



International
Standard

ISO 19403-2

**Paints and varnishes —
Wettability —**

**Part 2:
Determination of the surface
free energy of solid surfaces by
measuring the contact angle**

Peintures et vernis — Mouillabilité —

*Partie 2: Détermination de l'énergie libre de surface des surfaces
solides par la mesure de l'angle de contact*

**Second edition
2024-09**

Reference number
ISO 19403-2:2024(en)

Full document details: ISO 19403-2-2024

© ISO 2024  **Documents**
Document Sharing Hub



COPYRIGHT PROTECTED DOCUMENT

© ISO 2024

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	1
5 Apparatus and materials	2
6 Sampling	3
7 Procedure	3
7.1 General for measuring on the horizontal drop	3
7.1.1 Setting up the contact angle measuring system	3
7.1.2 Test conditions	4
7.1.3 Conditioning of the test panels	4
7.2 Measurement	4
7.2.1 General	4
7.2.2 Static method	4
7.2.3 Dynamic method (progressive contact angle)	5
7.2.4 Determination of the contact angle	6
8 Evaluation	6
8.1 General	6
8.2 Owens-Wendt-Rabel-Kaelble method (OWRK method)	6
8.3 Wu method	7
9 Precision	8
9.1 General	8
9.2 Repeatability limit, r	8
9.3 Reproducibility limit, R	8
9.4 Calculation in accordance with the Owens-Wendt-Rabel-Kaelble method	8
10 Test report	9
Annex A (informative) Notes on measuring practice	10
Bibliography	14

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 139, *Paints and varnishes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 19403-2:2017), which has been technically revised.

The main changes are as follows:

- the minimum size of the text samples has been changed to 4 cm × 4 cm;
- definition 3.1 on “recently advanced contact angle” has been added;
- the use of ethylene glycol as test liquid has been deleted;
- in 7.2.1, the information on the camera tilt angle has been added;
- the normative references have been updated.

A list of all parts in the ISO 19403 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Paints and varnishes — Wettability —

Part 2:

Determination of the surface free energy of solid surfaces by measuring the contact angle

1 Scope

This document specifies a test method to measure the contact angle for the determination of the surface free energy of a solid surface. The method can be applied for the characterization of substrates and coatings.

NOTE 1 For the determination of the surface free energy of polymers and coatings, it is preferred to use either the method according to Owens, Wendt, Rabel and Kaelble [3], [4], [5] or the method according to Wu.

NOTE 2 The morphological and chemical homogeneity have an influence on the measuring results. The procedures indicated in this document are based on the state-of-the-art employing the drop projection method in penumbral shadow. Other methods are not excluded.

Measuring the contact angle on powders is not part of this document.

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 4618, *Paints and varnishes — Vocabulary*

ISO 19403-1:2022, *Paints and varnishes — Wettability — Part 1: Vocabulary and general principles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618, ISO 19403-1 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

recently advanced contact angle

contact angle of a droplet at rest after the three-phase contact line has advanced over a previously dry surface

Note 1 to entry: The recently advanced contact angle is thermodynamically not defined.

4 Principle

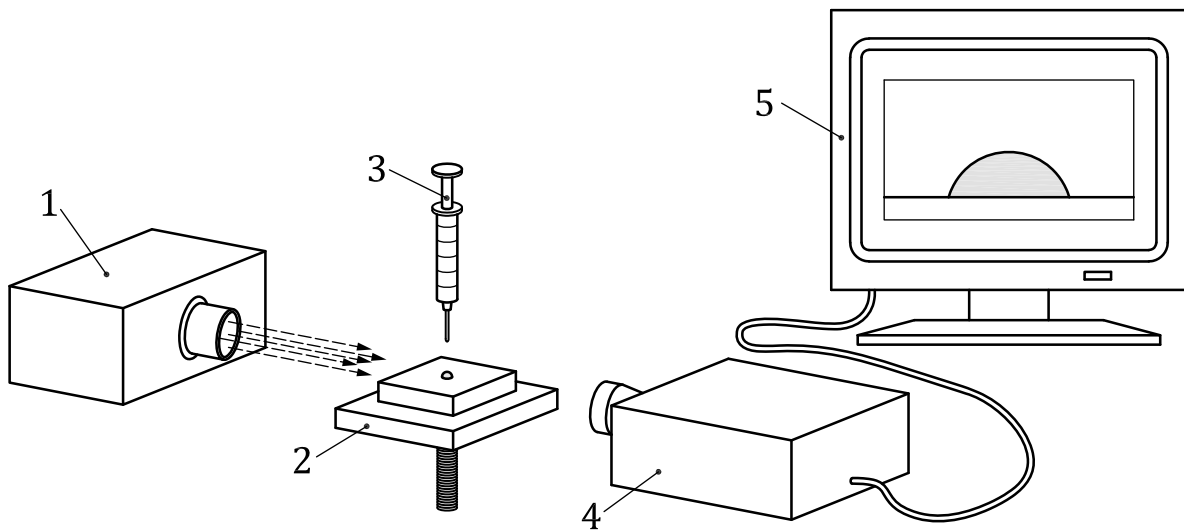
A minimum of three drops of at least two test liquids are dosed onto the flat surface of a test specimen. For every drop, the contact angle is measured. From the averaged contact angles of every liquid, their surface

tensions, as well as their polar and dispersive fractions, the surface free energy of the solid is calculated by means of an appropriate model, divided into the polar and dispersive fractions.

5 Apparatus and materials

Ordinary laboratory apparatus, together with the following shall be used.

5.1 Contact angle measuring system, i.e. any state-of-the-art contact angle measuring device, preferably with digital image capture and analysis for measuring the contact angle. [Figure 1](#) shows a schematic example of a contact angle measuring system.



Key

- 1 light source
- 2 specimen holder
- 3 graduated micro syringe or pressure based liquid needle dosing system
- 4 optical system
- 5 screen

NOTE 1 The image capturing system is oriented in a way that the optimal image resolution ratio (ratio of width and height) can be used.

NOTE 2 The device used can differ from the schematic diagram in regard to light path and the arrangement of the components.

Figure 1 — Schematic diagram of a contact angle measuring system

5.2 Dosing unit, which makes it possible to precisely apply drops in the range of microlitres to the surface. It should facilitate a drop deposition guaranteeing that one of the contact angles (as described in ISO 19403-1:2022, 3.1.9) can be reproducibly assessed. The recently advanced contact angle after liquid needle drop deposition has the least human influence and is thus recommended.

5.3 Test liquids, including at least two of those suggested in [Table 1](#). The test liquids shall have at least purity grade “for analysis”. Water shall have a surface tension of at least 71,5 mN/m at standard climate, i.e. $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 5) \%$ relative humidity.

It is recommended to measure the surface tension of the liquids to be used in accordance with ISO 19403-3. For guidance, the values from the literature for the surface tension, σ_l , are indicated in [Table 1](#). It is also possible to use an individually measured value of the surface tension as a reference value. According to