BRITISH STANDARD

BS EN 2950:2008

Aerospace series — Test method — Wrought heat resisting alloys Semi-finished products and parts — Conditions for macrographic and micrographic examination — Atlas of structures and defects

ICS 49.025.01

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British Standards

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee ACE/61/-/48, Heat resisting alloys.

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

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Aerospace series - Test method - Wrought heat resisting alloys Semi-finished products and parts - Conditions for macrographic and micrographic examination - Atlas of structures and defects

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Luft- und Raumfahrt - Prüfverfahren - Umgeformte Erzeugnisse aus hochwarmfesten Legierungen - Prüfbedingungen für makrographische und mikrographische Untersuchung - Gefüge- und Fehleratlas

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Foreword

This document (EN 2950:2008) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2009, and conflicting national standards shall be withdrawn at the latest by February 2009.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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1 Scope

The present document defines the conditions for the macrographic and micrographic examination of heat resisting alloy semi-finished and parts.

It includes an atlas of commonly encountered and structural defects.

The present document shall be applied in conjunction with the material standards specifying the criteria of acceptance.

The present document is not intended to apply to cast or powder metallurgy products.

2 Normative references

The following referenced documents are indispensable for the application 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.

EN 2078, *Aerospace series — Metallic materials — Manufacturing schedule, inspection schedule, inspection and test report — Definition, general principles, preparation and approval*

3 Terms and definitions

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

3.1
tree rings
one or more concentric or non-concentric rings evidenced by a difference in texture associated with minor composition gradients due to ingot solidification

3.2
dendritic aspect
coarse structure having a fir-tree like appearance initiated during the solidification of the ingot

3.3
grain flow
fibre like lines which are caused by orientation of the constituents of the metal during deformation

3.4
recrystallisation
formation of a new grain structure from that existing previously

3.5
freckles
a type of segregation consisting of circular or near-circular dark etching areas, generally enriched with carbides and hardening elements

3.6
white spots
a type of segregation consisting of bright white areas having bulk or fibrous configuration, generally depleted in carbides and hardening elements

3.7
stringer
predominantly straight linear formation which is ≤ 2 particles in width

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3.8
cluster
predominantly straight elongated formation which is mainly > 2 particles in width

3.9
chain
linear formation whose particle distribution does not lie predominantly in a straight line

3.10
random
distribution of particles with no particular orientation

4 Macrographic examination

4.1 General

Macrographic examination shall be carried out in accordance with this standard and by reference to Annex A (normative) to verify that the requirements of the relevant material standard, technical specification or order have been met.

4.2 Product surface examination

4.2.1 General

Examination shall be performed on the entire surface of the product in the delivery heat treatment condition unless otherwise agreed between the manufacturer and the purchaser. Handling zones which may cause imperfect etching shall be defined and agreed between the manufacturer and the purchaser, and shall not be taken into account in the evaluation.

4.2.2 Surface preparation

Preparation shall not alter, contaminate or cold work the surface structure.

The product shall be cleaned and degreased to ensure uniform etching.

4.2.3 Macroetching

The etching method to be used shall be agreed between the manufacturer and purchaser. A list of typical etching reagents and conditions are given in Table 1. All structural characteristics, particularly the segregation resulting from solidification of the ingot shall be revealed.

After etching, the surfaces shall be cleaned in a way which does not affect the quality of the contrast and shall be protected from deterioration and contamination until inspection is carried out.

4.2.4 Examination

Examination shall be carried out under a minimum light intensity of 250 Lux.

Examination shall normally be performed without magnification but when necessary may be supplemented by the use of a magnification up to a maximum of × 12.

In case of doubt or when the structural features are unusual, a micrographic examination of the affected area shall be made in accordance with Clause 5.

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4.3 Cut-up examination

4.3.1 General

Unless otherwise agreed between the manufacturer and the purchaser, examination shall be performed on a plane section of the product in the delivery heat treatment condition.

The location and orientation of the plane section shall be as required by the relevant technical specification or order.

