



Universidad de  
Castilla-La Mancha



## Grupo de Trabajo CNT 53/GT 8

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**“Ensayo biaxial tracción-compresión en laminados de matriz polimérica reforzados con fibra”**

**Secretaría: Asociación Española de Industriales de Plásticos (ANAIP)**

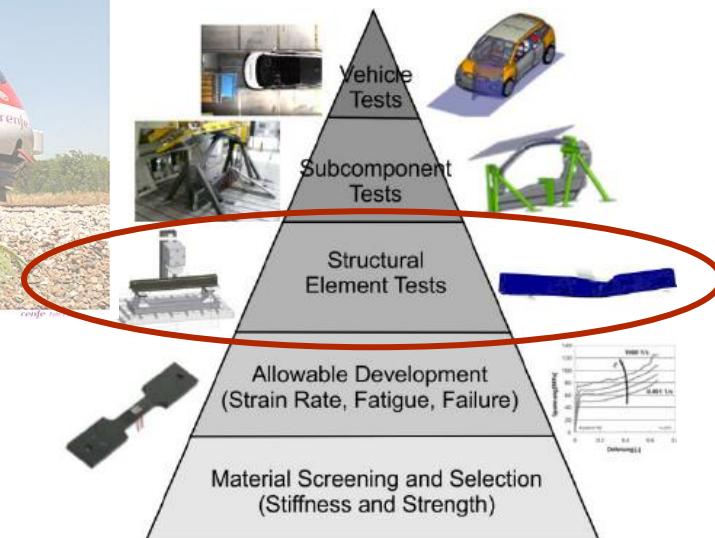
## Continuum Mechanics, Engineering of Structures and Materials (COMES)

