Technical Specification

ISO/TS 23927

First edition
2024-03

Laminates and moulding compounds — Prepregs — Determination of tack

Stratifiés et composés à mouler — Préimprégnés — Détermination du tack

Reference number
ISO/TS 23927:2024(en)

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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 13, *Composites and reinforcement fibres*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Tack is an important property of prepregs that relates to the integrity of the composite laminate being produced. The practice of determining tack in prepregs is mostly qualitative as it is often done by the experience of the personnel involved. On the other hand, in some automated manufacturing using prepregs, tack needs to be measured as a part of the manufacturing process. This document is intended to provide standing alone quantitative method for the measurement of tack in prepregs.

Laminates and moulding compounds — Prepregs — Determination of tack

1 Scope

This document specifies the test method for determining the tack in prepregs under defined conditions.

This document is applicable to but not limited to unidirectional and multidirectional thermoset based prepregs made with glass fibres, carbon fibres, aramid fibres and other similar fibres included.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 7500-1:2018, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines- Verification and calibration of the force-measuring system*

ISO 21920-2, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
tack
f_t
maximum areal force measured in separating a given probe surface from the prepreg surface

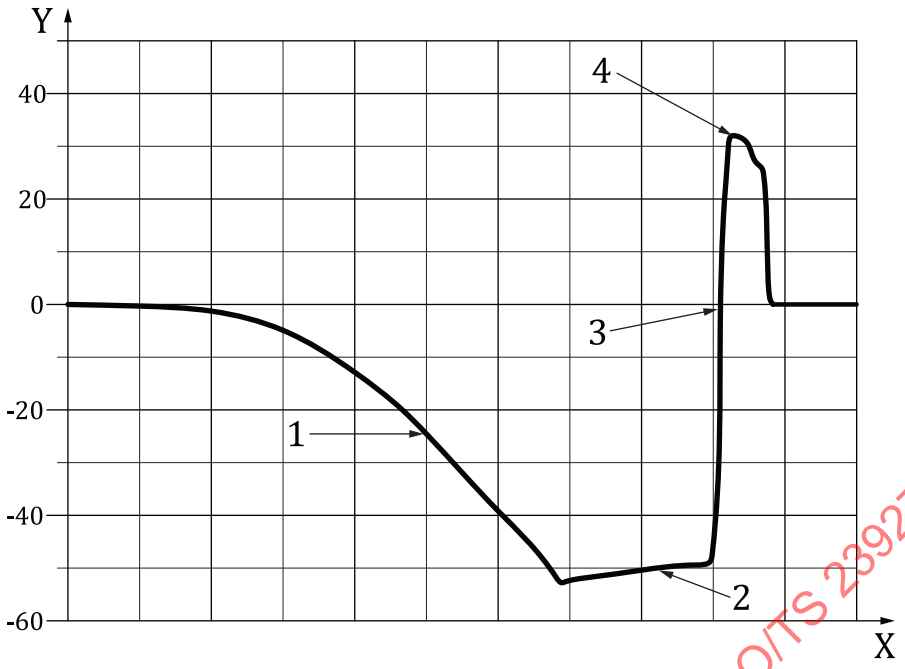
Note 1 to entry: It is expressed in Newtons (N).

Note 2 to entry: to entry:(see Figure 1).

4 Principle

The tack of a prepreg is measured on the flat surface side by imposing a cycle of loading (compression) and retracting (tension) the probe having a specific area and surface roughness. The maximum retracting force measured in the force-time curve during this procedure is determined as tack (see Figure 1).

The tack on prepregs is known to be dependent on the loading dwell time, the contact pressure at the interface, probe characteristics, the temperature and the rate of retraction[1],[2],[3].



