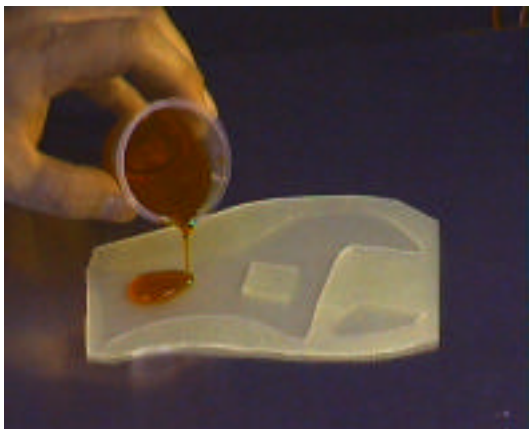


Fig. 4 Pour epoxy and level

Allow coating to cure to taffy like state (Fig. 5) and remove dams (Fig.6). At room temperature the curing process can take several hours. Applying a small amount of heat can accelerate the curing process. The coating can be brought to a taffy like state in under an hour if held at 100°F. Since, the coating is pretrimmed and does not need to be directly handled it can be used at a much softer state than traditional contouring.[5]



Fig. 5 Allow coating to partially cure



Fig. 6 Peel off dams

Step 5 Apply coating

Warm remaining epoxy and paint on part. Then apply prefab coating sheet to part starting at locations of critical tolerance and slowly rolling coating down making sure to work out any air pockets. Heat the coating and transfer sheet with a hair dryer to make them more pliable and easier to apply. In the event of air pocket you can pin prick a hole in the coating with a syringe, although it is best to avoid getting into this situation.

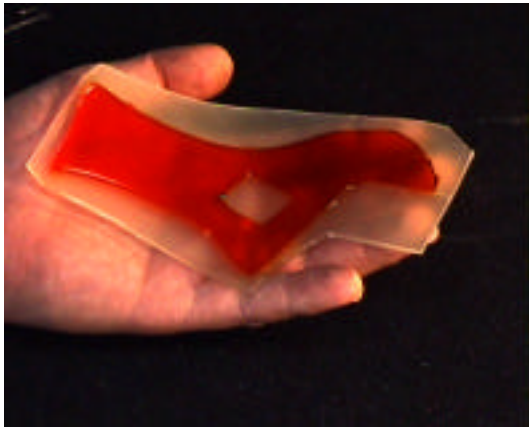


Fig. 7 Feel comfortable handling coating on sheet



Fig. 9 Peel off transfer sheet



Fig. 8 Glue coating in place

Wait until the epoxy has fully cured and then peel off the transfer sheet. This transfer sheet or a fresh sheet can be formed over the coating to act as a protective shell. A single ding can ruin an entire coating.

3.0 Conclusion

TACTS is well founded in traditional methods but can be executed with significantly less skill and in a shorter period of time. The methods are easy to learn, inexpensive to maintain and require minimal facilities. Variations of this method include direct molding of coatings to flat specimens using Plexiglas molding plates. In this way very thin consistent coatings can be applied. The TACTS method allows researchers to apply any thickness of new or traditional polymers without immediate regard to application technology.

4.0 Acknowledgements.

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5.0 References

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