Effect of Bondline Thickness on Mechanical Performance of Adhesive Bonds

Background

- Adhesives are becoming increasingly common in aerospace
- Traditional fastening methods increase weight, sometimes unsuitable for certain cases
- Limited understanding of bondline thickness affecting mechanical properties of the bonded joint
- Variety of factors directly affect bonding system
  - Substrate, adhesive, surface preparation, bonding thickness
- What is the optimal adhesive thickness to maximize mechanical properties?

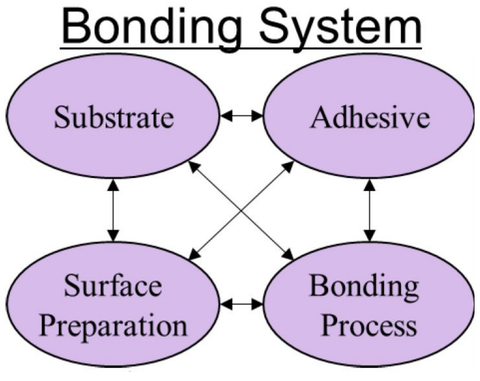

Fig. 1: Bonding is a system with 4 main components

Methods

- 7075-O-Bare Aluminum for substrate
- AF 163-2K adhesive
- Isopropyl alcohol cleaning solution
- Orbital sander with aerospace grade non-stearated sandpaper
- Utilized variations of wedge crack test (ASTM D3762) and lap-shear (ASTM D1002)
- Analyze coupons for modes and data analysis from instron data

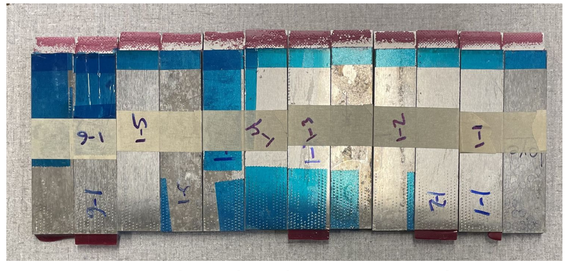

Fig. 2: 1-layer lap shear test samples

Fig. 3: 1-layer wedge crack test sample 1

Results/Findings

- Shear strength decreased with increasing bondline thickness
- Little to no significant performance variation between 1-layer and 3-layer coupons on lap shear
- 5-layer had the worst performance on lap shear
- Some bending on the lap shear testing area
- Significant bending of coupons on wedge crack
- Lots of adhesion failure modes

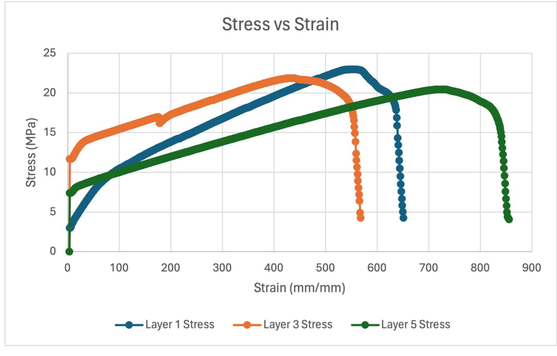

Figure 4: Lap shear tensile strength graph

Layer	Average Shear Strength (psi)
1	3302.765366
3	3193.032623
5	2814.675513

Fig. 5. Data table for lap shear results

Discussion and Conclusions

- Bonding is a complex system and all components have significant effects
- It is challenging to truly isolate any one component of a bonding system
- Shims are vital for controlling bondline of film adhesives
- Use of primer would have greatly assisted adhesion on surface
- Bare 7075-O aluminum was too malleable to work with
  - Need heat treated aluminum in future
- More work must be done to draw conclusions about effect of bondline thickness on mechanical performance

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