European Joining Platform Meeting

June 17th 2015 ,TWI Cambridge

Industrial Priorities On Challenges In Joining

Perspectives From A Car Body Fastener Manufacturer

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Confidential

CHALLENGES

THREE CHALLENGES WHERE FURTHER SPR JOINING TECHNOLOGY DEVELOPMENT IS REQUIRED…

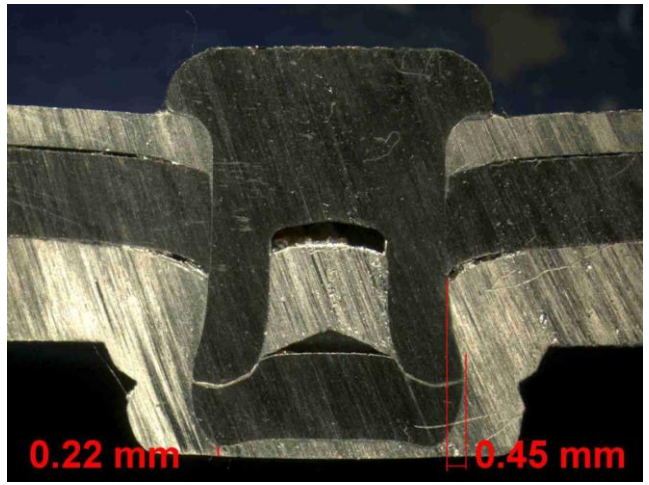
- **Three Mixed Materials Joining Challenges**
  - **1. Ultra High Strength Steel to Aluminium Joining**
  - **2. Develop Fasteners for CFRP to Aluminium and Steel**
  - **3. Fastener coatings not requiring over painting with ecoat**

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Challenge 1: Ultra High Strength Steel To Aluminium Joining

- Large Demand for joining hot stamped steel (1500 to 2000 MPa) to aluminum and steel.
- This is pushing the boundaries of what can be achieved with a rivet made of 1800MPa steel.

- Example of 3T joining a boron steel with a UTS of 1550 MPa using PG-rivet patented technology.



Top sheet: 0.9mm AA6111

Middle sheet: 2.1mm 1550MPa Boron steel

Bottom sheet: 2.5mm NG5754

- Currently to achieve this successful joint with 1500MPa steel requires the following..
  - A more ductile steel or aluminium material must be in the lower sheet location and the boron steel cannot be excessively thick.
  - A deep die is required to accommodate the slug of steel because the pierced disc of high strength steel does not deform to flow up inside the rivet bore.

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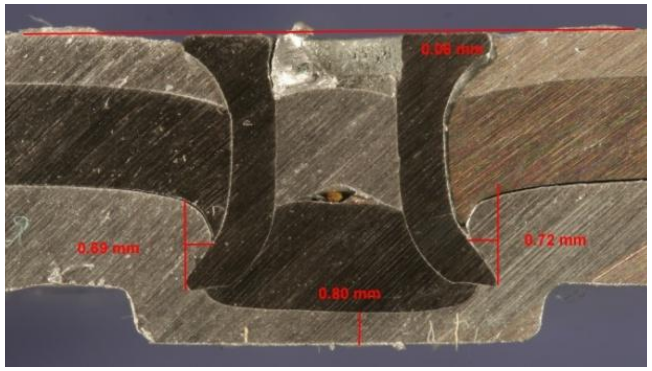
Challenge 1: Ultra High Strength Steel To Aluminium Joining

- A semi-tubular rivet needs to be hard enough to pierce the steel, large enough to provide the column strength required, and ductile enough to flare the skirt to form a mechanical interlock.

- **Challenge: Find or develop a more advanced fastener material .**
  - A material very hard but also ductile enough to be flared or swaged without cracking.
  - Opportunity for collaborative project with a material supplier to develop a new technology ?

  - Example showing high strength steel not flowing up bore of rivet

3T Aluminium to Steel to Aluminium Joint
Steel middle sheet has not flowed up the rivet bore

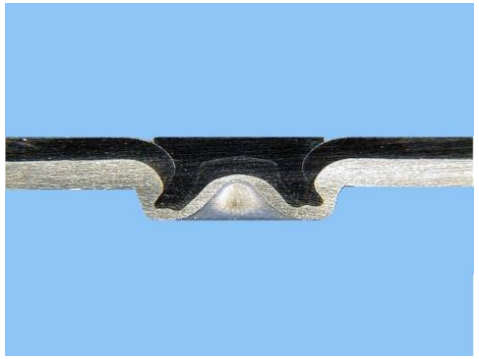


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CHALLENGE 2: DEVELOP FASTENERS FOR CFRP TO ALUMINIUM AND STEEL

- Examples, showing current capability of SPR for mixed material joining

Steel
Aluminium

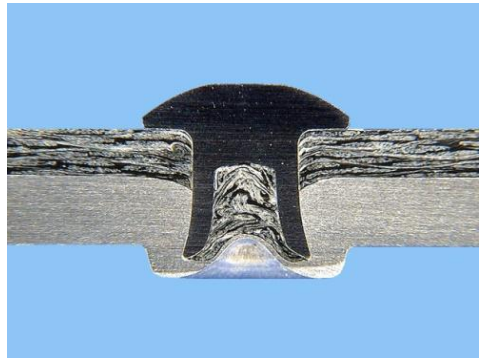




Aluminium
Steel

Steel
Aluminium
Steel





Composite (GFRP)
Aluminium

- Most car body rivet applications require countersunk heads to produce flush top sheet surfaces to enable further parts to be added to the assembly.
- For applications it is unusual for customers to accept a proud flat head or pan head fastener.

