

- Vander Voort, G. V., *Metallography Principles and Practice*, ASM International, Materials Park, Ohio, USA, 1999.
- Waschull, H., *Präparative Metallographie*, Wiley-VCH Verlag, Weinheim, Germany, 1993 (In German).
- Weck, E. and Leistner, E., *Metallographic Instructions for Colour Etching by Immersion*, Part I (1982), II (1983), III (1986), Deutscher Verlag für Schweisstechnik GmbH, Düsseldorf, Germany.

27.2 Periodicals

THE PERIODICALS STATED IN THIS LIST COVER THE FIELD OF METALLOGRAPHIC/materialographic preparation and interpretation, but it should not be considered a complete list of all periodicals covering these subjects.

- Advanced Functional Materials*, English/18 issues yearly, Wiley-VCH, P.O. Box 191161, D-69451, Weinheim, Germany.
- Advanced Materials*, English/24 issues yearly, Wiley-VCH, P.O. Box 191161, D-69451, Weinheim, Germany.
- Advanced Materials and Processes*, English/monthly, ASM International, Materials Park, OH 44073, USA.
- Advanced Engineering Materials*, English/monthly, Wiley-VCH, P.O. Box 191161, D-69451, Weinheim, Germany.
- Alloy Digest*, English/bimonthly, ASM International, Materials Park, OH 44073, USA.
- Electronic Device Failure Analysis*, English/quarterly, ASM International, Materials Park, OH 44073, USA.
- International Materials Reviews*, English/bimonthly, ASM International, Materials Park, OH 44073, USA.
- JOM*, English/monthly, TMS (The Minerals, Metals and Materials Society), 184 Thorn Hill Road, Warrendale, PA 15086, USA.
- Journal of Electronic Materials*, English/monthly, TMS (The Minerals, Metals and Materials Society), 184 Thorn Hill Road, Warrendale, PA 15086, USA.
- Journal of Failure Analysis and Prevention*, English/bimonthly, ASM International, Materials Park, OH 44073, USA.
- Journal of Materials Engineering and Performance*, English/bimonthly, ASM International, Materials Park, OH 44073, USA.
- Journal of Phase Equilibria and Diffusion*, English/bimonthly, ASM International, Materials Park, OH 44073, USA.
- Journal of the American Ceramic Society*, English/monthly, American Ceramic Society, P.O. Box 6136, Westerville, OH 43086-6136, USA.
- Journal of Thermal Spray Technology*, English/quarterly, ASM International, Materials Park, OH 44073, USA.
- Materials Characterization*, English/10 issues yearly, Elsevier Science Publishing Co. Inc., 655 Avenue of the Americas, New York, NY 10010, USA.
- Metallurgical and Materials Transactions A*, English/bimonthly, ASM International, Materials Park, OH 44073, USA.
- Metallurgical and Materials Transactions B*, English/bimonthly, ASM International, Materials Park, OH 44073, USA.
- Praktische Metallographie/Practical Metallography*, bilingual, German/English/monthly, Carl Hanser Verlag, Kolbergstrasse 22, 81679 München, Germany.
- SlipLines*, newsletter, English/quarterly, IMS (International Metallographic Society), ASM International, Materials Park, OH 44073, USA.
- Structure*, English/German/French editions, twice a year, Struers A/S, Pederstrupvej 84, 2750 Ballerup, Denmark.
- Welding Journal*, English/monthly, AWS (American Welding Society), 550 N.W. LeJeune Road, Miami, FL 33126, USA.

Appendixes

Appendix I: Other Standards on Metallography/ Materialography

A NUMBER OF STANDARDS, OTHER THAN ASTM, COVERING METALLOGRAPHY/materialography from ISO (International Standard Organization) and a number of important industrial countries are listed below. The list is not complete.

ISO standards/National standards: The national standards, which are local versions of ISO standards, are not indicated below.

CEN (European Committee for Standardization) is involved in European Stan-

dards (EN), Technical Specifications (CEN TS), Technical Reports (CEV TR) and CEN Work Agreements (CWA). All documents are supplied by the national members of CEN.

