Mechanical behaviour of adhesively bonded ASTERM ablative TPS after Plasma-jet testing

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RASTAS SPEAR

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*"**Ra**diation-**S**hapes-**T**hermal Protection Investigation**s** for High **Sp**eed **E**arth **R**e-entry"*

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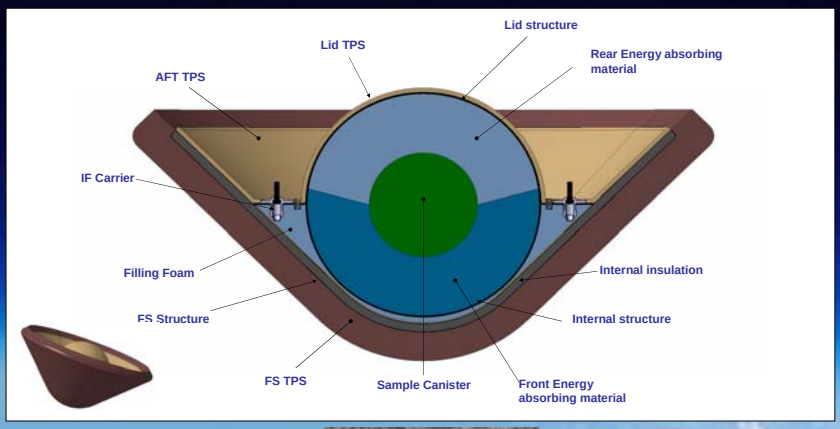
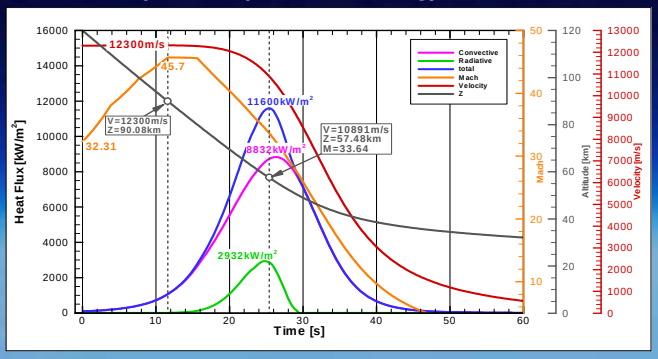
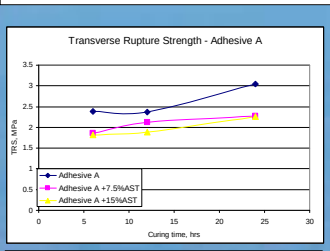
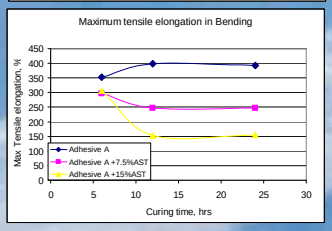
CONCEPT OF A SAMPLE-RETURN VEHICLE FOR BALLISTIC EARTH RE-ENTRY



Main characteristics of a ballistic Earth re-entry. *Effective max. total heat flux is about 11.6MW/m², max. velocity 12.3km/sec (47.5Mach), total heat energy about 250MJ/m².*

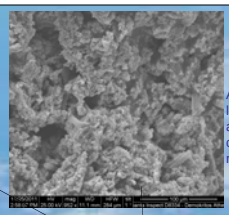




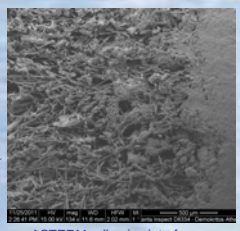


Bending tests of some adhesive joints tested. Transverse rupture strength decreases by adding ASTERM powder but increases with curing time. No decohesion was noted at the interfaces so the results reflect the actual maximum extension during bending of the adhesives tested and range from about 150% in the case of adhesive A + ASTERM after 24 hrs to 450% in the case of one of the adhesives as supplied.

