SLOVENSKI STANDARD
SIST-TP CEN ISO/TR 5602:2023

01-februar-2023

Viri napak pri uporabi elektrokemijske impedančne spektroskopije pri preiskavah premazov in drugih materialov (ISO/TR 5602:2021)

Sources of error in the use of electrochemical impedance spectroscopy for the investigation of coatings and other materials (ISO/TR 5602:2021)

Fehlerquellen bei der Anwendung elektrochemischer Elektroimpdanzspektroskopie bei der Untersuchung von Beschichtungen und anderer Stoffe (ISO/TR 5602:2021)

Sources d'erreur dans l'utilisation de la spectroscopie d'impédance électrochimique pour l'étude des revêtements et autres matériaux (ISO/TR 5602:2021)

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87.040	Barve in laki	Paints and varnishes

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TECHNICAL REPORT

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CEN ISO/TR 5602

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English Version

Sources of error in the use of electrochemical impedance spectroscopy for the investigation of coatings and other materials (ISO/TR 5602:2021)

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Fehlerquellen bei der Anwendung elektrochemischer Elektroimpdanzspektroskopie bei der Untersuchung von Beschichtungen und anderer Stoffe (ISO/TR 5602:2021)

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European foreword

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The text of ISO/TR 5602:2021 has been approved by CEN as CEN ISO/TR 5602:2022 without any modification.

TECHNICAL REPORT

ISO/TR 5602

First edition
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Sources of error in the use of electrochemical impedance spectroscopy for the investigation of coatings and other materials

Sources d'erreur dans l'utilisation de la spectroscopie d'impédance électrochimique pour l'étude des revêtements et autres matériaux

Reference number
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Foreword

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This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

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Introduction

Electrochemical impedance spectroscopy is described in detail in ISO 16773-1 to ISO 16773-4. It became apparent during use of these standards that sources of error and measurement artefacts that lead to incorrect interpretations are not dealt with comprehensively. This document supplements the ISO 16773 series of standards to deal with this issue.

Sources of error in the use of electrochemical impedance spectroscopy for the investigation of coatings and other materials

1 Scope

This document describes the main sources of error in the use of electrochemical impedance spectroscopy for the investigation of coatings and other materials. The sources of error listed here include all process steps from the set-up of the sample with the measuring cell right through to evaluation.

NOTE The sources of error discussed here do not represent a complete list.

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 — Terms and definitions*

ISO 16773-1, *Electrochemical impedance spectroscopy (EIS) on coated and uncoated metallic specimens — Part 1: Terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618, ISO 16773-1 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/

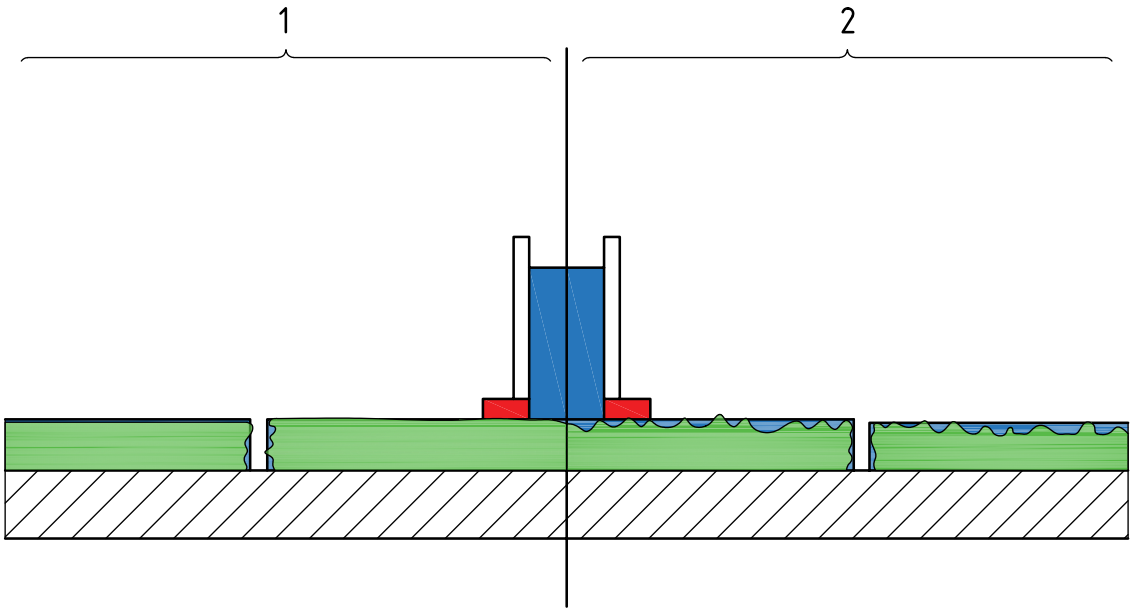
3.1
limit impedance
minimum or maximum impedance that can be measured using the impedance spectrometer

3.2
limit frequency
minimum or maximum frequency that can be set on the impedance spectrometer

4 Error in the make-up of the measuring cell

4.1 Roughness of the surface

A wet and rough surface could conduct stray currents to a scratch or artificial defect, see Figure 1. This could yield in a spectrum showing a much lower resistance than in reality. Examples of spectra are shown in Figure 2.

