INTERNATIONAL ISO

Third edition
2017-11

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

Reference number
ISO 294-5:2017(E)

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Foreword

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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.

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.