ISO (INTERNATIONAL STANDARD ORGANIZATION)

ISO 643	Steels—Micrographic determination of the ferritic or austenitic grain size
ISO 945	Cast iron—Designation of microstructure of graphite
ISO 1083	Spheroidal graphite cast irons—Classification
ISO 1463	Metallic and oxide coatings—Measurements of thickness—Microscopical method
ISO 2064	Metallic and other inorganic coatings—Definitions and conventions concerning the measurement of thickness
ISO 2624	Copper and copper alloys—Estimation of average grain size
ISO 2639	Steel—Determination and verification of the effective depth of carburized and hardened cases
ISO 3057	Nondestructive testing—Metallographic replica techniques of surface examination
ISO 3082	Iron ores—Sampling and sample preparation procedures
ISO 3085	Iron ores—Experimental methods for checking the precision of sampling, sample preparation and measurement
ISO 3754	Steel—Determination of effective depth of hardening after flame or induction hardening
ISO 3763	Wrought steels—Macroscopic methods for assessing the content of nonmetallic inclusions
ISO 3887	Steels—Determination of depth of decarburization
ISO 4499	Hard metals—Metallographic determination of microstructure
ISO 4505	Hard metals—Metallographic determination of porosity and uncombined carbon
ISO 4524-1	Metallic coatings—Test methods for electrodeposited gold and gold alloy coatings—Part 1 Determination of coating thickness
ISO 4967	Steel—Determination of content of nonmetallic inclusions—Micrographic method using standard diagrams
ISO 4968	Steel—Micrographic examination by sulfur prints (Baumann method)
ISO 4969	Steel—Macroscopic examination by etching with strong mineral acids
ISO 4970	Steel—Determination of total or effective thickness of thin surface-treated layers
ISO 5949	Tool steels and bearing steels—Micrographic method for assessing the distribution of carbides using reference photomicrographs
ISO 6196	Micrographics—Vocabulary—Part 1: General terms

ISO 8036	Optics and photonics—Microscopes—Immersion liquids for light microscopy
ISO 9042	Steels—Manual point counting method for statically estimating the volume fraction of a constituent with a point grid
ISO 9220	Metallic coatings—Measurement of coating thickness—Scanning electron microscope method
ISO 11567	Carbon fibre—Determination of filament diameter and cross-sectional area
ISO 13520	Determination of ferrite content in austenitic stainless steel castings
ISO 14250	Steel—Metallographic characterization of duplex grain size and distribution
ISO/TR 14321	Sintered metal materials, excluding hardmetals—Metallographic preparation and examination
ISO 14703	Fine ceramics (advanced ceramics, advanced technical ceramics)—Sample preparation for the determination of particle size distribution of ceramic powders
ISO 14923	Thermal Spraying—Characterization and testing of thermally sprayed coatings
ISO 16793	Nuclear fuel technology—Guide for ceramographic preparation of UO ₂ sintered pellets for microstructure examination
ISO 17642-2	Destructive tests on welds in metallic materials—Cold cracking tests for weldments—Arc welding processes—Part 2: Self-restraint tests
ISO 20160	Implants for surgery—Metallic materials—Classification of microstructures for alpha+beta titanium alloy bars
ISO 21227	Paints and varnishes—Evaluation of defects on coated surfaces using optical imaging—Part 1: General guidance
FRANCE	
NF A04-105	Iron and steel. Methods of determination of the nonmetallic inclusion content of wrought steels. Part 1: Macroscopic methods.
NF A04-106	Iron and steel. Methods of determination of content of nonmetallic inclusions in wrought steel. Part II: Micrographic method using standards diagrams.
NF A04-107	Iron and steel. Micrographic method of determination of the nonmetallic inclusion content of unalloyed wire rod.
NF A04-108	Iron and steel. Characterization of sulfide shapes in structural steels with improved machinability using standard diagrams. Micrographic method.
NF A04-110	Iron and steel. Wire rods of non-alloy general purpose steel for wire drawing. Surface examination.
NF A04-111	Iron and steel. Micrographic determination of the extent of decarburization of non-alloy high carbon steel wire rod.