<https://blog.uclm.es/grupocomes/>

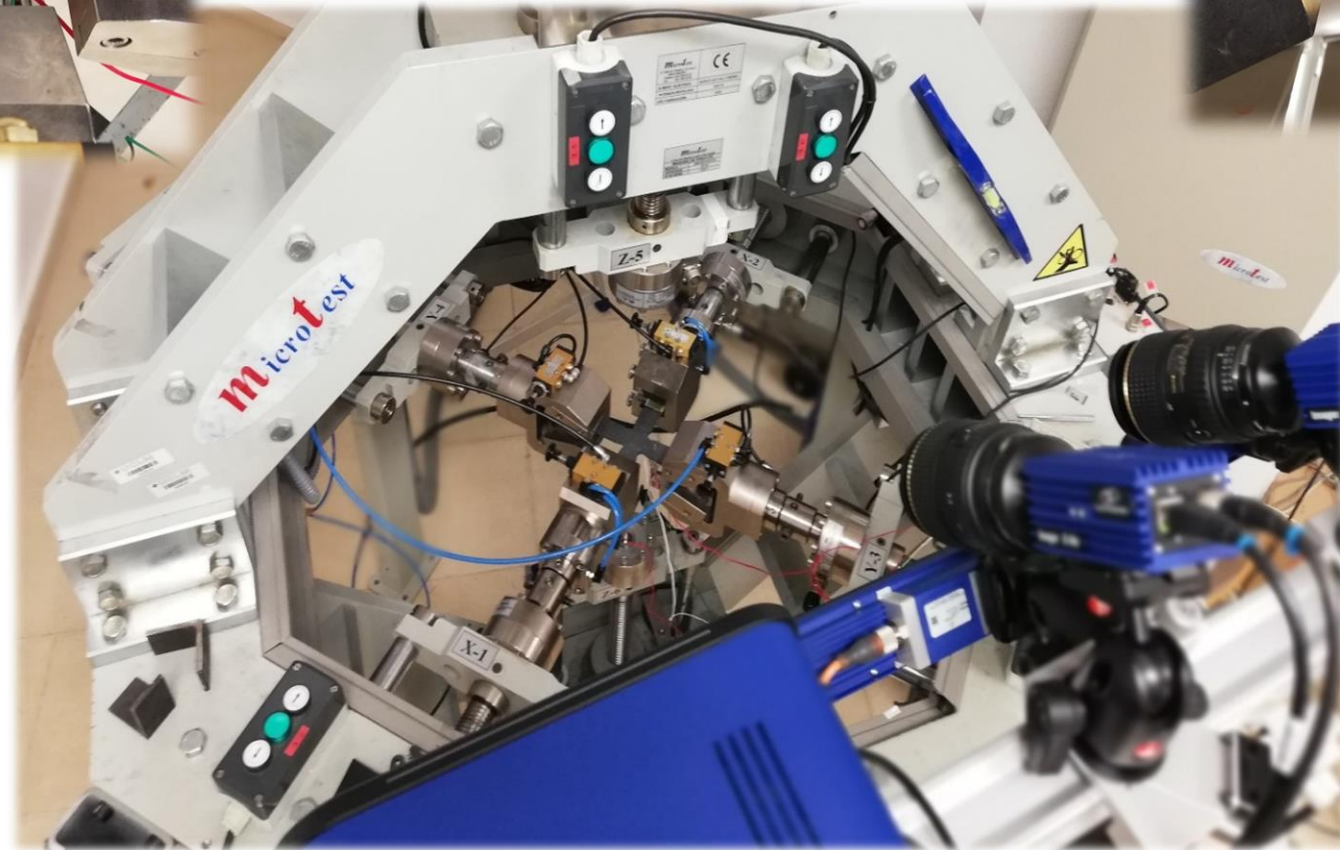
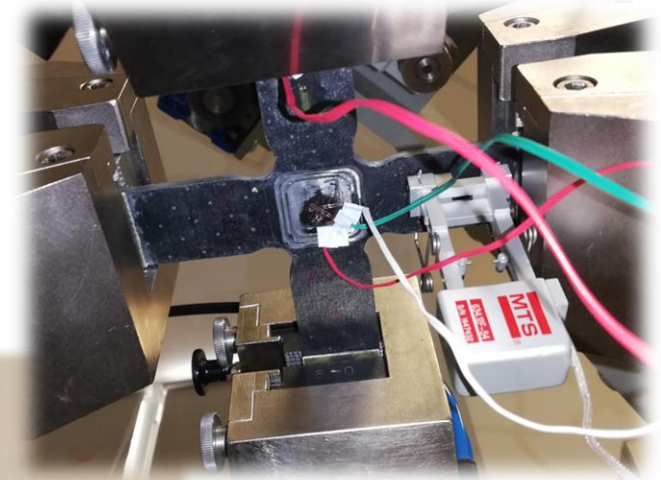
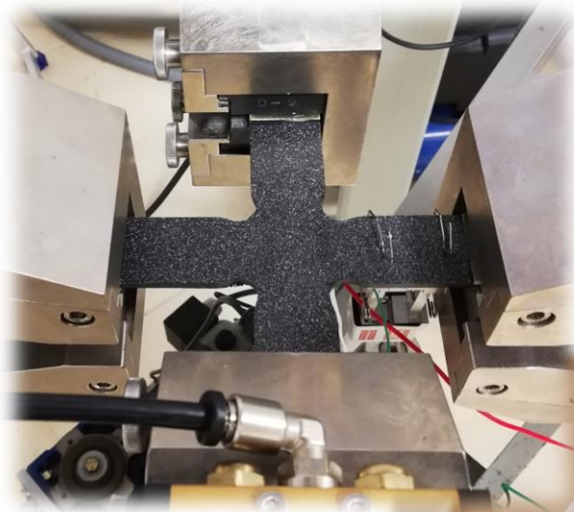