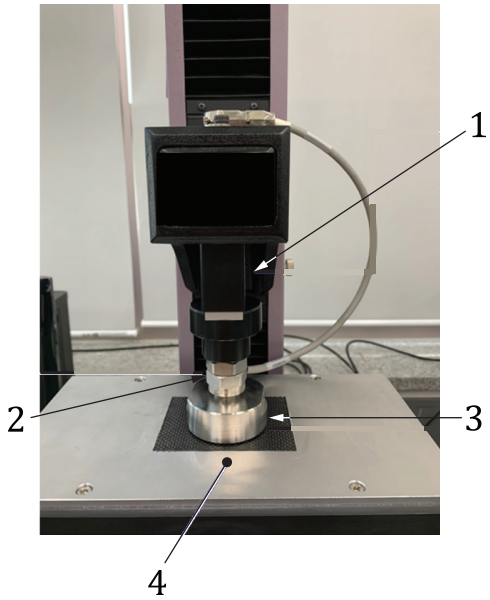
Key

X time
Y force
1 compression
2 dwell time
3 tension (retraction)
4 f_t

Figure 1 — Typical compression/tension (retraction) cycle

5 Apparatus

A typical tack measuring apparatus is illustrated in Figure 2. It consists of force indicator; axially aligned probe that is capable of providing intimate contact between the probe end and the prepreg specimen; and supporting platen that holds the prepreg flat in place. This apparatus is placed on the displacement control tension/compression testing machine for the measurement of tack. An example of a self-aligning jig for the probe is given in Annex B.



Key

1 force indicator
2 self-aligning probe rod
3 prepreg specimen
4 support platen

Figure 2 — An example of a tack measuring apparatus

5.1 Probe

The probe shall be made from 304 stainless steel rod, having a diameter of 80 mm, with one end machined 90° to the longitudinal axis. The surface roughness of the machined end shall have the surface roughness no more than 500 nm, less than 250 nm RMS as measured in accordance with ISO 21920-2. The hardness of the probe shall be greater than or equal to 80 HRB. In order to maintain flat contact between the probe and the support plate, use of self-aligning probe is required (see Figure 2 and Annex B). The cleaning and polishing shall not produce scratch and or wayiness to the probe surface.

NOTE Other shapes, dimensions and materials can be used upon agreement by the parties involved. This can lead to different result from the standard.

5.2 Support platen

The support platen shall be made of the same materials as the probe. The dimension of the plate shall be at least 1,5 times greater than the prepreg specimen (≥ 100 mm × 100 mm). The flatness of the platen shall have the maximum flatness deviation of 0,01 mm over 100 mm.

NOTE 1 Other shapes and materials can be used upon agreement by the parties involved.

NOTE 2 It has been shown that for faster measurement a movable support platen can be used. The platen in this case was rectangular in shape having one side maintained at 60 mm but larger for other dimension to accommodate longer strip of prepregs. The measurement was facilitated by incrementally moving the platen after each measurement without changing the prepreg specimen.

5.3 Force measurement system

The force measurement system shall be free of inertia and comply with class 1 of ISO 7500-1.

5.4 Tension/compression testing machine

5.4.1 General

The testing machine shall conform with ISO 7500-1, as follows.

5.4.2 Test speed

The testing machine shall be capable of maintaining the test speed as specified in ISO 7500-1:2018, Table 1.

NOTE The force control mode can be used upon agreement between parties involved.

5.4.3 Recording of data

The data acquisition frequency needs for the recording of data (force, time) shall be sufficiently high in order to meet accuracy requirements.

6 Test specimens

The prepreg specimen shall be square with having 100 mm × 100 mm in size. The specimen shall be cut to dimensions using a shear or its equivalent to an accuracy of ±2,0 mm.

NOTE Other shapes and dimensions can be used upon agreement by the parties involved.

7 Number of test specimens

A minimum of five test specimens from the same prepreg roll shall be tested. The number of measurements may be more than five if greater precision of the mean value is required. It is possible to evaluate this by means of the confidence interval (95 % probability per ISO 2602).

8 Conditioning

The test specimen shall be conditioned using the most appropriate set of conditions from ISO 291 and the condition time is at least 4 h, unless otherwise agreed upon by the parties involved. For example, for testing at elevated or low temperatures.

The preferred atmosphere is (23 ± 2) °C and (50 ± 10) % RH.

9 Procedure

9.1 Test atmosphere

Conduct the test in the same atmosphere used for conditioning the test specimen, unless otherwise agreed upon by the interested parties, for example, for testing at elevated or low temperatures.

9.2 Probe setting

Before placing the specimen on the flat support platen, check the alignment and contact between the surfaces of the probe and the flat support platen. A visual check of the probe surface and edges shall be made to ensure no damage is present. The probe shall be cleaned with same solvent between tests that does not affect the specimen and does not leave any residues on the probe end that may influence the test result.

9.3 Specimen seating

On the cleaned support platen, place a thin-film acrylic double-sided tape and on top of that position the prepreg specimen (on one side with protective film removed) and evenly press the specimen against the

double-sided tape. Check for the firmness of the specimen setting. Do not remove the protective film on the side of the prepreg specimen facing the probe until the point of load application.

