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**Microstructure of cast irons —**  
**Part 3:**  
**Matrix structures**

*Microstructure des fontes —*  
*Partie 3: Structures de matrice*

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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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 25, *Cast irons and pig irons*.

ISO 945 consists of the following parts, under the general title *Microstructure of cast irons*:

- *Part 1: Graphite classification by visual analysis*
- *Part 2: Graphite classification by image analysis* [Technical Report]
- *Part 3: Matrix structures* [Technical Report]

The following parts are under preparation:

- *Part 4: Determination of nodularity in spheroidal graphite cast irons*

## Introduction

The designation of cast iron matrix structures as given in this part of ISO 945 is in conformity with the designations published by several national foundry organisations<sup>[1][2][3]</sup> or other publishers<sup>[4]</sup>.

This Technical Report aims to

- give the designations, precise descriptions and reference micrographs of the matrix structures of cast irons, and
- facilitate the discussion and to avoid misunderstanding between manufacturer and purchaser regarding the identification of matrix structures.

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# Microstructure of cast irons —

## Part 3: Matrix structures

### 1 Scope

This Technical Report gives the designations, descriptions and reference micrographs of the matrix structures of cast irons.

It applies to the following types of cast irons:

- grey cast irons ([Table 4.1](#));
- spheroidal graphite cast irons ([Table 4.2](#));
- austenitic cast irons ([Table 4.3](#));
- malleable cast irons ([Table 4.4](#));
- compacted (vermicular) graphite cast irons ([Table 4.5](#));
- ausferritic spheroidal graphite cast irons ([Table 4.6](#));
- abrasion-resistant cast irons ([Table 4.7](#)).

Each matrix structure is defined with explanations and micrographs.

Unless otherwise stated in [Clause 4](#), the micrographs shown correspond to samples etched with a solution of 2 % nitric acid in ethanol (Nital).

### 2 Designations and descriptions of cast iron microstructures

#### 2.1 Ferrite

Ferrite also known as  $\alpha$ -ferrite ( $\alpha$ -Fe) or alpha iron is a materials science term for iron, or for a solid solution with iron as the main constituent, with a body-centred cubic crystal structure. It is this crystalline structure which gives to steels and cast irons their magnetic properties, and is the classic example of a ferromagnetic material.

Since pearlite has ferrite as a component, any iron-carbon alloy will contain some amount of ferrite if it is allowed to reach equilibrium at room temperature. The exact amount of ferrite will depend on the cooling processes the iron-carbon alloy undergoes when it cools from liquid state.

#### 2.2 Pearlite

Pearlite is a two-phased, lamellar (or layered) structure composed of alternating layers of alpha-ferrite (according thermal dynamical condition 88 % by mass) and cementite (12 % by mass). The lamellar appearance is misleading since the individual lamellae within a colony are connected in three dimensions; a single colony is therefore an interpenetrating bicrystal of ferrite and cementite. Pearlite is a common microstructure occurring in many grades of cast irons.

If cast iron is cooled very slowly or as a result of heat treatment, the cementite can occur in globules instead of in layers. This structure is designated as globular pearlite.

### 2.3 Austenite

Austenite, also known as gamma phase iron ( $\gamma$ -Fe), is a non-magnetic allotrope of iron or a solid solution of iron, stabilized by an alloying element, e.g. nickel. Austenite is the face-centred cubic crystal structure of iron.

### 2.4 Acicular ferrite

Acicular ferrite is a microstructure of ferrite that is characterized by needle shaped crystallites or grains when viewed in two dimensions. The grains, actually three dimensional in shape, have a thin lenticular shape. This microstructure is advantageous over other microstructures because of its chaotic ordering, which increases toughness.

### 2.5 Ausferrite

Ausferrite is a special type of multi-phase microstructure that occurs when cast irons with a silicon content of about 2 % or higher are austempered.

Austempering consists of rapidly cooling the fully austenitic iron to avoid the formation of pearlite to a temperature above that of martensite formation and holding for the time necessary to precipitate the ausferrite matrix. This microstructure consists primarily of acicular ferrite in carbon enriched austenite.

### 2.6 Bainite

Bainite is a multi-phase microstructure, consisting of acicular ferrite and cementite that forms in cast irons during rapid cooling. It is one of the decomposition products that can form when austenite is cooled rapidly below the eutectoid temperature, but above the martensitic starting ( $M_s$ ) temperature. Bainite can also form from the decomposition of ausferrite upon extended heating above the temperature at which it was formed.

### 2.7 Cementite

Cementite, also known as iron carbide, is a compound of iron and carbon, with the formula  $Fe_3C$ .

By mass, it is 6,7 % carbon and 93,3 % iron. Cementite has an orthorhombic crystal structure.

In the iron-carbon system cementite is a common constituent because ferrite contains maximum 0,02 % by mass of carbon. Therefore, in cast irons that are slowly cooled, a part of these elements is in the form of cementite. In the case of white cast irons, cementite precipitates directly from the melt. In grey cast irons or spheroidal graphite cast irons, cementite forms either from austenite during cooling or from martensite during tempering, or from the decomposition of ausferrite. An intimate mixture of cementite with ferrite, the other product of austenite, forms a lamellar structure called pearlite (see [2.2](#)).

### 2.8 Ledeburite

Ledeburite is an eutectic mixture of austenite and cementite and is formed when the melt at least partly solidifies according the metastable Fe-C-Si system.

### 2.9 Martensite

Martensite is formed from austenite by rapid cooling (quenching) which traps carbon atoms that do not have time to diffuse out of the crystal structure. The martensite lattice is body-centred tetragonal composed of ferrite and carbon. This martensitic reaction begins during cooling when the austenite reaches the martensite start temperature ( $M_s$ ) and the parent austenite becomes mechanically unstable. At a constant temperature below  $M_s$ , a fraction of the parent austenite transforms rapidly, after which no further transformation occurs. When the temperature is decreased, more of the austenite transforms to martensite. Finally, when the martensite finish temperature ( $M_f$ ) is reached,

the transformation ends. Martensite can also be formed by application of stress in ausferritic spheroidal graphite cast irons (SITRAM effect: stress induced transformation from austenite to martensite). Thus, martensite can be thermally induced or stress induced.

### 3 Sampling and preparation of samples

#### 3.1 Samples taken from castings and cast samples

The location from which samples are taken should be agreed between the manufacturer and purchaser and should take into account the requirements specified in the appropriate material standard. If an examination report is required, the location from where the final sample is taken shall be recorded.

The sample should be of sufficient size to provide a true representation of the matrix structure in the agreed location from which it is taken.

#### 3.2 Sample preparation

Attention should be paid to the careful cutting, grinding, polishing and etching of samples, so that the matrix structure appears in its original form. Inappropriate preparation can cause alteration of the microstructure and misinterpretations.

Sample preparation should be carried out in four stages:

- 1) sectioning;
- 2) grinding;
- 3) polishing;
- 4) etching.

NOTE In some cases mounting of the sample in a polymeric material can be necessary.

The examination of the matrix structure shall be carried out in the etched condition.

## 4 Matrix structures

### 4.1 Grey cast irons

Table 4.1 — Grey cast irons according to ISO 185<sup>[5]</sup>

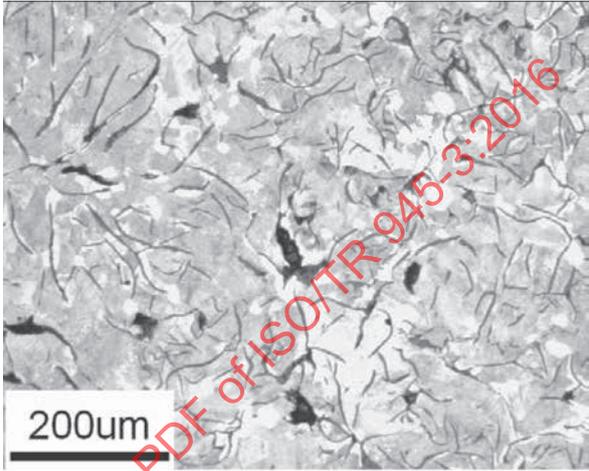
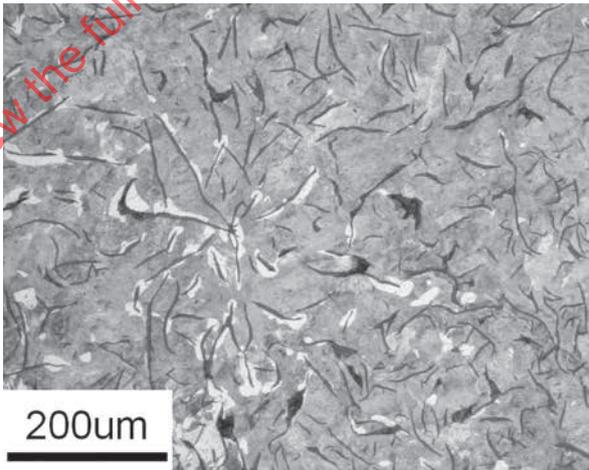
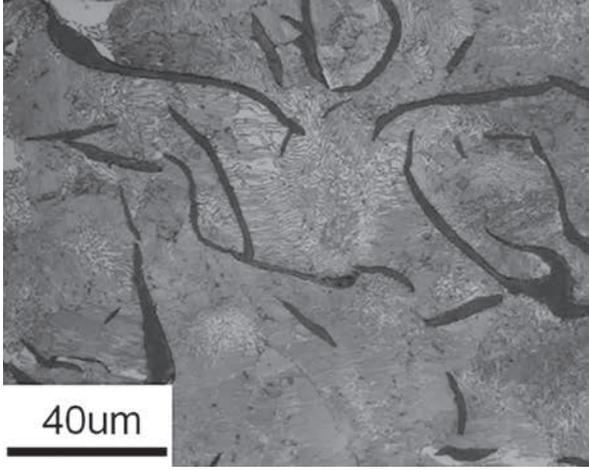
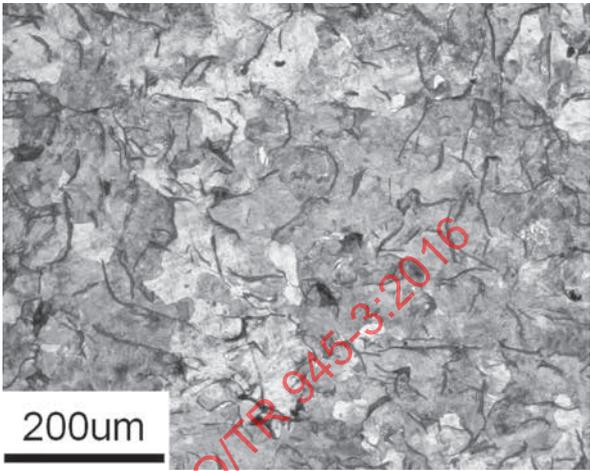
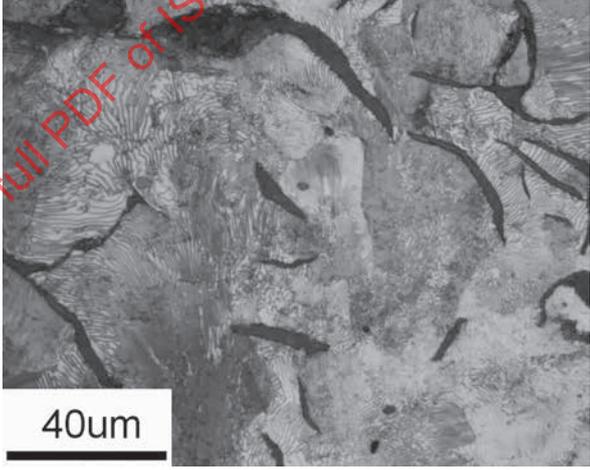
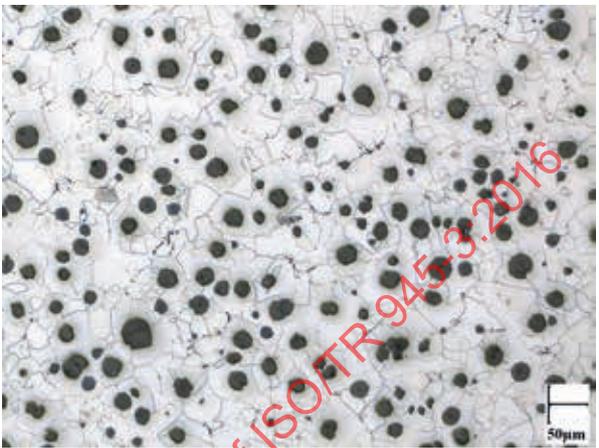
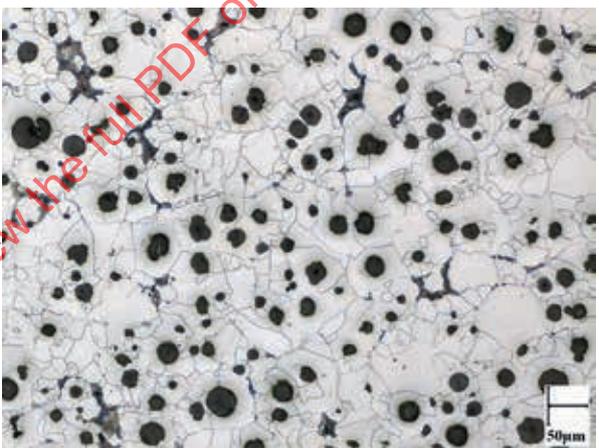
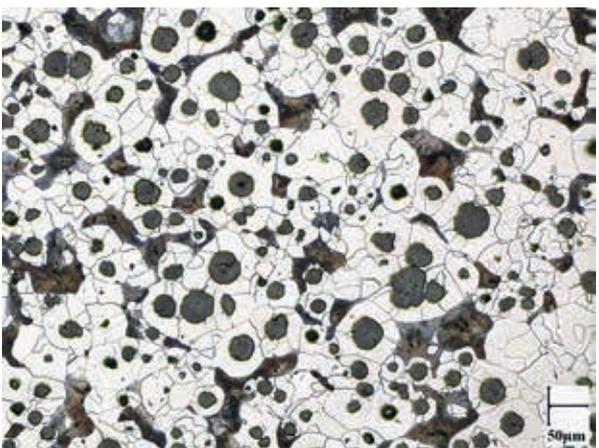
Micro-graph	Material designation	Matrix structure	Matrix structure
4.1.1	ISO 185/JL/100 ISO 185/JL/HBW155	Pearlite – ferrite 100 x  <div data-bbox="592 913 759 976">200 μm</div>	
4.1.2	ISO 185/JL/150	Pearlite – ferrite 100 x  <div data-bbox="592 1406 759 1469">200 μm</div>	
4.1.3	ISO 185/JL/HBW175	Pearlite – ferrite 500 x  <div data-bbox="592 1895 759 1957">40 μm</div>	