# Multiaxial stress/strain states

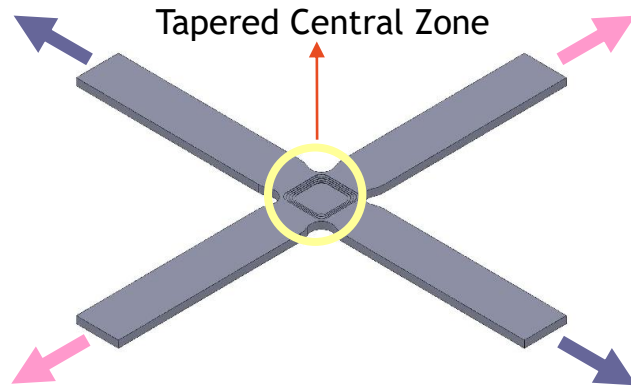
- Structural composite elements develop multiaxial stress states
- Little knowledge of the full multiaxial response (even the biaxial)
- Biaxial testing with cruciform specimens



# Biaxial testing with cruciform specimens



# Biaxial testing with cruciform specimens



Programa Estatal de I+D+i Orientada a los Retos de la Sociedad

DPI2009-08578

DPI2016-77715-R

MC Serna Moreno, JJ López Cela, *Compos Sci Technol*, 72, 91-96, 2011

MC Serna Moreno, JL Martínez Vicente, JJ López Cela, *Compos Struct*, 103, 91-96, 2013

MC Serna Moreno, JL Martínez Vicente, *Compos Struct*, 119, 264-271, 2015

M.C. Serna Moreno, JL Curiel Sosa, J Navarro Zafra, JL Martínez Vicente, JJ López Cela, *Compos Struct*, 122, 440-444, 2015

J. Navarro-Zafra, J.L. Curiel-Sosa, M.C. Serna Moreno, *Compos Struct*, 133, 1093-1100, 2015

J. Navarro-Zafra, J.L. Curiel-Sosa, M.C. Serna Moreno, *Appl Compos Mater*, 23, 139-154, 2016

M.C. Serna Moreno, S Horta Muñoz, *Compos Struct*, 234, 111697, 2020

JL Martínez Vicente, *PhD Thesis*, UCLM, 2016

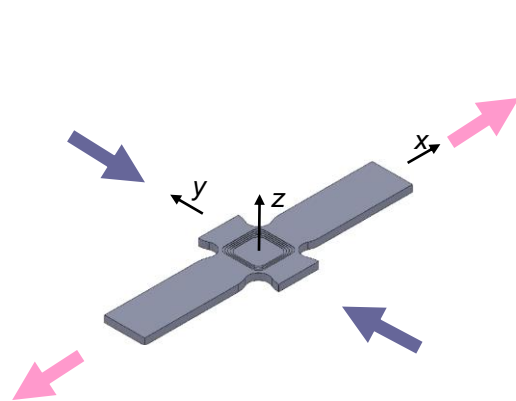
S Horta Muñoz, *PhD Thesis*, UCLM, 2020

# Project BISHEAR - PDC2021-121154-I00

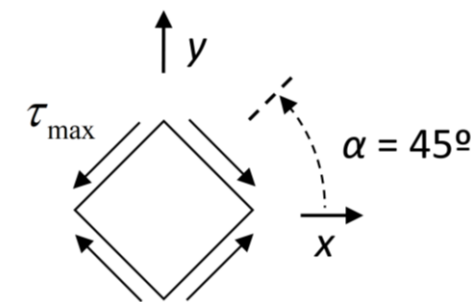
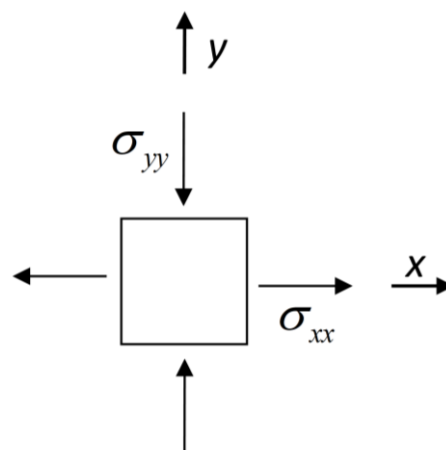
Towards the standardization of the tension-compression biaxial test for determining mechanical properties under in-plane pure shear states



