Investigating the Impact of Solvent Wiping and Sanding Procedures on Surface Energy

Introduction

Solvent wiping and sanding procedures can greatly affect the surface energy of a substrate. To investigate the surface energy differences of an epoxy composite laminate, tool side surface, following different preparation procedures, various laminate surface conditions were evaluated using water contact angle measurements, obtained with a BTG Surface Analyst™.

The Surface Analyst™ measures the contact angle of water that is applied to the surface in a precise, controlled manner. This contact angle is determined by the surface energy of the substrate and the liquid and how strongly they interact with each other. The relationship between this contact angle and surface energy is complex but fairly well understood, but more importantly it correlates very well with the strength of adhesion of a paint or adhesive to the substrate.

Experimental

Effect of Solvent Wiping

To examine the surface energy differences due to solvent wiping techniques, the epoxy composite laminate substrates were contaminated with MIL-PRF-32014 grease and subjected to either a “proper” or “improper” acetone wipe. A “proper” wipe consists of a unidirectional wipe with a solvent-soaked lint-free wiper, followed immediately by a dry wipe with a lint-free wiper. An “improper” wipe consists of a non-unidirectional wipe pattern and lacks the final dry wipe.

Effect of Sanding Procedure

To investigate the surface energy differences due to sanding procedures, the epoxy composite laminate substrates were contaminated with MIL-PRF-32014 grease, subjected to a “proper” acetone wipe at different steps in the procedure and sanded using 150 grit sandpaper. One

substrate was contaminated with MIL-PRF-32014 grease, sanded, properly wiped, then evaluated. A second substrate was contaminated, properly wiped, sanded, properly wiped a second time, then evaluated. Finally, an uncontaminated substrate was properly wiped, sanded, then properly wiped prior to evaluation.

Results and Discussion

Figure 1 shows the contact angles of substrates both before and after contamination and multiple wiping procedures.

The as-received laminate had a contact angle of around 50°. Contamination with a small amount of grease increased the contact angle to 70°. An "improper" wipe of the surface lowered the contact angle, but the standard deviation was quite large, indicating the "improper" wipe does not remove contamination uniformly from the surface. The "proper" wipe procedure lowered the contact angle below that of the as-received surface, and the standard deviation indicates the surface is quite uniform. The Surface Analyst was successfully able to distinguish the as-received surface from the contaminated surface from the wiped surfaces.

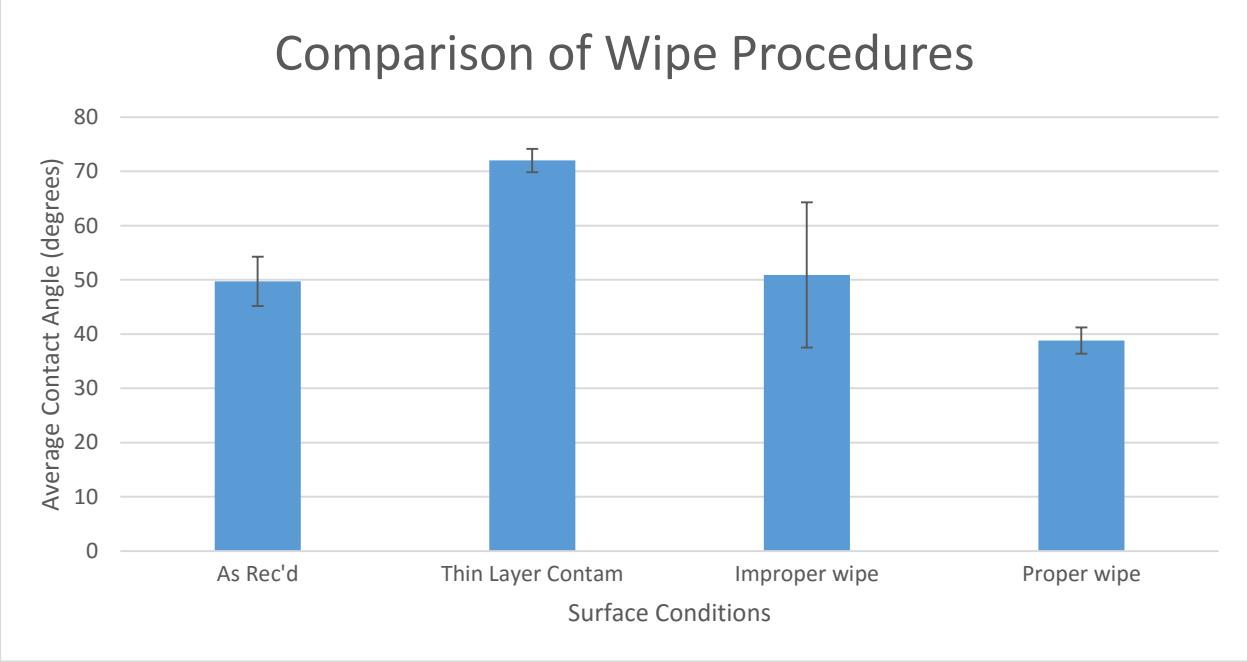

Figure 1. Average WCA for epoxy composite laminate substrates with varying surface energies. Water contact angles reported are an average of ten measurements on composite surface. Error bars shown are ± one standard deviation.