Table 4.1 (continued)

Micro-graph	Material designation	Matrix structure	
4.1.4	ISO 185/JL/200 ISO 185/JL/225 ISO 185/JL/250 ISO 185/JL/275	Predominantly pearlite 100 x Shown is JL/250  <div style="border: 1px solid black; padding: 2px; display: inline-block;">200 <math>\mu</math>m</div>	
4.1.5	ISO 185/JL/HBW195 ISO 185/JL/HBW215	Predominantly pearlite 500 x Shown is JL/250  <div style="border: 1px solid black; padding: 2px; display: inline-block;">40 <math>\mu</math>m</div>	
4.1.6	ISO 185/JL/300 (shown) ISO 185/JL/350  ISO 185/JL/HBW235 ISO 185/JL/HBW255	Pearlite 100x  <div style="border: 1px solid black; padding: 2px; display: inline-block;">200 <math>\mu</math>m</div>	

4.2 Spheroidal graphite cast irons

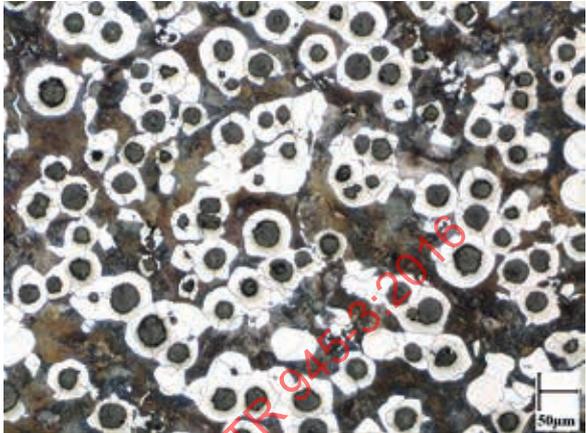
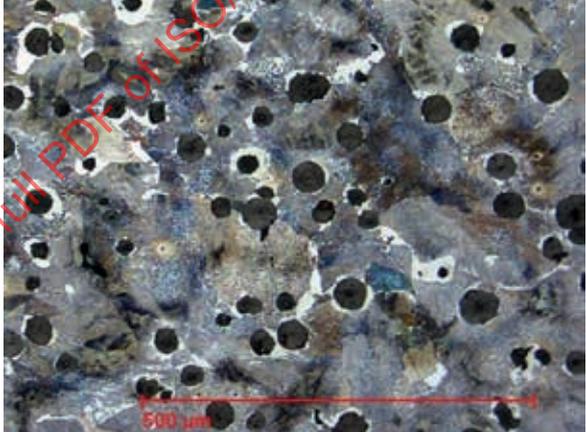
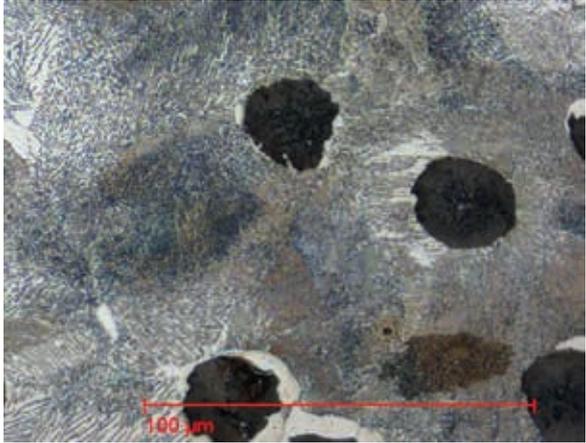
Table 4.2 — Spheroidal graphite cast irons according to ISO 1083<sup>[6]</sup>

Micro-graph	Material designation	Matrix structure	
4.2.1	ISO 1083/JS/350-22 ISO 1083/JS/400-18 ISO 1083/JS/400-15 ISO 1083/JS/500-10  ISO 1083/JS/HBW130 ISO 1083/JS/HBW150 ISO 1083/JS/HBW155	Ferrite 100x  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">200 μm</div>	
4.2.2	ISO 1083/JS/450-10 ISO 1083/JS/HBW185	Predominantly <sup>a</sup> ferrite 100x  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">200 μm</div>	
4.2.3	ISO 1083/JS/500-7 ISO 1083/JS/550-5 ISO 1083/JS/HBW200 ISO 1083/JS/HBW215	Ferrite – pearlite 100x  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">200 μm</div>	

<sup>a</sup> The term “predominantly” does not appear in ISO 1083, only “ferrite”.

NOTE Information regarding the evaluation of the pearlite content of the matrix of spheroidal graphite cast iron is given in [Annex A](#).

Table 4.2 (continued)

Micro-graph	Material designation	Matrix structure	
4.2.4	ISO 1083/JS/600-3 ISO 1083/JS/HBW230	Pearlite – ferrite 100x  	
4.2.5	ISO 1083/JS/700-2	Predominantly <sup>a</sup> pearlite 100x  	
4.2.6	ISO 1083/JS/HBW265	Pearlite 500x  	

<sup>a</sup> The term “predominantly” does not appear in ISO 1083, only “ferrite”.

NOTE Information regarding the evaluation of the pearlite content of the matrix of spheroidal graphite cast iron is given in [Annex A](#).

Table 4.2 (continued)