Programa Estatal para Impulsar la Investigación Científico-Técnica y su Transferencia  
Proyectos «Prueba de Concepto» 2021



Tension-Compression test (T-C test)



Pure shear stress/strain state

# Why shear stress/strain states?

Critical for the design of primary light-weight structures



# Why a new shear test for composites?

Comparison of the main capabilities of the existing shear tests

Testing method	Uniform stress	Shear strength	Shear modulus
Short beam shear (ASTM D2344)		X	
Iosipescu shear (ASTM D5379)	X	X	X
±45° tensile shear (ISO 14129)		X	X
Two-rail shear (ASTM D4255)		X	X
Three-rail shear (ASTM D4255)		X	X
Double-notched shear (ASTM D3846)		X	X
Torsion of a thin tube (ASTM D5448)	X	X	X
V-notched rail shear (ASTM D7078)	X	X	X
Shear frame (ISO 20337)	X	X	X
Cross-beam sandwich		X	X
Torsion of a solid rod		X	X
Four-point shear		X	
Picture frame shear		X	X
Plate twist			X
Tensile 10° off-axis		X	X

<https://www.compositesworld.com/articles/a-comparison-of-shear-test-methods>



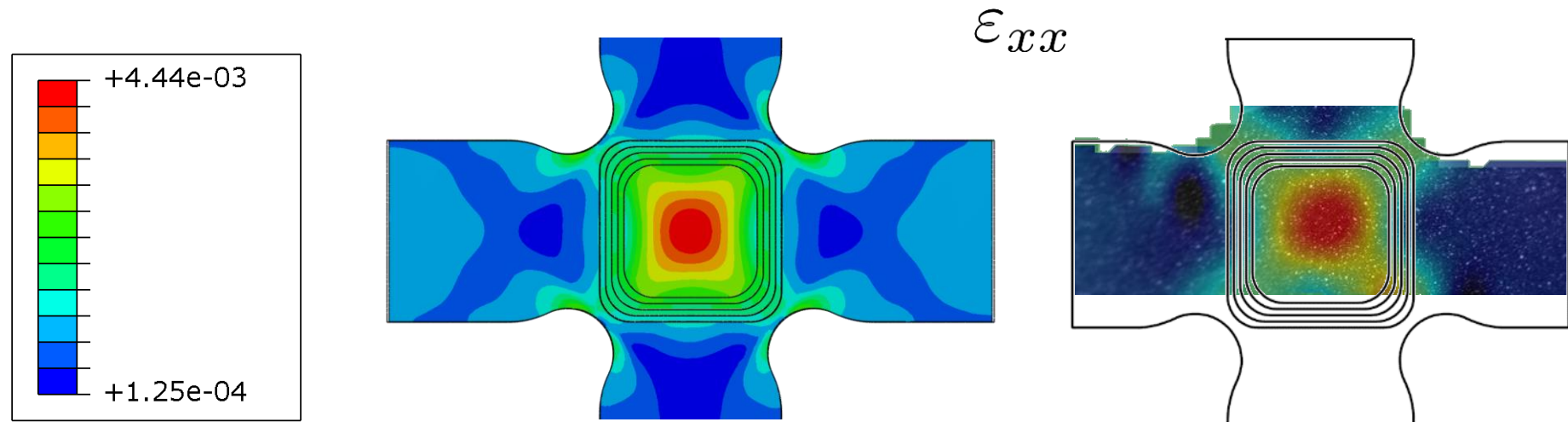
# T-C test

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- Uniform and pure shear stress state in the center of the specimen.
- The full stress-strain response is observed: both linear and non-linear evolution.
- Shear modulus  $G$  and shear strength  $\tau$  can be obtained.
- In a laminate, the three stiffnesses ( $G_{12}$ ,  $G_{13}$  and  $G_{23}$ ) and the three shear strengths ( $\tau_{12}$ ,  $\tau_{13}$  and  $\tau_{23}$ ) in the principal material directions can be obtained.