The cutting method shall not cause damage to the structure. Slices shall be of sufficient thickness to allow further examination perpendicular to this plane section if required.

4.3.2 Surface preparation

The surface to be examined shall be prepared in such a way that any contamination and mechanical alteration of the surface are avoided or eliminated.

The resulting surface shall be cleaned and degreased to ensure uniform etching.

4.3.3 Macroetching

Wherever possible, electro-chemical techniques shall be used.

The etching method to be used, shall be carried out by a technical agreed between manufacturer and purchaser. A list of typical etching reagents and conditions is given in Table 1.

Etching shall reveal all structure characteristics, particularly segregation resulting from the ingot solidification. After etching, the surface shall be cleaned in a way which does not affect the quality of the contrast and shall be protected from deterioration and contamination until inspection is carried out.

Table 1

Alloy type	Etchant		Conditions
	Name	Composition vol. %	
Fe, Ni base	Hydrochloric etch	HCl ..... 50 H_2O 50	Electrolytic ($40\ A/dm^2 < I < 100\ A/dm^2$) Ambient temperature
Fe, Ni base with Nb	Ferric chloride	$FeCl_3$ ..... 49 HCl ..... 4 H_2O 47	Chemical $40\ °C < \theta < 120\ °C$
Fe, Ni, Co base	Sulphuric etch	H_2SO_4 ..... 95 H_2O 5	Electrolytic $25\ A/dm^2$ Ambient temperature

4.3.4 Examination

Macrographic examination shall be carried out in accordance with 4.2.4.

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5 Micrographic examination

5.1 General

Micrographic examination shall be carried out in accordance with this standard and by reference to Annex B (normative) and to verify the requirements of the relevant material standard and/or order have been met.

5.2 Product surface examination

5.2.1 General

Examination shall be carried out to investigate anomalies observed during macrographic examination (see 4.2.4) or when required by the material standard.

5.2.2 Surface preparation

Material shall be removed from the surface to be examined until it is polished to a mirror finish and is free from cold working, contamination and the effects of prior surface preparation.

5.2.3 Microetching

Micro examination may be required in either or both polished and etched conditions. When etching is required, the method to be used shall be agreed between manufacturer and purchaser. A list of typical etching reagents and conditions is given in Table 2.

After etching, the surfaces shall be cleaned in a way which does not affect the quality of the contrast, and shall be protected from deterioration and contamination until examination is carried out.

Table 2

Alloy type	Etchant		Conditions
	Name	Composition	
Co base	Nital	2 % ≤ HNO_3 ≤ 10 % ethyl alcohol	Electrolytic Ambient temperature
Fe, Ni base low Al, Ti content	Fry's reagent	$CuCl_2$ ..... 20 g HCl ..... 200 ml H_2O ..... 100 ml	Chemical Ambient temperature
Fe, Ni, Co base	Murakami's reagent	KOH ..... 10 g $K_3Fe(CN)_4$ ..... 8 g H_2O ..... 100 ml	Chemical 60 °C < θ < 90 °C
Ni base high Al, Ti content	Glyceregia	HCl ..... 20 ml HNO_3 ..... 10 ml Glycerol ..... 35 ml	Electrolytic Ambient temperature
Ni base High Cr, Al, Ti content	HF/Glycerol	HF ..... 5 ml Glycerol ..... 10 ml H_2O ..... 85 ml	Electrolytic Ambient temperature

5.2.4 Examination

Examination shall be carried out directly on the prepared surface or by using a replica, under an optical microscope with a minimum magnification of × 50.

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Wherever possible, examination shall be made at the same magnification as the reference photomicrograph. In all cases, the magnification used shall permit resolution of the structural characteristics sought.

5.3 Cut-up examination

5.3.1 General

Examination shall be carried out on a plane section of the product in order to investigate anomalies observed during macrographic examination (see 4.3.4) or when required by the material standard, technical specification or order. In case of such a requirement, this examination shall be carried out in the heat treatment condition required by the relevant material standard.