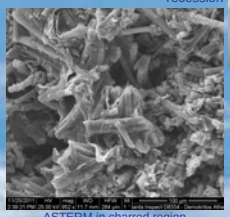
The ASTERM-loaded adhesive remained well bonded after testing with minimal additional recession



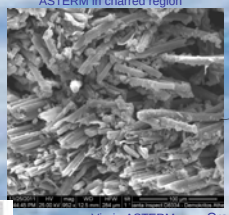
ASTERM-loaded adhesive in charred region



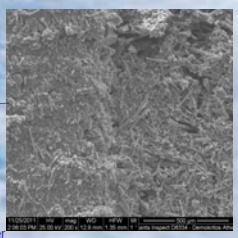
ASTERM-adhesive interface in charred region



ASTERM in charred region

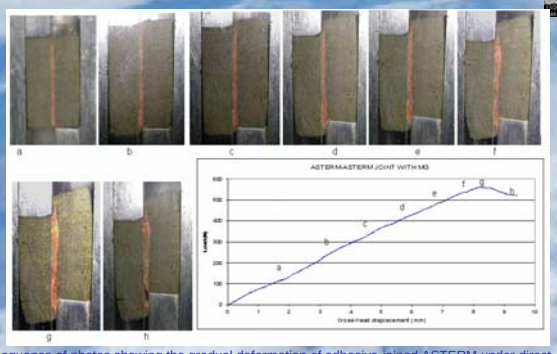


Virgin ASTERM

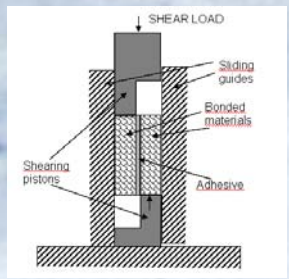


Virgin ASTERM-adhesive interface

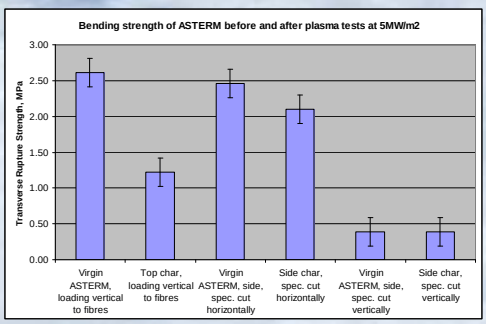
Cross section of an adhesively joined ASTERM (supplied by EADS/ASTRIUM) specimen after Plasma jet testing at 5MW/m² for 12 seconds at the Sirocco facility at CIRA. Total recession at top is about 2mm, it is fairly uniform and <0.5mm on the sides. Charred region varies from 6 to 12mm. Recession of the adhesive is slightly larger (photo on top left). The adhesive used was an RTV Silicone elastomeric rubber mixed with small amount of ASTERM powder



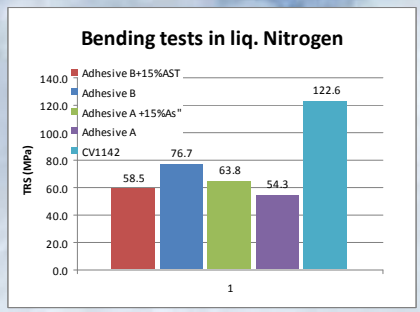
Sequence of photos showing the gradual deformation of adhesive-joined ASTERM under direct shear loading and its correspondence on the load-displacement curve. Original joint thickness was 1mm. The very good adhesion and very large extension at final failure is clearly visible.



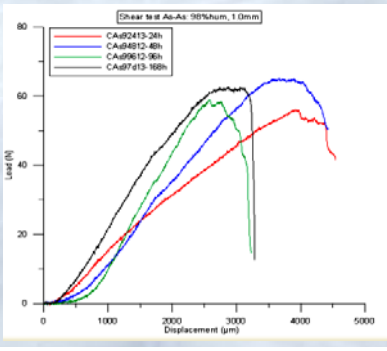
Schematic of the directly shear test and typical load-displacement curves (below)



Bending strength of charred ASTERM from the top and the side surface (specimens cut both horizontally and vertically) in comparison with the strength values measured on similar size specimens on virgin ASTERM



Bending strength at liquid Nitrogen temp (-196oC) of various adhesives



Interim Conclusions:

- Commercially available RTV silicone elastomeric rubber adhesives perform satisfactorily for joining and bonding ASTERM ablative TPS
- Room temperature and cryogenic mechanical behaviour are sufficient for use for joining and bonding ASTERM tyiles to various substrates including aluminium, CFRP etc
- Post Plasma-jet analyses show that recession of ASTERM and of ASTERM-containing adhesives is minimal and the remanent strength of the ASTERM (and the joints) is satisfactory

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