Shear Strength Tests on Dissimilar Materials

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Materials Science & Technology

The ADMACOM Project

ADvanced MAnufacturing routes for metal/composite COMponents for aerospace.

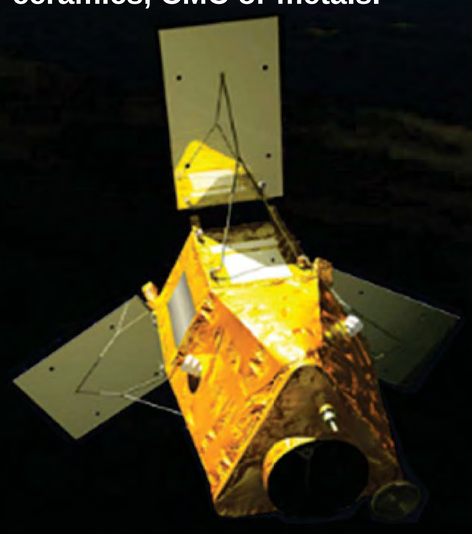
The concept behind ADMACOM is that novel, reliable and efficient joining of dissimilar materials is a powerful manufacturing tool for enabling a speedy drive towards innovation and efficiency of several key EU industrial products, such as new composite materials for aerospace, one of the main EU leading commercial sectors

A wide number of ceramic matrix composites (CMC) and ceramics could be used right now to replace existing aerospace components, thus contributing to the increasing demand for novel components with improved properties such as light weight for reducing fuel consumption and CO_2 emission.

The applications

Nowadays the joining of dissimilar materials to accumulate and enhance the positive characteristics of the individual components in a single part is of a vital importance in industry.

The more important materials to join for the aerospace, energy, ground transportation, defense and tooling industry are ceramics to other ceramics, CMC or metals.



Satellite [1]– joining of:

- SiC to SiC or Ti alloy

Re-entry vehicle[2]– joining of:

- C/SiC to C/SiC or Ti alloy
- SiC/SiC to SiC/SiC or Ti alloy

Shear strength tests

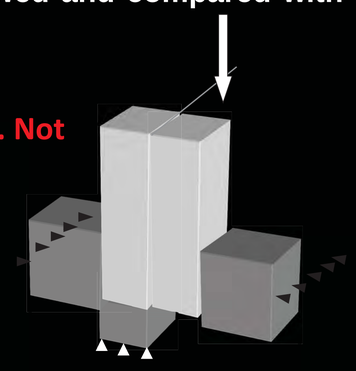
In addition to the difficulty of the joining, the shear mechanical characterization is a pending task. Different shear test standards have been developed to measure the shear strength of joined ceramics. Most of them, such as lap test, measure “apparent shear” resulting from a mixed state of stresses including shear, bending, and tensile stresses. These make the comparison of data from different test methods impossible. Furthermore, there is only one standard to measure the pure shear strength, the asymmetrical four-point bending test. This method presents some drawbacks, the main being the impossibility to perform the test when the shear strength of the joint is over the 50% of the bending strength of the unbounded material.

In this work, the different standards to measure the shear strength are reviewed and compared with the most promising shear test: the torsional shear test.

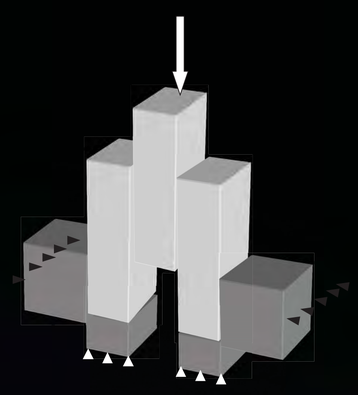
Apparent shear:

Double notched (DN) :
Critical role of notches.

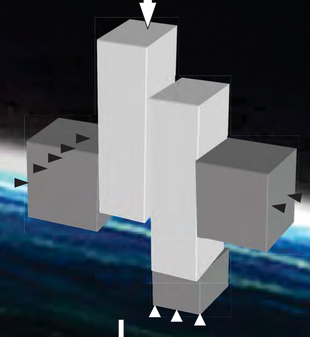
Single lap (SL):
Critical alignment joint/fixtures. Not suitable for strong joints



Double lap off set (DLO):
Underestimates values.



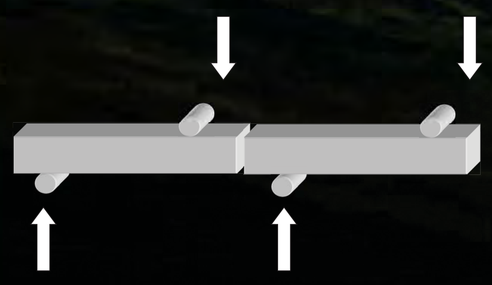
Single lap off set (SLO):
Critical role of lateral fixtures.



B 898:
Huge amount of material is needed.

Brazilian:
The shear value is not straightforward.

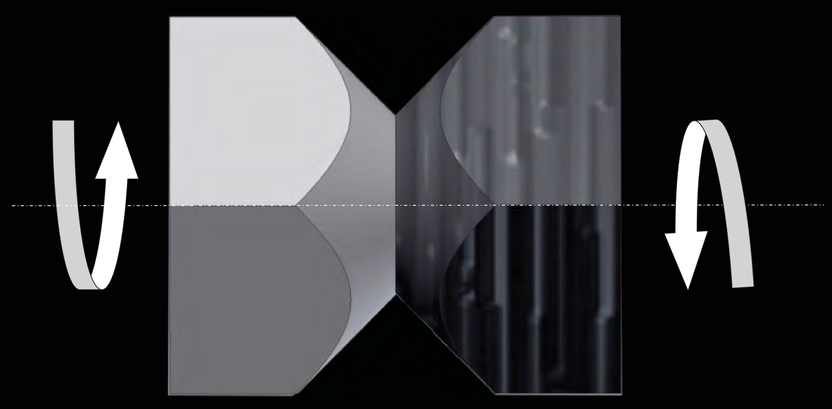
Pure shear:



4-Points Assymetrical bending:
Notches needed when the strength of the joint is high. It is not suitable for strong joints.

Torsional shear test

The pure shear can be measured by a torsional shear test; the test is a modification of the standards ASTM F1362 and ASTM F734-95. This is the test chosen in the ADMACOM project to characterize the shear strength of the samples at room and high temperature. The torsional test allows to measure high strength joints. Ceramics to ceramics, metal to metals and ceramics to metals are being tested and compared with different standards with the aim to standardize this method.



References

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- *Ventrella et al., J Mater Sci (2010) 45:4401–4405*
- *E. Martin et al., Materials Characterization (2010)*
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SEVENTH FRAMEWORK PROGRAMME

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