Data in Brief 47 (2023) 108966

Contents lists available at ScienceDirect

Data in Brief

journal homepage: www.elsevier.com/locate/dib

Data Article

Thermomechanical characterisation data of 30 g/m^2 and 150 g/m^2 cured unidirectional carbon/epoxy tape prepreg TP 402/T700S

Serafín Sánchez-Carmona*, María Luisa Velasco, Alberto Barroso, Elena Correa

Group of Elasticity and Strength of Materials, Department of Continuum Mechanics and Theory of Structures, School of Engineering, Universidad de Sevilla, 41092 Seville (Spain)

ARTICLE INFO

Article history:
Received 9 January 2023
Revised 12 January 2023
Accepted 3 February 2023
Available online 9 February 2023

Dataset link: Tensile static tests and thermal expansion coefficients evaluation data of 30 g/m2 and 150 g/m2 cured unidirectional carbon/epoxy prepreg TP402/T700S (Original data)

Keywords:
Mechanical properties
Elastic Modulus
Ultimate Tensile Strengths
Shear Modulus
Coefficient of Thermal Expansion (CTE)
Ultra-thin ply
Composite

ABSTRACT

With the aim to calculate through the Classical Laminate Theory the most reliable stress value generated in the 90° layer of cross-ply laminates tested under fatigue loading [1], the mechanical and thermal properties were measured for a novel composite material TP402/T700S 12K/35% using two different unidirectional tape prepregs, 30 and 150 g/m^2.
0° unidirectional (UD-0), 90° unidirectional (UD-90), ±45°, 10° off-axis and samples for thermal properties measurements were manufactured in an autoclave.
Tensile and thermal tests were performed in an Instron 4482 and in an oven, respectively, using strain gauges for all of them.
Data collected was analysed following technical standards. The values of the mechanical properties, i.e., elastic and shear stiffness and strength, and the coefficients of thermal expansion (CTEs), α_1 and α_2, were calculated also obtaining the corresponding statistics.

DOI of original article: 10.1016/j.compstruct.2022.116564

* Corresponding author's email address and Twitter handle
E-mail address: sscarmona@us.es (S. Sánchez-Carmona).
Social media: @sersancarmona (S. Sánchez-Carmona)

https://doi.org/10.1016/j.dib.2023.108966

Specifications Table

Subject	Engineering Materials Science
Specific subject area	Mechanical and thermal characterisation of a composite material using two different grammages supplied by North Thin Ply Technology (NTPT) for aerospace applications
Type of data	Table Graph
How the data were acquired	Composite laminates were manufactured by hand-lay-up and cured in an autoclave. Tensile tests were performed using an Instron 4482 and thermal test was carried out in an oven also employing a Wheatstone bridge. The strains were measured placing strain gauges 1-XY31-3/120 and/or 1-LY41-6/120. Data collected was analysed following technical standards.
Data format	Raw Analysed
Description of data collection	The composite samples made of TP402/T700S 12K/35% using two different grammages, 30 and 150 g/m^2, were cured in an autoclave. The samples were cut following the technical standards ASTM D3039 [2] and ASTM E831 [3], and Marín et al. [4]. Tensile tests were controlled under displacement at a speed between 1 and 1.5mm/min for UD-0, ±45° and 10° off-axis specimens and 0.3mm/min for UD-90 samples. Thermal test was performed in an oven and the strains were captured with a Wheatstone bridge, reaching 3 different control temperatures.
Data source location	Data was collected by these authors, members of the Group of Elasticity and Strength of Materials of the Department of Continuum Mechanics and Theory of Structures from the School of Engineering of the University of Seville (Seville, Spain).
Data accessibility	The raw dataset can be found in Mendeley Data (DOI: 10.17632/s2pp9hbbzf.1) Direct URL to data: https://data.mendeley.com/datasets/s2pp9hbbzf
Related research article	[1] S. Sánchez-Carmona, E. Correa, A. Barroso, and F. París, “Experimental observations of fatigue damage in cross-ply laminates using carbon/epoxy ultra-thin plies,” *Compos. Struct.*, vol. 306, no. 116564, 2023.

