BRITISH STANDARD

BS 6564-3: 1990

Polytetrafluoroethylene (PTFE) materials and products —

Part 3: Specification for E glass fibre filled polytetrafluoroethylene

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Plastics Standards Policy Committee (PLM/-) to Technical Committee PLM/34, upon which the following bodies were represented:

British Fluoropolymer Processors' Group
British Plastics Federation
British Valve and Actuator Manufacturers' Association
Engineering Equipment and Materials Users' Association
Ministry of Defence

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Contents

Foreword

This Part of BS 6564 has been prepared under the direction of the Plastics Standards Policy Committee.

This Part provides the composition and physical property requirements for E glass fibre filled polytetrafluoroethylene fabricated products. The style of the designation follows closely the designation introduced into BS 6564-2 for unfilled products.

In this Part of BS 6564, the requirements are specified in three grades of product which are designated grade G5, G15 and G25 containing a nominal 5 %, 15 % and 25 % of E glass fibre filler.

Requirements are also specified for three subgrades of product which are designated subgrade A1, subgrade A and subgrade B (subgrade A1 denoting the highest quality and subgrade B the lowest quality specified in this Part of BS 6564).

The products are also designated as being one of two types, depending on the degree of dimensional stability: type 1 products are designated as those which meet the requirements for dimensional stability given in Table 2; type 2 products, usually products which are described as "as fabricated", do not necessarily meet these requirements.

This Part of BS 6564 does not include any detailed information on machining tolerances but it should be noted that some difficulty in achieving closely controlled dimensions may be experienced when working with PTFE. The British Fluoropolymer Processors' Association has published a document[1)] which gives guidance on this subject.

CAUTION. Care should be exercised when specifying extruded materials for machining into components which are required to conform to close tolerances as the release of locked-in stress may occur in the components after machining.

It is intended to introduce a wear test in the future when a satisfactory test has been identified.

Various requirements and methods of test, which are not specified in this Part of BS 6564 but which may need to be agreed between the purchaser and the supplier, are listed in Appendix A.

Other Parts and Sections of BS 6564 are as follows.

— *Part 1: Polytetrafluoroethylene powders for moulding and extrusion;*

— *Section 1.1: Specification;*

— *Section 1.2: Method of specifying;*

— *Part 2: Specification for fabricated unfilled polytetrafluoroethylene products.*

NOTE 1 In Part 2 of this standard, the first element of the designation for fabricated unfilled PTFE products will be the letter "U". The remainder of the designation will correspond to that specified for glass fibre filled PTFE fabricated products in this Part of BS 6564 (see clause **2**).

WARNING. It is essential that tobacco products are kept well away from areas where they could be contaminated by PTFE dust. The smoking of tobacco products contaminated by PTFE can result in a temporary, flu-like condition, known as "polymer fume fever". This condition is the only adverse effect observed in humans to date. The symptoms do not ordinarily occur until several hours after inhalation of the fumes and pass off within 36 h to 48 h even in the absence of treatment. Observations indicate that these attacks have no lasting effects and that the effects are not cumulative.

1) Publication No. 284/1, *Code of practice for machining tolerances for components machined from PTFE,* which may be purchased from the British Fluoropolymer Processors' Association, 5 Belgrave Square, London SW1X 8PH.

When heated above 260 °C, PTFE will begin to degrade and the rate of degradation will increase with increasing temperature. The gases produced during degradation will vary according to the temperature and other conditions but will invariably contain toxic components and good ventilation is therefore essential.

NOTE 2 It is strongly recommended that users of this standard refer to BFPA Publication No. 254/1[2)] for further information.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

[2)] Publication No. 254/1, *Industrial health and safety for PTFE polymers,* which may be purchased from the British Fluoropolymer Processors' Association, 5 Belgrave Square, London SW1X 8PH.

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0 Introduction

Fabricated unfilled polytetrafluoroethylene (PTFE), whilst having many advantageous properties making it a material of wide applicability, suffers from relatively poor resistance to wear and high deformation when subjected to compressive loads. These deficiencies may be improved by the incorporation of fillers such as glass fibre. In order that such enhancements may be realized, up to 25 % (*m*/*m*) of E glass fibre filler, milled typically to an aspect ratio of 10 : 1 (length : diameter), is intimately compunded into the PTFE before fabrication.