# T-C test with $[\pm 45]_{nS}$ laminates

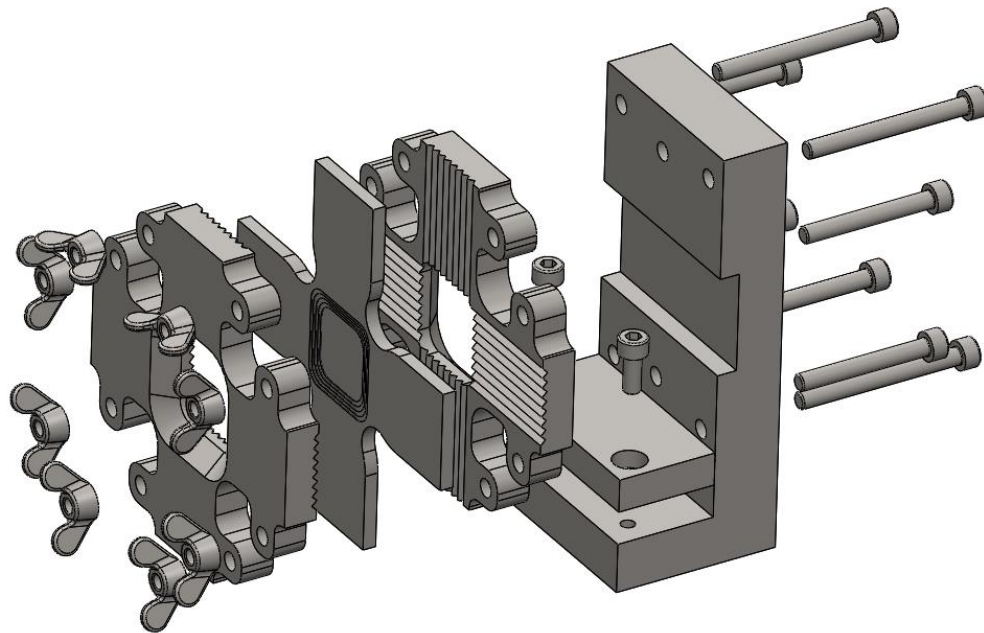
Uniform and pure shear stress state in the center of the specimen