Value of the Data

- This dataset provides a complete thermomechanical characterisation of a material which is not detailed neither in the supplier datasheet nor in any previous publication.
- Researchers will benefit from this composite characterisation when they are working with this material or a similar one.
- These experimental properties can be used for analytical and numerical models, achieving more realistic results.
- Elastic stiffnesses and tensile strength together with CTEs are reported.

1. Objective

Composite laminates made of low grammage prepregs involve ultra-thin layer thicknesses. The related research article provides experimental aspects about the appearance of damage in composite laminates involving ultra-thin plies under fatigue loading. Hence, the objective of this article is to provide experimental values for the thermomechanical properties of the different prepreg materials used in the related article to take them into account for the calculation of the required stresses in the studied composite laminates. Furthermore, this experimental characterisation can help the scientific community to assess if these properties are dependent on the prepreg grammages used for the manufacture of composite laminates.

2. Data Description

The data reported herein contain the values of the elastic modulus in the fibre direction, E_{11}, the elastic modulus perpendicular to fibre direction, E_{22}, and the in-plane Poissonś coefficient,

ν_{12}, for the 30g/m^2 prepreg (Table 1) and for the 150g/m^2 prepreg (Table 2). The in-plane shear modulus is also reported in Table 2, showing the value obtained after a ±45° test, G_{12}^{45}.

Table 3 shows, for the 30g/m^2 prepreg, the ultimate tensile strength in the fibre direction, X_T, and the ultimate tensile strength perpendicular to fibre direction, Y_T, and Table 4 shows the same strength values for the 150g/m^2 case. Moreover, the in-plane shear strength, S, is also reported in Table 4, which was obtained from 10° off-axis tests.

Table 5 details the CTEs for the 30g/m^2 material after a thermal test reaching 3 different control temperatures to compare the values after two different thermal increments.

All the tables report the statistics values of the standard deviation in the same unit than the property and the coefficient of variation (CV), i.e. percentage (%).

On the one hand, the stress-strain curves obtained from tensile testing of 150g/m^2 specimens are illustrated for UD-0 samples in Fig. 1 and for UD-90 in Fig. 2. For the same prepreg, the results from ±45° specimens tensile test are shown in Fig. 3.

On the other hand, Figs. 4 and 5 chart the stress-strain curves of 30g/m^2 specimens for UD-0 tensile test and for UD-90 tensile test, respectively.

Table 1
Stiffness properties for TP402/T700S 12K/35% using 30g/m^2 prepreg.

	Average	Standard deviation	CV (%)
E_{11}(GPa)	112.257	±5.637	5.021
E_{22}(GPa)	7.921	±0.111	1.398
ν_{12}	0.334	±0.024	7.300

Table 2
Stiffness properties for TP402/T700S 12K/35% using 150g/m^2 prepreg.

	Average	Standard deviation	CV (%)
E_{11}(GPa)	104.630	±7.212	6.893
E_{22}(GPa)	8.159	±0.293	3.593
ν_{12}	0.308	±0.050	16.221
G_{12}^{45}(GPa)	3.254	±0.120	3.703

Table 3
Ultimate tensile strength properties for TP402/T700S 12K/35% using 30g/m^2 prepreg.

	Average	Standard deviation	CV (%)
X_T(MPa)	1955.952	±107.044	5.473
Y_T(MPa)	36.880	±3.473	9.417

Table 4
Ultimate tensile strength properties for TP402/T700S 12K/35% using 150g/m^2 prepreg.

	Average	Standard deviation	CV (%)
X_T(MPa)	1875.999	±148.861	7.935
Y_T(MPa)	31.923	±5.427	17.001
S (MPa)	67.917	±7.885	11.611

Table 5
CTEs for TP402/T700S 12K/35% using 30g/m^2 prepreg.

