

Improving Adhesive Bonding of Composites Through Surface Characterization

Brian D. Flinn, Molly Phariss, Bjorn Ballien
Department of Materials Science and
Engineering
University of Washington

FAA Center of Excellence for
Advanced Materials in Transport Aircraft Structures
(AMTAS)

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Objective

Further understand the effect of surface preparation on the durability of composite bonds through surface analysis coupled with mechanical testing and fractography

Bonding Background

- Success hinges on strong primary chemical bonding and mechanical factors (lesser)
 - Surface area
 - Mechanical interlocking
- Surface preparation is most important factor
 - Contamination from processing/environment
 - Create chemical active surfaces
- Concerns with any bond
 - Post manufacture nondestructive testing is insufficient
 - Can't show poor bonds unless actual gaps in joint
 - Can't identify bonds prone to environmental degradation
 - Not entirely quantifiable from accelerated aging tests
 - Moisture attack is primary cause of service failure

Surface Analysis Techniques

- Scanning Electron Microscopy (SEM)
 - Determine if surface has been properly abraded
 - Overabrasion shows with exposed or broken fibers
 - Post-fracture images show
 - Whether specific features acted as crack initiation sites
 - Porosity or voids
 - Distinguish between interfacial and thin-layer cohesive failure
 - Small patches of interfacial failure in primarily cohesive failure (or vice versa)
- Profilometry and AFM
 - 2D or 3D topographic data
 - Quantification of preparation treatment
 - determination of optimal grit blaster settings
 - effects of peel ply removal or plasma

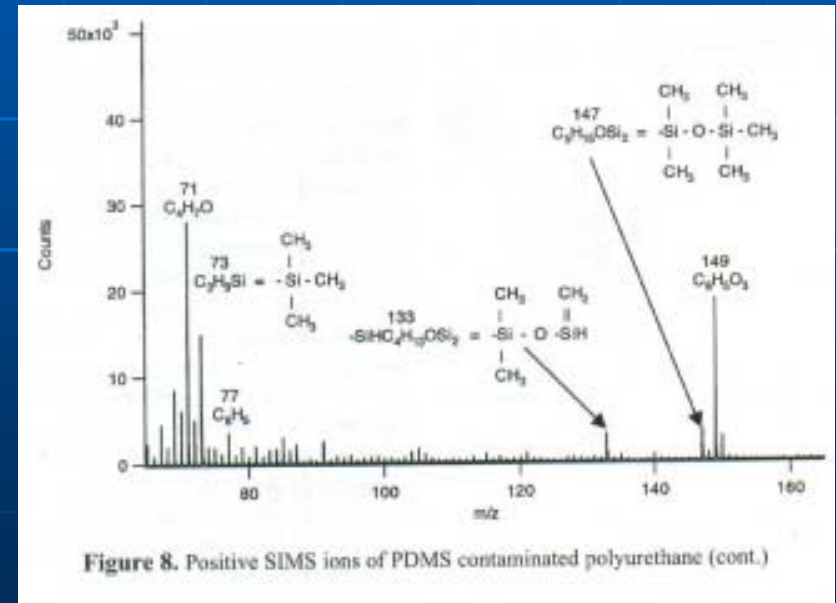
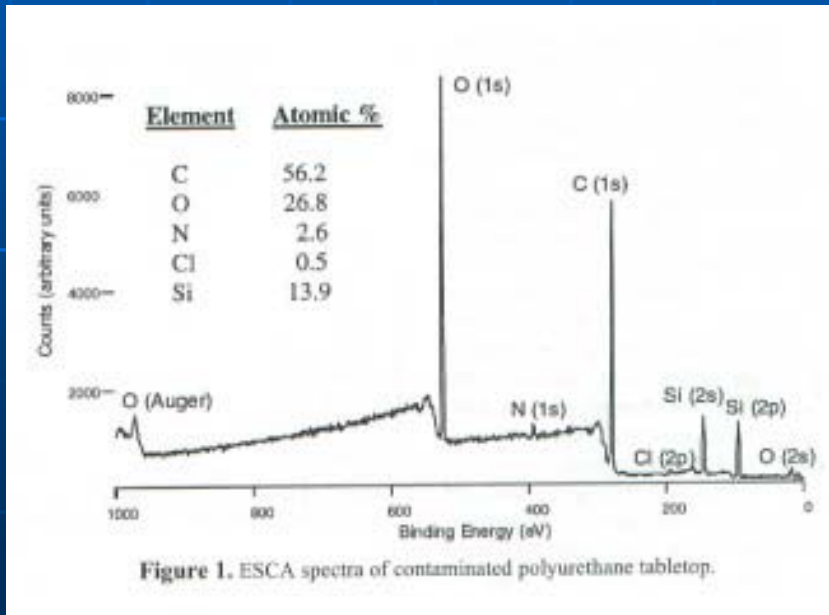
Surface Analysis Techniques