NOTE 1 Suitable seating methods other than one using double-sided tape can also be applied.

NOTE 2 Use of a roller can provide uniform seating of the specimen against double sided tape.

NOTE 3 The protective film on the side of the prepreg specimen facing the probe can be removed before the point of load application upon agreement by the parties involved.

9.4 Test

9.4.1 General

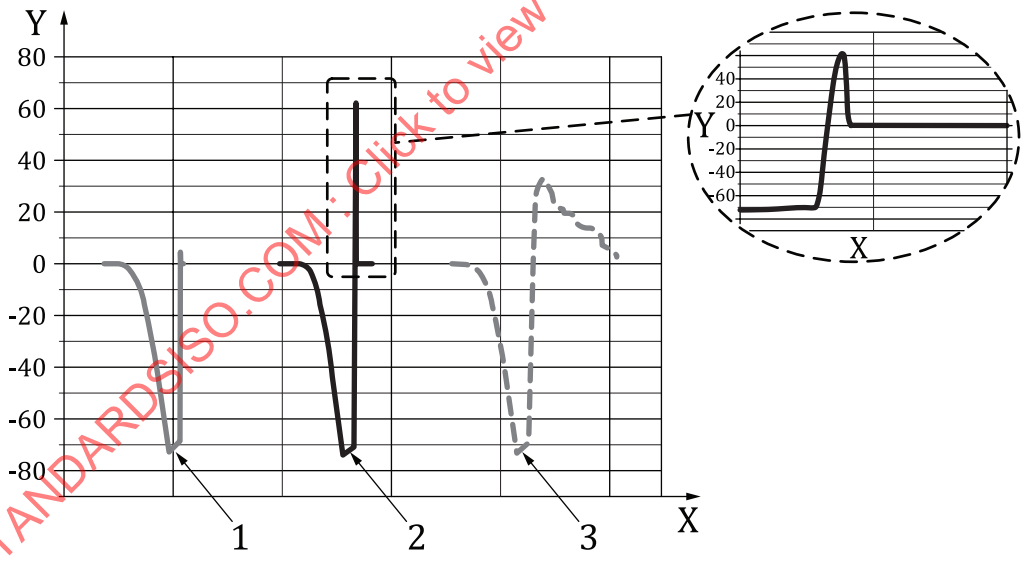
Set the force measurement system to zero with the probe in a free hanging position. The force-time diagram shall be recorded for the whole compression/hold (dwell)/tension cycle (see Figure 1).

9.4.2 Contacting the specimen

Bring the probe into contact with the prepreg surface and increase the compression force to (900 ± 10) N using a displacement rate of 1 mm/min. Hold the compression force constant to (900 ± 10) N for a dwell time of (100 ± 1) seconds.

9.4.3 Measurement of the tack force

Immediately when the dwell time is over, start the testing machine in tensile direction at a speed of the probe of 25 mm/min. Validate the test by checking, if no sticky residue deposit is visible on the probe surface after the test. If the test cannot be validated, repeat the test with increase of the test speed by increments of 5 mm/min until a valid result is obtained. Produce at least 5 valid test results at the same speed[1].



Key

X time
Y force
1 high speed
2 intermediate speed
3 low speed

Figure 3 — Effect of test speed on force – time behaviour

10 Expression of result

10.1 Tack

Record the maximum tensile (retraction) force measured on the force – time curve, f_t, (see Figure 1), given in Newtons. An arithmetic mean value from at least five f_t values shall be determined.

10.2 Tack strength

In case where the probe contact area (A) is to be considered, tack strength is expressed as Formula (1):

$$\sigma_t = \frac{f_t}{A} \quad (1)$$

where σ_t is the tack expressed in megapascals (MPa).