Whilst the addition of such amounts of E glass fibre filler gives improved wear, performance and resistance to compressive forces, care should be taken as other properties may be adversely affected, e.g. the resistance to attack by certain chemicals may deteriorate, the coefficient of friction may rise and the electrical properties may be modified (particularly under conditions of high ambient humidity).

1 Scope

This Part of BS 6564 specifies requirements for fabricated E glass fibre filled polytetrafluoroethylene (PTFE) products which may occur in several forms, available in the grades, subgrades and types as indicated in Table 1.

NOTE 1 E glass is defined in BS 3447 as "a glass containing not more than 1 % of alkali (calculated as Na_2O) and used for the manufacture of glass fibres".

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definition

For the purpose of this British Standard the following definition applies.

product batch

a group of mouldings or extrusions produced from the same batch of powder, subjected to the same fabrication techniques and conditions and to the same thermal regime

3 Designation

Products complying with this Part of BS 6564 shall be designated by a code containing the following elements.

a) A letter followed by a number denoting the grade of the material. Fibre glass filled PTFE products are denoted by the letter G followed by a number denoting the percentage nominal glass fibre content[3)].

b) A letter, or a combination of letters and numbers, denoting the subgrade of the product, i.e. A1, A, B (as specified in Table 1).

c) An oblique stroke followed by a number denoting the type of product, i.e. 1 or 2.

NOTE Type 1 products are designated as those which meet the requirements for dimensional stability given in Table 2; type 2 products, usually products which are described as "as fabricated", do not necessarily meet these requirements.

Example. G 15 A1/1 (grade G 15, subgrade A1, type 1).

4 Composition and appearance

The products shall be manufactured from E glass filled polytetrafluoroethylene which contains no other additives except pigments. The use of reprocessed material shall be permissible providing that products containing reprocessed material meet the requirements of this standard (see notes 1 to 3 and Appendix A).

The addition of up to 1.5 % (*m*/*m*) of pigment shall be permitted during the manufacture of an item, for the purposes of identification or decoration. The presence of added pigment shall be reported in all documentation relating to a particular product.

NOTE 1 The colour of the unpigmented products varies from semi-translucent white to mottled grey. Colours outside this range will normally be obtained by pigmentation.

NOTE 2 The presence of pigments may affect some properties of the material, e.g. chemical resistance and electrical properties, and it is advisable for the purchaser and the supplier to agree the type, grade and quantity of pigment to be used (see Appendix A).

NOTE 3 Due to the nature of some manufacturing methods, accurate reproduction of colour in pigmented items is difficult and some variation may be exacerbated by high E glass filler content.

NOTE 4 Products are normally available free from surface defects or inclusions.

5 Performance and physical properties

The products shall comply with the appropriate requirements given in Table 2.

To comply with the requirements for tensile strength and elongation at break, the minimum mean values, determined by the method specified, shall be as specified in Table 2.

If any individual result for tensile strength or elongation at break is below the compliance limit specified in Table 2 and more than 15 % below the mean value, a further set of test specimens shall be tested and if the second set of results fail to meet the compliance limits specified, the material shall be deemed not to comply with this Part of BS 6564.

[3)] See note 1 in foreword.

Table 1 — Forms, grades, subgrades and types covered by BS 6564-3

Form	Grade	Subgrade	Type
Moulded basic shapes, moulded or extruded rod, moulded or extruded tube and moulded sheet	G5	A1, A, B	Types 1 and 2
	G15	A1, A, B	Types 1 and 2
	G25	A1, A, B	Types 1 and 2
Veneered tape	G5	A1, A, B	Type 2 only
	G15	A1, A, B	Type 2 only
	G25	A1, A, B	Type 2 only