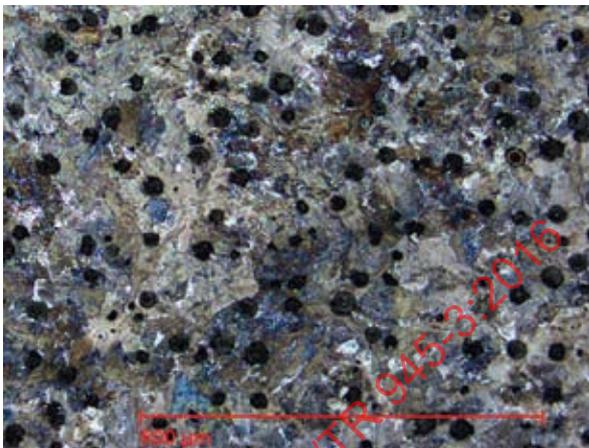
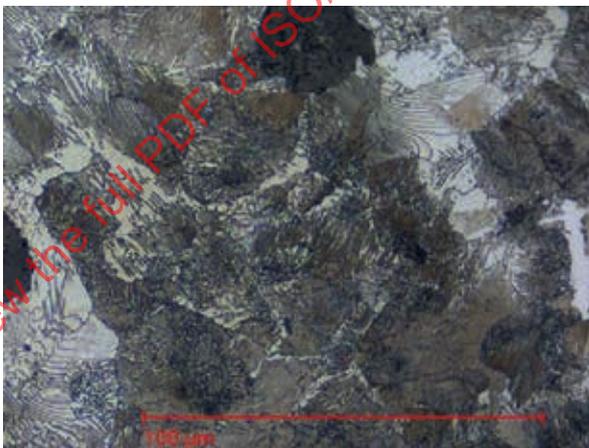
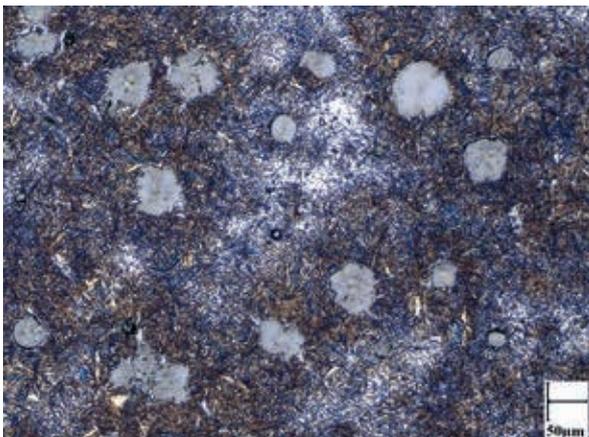
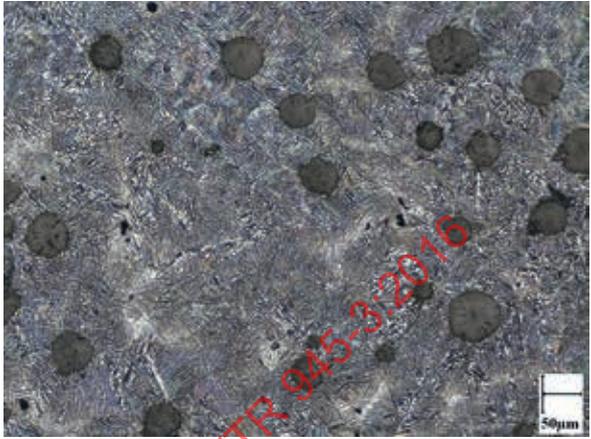
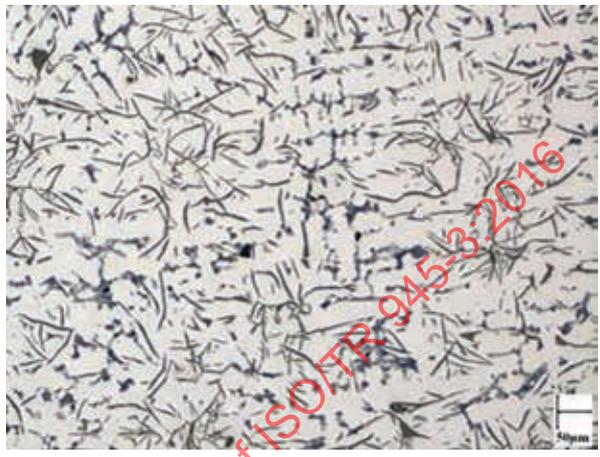
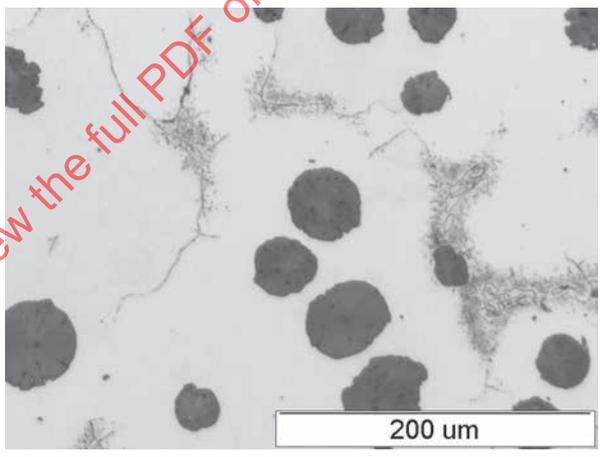
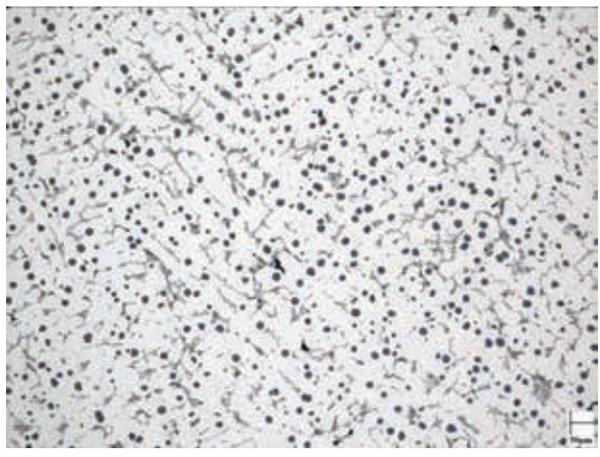
Micro-graph	Material designation	Matrix structure	
4.2.7		Pearlite (shown) or tempered martensite (shown in 4.2.9) 100x	
4.2.8	ISO 1083/JS/800-2 ISO 1083/JS/HBW300	Pearlite 500x	
4.2.9		Tempered martensite 100x	
<p><sup>a</sup> The term “predominantly” does not appear in ISO 1083, only “ferrite”.</p> <p>NOTE Information regarding the evaluation of the pearlite content of the matrix of spheroidal graphite cast iron is given in <a href="#">Annex A</a>.</p>			

Table 4.2 (continued)

Micro-graph	Material designation	Matrix structure	
4.2.10	ISO 1083/JS/900-2	Bainite-martensite (shown) or tempered martensite (shown in 4.2.9) 100x  	
4.2.11	ISO 1083/JS/HBW330	Bainite-martensite 1 000x  	
<p><sup>a</sup> The term “predominantly” does not appear in ISO 1083, only “ferrite”.</p> <p>NOTE Information regarding the evaluation of the pearlite content of the matrix of spheroidal graphite cast iron is given in <a href="#">Annex A</a>.</p>			

4.3 Austenitic cast irons

Table 4.3 — Austenitic cast irons according to ISO 2892[Z]

Micro-graph	Material designation	Matrix structure	
4.3.1	ISO 2892/JLA/XNi15Cu6Cr2 ISO 2892/JLA/XNi13Mn7	Austenite 100x Shown is JLA/XNi15Cu6Cr2	
4.3.2	ISO 2892/JSA/XNi20Cr2 ISO 2892/JSA/XNi23Mn4 ISO 2892/JSA/XNi20Cr2Nb ISO 2892/JSA/XNi22 ISO 2892/JSA/XNi35	Austenite Shown are JSA/XNi20Cr2 200x	
4.3.3	ISO 2892/JSA/XNi35Si5Cr2 ISO 2892/JSA/XNi13Mn7 ISO 2892/JSA/XNi30Cr3 ISO 2892/JSA/XNi30Si5Cr5 ISO 2892/JSA/XNi35Cr3	and JSA/XNi35Cr3 100x	

4.4 Malleable cast irons

Table 4.4 — Malleable cast irons according to ISO 5922[8]

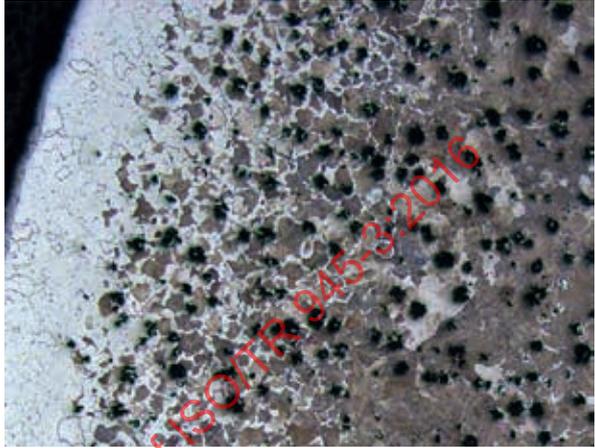
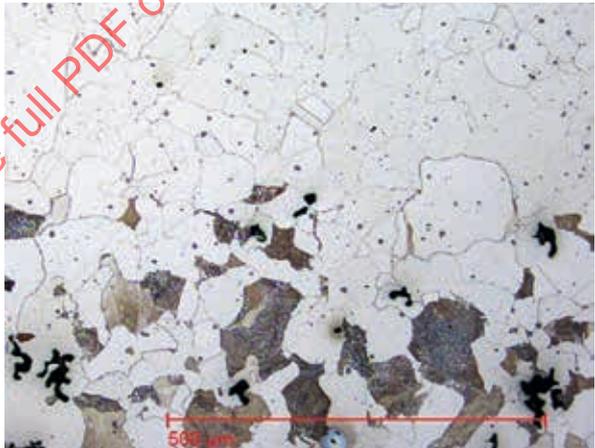
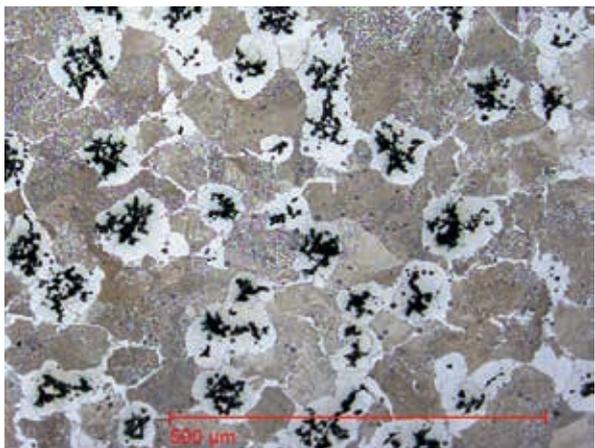
Micro-graph	Material designation	Matrix structure	
4.4.1		Ferrite and pearlite 25x  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin-left: auto;">800 μm</div>	
4.4.2	ISO 5922/JMW/350-4 Furnace cooled	Surface zone Predominantly ferritic 100x  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin-left: auto;">200 μm</div>	
4.4.3		Core zone Pearlite and ferrite 100x  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin-left: auto;">200 μm</div>	

Table 4.4 (continued)

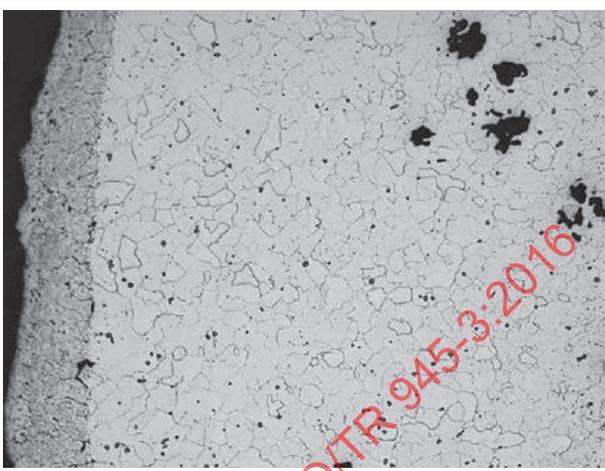
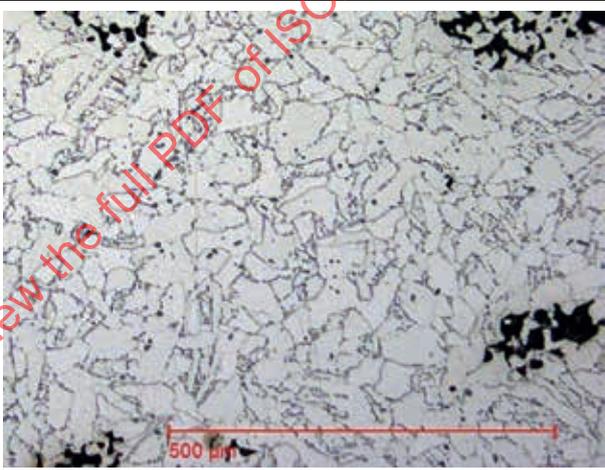
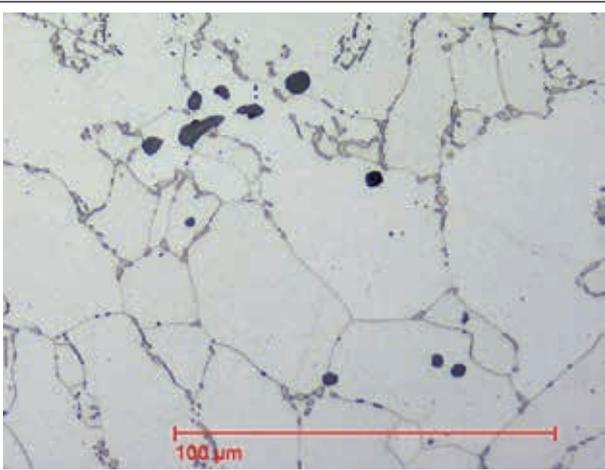
Micro-graph	Material designation	Matrix structure	
4.4.4		Surface zone Ferrite 50x	
4.4.5	ISO 5922/JMW/360-12 Air quenched	Core zone Predominantly ferritic 100x	
4.4.6		Core zone Predominantly ferritic 500x	

