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Plastics — Injection moulding of test specimens of thermoplastic materials —

Part 5: Preparation of standard specimens for investigating anisotropy

Plastiques — Moulage par injection des éprouvettes de matériaux thermoplastiques —

Partie 5: Préparation d'éprouvettes normalisées pour déterminer l'anisotropie

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 61, *Plastics*, Subcommittee SC 9, *Thermoplastic materials*.

This third edition cancels and replaces the second edition (ISO 294-5:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the size of the plate has been changed from 80 mm × 90 mm × 2 mm to 80 mm × ≥90 mm × 2 mm, preferably 80 mm × 120 mm × 2 mm;

— the maximum mould-locking force in 4.2 has been recalculated.

A list of all parts in the ISO 294 series can be found on the ISO website.

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Introduction

Reinforced and self-reinforcing injection-mouldable thermoplastics are used in a wide variety of applications, some of which can be safety-related. During the injection-moulding process, reinforcement fibres can preferentially align with the flow of the molten material and not across the flow direction. This preferential alignment causes an imbalance in the properties of the moulded thermoplastic so that, in the flow direction, the alignment of the reinforcing fibres causes a higher strength and stiffness than in the cross direction with fewer aligned fibres. This difference in properties is termed anisotropy and it may result in an injection-moulded component having less than the desired or designed strength. To aid designers in understanding the potential strength of an injection-moulded component, it is desirable to know about the anisotropy of an injection-moulded component.

During the development of this document, it was found that injection-moulded test specimens do not exhibit the same fibre alignment across their thickness, but that the outer layers have fibres preferentially aligned in the mould filling direction while the core has randomly oriented fibres (i.e. no preferential alignment). The ratio of the cross-sectional area of aligned-fibre orientation (i.e. "skin" layer thickness) to that of random-fibre orientation (i.e. "core" thickness) is affected by the specimen thickness and the mould filling rate, i.e. the average injection velocity. Thicker specimens exhibit a lower proportion of aligned fibres than do thinner specimens. Slower mould fill speeds lead to thicker "skin" layers with aligned fibres. As a result, to obtain meaningful data on a particular design of moulding, an investigator should prepare specimens with the maximum anisotropic properties, as this data will best represent the upper and lower bounds of a composite structure. Since the specimen thickness and injection velocity have a significant influence on the final anisotropy, this document should only be used for determining information that is useful in designing mouldings and not as a quality control test for the plastic material itself.

A survey of more than 10 raw material suppliers worldwide carried out from 2010 to 2013 clearly indicated that the preparation of plates which provide a suitable degree of anisotropy requires plates with non-square shape to ensure a fibre orientation in flow direction. Under the conditions of this study, the highest degree of anisotropy was obtained using a plate with dimensions 120 mm × 80 mm × 2 mm. It can be considered that plates longer than 120 mm will show at least as good results. Square plates (e.g. 80 mm × 80 mm × 2 mm or even 150 mm × 150 mm × 2 mm) resulted in problems sometimes independent of the size. Within this study, the plate with size 90 mm × 80 mm × 2 mm as required in the previous edition of this document did not perform well in any case.

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Plastics — Injection moulding of test specimens of thermoplastic materials —

Part 5: Preparation of standard specimens for investigating anisotropy

1 Scope

This document specifies a mould (designated the type F ISO mould) for the injection moulding of plates with a preferred size of 80 mm × 120 mm and a minimum size of 80 mm × ≥90 mm and with a preferred thickness of 2 mm for single-point and multi-point data acquisition. It has been found to provide the maximum anisotropic properties, with only a slight sensitivity to the rate of injection. Whenever possible, a two cavity mould is intended to be used. For the design of plastic parts, this will provide upper and lower bounds for the tensile properties. Matching the plate thickness to a given part thickness is not a suitable criterion because of the effect of mould filling rate and part geometry on anisotropy.

Investigation of the anisotropy of materials is a special procedure intended to provide guidance in the design of mouldings for end-use applications and is not intended as a quality control tool.

In the injection moulding of thermoplastic materials, the flow of molten polymer can influence the orientation of fillers such as fibreglass or the orientation of polymer chains, resulting in anisotropic behaviour.

For the purposes of this document, the flow direction is defined as the direction from the gate to the far end of the mould cavity and the cross direction as the direction perpendicular to the flow direction.

The type F mould is not intended to replace the type D mould used to determine the moulding shrinkage of thermoplastics.

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 294-1:2017, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar test specimens*

ISO 20753, *Plastics — Test specimen*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 294-1 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

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