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Rubber, vulcanized — Determination of tension fatigue

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National foreword

This British Standard is the UK implementation of ISO 6943:2017. It supersedes BS ISO 6943:2011, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/22, Testing and analysis of rubber.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.

This fourth edition cancels and replaces the third edition (ISO 6943:2011), of which it constitutes a minor revision to update the normative references in Clause 2.

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Rubber, vulcanized — Determination of tension fatigue

WARNING 1 — Persons using this document should be familiar with normal laboratory practice. This document does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

WARNING 2 — Certain procedures specified in this document might involve the use or generation of substances or the generation of waste, that could constitute a local environmental hazard. Reference should be made to appropriate documentation on safe handling and disposal after use.

1 Scope

This document specifies a method for the determination of the resistance of vulcanized rubbers to fatigue under repeated tensile deformations, the test piece size and frequency of cycling being such that there is little or no temperature rise. Under these conditions, failure results from the growth of a crack that ultimately severs the test piece.

The method is restricted to repeated deformations in which the test piece is relaxed to zero strain for part of each cycle. Analogous fatigue processes can occur under repeated deformations which do not pass through zero strain and also, in certain rubbers, under static deformation, but this document does not apply to these conditions.

The method is believed to be suitable for rubbers that have reasonably stable stress-strain properties, at least after a period of cycling, and that do not show undue stress softening or set, or highly viscous behaviour. Materials that do not meet these criteria might present considerable difficulties from the points of view of both experiment and interpretation. For example, for a rubber that develops a large amount of set during the fatigue test, the test strain will be ill-defined and the fatigue life is likely to differ markedly under constant maximum load and constant maximum extension conditions; how the results for such a rubber should be interpreted or compared with those for other rubbers, has not been established by basic work. As a general guide, a rubber for which the set determined in accordance with 9.5 and 10.2 exceeds 10 % is likely to fall into this category. For this reason, the method is not considered suitable for most thermoplastic elastomers.

Similar considerations apply with regard to other changes in elasticity behaviour during testing.

This fatigue test is distinct from the flexometer tests described in the various parts of ISO 4666, where fatigue breakdown occurs under the simultaneous action of stress and temperature.

Advantages over the De Mattia flex cracking and cut growth test (see ISO 132) include the following:

— the test yields quantitative results which do not depend on operator interpretation and which can be recorded automatically;

— the initial deformation is clearly defined and can readily be varied to suit different applications.

Great caution is necessary in attempting to relate standard test results to service performance since the comparative fatigue resistance of different vulcanizates can vary according to the test conditions used and to the basis by which the results are compared. Guidance on the selection of test conditions and on the interpretation of results is given in Annex A.

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.

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ISO 18899:2013, *Rubber — Guide to the calibration of test equipment*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

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

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

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

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

3.1
fatigue life
number of cycles required to break a test piece repeatedly deformed to a prescribed tensile strain

3.2
tension fatigue
fracture, through crack growth, of a component or test piece subjected to a repeated tensile deformation

4 Principle

Dumb-bell or ring test pieces are repeatedly deformed in simple extension until they fail by breaking. The test pieces are relaxed to zero strain for part of each cycle. The number of deformation cycles to failure, defined as the fatigue life, is determined as a function of the maximum strain and, if required, as a function of the maximum stress or strain energy density imposed during the test.

5 Apparatus

5.1 Fatigue-testing machine

The fatigue-testing machine shall provide a reciprocating motion at a frequency which shall normally be within the range 1 Hz to 5 Hz.

For testing dumb-bell test pieces, the machine shall be provided with clamps that grip the test piece sufficiently firmly to prevent slippage, irrespective of the magnitude of the strain applied.

For testing ring test pieces, each station on the machine shall be provided with two pairs of rollers, one pair fixed to the body of the machine and the other to the reciprocating part. To minimize friction, the rollers shall be fabricated from stainless or chromium-plated steel, well-polished and fitted with free-running ball races. The roller arrangement shall be such that the test pieces are held securely in place over the rollers throughout the test.

The stroke of the machine and the position of the fixed clamps or rollers shall be adjustable to provide a range of test strains. In all cases, the test piece shall be relaxed to zero strain for part of each cycle.

The fixed clamps or rollers should preferably be fitted with contacts or other means of operating counters to register the number of cycles to failure of each test piece.

If it is required to determine the maximum stress of the cycle, manual or automatic means for measurement of the load shall be provided. Stress-strain properties and strain energy density under test conditions can be determined for rings if automatic equipment for force-extension measurement is provided.

Alternatively, and for dumb-bell test pieces, stress-strain properties can be determined separately using a conventional tensile-testing machine.

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