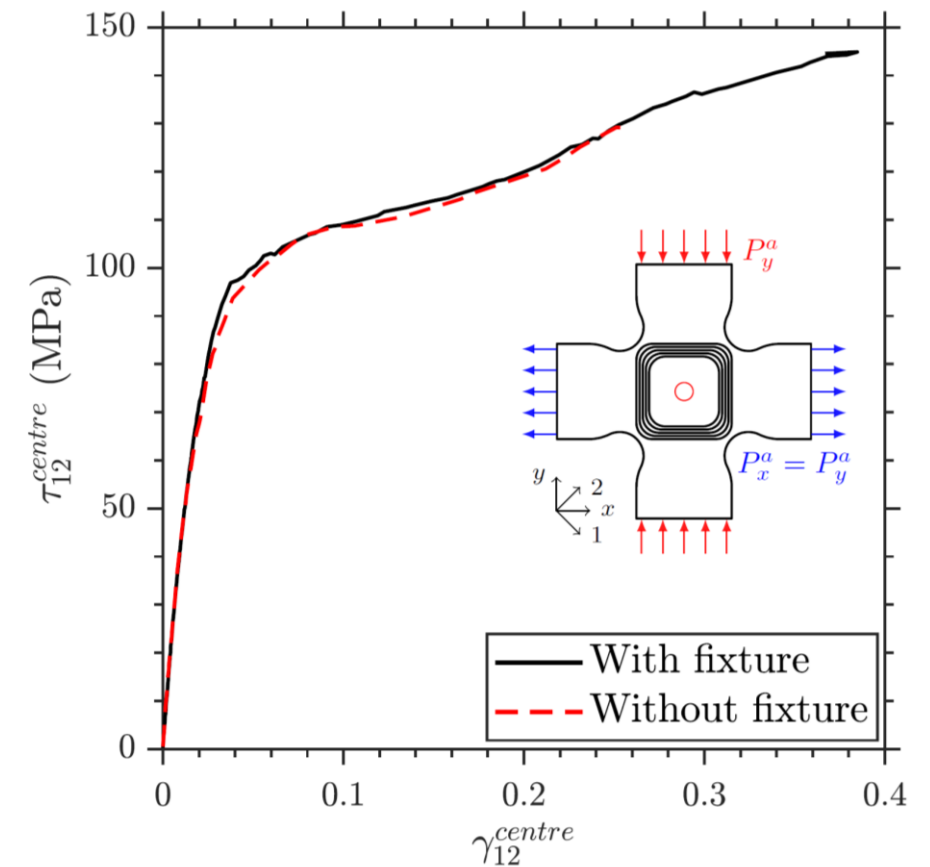
S Horta Muñoz, *PhD Thesis*, UCLM, 2020

# T-C test with $[\pm 45]_{nS}$ laminates

- Full stress-strain response is observed: both linear and non-linear evolution.
- Shear modulus  $G_{12}$  and shear strength  $\tau_{12}$  can be obtained.

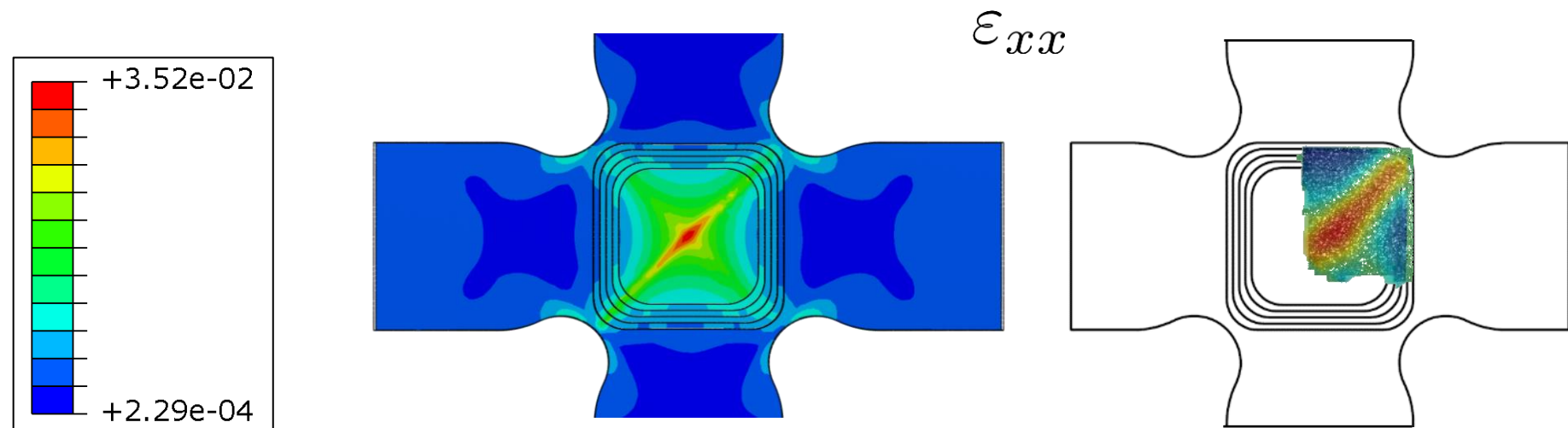


M.C. Serna Moreno and S. Horta Muñoz, Patent proposal  
P2018/109819, 2018.