	Average	Standard deviation	CV (%)
α_1 ($^\circ C^{-1}$)	-1.30e-5	±1.34e-6	10.33
α_2 ($^\circ C^{-1}$)	1.78e-5	±4.03e-6	22.63

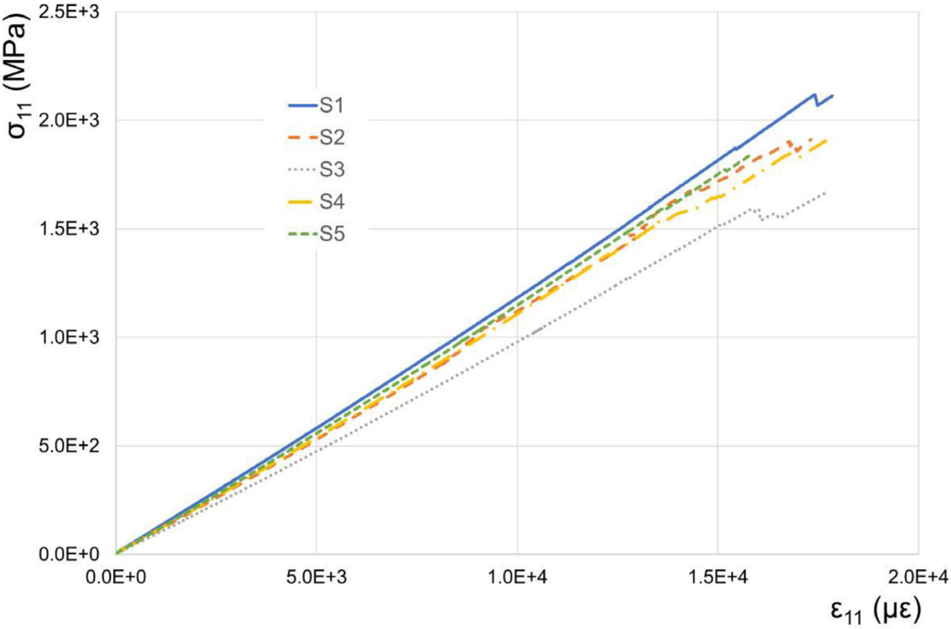

Fig. 1. Stress-Strain curves under tensile loading for UD-0 samples (150g/m^2 prepreg).

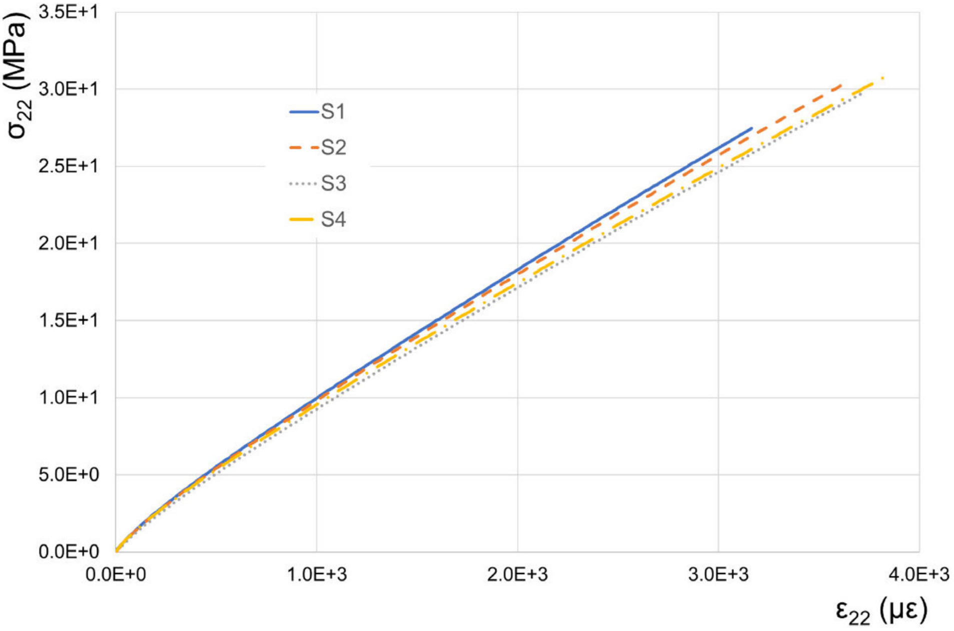

Fig. 2. Stress-Strain curves under tensile loading for UD-90 samples (150g/m^2 prepreg).