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Challenge 2: Develop Fasteners for CFRP to Aluminium and Steel

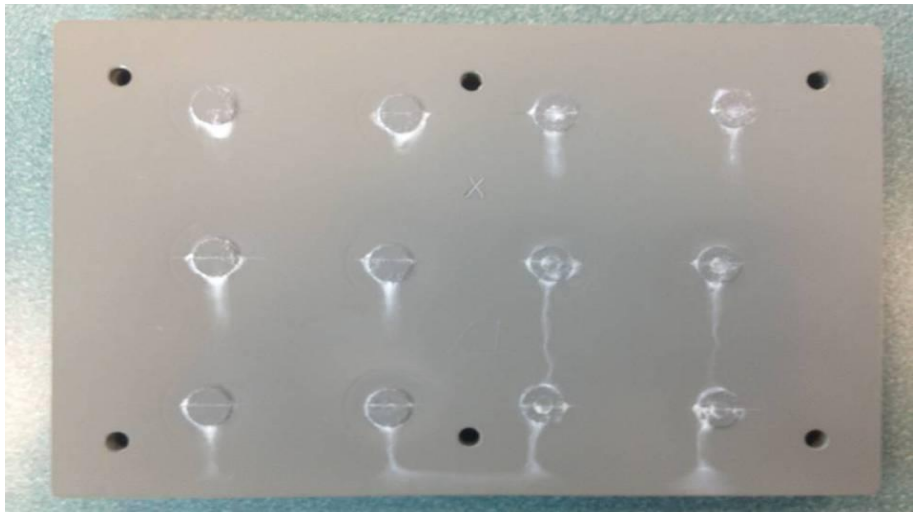
- A number of automotive customers are asking for fasteners to join CFRP to aluminium.
- Typically they want to join long fibre materials (woven fabrics) made with TP or TS resins
- **Challenge:**
  - Installing fixings without fibre damage in long fibre composites
  - Solving delta-alpha thermal distortion on assemblies during ecoat or adhesive oven bake
  - Preventing galvanic corrosion, & repair/recycling. (Carbon fibres are excellent cathodes)



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CHALLENGE 3 - FASTENERS NOT ECOAT PAINTED AFTER INSERTION

- Currently Fasteners in car bodies are typically ecoated after the car has been assembled; the ecoat provides excellent corrosion protection to the whole assembly.
- The zinc/tin plating on the fasteners provides pre-insertion corrosion protection and also additional sacrificial corrosion protection in the event of the paint coating being damaged in service.
- The typical corrosion test is 1000 hr NSS with a single scribe line pre cut through paint to evaluate corrosion creepage in the event of damage to the protective ecoat layer.
- The typical target is less than 1mm of corrosion creepage from a scribe cut accross the fastener and no red corrosion.



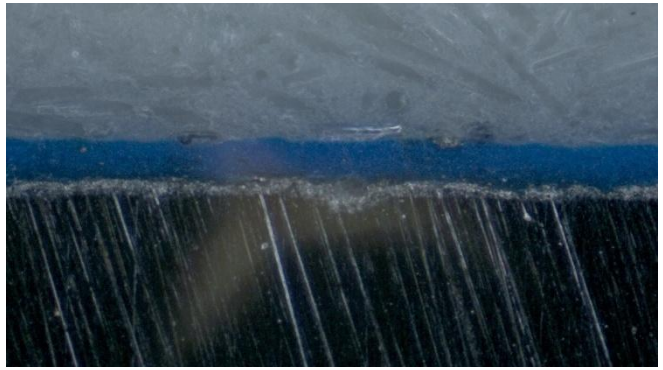
Ecoated panel with deep scribe cut across rivet heads.
Image from after a 1000hr NSS corrosion test.
Result = Pass no red rust

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CHALLENGE 3 - FASTENERS NOT ECOAT PAINTED AFTER INSERTION

- **Predicted Future Demand :**
- Using a broad mix of materials such as magnesium and composites will encourage the assembly of pre-finished parts rather than the current approach of ecoating the whole body after assembly.
- **Challenge:**
- To develop new fastener coatings which are:
  - Damage tolerant of feeding and installation processes.
  - Capable of 1000 hrs plus NSS durability without over painting after insertion.
  - Able to seal exposed edges on the pre-finished parts created by the fastener insertion.







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- Manufacturing variables which could affect joining results include component production tolerances, component clamping and fit up tolerances, rivet production tolerances, riveting equipment tolerances, substrate material properties, substrate ductility, and substrate heat treatment or ageing hardening condition. Conducting tests using substrate materials at both extremes of their potential range of ductility and hardening condition is strongly recommended to establish process window and process robustness data.
- Henrob recommends that joints containing adhesive are tested with adhesive in the joints to ensure the effect of adding adhesive to the joint has been considered. Henrob recommends joint strength, durability, and corrosion testing is carried out on every material combination.
- Henrob recommend conducting a broad range of tests on joints, including the testing of joints made using the actual production components. Testing should include shear strength, peel strength, mixed-mode loading, constant amplitude fatigue, variable amplitude fatigue using representative road load data, durability under real life service conditions, change in dynamic stiffness, impact and energy absorption, corrosion in hot-wet and saline environments, corrosion on a real vehicle in a range of hostile environments, creep, and thermal effects.
- Tests should be conducted using a number of replicate parts to determine if a surface pre-treatment, joining technology, or coating system offers the consistency of performance required for a particular application. In lab trials restrictions such as the amount of sheet material available can mean that it is not always possible to conduct a full range of tests. The range and number of tests conducted should be taken into consideration when using data for design purposes.

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