January 2008

DVS – DEUTSCHER VERBAND FÜR SCHWEISSEN UND VERWANDTE VERFAHREN E.V.

Testing of joints between polymeric materials
Testing of adhesive-bonded joints in the shear and peeling tests

DVS
Technical Code
DVS 2203-6
Supplement 2

Contents:

1 Scope of application

This supplement deals with the testing of adhesive-bonded joints between polymeric materials with each other and with other materials by means of shear and peeling tests.

2 Stress types

As a rule, the forces effective on an adhesive-bonded joint arise in the form of tensile, shear or peeling stresses (Fig. 1). Peeling stresses must be reduced to a minimum by taking design-related measures.

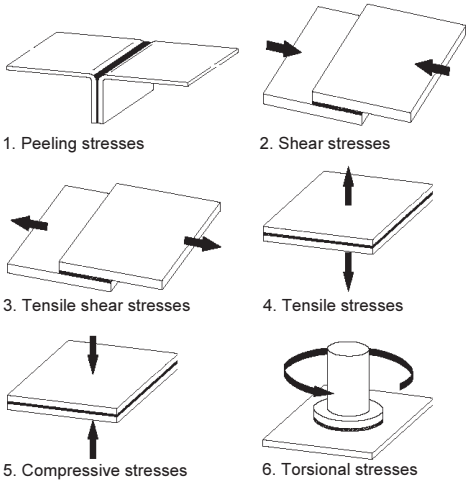

Figure 1. Stress types.

3 Tests

In most cases, tests on adhesive-bonded joints have various objectives.

A few are specified below:

- determination of the adhesive bonding execution and adhesive suitable for a certain adhesive bonding task
- determination of the strength values required for an adhesive bonding task (maximum and long-time strength behaviour)
- determination of the deformation behaviour of an adhesive-bonded joint with regard to external forces
- determination of the behaviour of the adhesive-bonded joint in operating conditions close to practice (strength, temperature, media etc.)
- determination of the adhesive/material-specific optimum pre-treatment process (cleaning, roughening, pickling etc.)
- determination of suitable application processes for the adhesive bonding operation
- refinement of an adhesive formulation for special applications in agreement between the user and the adhesive manufacturer
- checking of the adhesive bonding execution according to DVS 2221

3.1 Type and set-up

The test specimens can either be manufactured in the form of single specimens or be cut out of two-dimensional adhesive-bonded joints. Fixing jigs are used for the adhesive bonding of single specimens in order to obtain reproducible adhesive-bonded joints. At least five test specimens per test are required for a sufficient statistical collection.

The testing methods described below serve to establish the properties and behaviour to be expected from an adhesive-bonded joint. The overlapping length $l_ü$ to be tested is dependent on the material, the adhesive and the thickness. It is usually 10 mm.

3.2 Tensile shear test

The specimens described in greater detail below are used in the tensile shear test:

Tensile shear test specimen, adhesive-bonded with a single overlap

In the case of the tensile shear test specimen adhesive-bonded with a single overlap, it is necessary to take account of the arising bending moment, which influences the measured value due to peripheral peeling forces.

DVS, Technical Committee, Working Group "Joining of Plastics"

Orders to: DVS Media GmbH, P. O. Box 10 19 65, 40010 Düsseldorf, Germany, Phone: +49(0)211/1591-0, Telefax: +49(0)211/1591-150

Figure 2. Tensile shear test specimen, adhesive-bonded with an overlap.

Strip-shaped tensile shear test specimen from a two-dimensional adhesive-bonded joint

Two-dimensional trial adhesive-bonded joints are more efficient and more reliable to manufacture but require the careful cutting-out of the tensile shear test specimens. Fig. 3 shows the side view of a strip-shaped tensile shear test specimen which was cut out of a two-dimensional adhesive-bonded joint. The two saw cuts which delimit the testing length $l_ü$ are characteristic.