Table 4.4 — (continued)

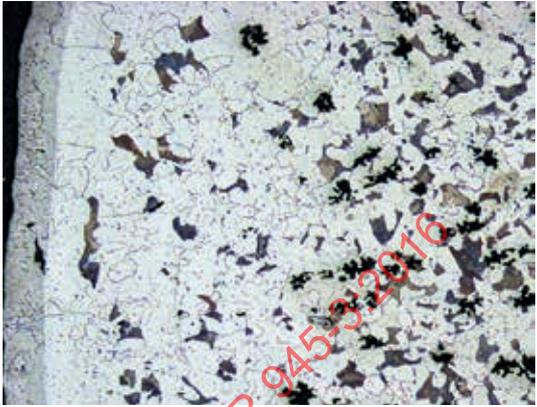
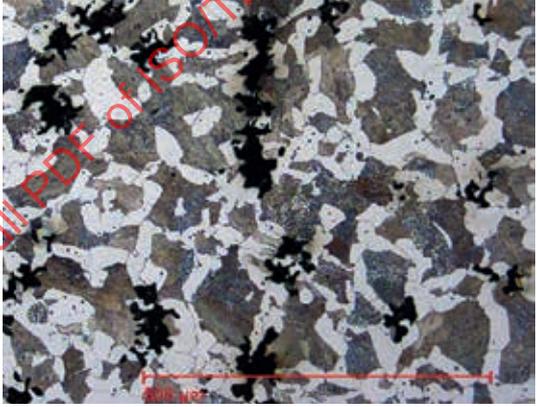
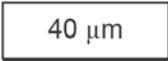
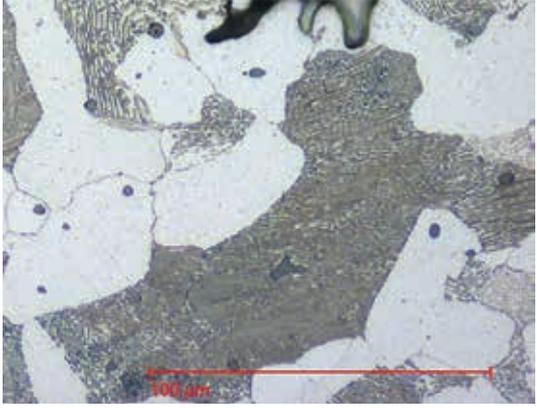
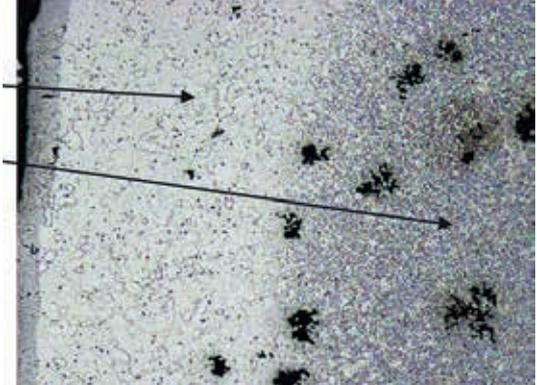
Micro-graph	Material designation	Matrix structure	
4.4.7	ISO 5922/JMW/400-5 Furnace cooled	Surface zone Predominantly ferritic 50x  	
4.4.8		Core zone Ferrite and pearlite 100x  	
4.4.9		Core zone Ferrite and pearlite 500x  	
4.4.10	ISO 5922/JMW/450-7 Air quenched	Surface zone Ferrite and globular pearlite 50x  	

Table 4.4 — (continued)

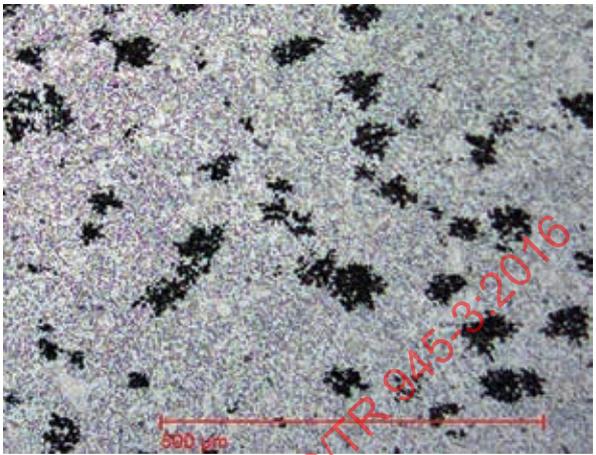
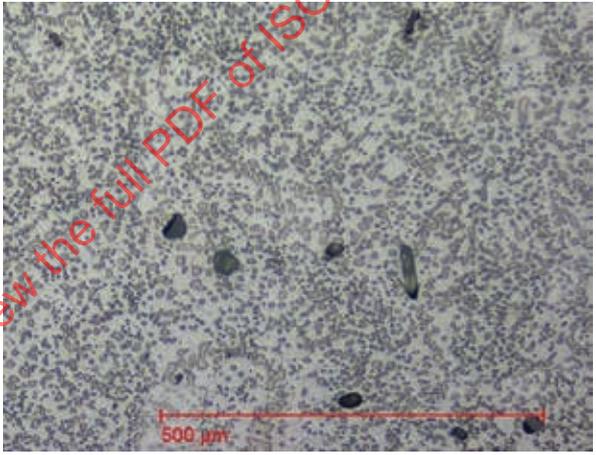
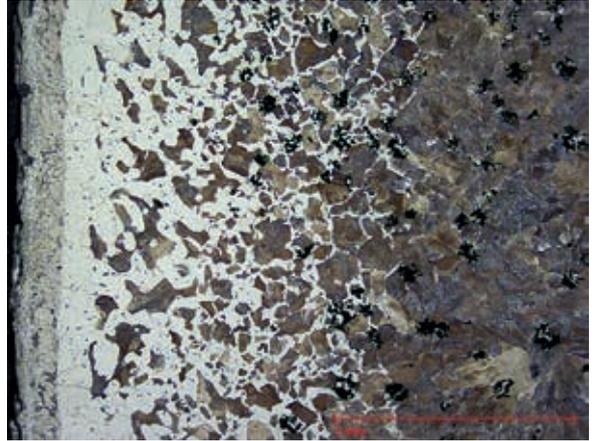
Micro-graph	Material designation	Matrix structure	
4.4.11		Core zone Globular pearlite 100x	
4.4.12		Core zone Globular pearlite 100x	
4.4.13	ISO 5922/JMW/550-4 Furnace cooled	Surface zone Transition of ferrite (surface) to pearlite (core) 30x	

Table 4.4 — (continued)

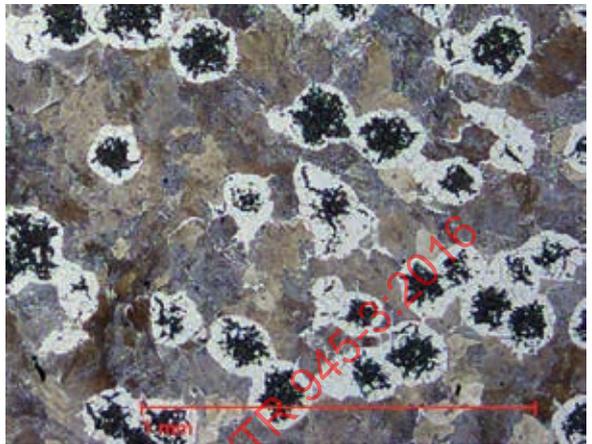
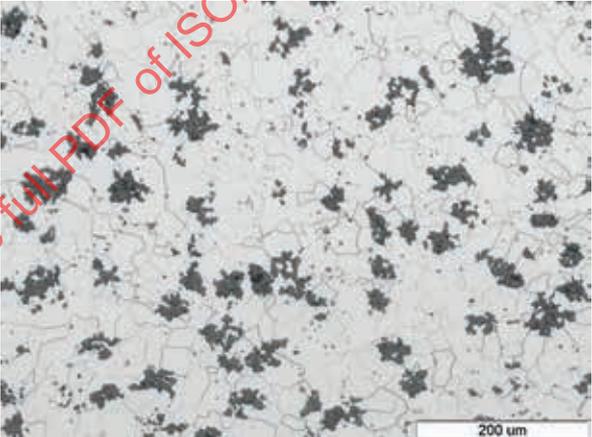
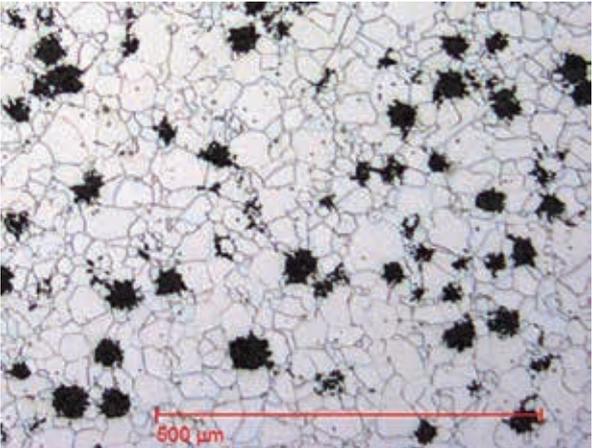
Micro-graph	Material designation	Matrix structure	
4.4.14		Core zone Pearlite and ferrite 100x  <div data-bbox="678 730 847 797" style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">200 μm</div>	
4.4.15	ISO 5922/JMB/275-5 ISO 5922/JMB/300-6 Furnace cooled	Ferrite 100x Shown is JMB/275-5  <div data-bbox="678 1189 847 1256" style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">200 μm</div>	
4.4.16	ISO 5922/JMB/350-10 Furnace cooled	Ferrite 100x  <div data-bbox="678 1659 847 1727" style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">200 μm</div>	

Table 4.4 (continued)