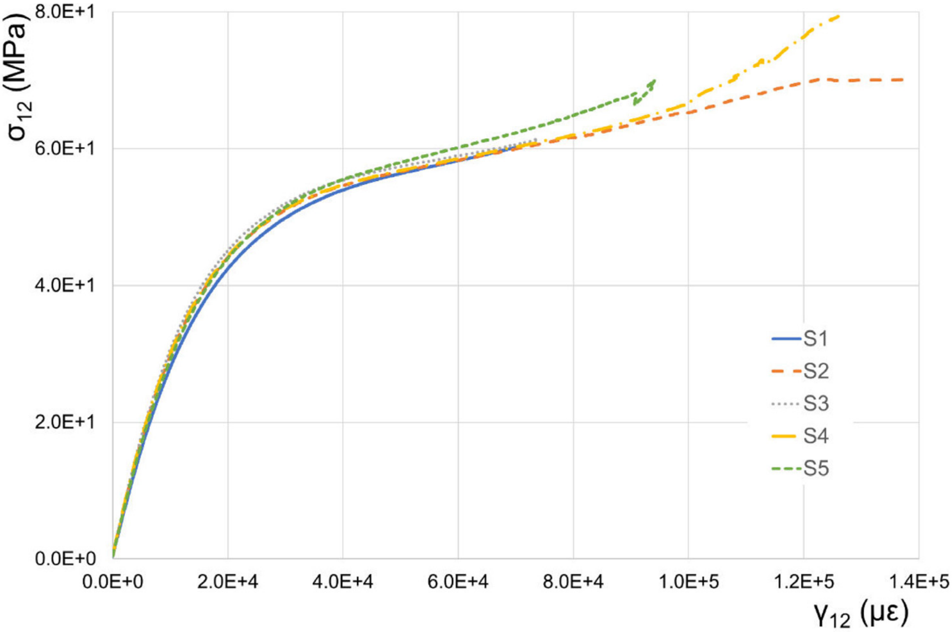

Fig. 3. Stress-Strain curves under tensile loading for ±45° samples (150g/m^2 prepreg).