5.3.2 Sampling

The location and orientation of samples shall be as required by the relevant material standard or order or as determined by the presence of macro anomalies.

The sampling method shall not cause damage to the structure.

5.3.3 Surface preparation

The surface preparation shall be carried out in accordance with 5.2.2.

5.3.4 Microetching

Microetching shall be carried out in accordance with 5.2.3.

5.3.5 Examination

Examination shall be carried out in accordance with 5.2.4.

6 Reporting of results

The results of macro or micro examination shall be recorded in the inspection and test report in accordance with EN 2078.

Each photograph of the structure shall be identified with the location, orientation, etch method and magnification.

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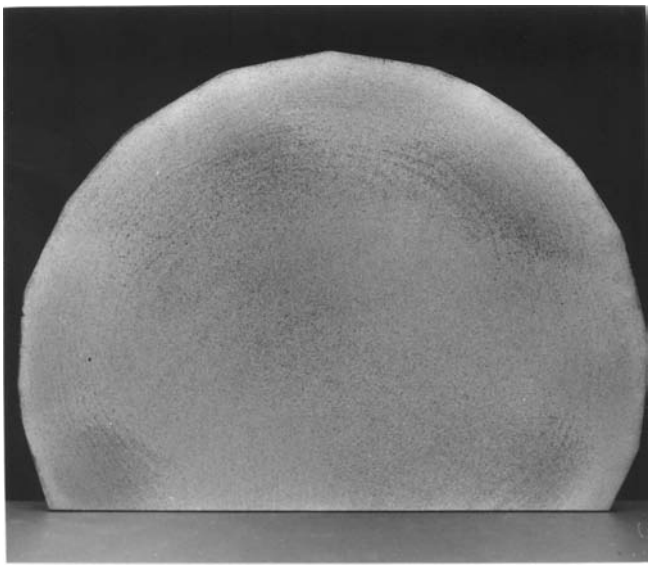
Annex A
(normative)

Atlas of macrographic references

A.1 Tree rings

A.1.1 Concentric tree rings

See Figure A.1 (A to E).



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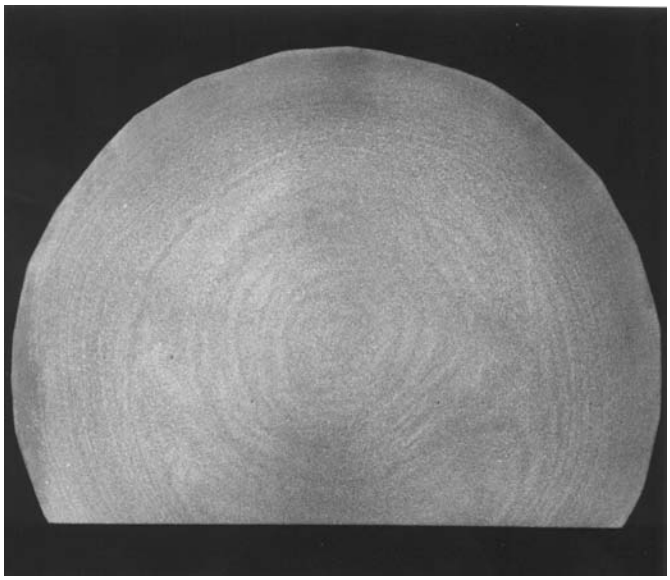