Table 2 — Performance and physical properties

Requirement	Applicable to	Method	Compliance criteria			
			Filler content	Subgrade A1	Subgrade A	Subgrade B
Tensile strength	All products	BS 2782: Method 327A	%	MPa	MPa	MPa
			5	16	15	14
			15	15	14	13
			25	14	12	11
Elongation at break	All products	BS 2782: Method 327A		%	%	%
			5	230	210	190
			15	200	180	160
			25	160	140	120
Density at 23 ± 2 °C	All products	BS 2782: Method 620A or Method 620D		g/cm^3		
			5	2.19 ± 0.04		
			15	2.21 ± 0.04		
			25	2.23 ± 0.04		
Resistance to heat	All products	Appendix B of BS 6564-2:1985	All grades	The material shall show no signs of melting and the loss in mass shall not exceed 0.5 %		
Compressive modulus	Subgrades A1 and A	Appendix B		MPa	MPa	MPa
			5	475	475	—
			15	550	550	—
			25	750	750	—
Dimensional stability	All type 1 products except tube and veneered tape	Appendix C of BS 6564-2:1985	All grades	The maximum change shall not exceed 0.5 %		
	Type 1 tube	Appendix D of BS 6564-2:1985	All grades	The maximum changes in length and diameter shall each not exceed 0.5 %		
Geometric stability	Type 1 tube	Appendix D of BS 6564-2:1985	All grades	The maximum change shall not exceed $\frac{D}{4T}$ % where D is the nominal external diameter, T is the nominal wall thickness		
Filler content	All products	Appendix A of BS 6564-1.1:1989	*% (m/m)*			
			5 ± 1 (i.e. 4 to 6)			
			15 ± 2 (i.e. 13 to 17)			
			25 ± 2 (i.e. 23 to 27)			

6 Dimensional tolerances

6.1 General

Dimensions shall be measured at 23 ± 2 °C.

NOTE For moulded basic shapes, see Appendix A.

6.2 Rod and tube

The tolerance on the nominal outside diameter shall be as given in Table 3.

Table 3 — Tolerance on nominal outside diameter

Nominal outside diameter	Tolerance
mm	mm
Up to and including 12.5	− 0 + 0.50
Over 12.5 up to and including 25.0	− 0 + 0.75
Over 25.0	− 0 + 2.50

The actual inside diameter (bore) of tube shall at no point be greater than the nominal inside diameter.

NOTE 1 Minimum tolerances on inside diameters of tube are not specified because these are dependent on whether the tube is to be machined or not and on the intended use.

For finished tube, after machining if appropriate, the eccentricity of the bore shall not exceed 4.0 % of the nominal inside diameter (FIM[4] of 8 %). For tube supplied as machining stock, the tube shall be capable of being machined concentrically to the required dimensions.

NOTE 2 Moulded rod of diameter greater than 50 mm, and moulded tube of outside diameter greater than 50 mm and wall thickness greater than 15 mm, may be considered as moulded basic shapes (see Appendix A).

6.3 Sheet

The tolerances on both the width and the length of the sheet shall be 0 mm, + 6.5 mm.

The tolerance on the thickness of the sheet shall be as given in Table 4.

Table 4 — Tolerance on thickness of sheet

Nominal thickness	Tolerance
mm	mm
Up to and including 2.5	− 0 ± 0.5
Over 2.5 up to and including 4.0	+ 0.7 − 0
Over 4.0 up to and including 5.0	+ 0.8 − 0
Over 5.0	%
	+ 15

NOTE Moulded sheet of thickness greater than 15 mm may be considered as a moulded basic shape (see Appendix A).

6.4 Veneered tape

The tolerance on the nominal width and nominal thickness of the tape shall be as given in Table 5.

Table 5 — Tolerance on nominal width and nominal thickness of veneered tape

Nominal dimension	Tolerance
mm	mm
Width	
Up to and including 200	− 0 + 1.5
Over 200 up to and including 300	− 0 + 3.0
Over 300	− 0 + 5.0
Thickness	
Up to and including 0.15	− 0 + 0.025
Over 0.15 up to and including 0.40	− 0 + 0.050
Over 0.40 up to and including 0.75	− 0 + 0.075
Over 0.75	As specified in **6.3** for moulded sheet

7 Sampling

A separate sample shall be taken to represent each product batch (see clause **2**) and shall be of sufficient size to enable the required test specimens to be prepared from it.

In the case of moulded shapes which are too small to produce the required test specimens or too large to be sampled and tested without loss of more than 1 % of the batch of product, it shall be permissible to produce a test moulding. Such a test moulding shall be produced from the same batch of powder, and shall be subjected to the same moulding conditions and the same thermal regime as the product batch it represents. The test specimens for the determination of dimensional or geometric stabilities (for type 1 products) shall be cut from their actual batch and not from a specially moulded test sample.

NOTE For sampling on continuous production, see Appendix A.

[4] FIM is full indicated movement, see BS 308-1.