11 Test report

The test report shall include at least the following information:

a) a reference to this document, i.e. ISO/TS 23927:2024;

b) identification of the specimen, including prepreg type (architecture and tow size), fibre, resin and manufacture;

c) description of test apparatus;

d) conditioning atmospheres and time;

e) specimen dimensions including thickness;

f) method for specimen seating;

g) solvent used to clean probe;

h) test speed;

i) compression load and dwell time;

j) test temperature and humidity, if different from the conditioning atmosphere;

k) full cycle force-time curve;

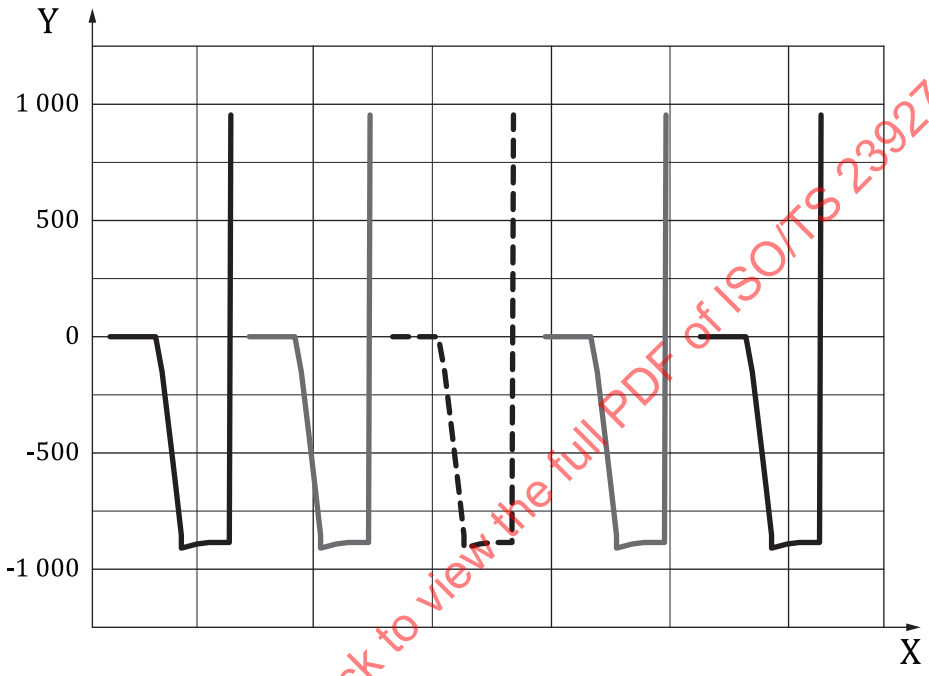
l) measured tack values and their arithmetic average in both Newtons and megapascals;

h) other relevant information that may have affected the results obtained.

Annex A
(informative)

Determination of tack — Example

An example of force-time curve for tack measurement cycle is illustrated in Figure A.1, for woven carbon fibres impregnated with epoxy resin. A compression force of 890 N, probe diameter of 80 mm, dwell time of 100 second and the test speed of 25 mm/min were used.



Key

X time

Y force

Figure A.1 — Example of typical force – time curves

Annex B
(informative)

Example of a probe and a self-aligning jig

Typical examples of a probe and an alignment jig assembly for the tack measurement are illustrated in Figures B.1 and B.2, respectively.

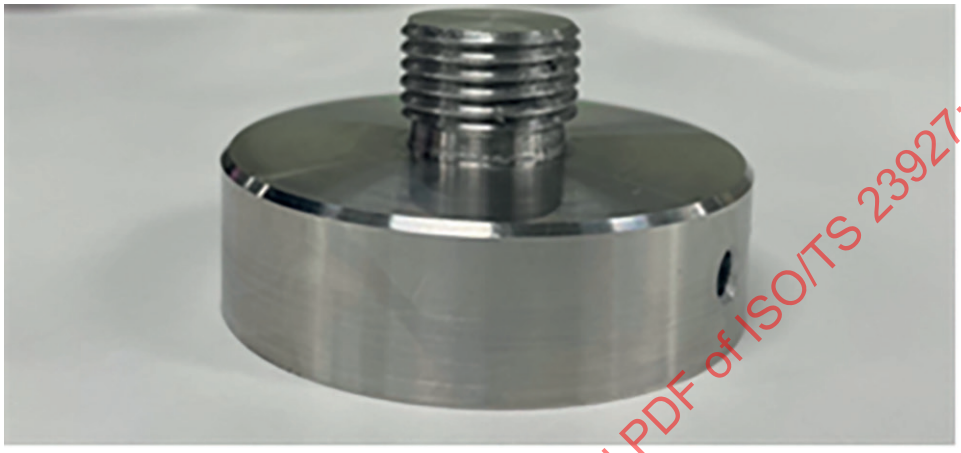


Figure B.1 — Example of a stainless steel 80 mm diameter probe