Figure 2 shows the water contact angle averages for the surfaces subject to different sanding procedures. While sanding does reduce the contact angle of the contaminated surface, the contact angle reduction can be influenced by the cleanliness of the surface beforehand. A "proper" wipe prior to sanding will prevent incorporation of contaminants into the sanded

surface. It is thought that contaminants that are present when sanding occurs can be incorporated into surface asperities, and can bloom to the surface after sanding. The contaminated surface that received a proper wipe prior to sanding yielded a surface that is not statistically significantly different than a surface not purposefully contaminated prior to wiping/sanding.

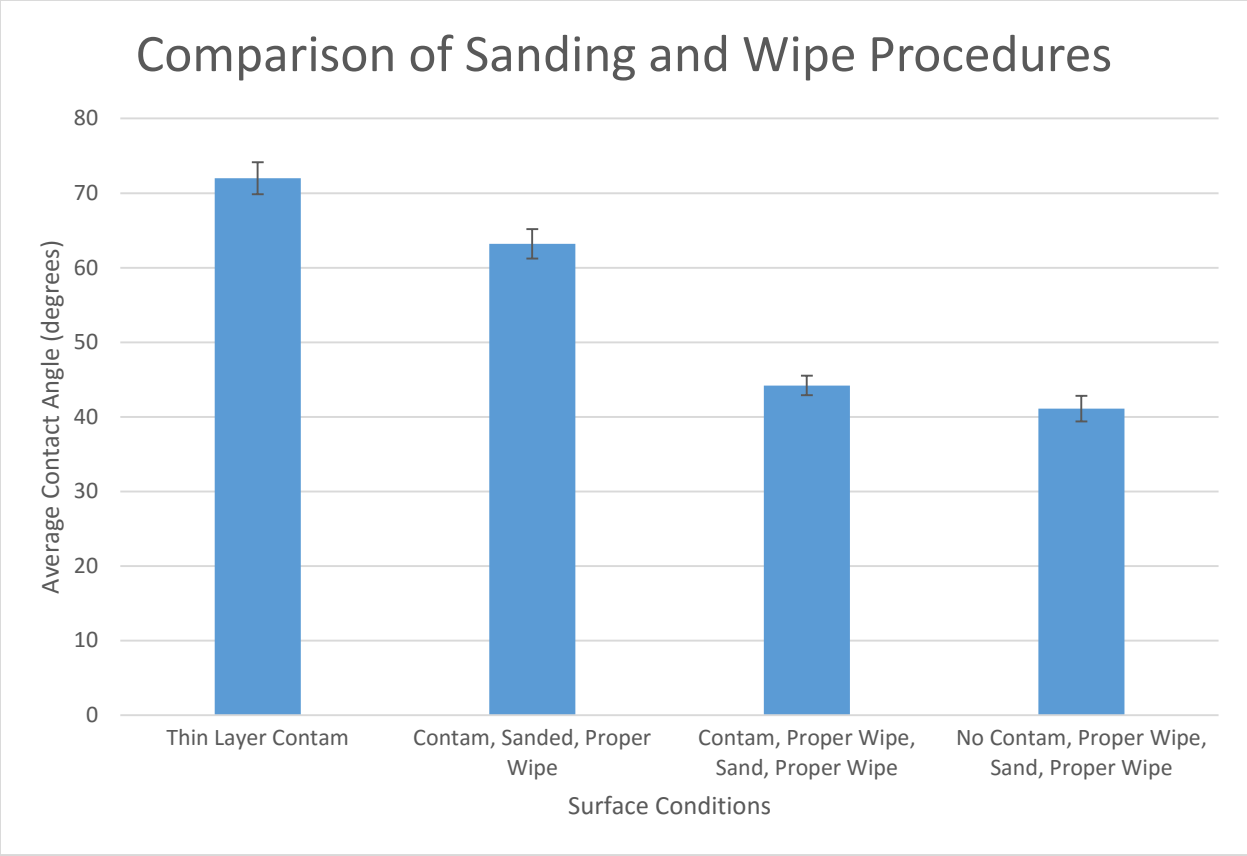

Figure 2. Average WCA for epoxy composite laminate substrates with varying surface energies. Water contact angles reported are an average of ten measurements on composite surface. Error bars shown are ± one standard deviation.

Conclusions

Variations in wiping and wiping/sanding procedures produce surfaces with variations in surface energy, exhibited by the variations in water contact angle as measured by the Surface Analyst. The Surface Analyst is capable of detecting significant differences between different surface conditions on the smooth, tool side surface of an epoxy composite laminate.