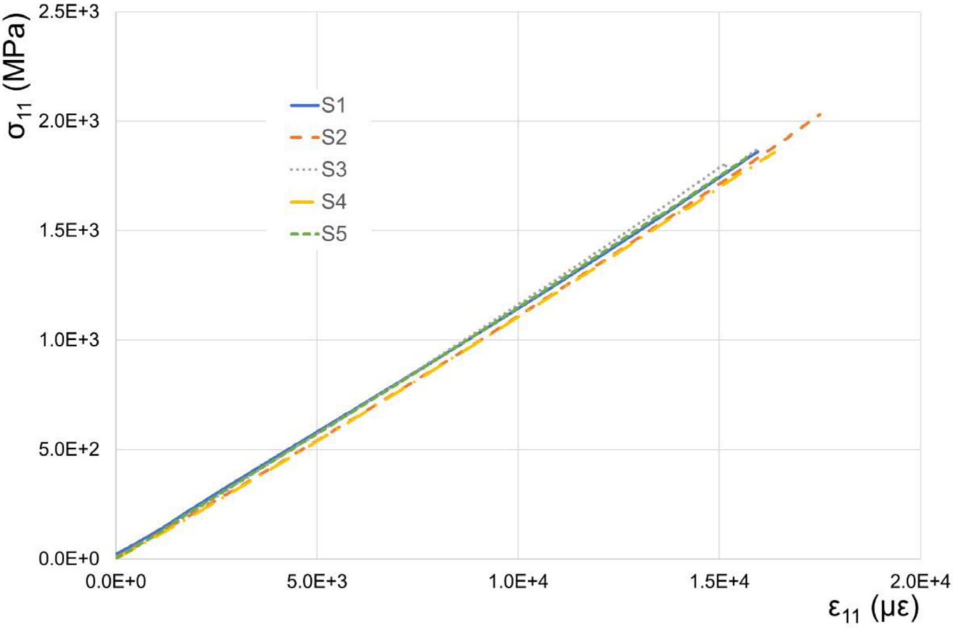

Fig. 4. Stress-Strain curves under tensile loading for UD-0 samples (30g/m^2 prepreg).

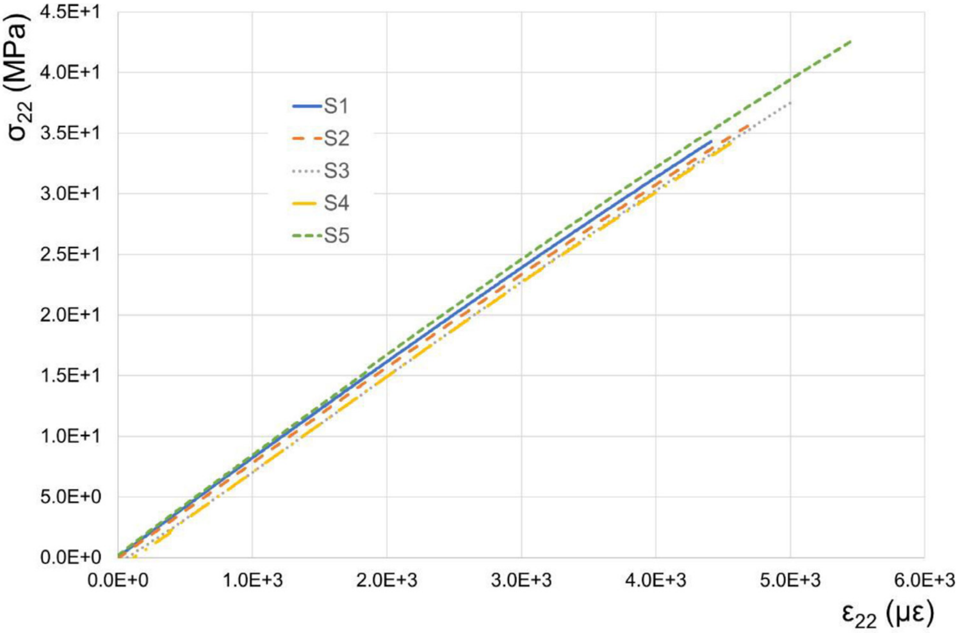

Fig. 5. Stress-Strain curves under tensile loading for UD-90 samples (30g/m^2 prepreg).

3. Experimental Design, Materials and Methods

3.1. Manufacturing process

After storing the prepreg rolls at -18°C, the material was manipulated in a clean room with the adequate ambient conditions. Once the rollers had reached the temperature of the room, these rollers were opened to start the manual manufacturing process.

All laminates (i.e., unidirectional, ±45° and 10°) were manufactured by hand laid-up. After four plies of each panel were laid-up, they were introduced in a vacuum bag for a pre-compactation in order to facilitate the air extraction, and, after 15 minutes, the hand lay-up process was continued. Once all laminates were staked, all of them were cured in an autoclave using a vacuum bag composed, in the following order, of a metallic moulding plate, one release film, the composite laminates, another release film, a breather fabric and the vacuum bagging film. This last film is bonded to the metallic plate using a sealant tape. The curing cycle used was the 2nd indicated for enhanced properties in the material datasheet [5].

3.2. Specimens preparation

Once the laminates were cured, glass/epoxy tabs were bonded to both panel sides. It is worth pointing out that tabs for 10° off-axis samples were carefully prepared following the ϕ angle calculated following the analytical calculations in Marín et al. [4].

