

Evaluation of a reprocessable vitrimer adhesive for non-structural applications

Sh Jalali (INEGI, Portugal) | R Soares | RJC Carbas | EAS Marques | LFM da Silva

1. Introduction

Vitrimers are innovative polymers that combine the strength of thermosets with the reprocessability of thermoplastics, enabled by dynamic covalent bonds. Their ability to be re-bonded multiple times makes them promising for aerospace repair applications. However, understanding their mechanical and rebonding behavior is key to future use. This poster presents initial experimental results on vitrimer-bonded and re-bonded joints

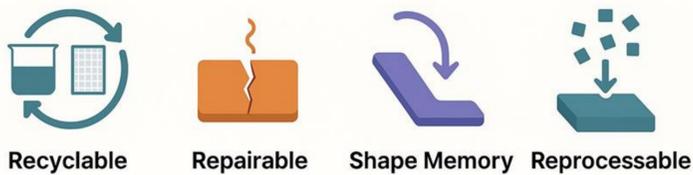


Figure 1. Vitrimer characteristics

2. Experimental details

Strength testing and analysis

Tensile and shear properties were measured using standard tests to evaluate vitrimer performance.

- Tensile test (ASTM D638): dog-bone specimens for strength and modulus
- Shear test (ASTM D5656 – TAST): to assess shear strength and stiffness

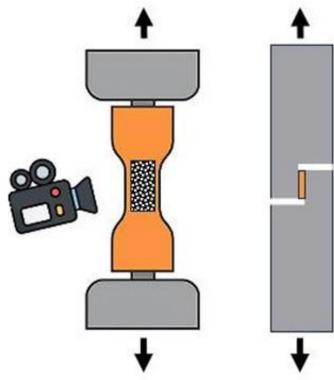


Figure 2. Tensile and shear testing procedure

These tests provide baseline data for understanding adhesive behaviour under load.

Bonding and rebonding in single lap joints

Joints with 0.1 mm and 0.5 mm adhesive thicknesses were tested to study the effect of thickness on bonding and rebonding. Each underwent three rebonding cycles plus a reference test. Joint geometry is shown in Figure 3. To maintain adhesion, adhesive thickness was reduced in each cycle:

- 0.1 mm joints: rebonded with ~0.0 mm
- 0.5 mm joints: rebonded with 0.4, 0.3, and 0.2 mm

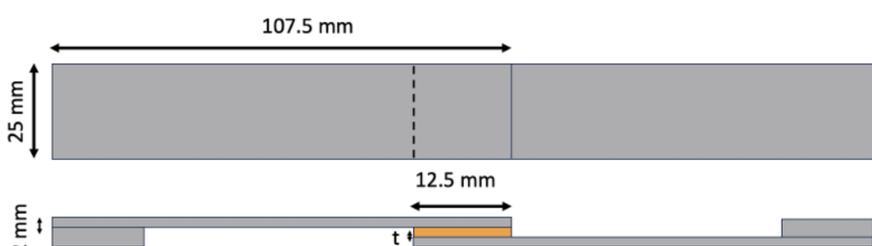


Figure 3. Single lap joint geometry (t is the thickness of adhesive - 0.1/0.5 mm)

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4. Results

Tensile & shear test results

Tensile test (ASTM D638):

Tensile specimens showed elastic – plastic behavior with ductile failure.

- Tensile strength: 48 ± 3 Mpa
- Young's modulus (E): 1218 ± 73 MPa
- Poisson's ratio (ν): 0.35

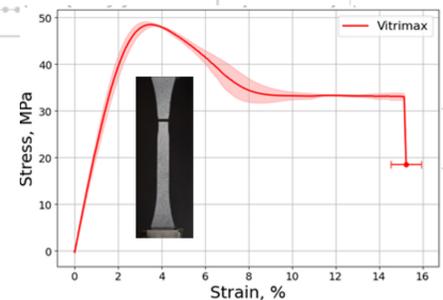


Figure 4. Tensile test results

TAST – Shear test (ASTM D5656):

Shear specimens revealed a rapid elastic response followed by strain softening.

- Shear strength (\mathcal{T}): 27 ± 7 MPa
- Shear modulus (G): 564 ± 32 MPa

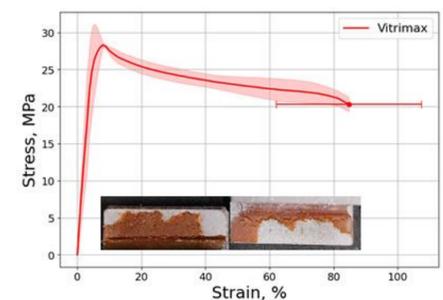


Figure 5. Shear test results

Bonding & rebonding performance

Rebonding performance varied significantly with adhesive thickness.

After three cycles:

- 0.5 mm joints retained 75% of their original strength
- 0.1 mm joints retained only 57%

Load–displacement curves show that thicker joints consistently reached higher peak loads and exhibited slightly better ductility across all cycles. These results highlight the importance of adhesive thickness in maintaining mechanical integrity during repeated bonding. Thicker adhesive layers improve durability and performance in repairable joint applications.

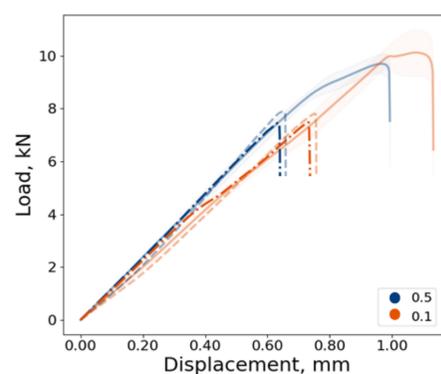


Figure 6. Load displacement behaviour

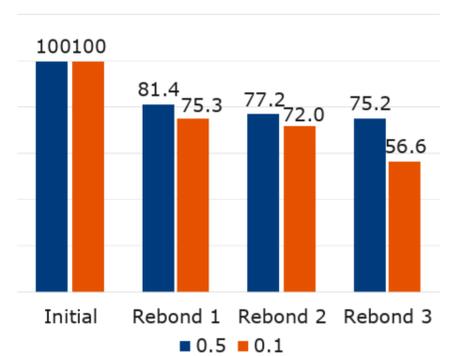


Figure 7. Percentage of strength loss in SLJs

5. Conclusions

- Mechanical tests confirmed solid tensile and shear performance.
- Rebonding tests showed strength retention over multiple cycles. Thicker adhesive layers improved durability and mechanical reliability.
- Results support the use of vitrimers in repairable bonding applications, especially in demanding structural fields.

References

[1] Vaught, Louis O., et al. "Shape Memory and Fatigue Reversal in a Covalent Adaptive Network Polymer below Glass Transition Temperature." *Macromolecules* 58.8 (2025): 3916-3923