B

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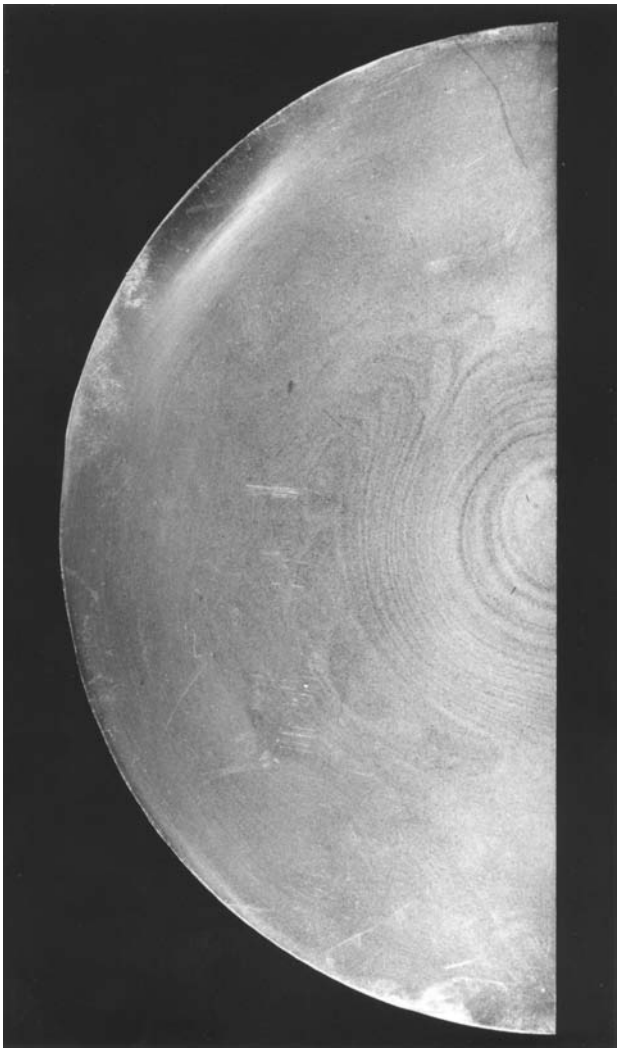

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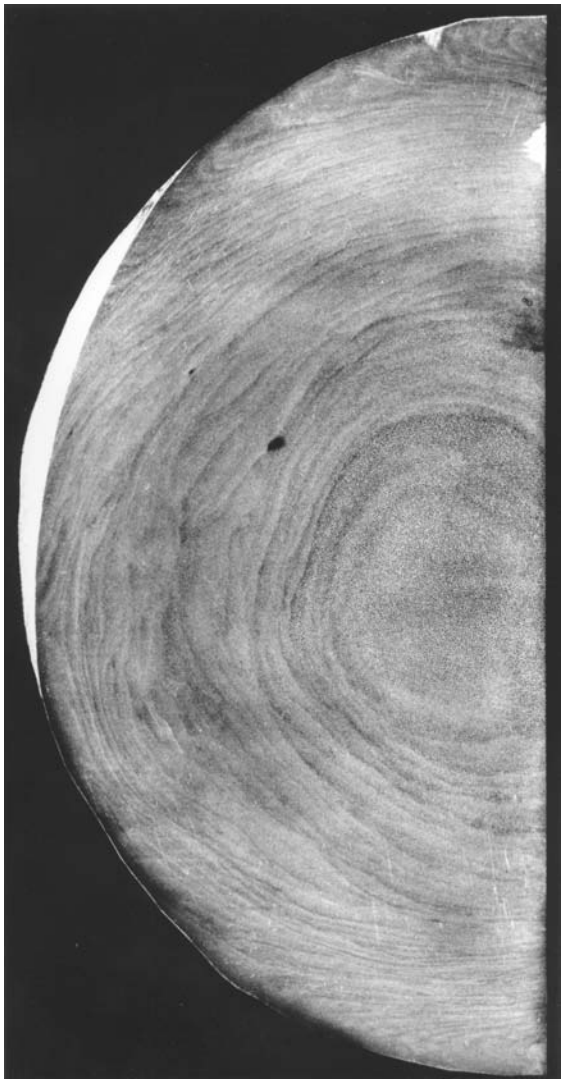