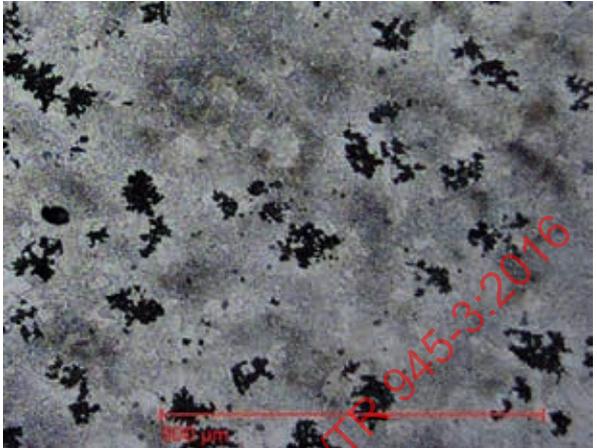
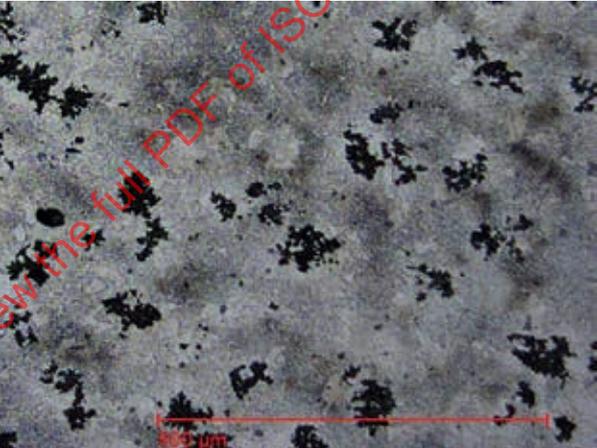
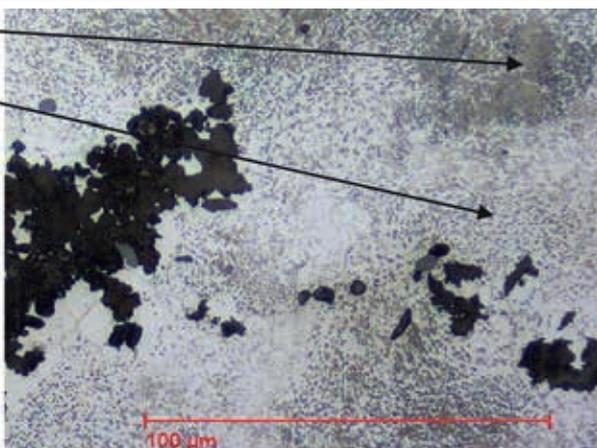
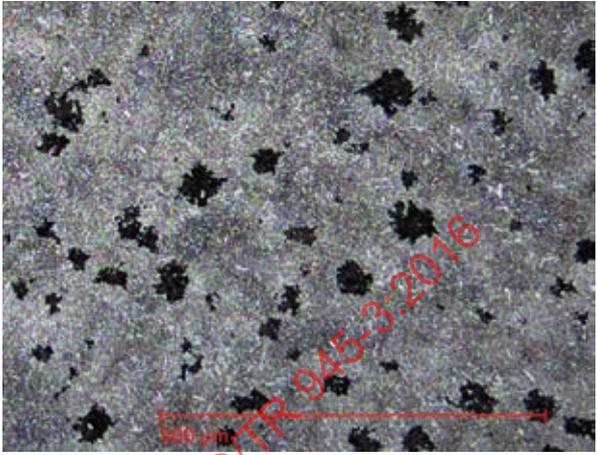
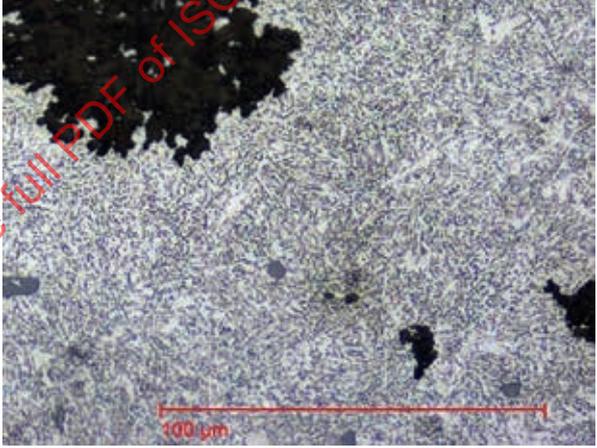
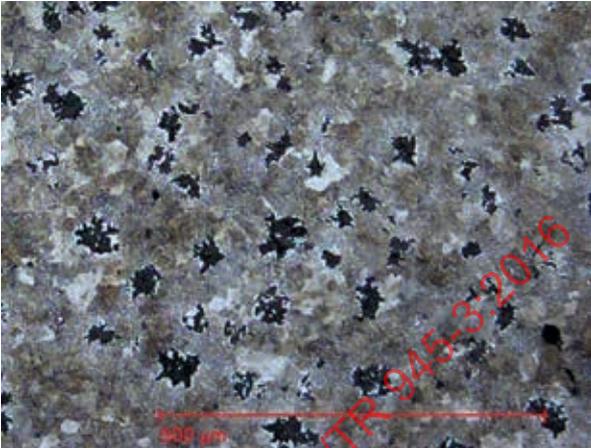
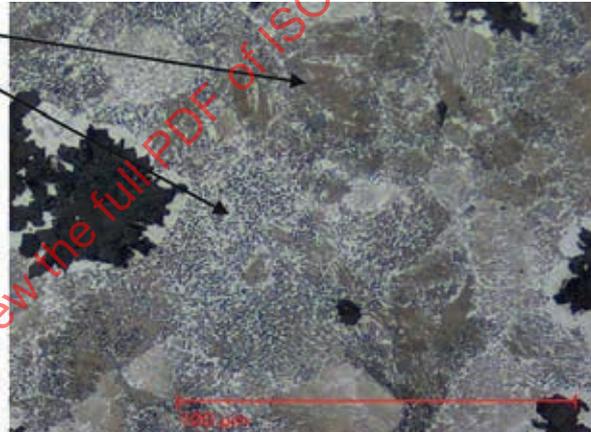
Micro-graph	Material designation	Matrix structure	
4.4.17	ISO 5922/JMB/450-6 Air quenched	Pearlite and globular pearlite 100x (see also 4.4.9)	
4.4.18	ISO 5922/JMB/500-5 ISO 5922/JMB/550-4	Pearlite and globular pearlite 100x Shown is JMB/550-4	
4.4.19	Air quenched	Pearlite Globular pearlite 500x Shown is JMB/550-4	

Table 4.4 (continued)

Micro-graph	Material designation	Matrix structure	
4.4.20	ISO 5922/JMB/500-5 ISO 5922/JMB/550-4	Globular pearlite 100x Shown is JMB/550-4  <div data-bbox="678 741 844 801" style="border: 1px solid black; padding: 2px; display: inline-block;">200 μm</div>	
4.4.21	Oil quenched	Globular pearlite 500x Shown is JMB/550-4  <div data-bbox="678 1211 844 1272" style="border: 1px solid black; padding: 2px; display: inline-block;">40 μm</div>	

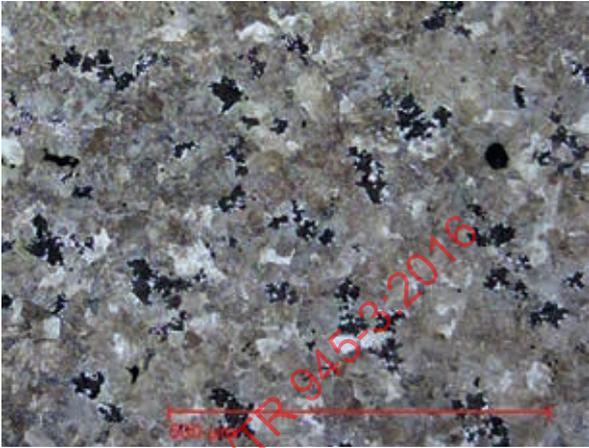
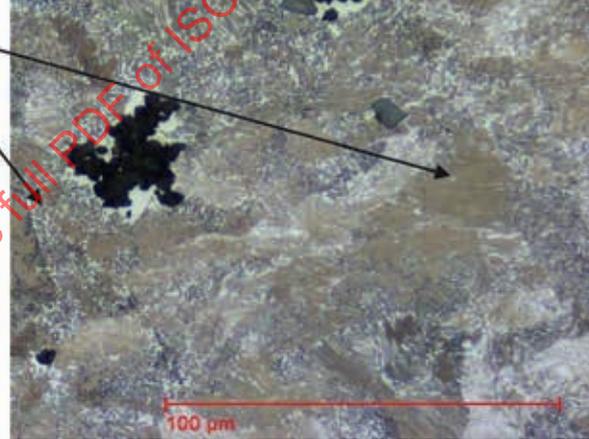
STANDARDSISO.COM : Click to view the full PDF of ISO/TR 945-3:2016

Table 4.4 (continued)

Micro-graph	Material designation	Matrix structure	
4.4.22	ISO 5922/JMB/600-3	Pearlite and globular pearlite 100x  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">200 μm</div>	
4.4.23	Air quenched	Pearlite  Globular pearlite 500x  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">40 μm</div>	

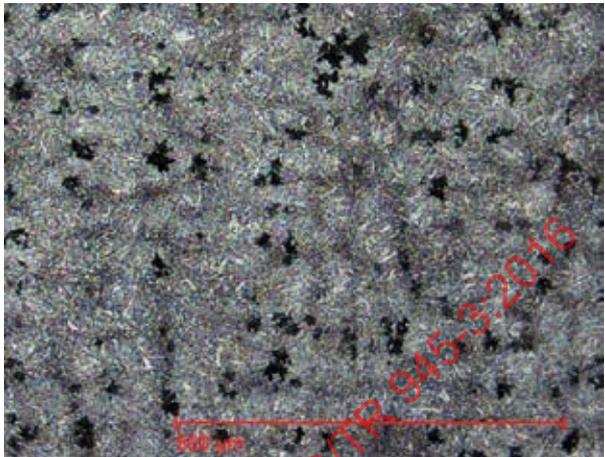
STANDARDSISO.COM : Click to view the full PDF of ISO/TR 945-3:2016

Table 4.4 (continued)

Micro-graph	Material designation	Matrix structure	
4.4.24	ISO 5922/JMB/650-2	Pearlite and globular pearlite 100x  	
4.4.25	Air quenched	Pearlite  Globular pearlite 500x  	

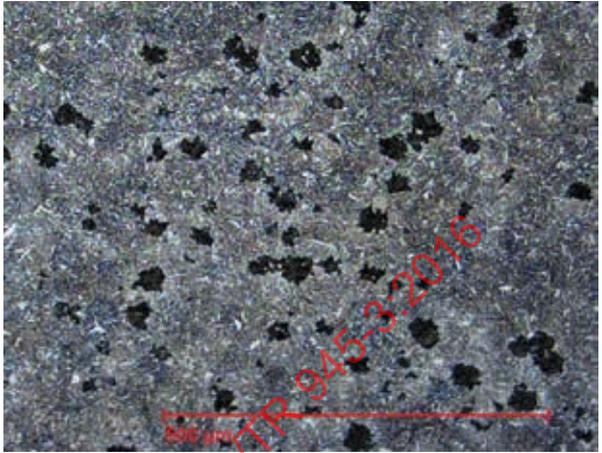
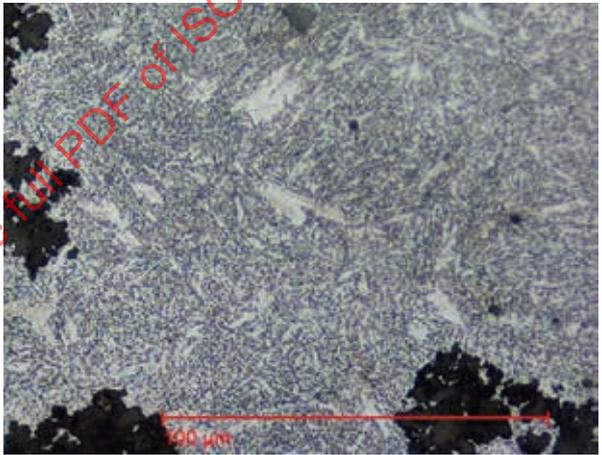
STANDARDSISO.COM : Click to view the full PDF of ISO/TR 945-3:2016

Table 4.4 (continued)

Micro-graph	Material designation	Matrix structure	
4.4.26	ISO 5922/JMB/650-2	Globular pearlite 100x	
4.4.27		Oil quenched	Globular pearlite 500x