Afterwards, the laminates were cut using a water refrigerated diamond disc saw.

The sample dimensions are taken from each technical standard, ASTM D3039 [2] and ASTM E831 [3], and Marín et al. [4]. UD-0 samples had a length of 250mm, a width of 15mm and a thickness of 1mm, bonding tabs of 50mm. UD-90 specimens had a length of 180mm, a width of 25mm and a thickness of 2mm, bonding tabs of 25mm. ±45° samples had a length of 250mm, a width of 25mm and a thickness of 2.04mm (12 plies), bonding tabs of 50mm. Off-axis samples had a length of 200mm, a width of 10mm and a thickness of 1.03mm (6 plies), bonding tabs with a ϕ angle of 22°.

3.3. Uniaxial tensile test

Tensile tests were performed using an Instron 4482 electromechanical testing machine with two different load cells, 100kN for UD-0, ±45° and off-axis samples, and 5kN for UD-90 samples. During testing the strains were measured placing a strain gauge 1-XY31-3/120 for UD-0 and ±45° specimens and 1-LY41-6/120 for UD-90 samples.

After testing, the dataset collected from each specimen was analysed following the recommendations of the technical standards ASTM D3039 [2] and ASTM D3518 [6], and Marín et al. [4]. Particularly, in-plane shear strength was calculated using Puck's criterion. After the calculations, the associated statistics were performed.

3.4. Thermal test

This test was carried out in an oven in which 2 different thermal increments were achieved, registering strains at 60, 70 and 80°C by means of a Wheatstone bridge. A strain gauge 1-XY31-3/120 was placed in the middle of the sample and the measured strains were corrected using the supplier datasheet curve in order to take into account the gauge self-deformation during the thermal test.

After testing the data collected were analysed using the basic equation $\Delta\varepsilon = \alpha\Delta T$. After the calculations, the associated statistics were performed.

Ethics Statements

This work didn't involve the use of either human or animal subjects and no social media platforms have been used. The manuscript adheres to Ethics in publishing standard.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Tensile static tests and thermal expansion coefficients evaluation data of 30 g/m2 and 150 g/m2 cured unidirectional carbon/epoxy prepreg TP402/T700S (Original data) (Mendeley Data).

CRediT Author Statement

Serafín Sánchez-Carmona: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – original draft; **María Luisa Velasco:** Methodology, Investigation, Data curation, Writing – review & editing; **Alberto Barroso:** Resources, Validation, Investigation, Writing – review & editing; **Elena Correa:** Resources, Supervision, Writing – review & editing, Funding acquisition.

Acknowledgments

This work was supported by the *Universidad de Sevilla* [grant number VIPPIT-2018-II.2]; and *Consejería de Economía y Conocimiento Junta de Andalucía* [project number P18-FR-3360] corresponding to the *I+D+I Programa Operativo FEDER 2014-2020*.

References

[1] S. Sánchez-Carmona, E. Correa, A. Barroso, F. París, Experimental observations of fatigue damage in cross-ply laminates using carbon/epoxy ultra-thin plies, Compos. Struct. 306 (116564) (2023).
[2] ASTM D3039/D3039M: Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials, Annu. B. ASTM Stand. (2017) 1–13.
[3] ASTM E831: Standard Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis, Annu. B. ASTM Stand. (2019) 1–5.
[4] J.C. Marín, J. Justo, A. Barroso, J. Cañas, F. París, On the optimal choice of fibre orientation angle in off-axis tensile test using oblique end-tabs: Theoretical and experimental studies, Compos. Sci. Technol. 178 (April) (2019) 11–25.
[5] North Thin Ply Technology, NTPT ThinPreg 402 data sheetNTPT Prod. Data Sheet, 2017.
[6] ASTM D3518/D3518M: Standard Test Method for In-Plane Shear Response of Polymer Matrix Composite Materials by Tensile Test of a 45° Laminate, Annu. B. ASTM Stand. (2018) 1–7.