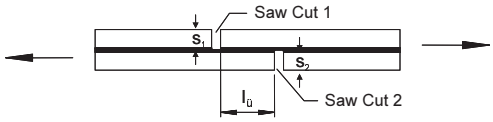

Figure 3. Tensile shear test speceimen from a two-dimensional adhesive-bonded joint, overlapping length limited by saw cuts.

Tensile shear test specimen with a double cover strap

In the case of the tensile shear test specimen with a double cover strap, two identical bending moments are effective against each other so that no additional peeling forces arise.

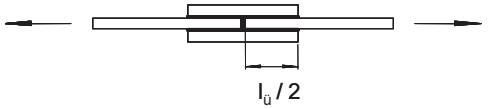

Figure 4. Tensile shear test specimen, with a double cover strap.

3.3 Compression shear test

In the case of the compression shear test, pressure is used in order to apply the shear forces in the adhesive-bonded face to one of the adhesive-bonded joining members. A few common test arrangements are portrayed below.

Compression shear test according to ASTM D 2564-02

This test according to ASTM D 2564-2 is suitable for PVC adhesive-bonded joints.

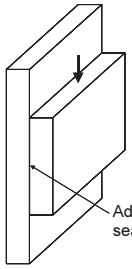

Figure 5. Compression shear test according to ASTM D 2564-02.

Pipe-sleeve adhesive bonding test

The shear test specimen according to DIN 16970 (Fig. 6) or according to DIN EN ISO 9311-2 is suitable for adhesive-bonded pipe-sleeve joints with a cylindrical adhesive bonding seam.

The testing speed is (5 ± 0.5) mm/min. It is necessary to record the greatest force at which the adhesive-bonded joint fails.

The shear strength "S" in MPa for each adhesive-bonded specimen is calculated according to the following equation:

$$S = \frac{F}{\pi d l}$$

Where:

"F" is the maximum force in Newton
"d" is the inside diameter of the fitting in millimetres
"l" is the length of the parts joined with each other in millimetres

The shear strength is the arithmetic mean of the results from five tests.

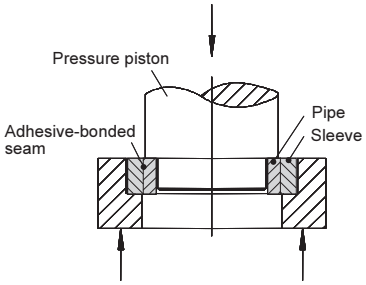

Figure 6. Shear test according to DIN 16970. The shearing of an adhesive-bonded pipe-sleeve joint or of similarly adhesive-bonded components is tested with the pressure beam of a testing machine or on a press.

3.4 Peeling test

In the case of thin, flexible materials, the testing and the assessment are frequently carried out using peeling test specimens in the "floating-roller test" according to DIN EN 1464 (Figure 7).

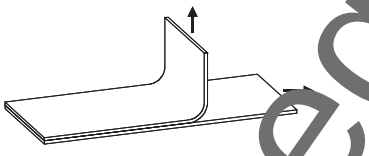

Figure 7. Test specimen for floating-roller test

4 Assessment

A basic distinction is made between qualitative and quantitative evaluation.

Qualitative evaluation:
Depending on the type of adhesive, the fracture patterns must be evaluated according to DIN EN ISO 10365 or DVS 2221.

Quantitative evaluation:
A shear or peel resistance or strength is determined from the measured shear or peeling forces via the specimen geometry. For this purpose the measured maximum force is divided by the specimen width (resistance) or by the adhesive-bonded area (strength), different depending on the applied standard.

5 Standards and guidelines which are also applicable

ASTM D 2564	Standard specification for solvent cements for poly(vinyl chloride) (PVC) plastic piping systems
DIN 16970	Adhesives for the joining of pipes and piping parts made of hard PVC; general quality requirements and tests
DIN EN 1464	Adhesives – Determination of the peel resistance of high-strength adhesive-bonded joints – Floating-roller test