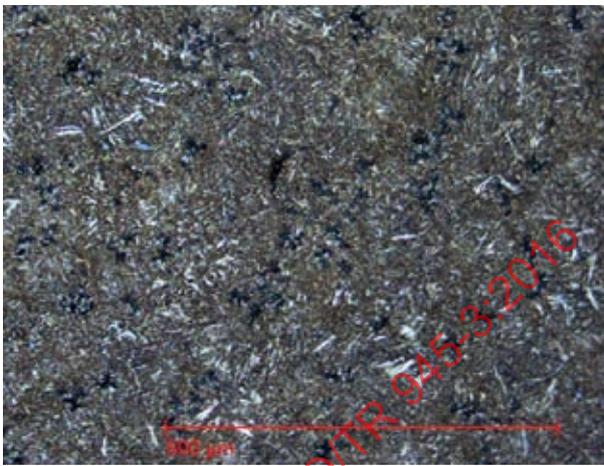
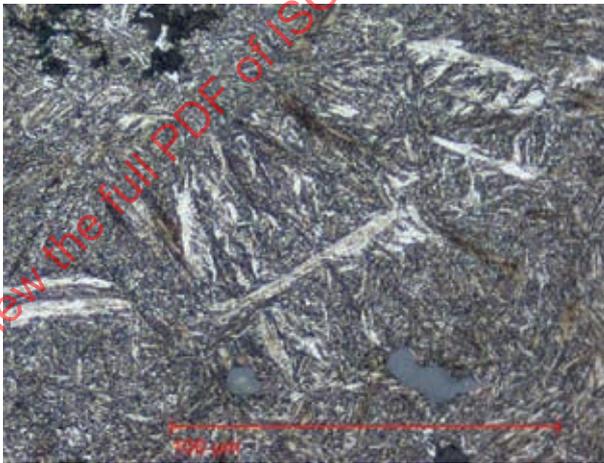
STANDARDSISO.COM · Click to view the full PDF of ISO/TR 945-3:2016

Table 4.4 (continued)

Micro-graph	Material designation	Matrix structure	
4.4.28	ISO 5922/JMB/700-2	Globular pearlite 100x	
4.4.29		Oil quenched Globular pearlite 500x	

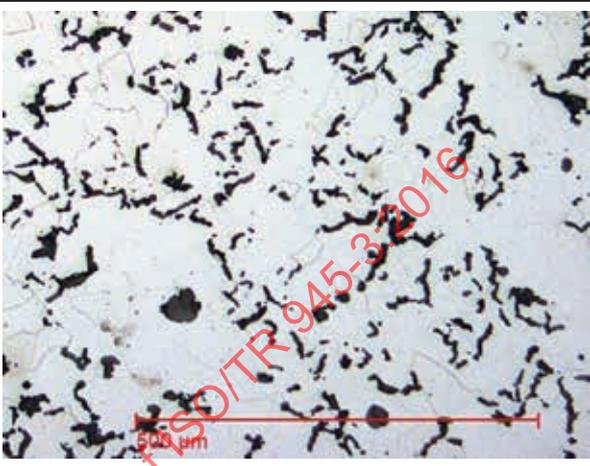
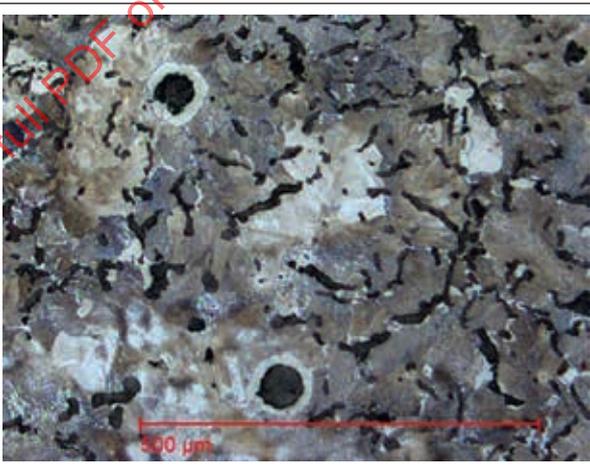
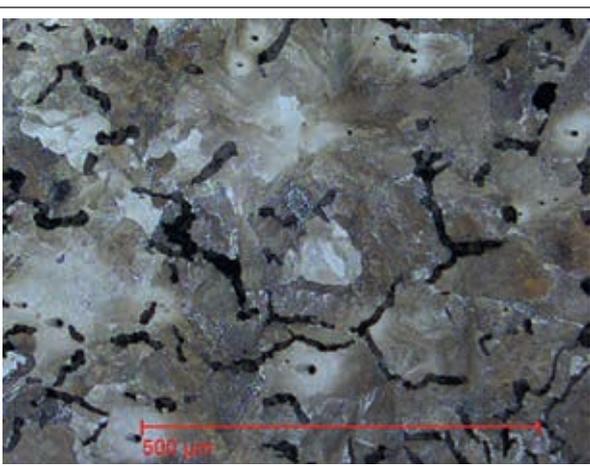
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Table 4.4 (continued)

Micro-graph	Material designation	Matrix structure	
4.4.30	ISO 5922/JMB/800-1	Tempered martensite 100x  	
4.4.31	Oil quenched	Tempered martensite 500x  	

## 4.5 Compacted (vermicular) graphite cast irons

Table 4.5 — Compacted (vermicular) graphite cast irons according to ISO 16112<sup>[9]</sup>

Micro-graph	Material designation	Matrix structure	Matrix structure
4.5.1	ISO 16112/JV/300	Predominantly ferrite 100x  	
4.5.2	ISO 16112/JV/350 ISO 16112/JV/400	Pearlite and ferrite 100x Shown is JV/400  	
4.5.3	ISO 16112/JV/450 ISO 16112/JV/500	Predominantly pearlite 100x Shown is JV/450  	

4.6 Ausferritic spheroidal graphite cast irons

Table 4.6 — Ausferritic spheroidal graphite cast irons according to ISO 17804<sup>[10]</sup>

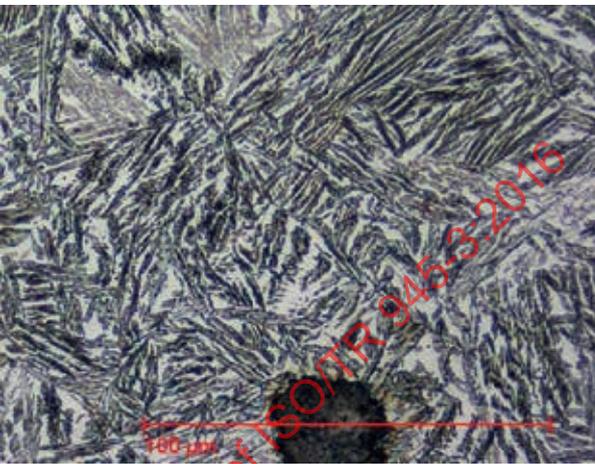
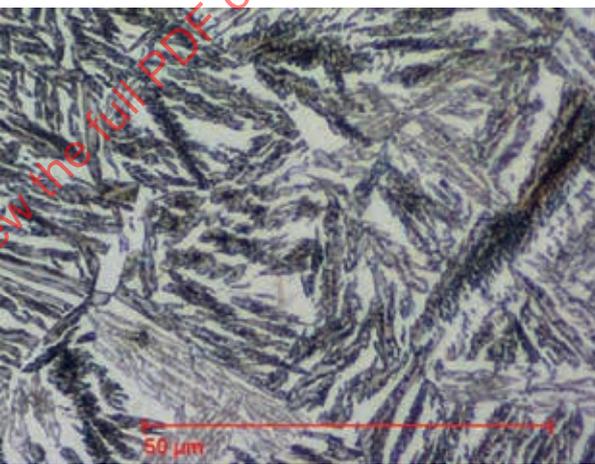
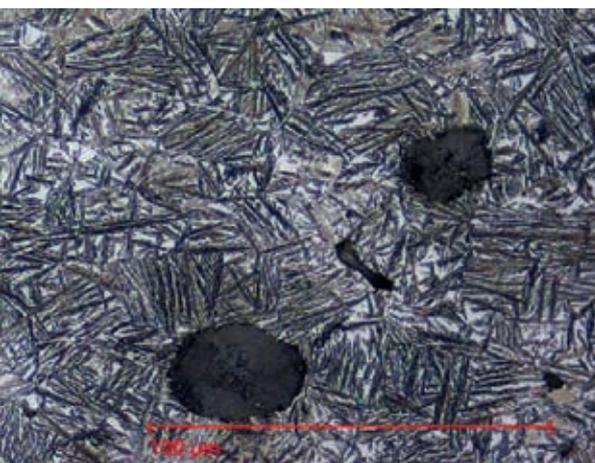
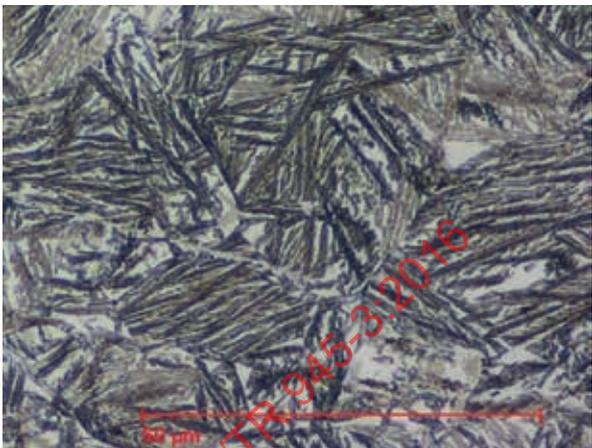
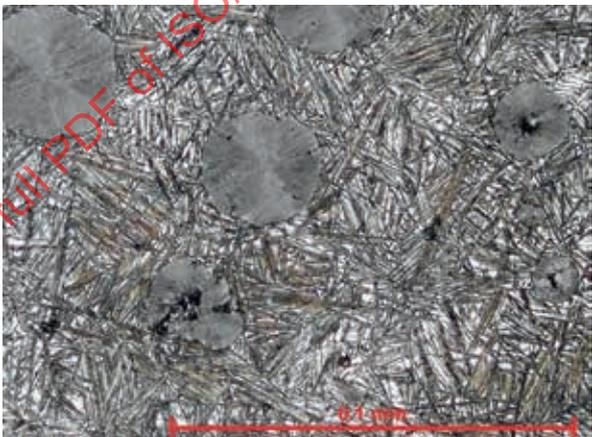
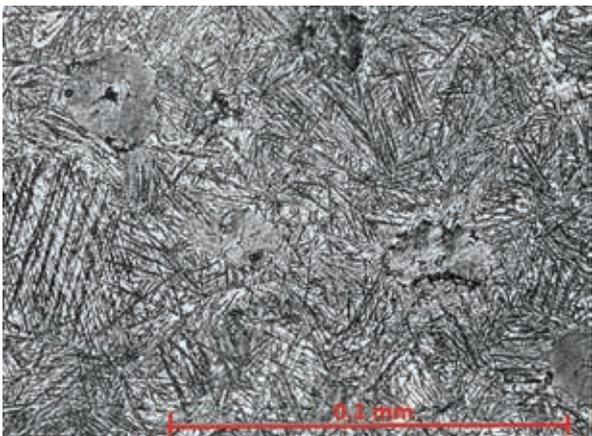
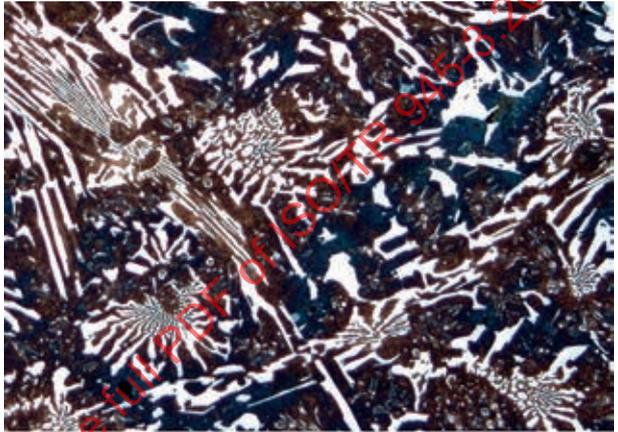
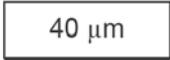
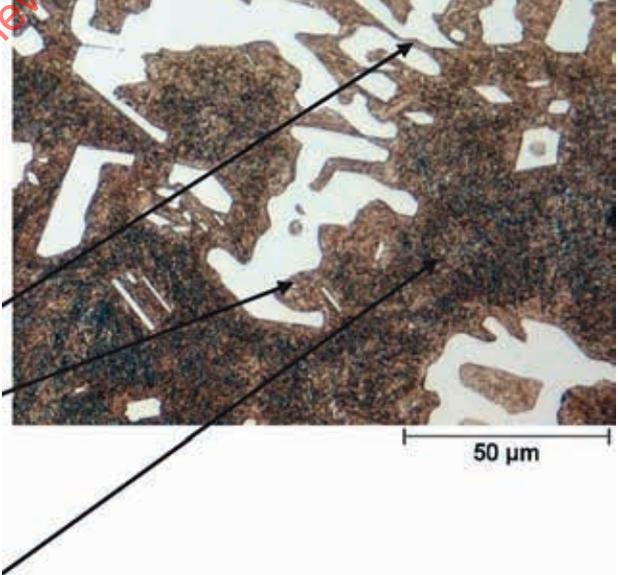
Micro-graph	Material designation	Matrix structure	
4.6.1	ISO 17804/JS/800-10	Ausferrite 500x Shown is JS/800-10 <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">40 μm</div>	
4.6.2	ISO 17804/JS/900-8	Ausferrite 1000x Shown is JS/800-10 <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">20 μm</div>	
4.6.3	ISO 17804/JS/1050-6 ISO 17804/JS/1200-3	Ausferrite 500x Shown is JS/1050-6 <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">40 μm</div>	