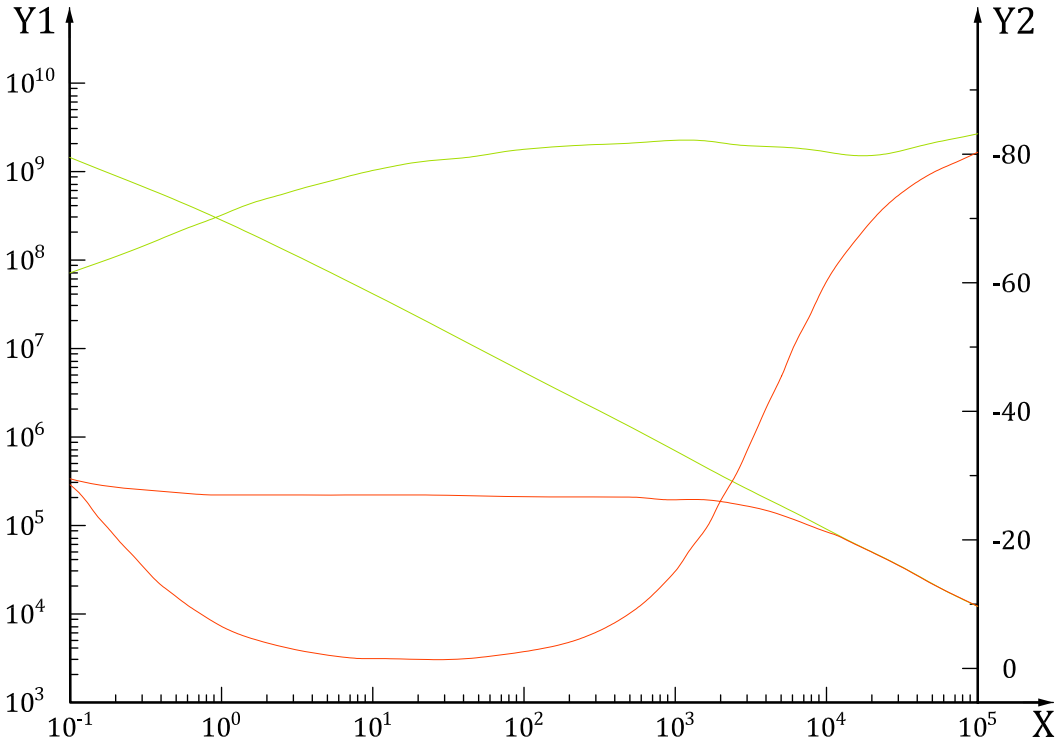


Key

1 without UV-irradiation
2 after UV-irradiation
PMMA tube
seal
coating
electrolyte
steel

Figure 1 — Conductive path from counter electrode to scratch due to surface roughness

The rough surface was measured on the unscratched area. Although the rough surface was dried with a tissue, the residual amount of water was sufficient to produce a conductive path via the scratch to the substrate. As result, the spectrum of the sample resulted in the incorrect identification of a defective coating. After 2 h of continuous immersion in the cell, the surface outside the cell had dried and the conductive path was interrupted, which resulted in a typical spectrum of an intact coating.



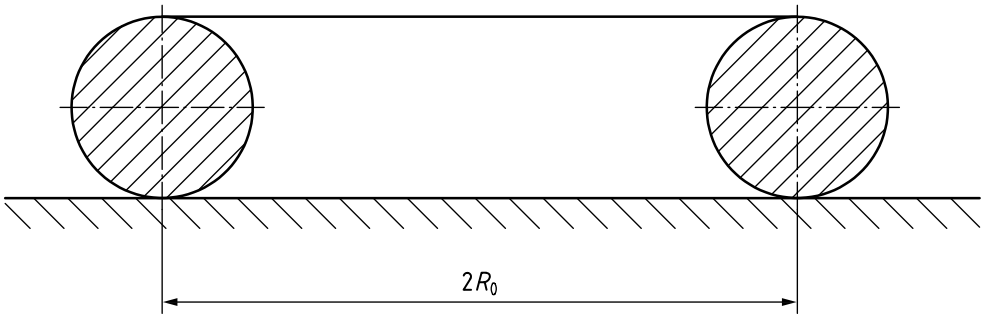
Key

X	frequency, f, in Hz
Y1	impedance, Z, in Ω
Y2	phase angle, φ, in degrees
	2 h drying
	wet

Figure 2 — EIS spectra of the initially wet coating and 2 h after drying

4.2 O-ring — Considerations about the precise determination of the exposed area

If an O-ring is used to seal the cell, the exposed area is smaller than the theoretically assumed area because the O-ring will be compressed, and therefore, the exposed area will be reduced (see Figure 3).



a) Ideal situation, uncompressed