# T-C test with $[\pm 45]_{nS}$ laminates

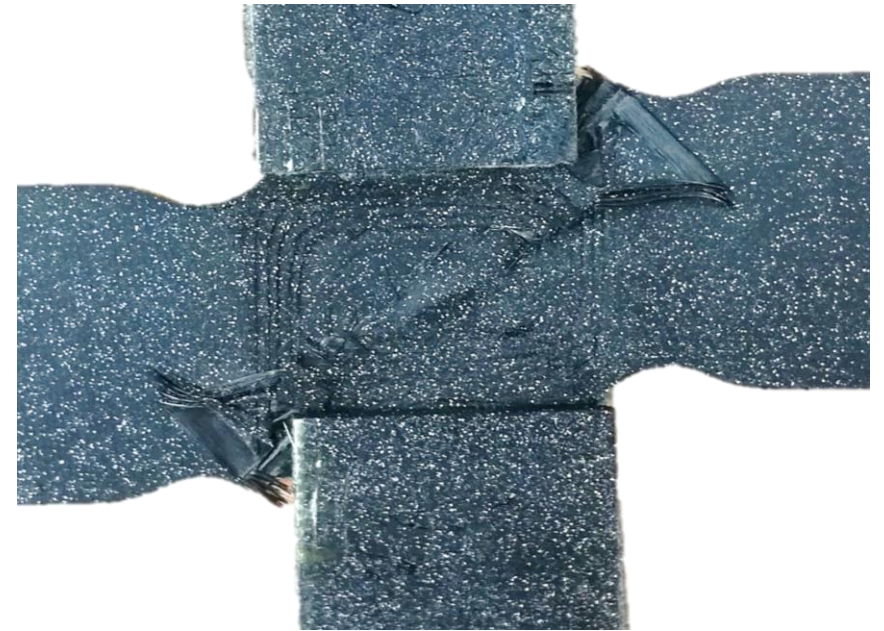
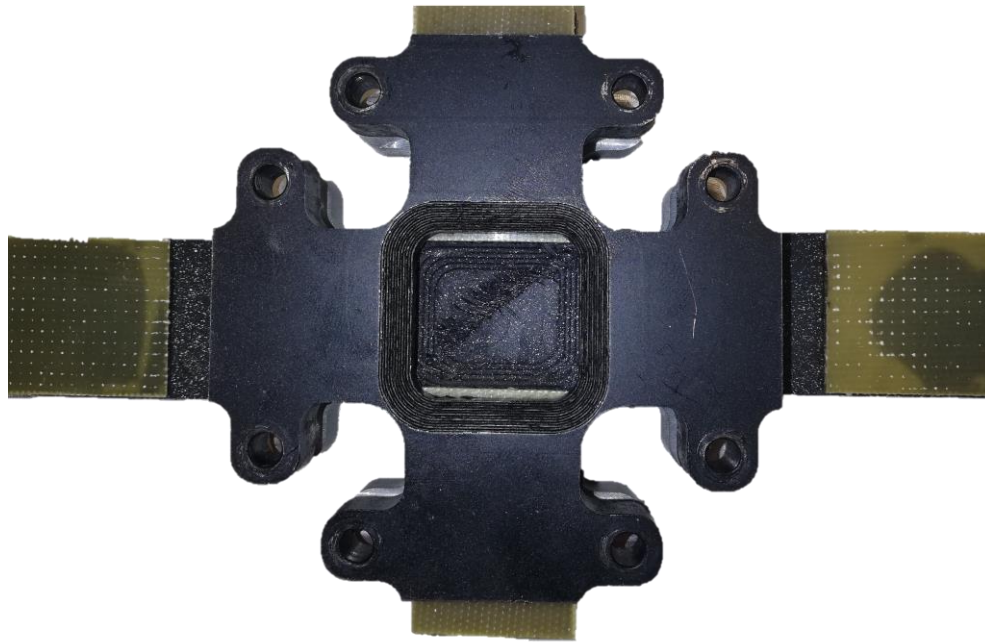
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S Horta Muñoz, *PhD Thesis*, UCLM, 2020

# T-C test with $[\pm 45]_{nS}$ laminates

- Full stress-strain response is observed: both linear and non-linear evolution.
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# Conclusions

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## T-C test

New methodology for precise observation of the pure shear response in polymer based materials even at high strains.

Reduction of the uncertainty of the tests for determining pure shear properties.

Reliable characterization for the design of critical light-weight composite structures



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