Table 4.6 (continued)

Micro-graph	Material designation	Matrix structure	Matrix structure
4.6.4	ISO 17804/JS/1050-6 ISO 17804/JS/1200-3	Ausferrite 1000x Shown is JS/1050-6  <div data-bbox="687 734 855 801" style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">20 μm</div>	
4.6.5	ISO 17804/JS/1400-1 ISO 17804/JS/HBW400	Ausferrite 500x  <div data-bbox="687 1193 855 1261" style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">40 μm</div>	
4.6.6	ISO 17804/JS/HBW450	Ausferrite 500x  <div data-bbox="687 1653 855 1720" style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">40 μm</div>	

4.7 Abrasion-resistant cast irons

Table 4.7 — Abrasion-resistant cast irons according to ISO 21988<sup>[11]</sup>

Micro-graph	Material designation	Matrix structure	
4.7.1	ISO 21988/JN/HBW340 ISO 21988/JN/HBW400	No micrographs were available for these two grades of unalloyed or low alloyed abrasion resistant cast irons	
4.7.2	ISO 21988/JN/HBW480Cr2 ISO 21988/JN/HBW510Cr2	No micrographs were available for these two grades of unalloyed or low alloyed abrasion resistant cast irons	
4.7.3		50x Shown is JN/HBW555Cr9  	
4.7.4	ISO 21988/JN/HBW500Cr9 ISO 21988/JN/HBW555Cr9 ISO 21988/JN/HBW630Cr9	500x Eutectic austenite partially transformed to martensite and fine secondary carbides by heat treatment Eutectic M <sub>7</sub> C <sub>3</sub> carbides Primary austenite dendrites partially transformed to martensite and fine secondary carbides by heat treatment Shown is JN/HBW555Cr9  	

NOTE 1 Etchant used on the samples 4.7.3 up to and including 4.7.8 is acidic ferric chloride (AFC) in ethanol.

NOTE 2 Information on etchant:

- add 25 ml of HCl to 100 ml of ethanol;
- progressively add 25 g of ferric chloride and stir until fully dissolved;
- dilute the solution of AFC to approximately 5 % to 50 % with additional ethanol to suit.

Table 4.7 (continued)

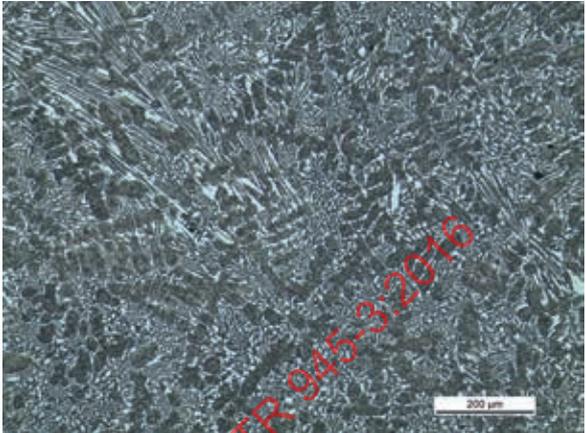
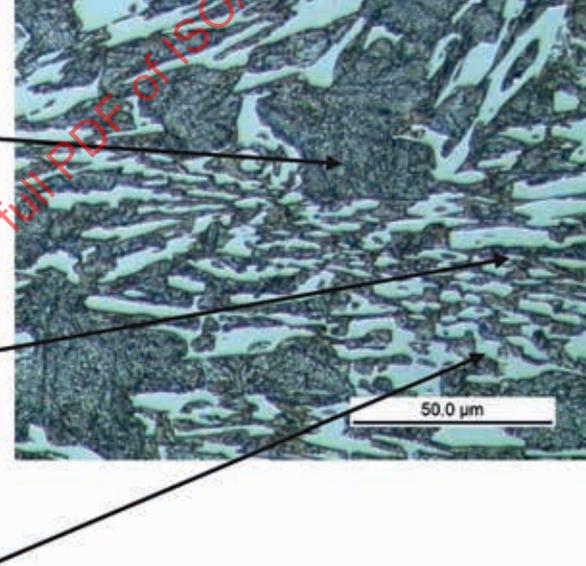
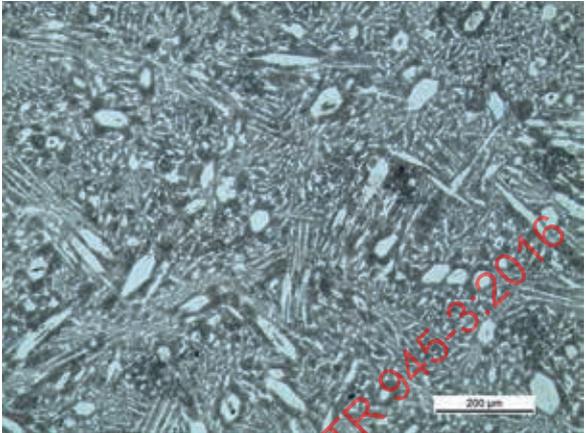
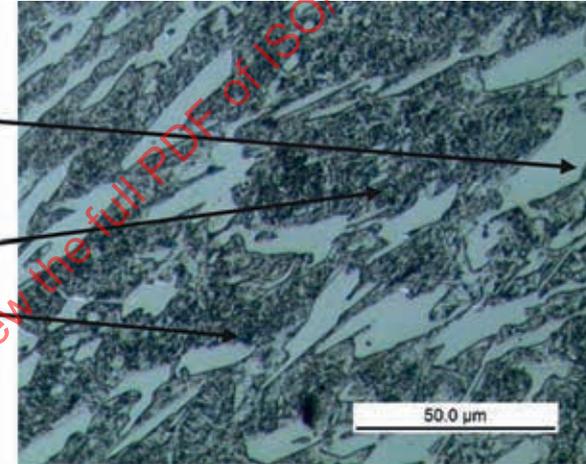
Micro-graph	Material designation	Matrix structure	
4.7.5		100x Shown is JN/ HBW555XCr16  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">200 μm</div>	
4.7.6	ISO 21988/JN/ HBW555XCr13 ISO 21988/JN/ HBW555XCr16	500x Primary austenite dendrites partially transformed to martensite and fine secondary carbides by heat treatment  Eutectic $M_7C_3$ carbides  Eutectic austenite partially transformed to martensite and fine secondary carbides by heat treatment  Shown is JN/ HBW555XCr16  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">40 μm</div>	
<p>NOTE 1 Etchant used on the samples 4.7.3 up to and including 4.7.8 is acidic ferric chloride (AFC) in ethanol.</p> <p>NOTE 2 Information on etchant:</p> <ul style="list-style-type: none"> <li>— add 25 ml of HCl to 100 ml of ethanol;</li> <li>— progressively add 25 g of ferric chloride and stir until fully dissolved;</li> <li>— dilute the solution of AFC to approximately 5 % to 50 % with additional ethanol to suit.</li> </ul>			

Table 4.7 (continued)

Micro-graph	Material designation	Matrix structure	
4.7.7		100x  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">200 μm</div>	
4.7.8	ISO 21988/JN/ HBW555XCr21	500x  Primary $M_7C_3$ carbides Eutectic $M_7C_3$ carbides Eutectic austenite partially transformed to martensite and fine secondary carbides by heat treatment  <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">40 μm</div>	

NOTE 1 Etchant used on the samples 4.7.3 up to and including 4.7.8 is acidic ferric chloride (AFC) in ethanol.

NOTE 2 Information on etchant:

- add 25 ml of HCl to 100 ml of ethanol;
- progressively add 25 g of ferric chloride and stir until fully dissolved;
- dilute the solution of AFC to approximately 5 % to 50 % with additional ethanol to suit.