XPS shows elemental chemical composition of surface

SIMS adds molecular information

SIMS imaging can show if treatments are uniform

Patterns in contamination



Current Surface Preparation Procedures

- Manufacturing
 - Peel ply removal in clean bond room
- Repair
 - hand grinding, cleaning and sanding
 - exposed and damaged fibers
 - increased chance of contamination
 - surface different than peel ply prep

Scope of Project

Comparison between surface pretreatments on BMS8-276 form 1 and/or form 3 laminates

- Peel Ply
 - Material
 - Texture
 - Moisture
- Abrasion
 - Hand sanding or grit blasting
 - Repair
- Plasma
 - Repair

Mechanical Test Methods

- Mode I (DCB and/or traveling wedge test)
- Mode II, mixed Mode
- Environmental Effects
 - static wedge and lap shear not optimal for composites
 - Work with WaSU (Lloyd Smith)

Effect of Peel Ply Material on Bond Quality

- 3 common peel plies
 - 60001, Nylon and SRB
 - Compare surfaces after peel ply removal
 - Compare bond performance
- Contribution
 - Add to existing knowledge base

Effect of Peel Ply Moisture Content on Bond Quality

- Currently no specifications on moisture content of peel ply (BMS8-308)
- Could a “wet” peel ply effect bonding?
- Prepare samples using 60001 with various conditioning (moisture exposures)
- Characterize peel ply and composite surfaces
- Measure bond performance

Effect of Peel Ply Texture on Bond Quality

- Is there an optimum texture of surface to promote bonding?
- Assuming chemical similar surfaces, this would investigate mechanical interlocking aspect of bond
- Obtain peel ply with various weaves (warp, fill, denier, etc)
- Produce coupons for testing (60001 available in 3 forms)
- Characterize surfaces and peel plies (mostly topography)
- Measure bond performance (mode I and II)
 - Mechanical interlocking may have stronger influence on Mode II.

Effect of Plasma Treatment on Bond Quality

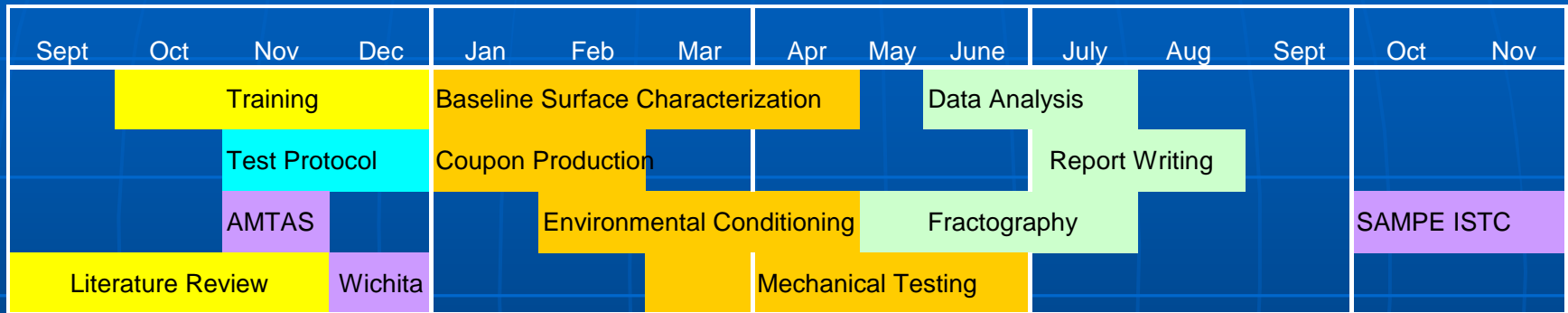
- Is plasma clean beneficial for repair?
 - Characterize repair surfaces with different pretreatments
 - Hand sand /grit blast
 - Plasma treated
 - Measure bond performance

Bonding of BMS8-276

Form 1 vs. Form 3

- Different mechanical behavior has been noted between form 1 and form 3 adhesive bond tests.
- Analyze form 1 & 3 after different surface prep.
 - Peel ply, grit, sand, plasma
 - ESCA, SIMS, SEM, Topography
- Measure bond behavior (mode I and II)

Project Time Line



Final project deliverables will be determined from breakout sessions at AMTAS and Wichita State project meetings

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