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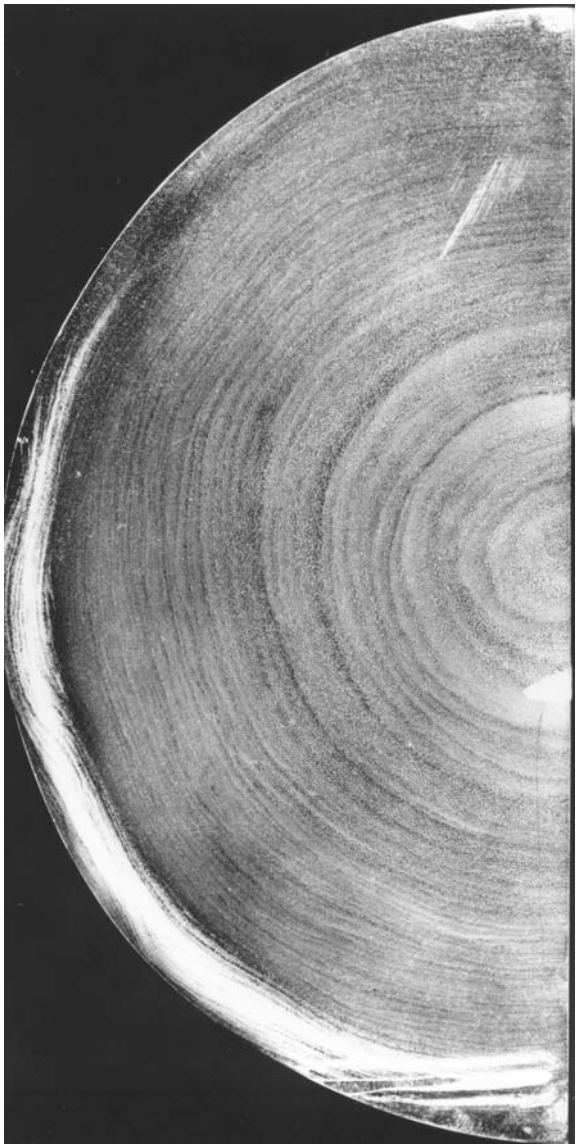

E

Figure A.1

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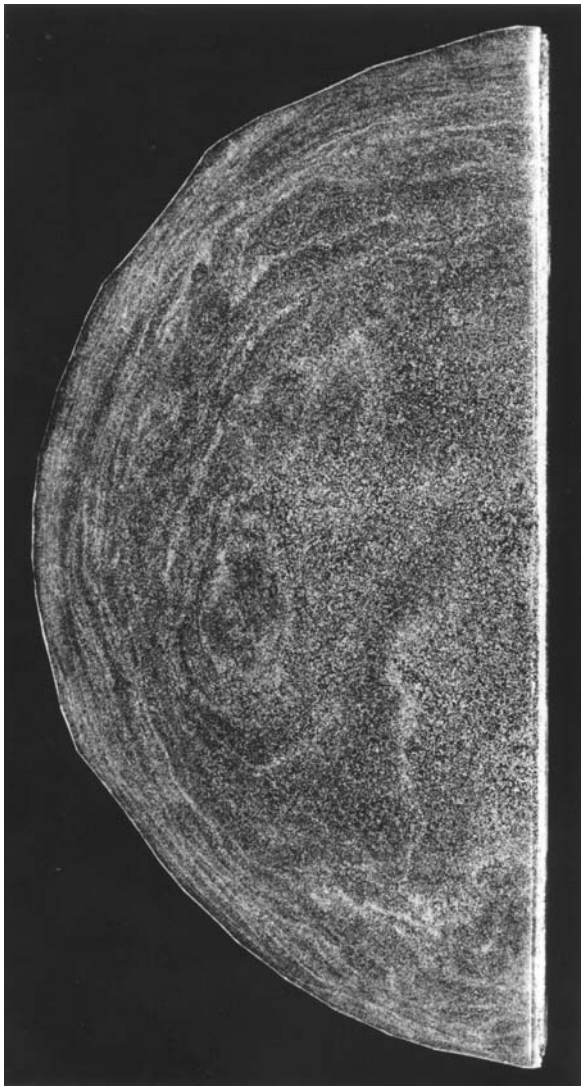
A.1.2 Non-concentric tree ring

See Figure A.2 (A to F).

A



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