8 Marking

At least the following information shall be marked on each package:

a) the manufacturer's name or trade mark;

b) the manufacturer's description of the product;

c) the manufacturer's batch number;

d) the designation of the product (see clause **3**);

e) the number and date of this British Standard, i.e. BS 6564-3:1990[5)];

d) the following warning:

"When heated above 260 °C, PTFE will begin to degrade and the rate of degradation will increase with increasing temperature. The gases produced during degradation will vary according to the temperature and other conditions but will invariably contain toxic components and good ventilation is therefore essential.

Tobacco products must be kept well away from areas where they could be contaminated by PTFE dust."

[5)] Marking BS 6564-3:1990 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Appendix A Information to be agreed between the purchaser and the supplier

The following, where necessary, and the appropriate methods of test, should be agreed between the purchaser and the supplier:

a) the colour of the product (see clause **4**);

b) the type and grade of pigment to be used (see clause **4**);

c) the dimensional tolerances on moulded basic shapes (see **6.1**, **6.2** and **6.3**);

d) tolerances on the straightness of rod or tube;

e) tolerances on the parallelism and/or flatness of sheet;

f) the method and frequency of sampling for continuous production processes;

g) the amount of reprocessed material which can be incorporated into the product.

Appendix B Method for determining compression modulus

B.1 Principle

The tangent to the initial portion of the compression stress-strain curve is used to determine the compression modulus.

B.2 Apparatus

B.2.1 *Testing machine,* complying with BS 2782:Method 345A. For accuracy the machine shall meet the requirements specified for grade "B" testing machines in BS 1610-1.

B.3 Test specimens

The test specimens shall be right cylinders, 12.50 ± 0.10 mm in diameter and 30.00 ± 0.15 mm in length.

Machine the two end faces of the specimen such that they are flat, parallel to each other, and normal to the cylindrical axis, and such that the cylindrical axis of each specimen is parallel to the direction of the pressure applied during the fabrication process. Prepare three test specimens from the material.

B.4 Conditioning

Condition the test specimens at a temperature of 23 ± 2 °C for at least 4 h. If the material has been exposed to temperatures below 20 °C in the 24 h period immediately prior to conditioning, condition for at least 24 h.

B.5 Procedure

Condition the test specimen as given in **B.4**. Then carry out the procedure given in clause **10** of BS 2782:Method 345A:1979, compressing the test specimen at a rate of 1.5 ± 0.3 mm/min.

Terminate the test when a compression strain of 10 % has been reached.

B.6 Calculation

Calculate the compression modulus for each test specimen from the tangent drawn to the initial portion of the force-deformation curve. Calculate the mean compression modulus.

B.7 Test report

The test report shall include the following:

a) the identity of the test material;

b) the date of the test;

c) the mean value of the compression modulus;

d) the method, BS number and date, i.e. Appendix B of BS 6564-3:1990.

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Publications referred to

BS 308, *Engineering drawing practice.*

BS 308-1, *Recommendations for general principles.*

BS 1610, *Materials testing machines and force verification equipment.*

BS 1610-1, *Specification for the grading of the forces applied by materials testing machines.*

BS 2782, *Methods of testing plastics.*

BS 2782-3, *Mechanical properties.*

BS 2782:Method 327A, *Determination of tensile strength and elongation at break of polytetrafluoroethylene (PTFE) products.*

BS 2782:Method 345A, *Determination of compressive properties by deformation at constant rate.*

BS 2782-6, *Dimensional properties.*

BS 2782:Methods 620A to 620D, *Determination of density of solid plastics excluding cellular plastics (immersion method). Determination of density of solid plastics excluding cellular plastics (immersion method). Determination of density of solid plastics excluding cellular plastics (pyknometer method). Determination of density of solid plastics excluding cellular plastics (sink-float method). Determination of density of solid plastics excluding cellular plastics (density gradient column method).*

BS 3447, *Glossary of terms used in the glass industry.*

BS 6564, *Polytetrafluoroethylene (PTFE) materials and products.*

BS 6564-1, *Polytetrafluoroethylene (PTFE) powders for moulding and extrusion.*

BS 6564-1.1, *Specification.*

BS 6564-1.2, *Method of specifying*[6)].

BS 6564-2, *Specification for fabricated unfilled polytetrafluoroethylene products.*

[6)] Referred to in the foreword only.

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