Table 4.7 (continued)

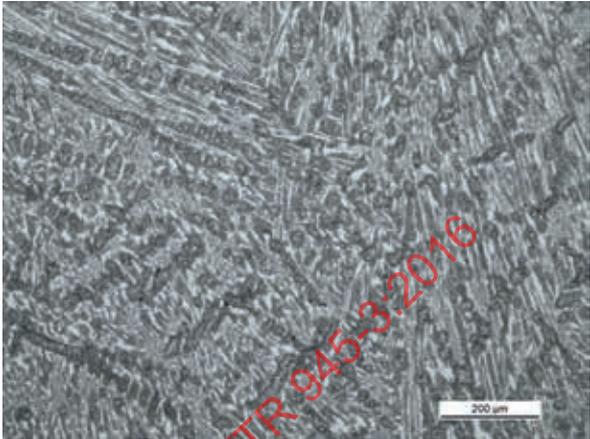
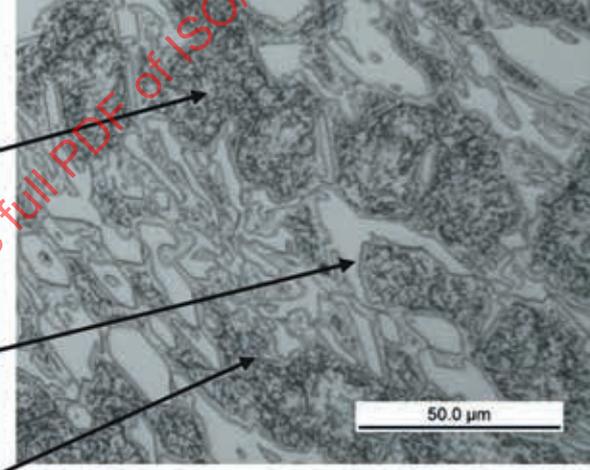
Micro-graph	Material designation	Matrix structure	
4.7.9		100x  	
4.7.10	ISO 21988/JN/ HBW555XCr27	500x Primary austenite dendrites partially transformed to martensite and fine secondary carbides by heat treatment Eutectic $M_7C_3$ carbides Eutectic austenite partially transformed to martensite and fine secondary carbides by heat treatment  	
<p>NOTE 1 Etchant used on the samples 4.7.3 up to and including 4.7.8 is acidic ferric chloride (AFC) in ethanol.</p> <p>NOTE 2 Information on etchant:</p> <ul style="list-style-type: none"> <li>— add 25 ml of HCl to 100 ml of ethanol;</li> <li>— progressively add 25 g of ferric chloride and stir until fully dissolved;</li> <li>— dilute the solution of AFC to approximately 5 % to 50 % with additional ethanol to suit.</li> </ul>			

Table 4.7 (continued)

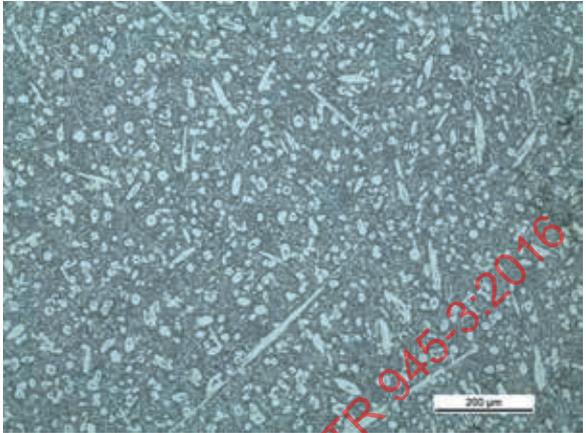
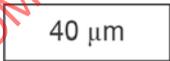
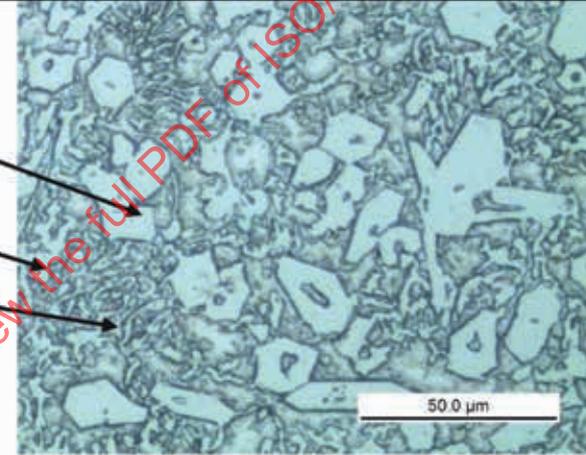
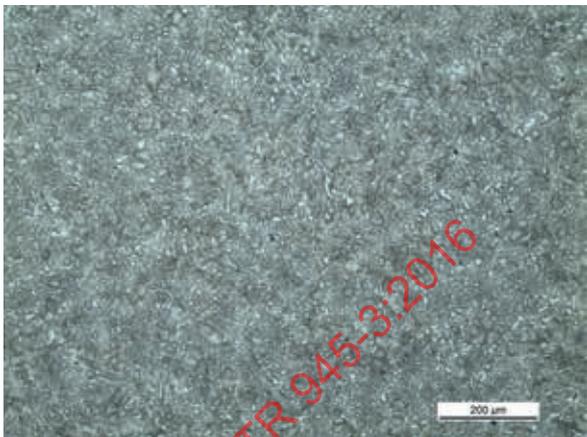
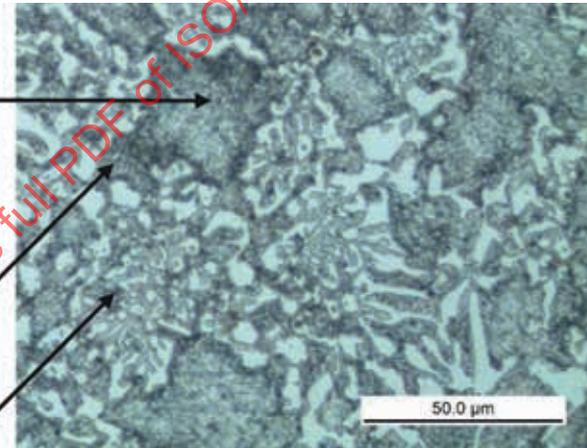
Micro-graph	Material designation	Matrix structure	
4.7.11		100x  	
4.7.12	ISO 21988/JN/HBW600X-Cr35	500x  Primary $M_7C_3$ carbides Eutectic $M_7C_3$ carbides Eutectic austenite partially transformed to martensite and fine secondary carbides by heat treatment  	
NOTE 1 Etchant used on the samples 4.7.3 up to and including 4.7.8 is acidic ferric chloride (AFC) in ethanol.			
NOTE 2 Information on etchant:			
<ul style="list-style-type: none"> <li>— add 25 ml of HCl to 100 ml of ethanol;</li> <li>— progressively add 25 g of ferric chloride and stir until fully dissolved;</li> <li>— dilute the solution of AFC to approximately 5 % to 50 % with additional ethanol to suit.</li> </ul>			

Table 4.7 (continued)

Micro-graph	Material designation	Matrix structure	
4.7.13		100x  	
4.7.14	ISO 21988/JN/ HBW600XCr20Mo2Cu	500x  Primary austenite dendrites partially transformed to martensite and fine secondary carbides by heat treatment  Eutectic $M_7C_3$ carbides  Eutectic austenite partially transformed to martensite and fine secondary carbides by heat treatment  	
<p>NOTE 1 Etchant used on the samples 4.7.3 up to and including 4.7.8 is acidic ferric chloride (AFC) in ethanol.</p> <p>NOTE 2 Information on etchant:</p> <ul style="list-style-type: none"> <li>— add 25 ml of HCl to 100 ml of ethanol;</li> <li>— progressively add 25 g of ferric chloride and stir until fully dissolved;</li> <li>— dilute the solution of AFC to approximately 5 % to 50 % with additional ethanol to suit.</li> </ul>			

## Annex A (informative)

### Spheroidal graphite cast irons: Evaluation of pearlite content

Pearlite content, expressed as area percentage, is defined by [Formula \(A.1\)](#):

$$\text{Pearlite content} = \frac{\text{area with pearlitic structure}}{\text{total area} - \text{area of graphite particles}} \times 100 \quad (\text{A.1})$$

Typical spheroidal graphite cast iron reference images, corresponding to 20 % to 100 % pearlite, are shown in [Figure A.1](#) for the evaluation of the pearlite content.

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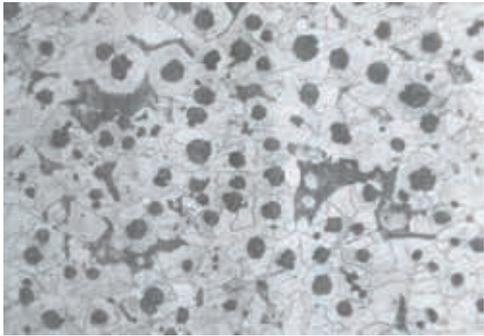
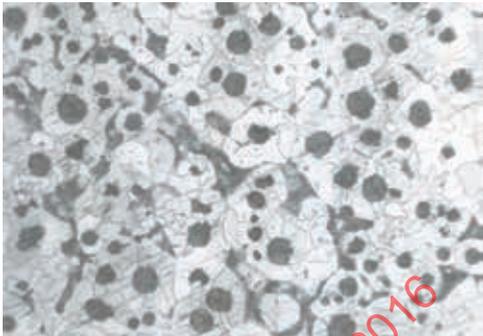
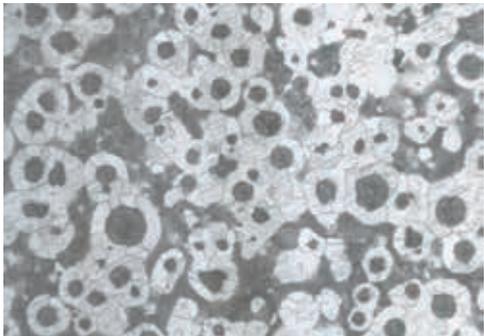
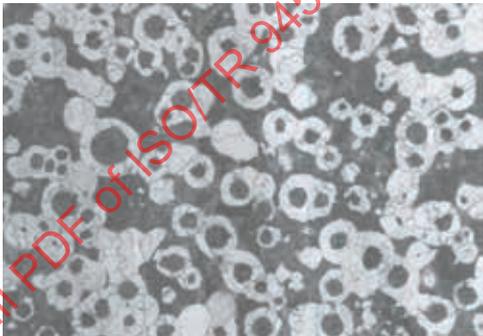
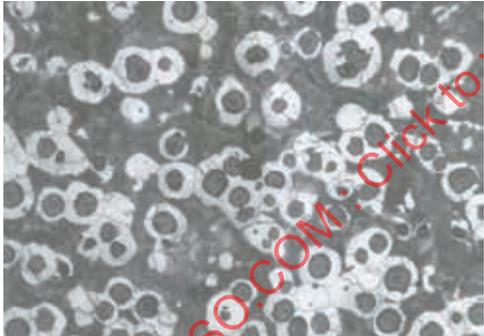
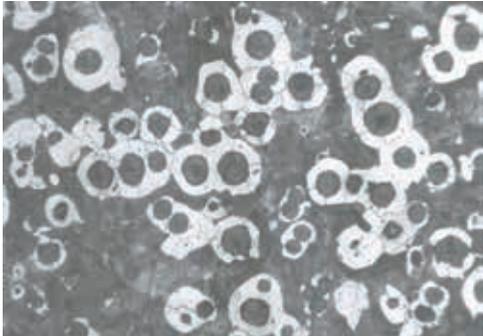
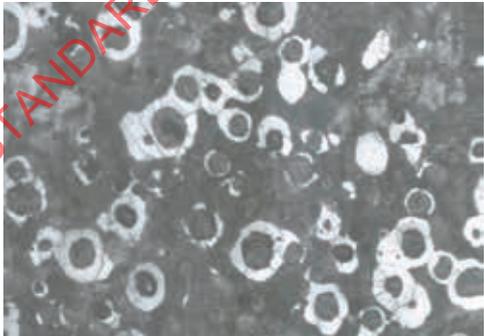
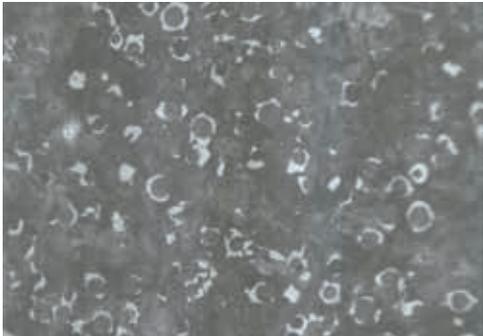
	
<b>20 % pearlite</b>	<b>30 % pearlite</b>
	
<b>40 % pearlite</b>	<b>50 % pearlite</b>
	
<b>60 % pearlite</b>	<b>70 % pearlite</b>
	
<b>80 % pearlite</b>	<b>90 % pearlite</b>

Figure A.1 — Spheroidal graphite cast irons matrix structure reference images

**Annex B**  
(informative)

**List of European and some national cast iron material designations corresponding to the ISO designations**

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