NF A04-112	Iron and steel. Macrographic method of showing and describing the chemical heterogeneity of effervescent steel wire rod.
NF A04-113	Iron and steel. High carbon steel wire rod derived from ingots. Macrographic method of showing and describing the chemical heterogeneity.
NF A04-114	Iron and steel. High carbon continuous cast steel wire rod. Macrographic method of showing and describing the chemical heterogeneity.
A04-115	Iron and steel. Characterization of sulfide shapes in free-cutting steels using standards diagrams. Micrographic method.
NF A04-203	Steel products. Determination of the effective hardening after flame or induction hardening.
NF A04-204	Steel products. Determination of the total or conventional thickness of surface hardened thin layers.
NF A04-503	Semi-products made from aluminum, copper, nickel and their alloys. Determination of grain size. Aluminium and aluminium alloys.
NF A05-150	Steel products. Techniques of micrographic examination.
NF A05-151	Steel products. Macrographic examination by sulfur print (Baumann method).
NF A05-152	Steel products. Macroscopic examination by etching with strong mineral acids.
NF A05-153	Iron and steel. Macroscopic examination by means of copper salt etching.
NF A05-154	Steel products. Metallographic replica techniques (optical examination).
NF A05-156	Iron and steel. Macrographic examination by sodium sulfur print (so-called lead print method).
A05-165	Steel products. Manual point counting method for statistically estimating the volume fraction of a constituent with a point grid.
NF A95-342	Powder metallurgy. Sintered materials including hardmetals. Micrographic examination techniques.
NF EN 1321	Destructive tests on welds in metallic materials. Macroscopic and microscopic examination of welds.
NF EN 12797	Brazing—Destructive tests of brazed joints.
NF EN 24499	Hard metals. Metallographic determination of microstructure.
NF EN 24505	Hard metals. Metallographic determination of porosity and uncombined carbon.
XP ENV 10247	Micrographic examination of the nonmetallic inclusion content of steels using standard pictures.

GERMANY

DIN V ENV 1071-5	(Pre-standard) Advanced technical ceramics—Methods of test for ceramic coatings—Part 5: determination of porosity
DIN CEN/TS 1071-10	Advanced technical ceramics—Methods of test for ceramic coatings—Part 10: determination of coating thickness by cross sectioning
DIN EN 1321	Destructive tests of welds in metallic materials—macroscopic and microscopic examination of welds
DIN EN 2004-10	Aerospace series—Test methods for aluminium and aluminium alloy products; Part 10: preparation of micrographic specimens for aluminium alloys
DIN EN 2007	Aerospace series—Test methods for aluminium and aluminium alloy products—metallographic determination of cladding thickness and copper diffusion in the cladding for rolled products
DIN EN 3684	Aerospace series—Test methods—titanium alloy wrought products—determination of beta transus temperature; metallographic method
DIN EN 10247	Micrographic examination of the nonmetallic inclusion content of steels using standard pictures
DIN 50192	Determination of the depth of decarburization
DIN 50600	Testing of metallic materials; metallographic micrographs; picture scales and formats
DIN 50601	Metallographic examination; determination of the ferritic or austenitic grain size
DIN 50602	Metallographic examination; microscopic examination of special steels using standard diagrams to assess the content of non-metallic inclusions
DIN 54150	Nondestructive Testing Impression Methods for Surface Examination
JAPAN	
JIS H 0501	Methods for estimating average grain size of wrought copper and copper alloys
JIS G 0551	Steels—Micrographic determination of the apparent grain size
JIS G 0552	Method of ferrite grain size test for steel
JIS G 0553	Macrostructure detecting method for steel, Edition 1
JIS G 0555	Microscopic testing method for the non-metallic inclusions in steel
JIS Z 6014	Micrographics—Test charts for digitizing image—Description and use in electronic imagery
UNITED KINGDOM	
BS M 37	Method for the etch inspection of metallic materials and components
BS EN 1321	Destructive test on welds in metallic materials. Macroscopic and microscopic examination of welds

BS 4490	Methods for micrographic determination of the grain size of steel
BS 5710	Macroscopic assessment of the nonmetallic inclusion content of wrought steels
BS 6285	Macroscopic assessment of steel by sulfur print
BS 6286	Measurement of total or effective thickness of thin surface-hardness layers in steel
BS 6479	Determination and verification of effective depth of carburized and hardened cases of steel
BS 6481	Determination of effective depth of hardening of steel after flame or induction hardening
BS 6533	Guide to microscopic examination of steel by etching with strong acids
BS 6617	Determination of decarburization in steel. Methods for determining decarburization by microscopic and microhardness techniques
BS 7590	Method for statistically estimating the volume fraction of phases and constituents by systematic manual point counting with a grid
BS 7590 A	Worksheet for the determination of volume fraction by systematic manual point count
BS 10247	Micrographic examination of the nonmetallic inclusion content of steels using standard pictures
BS EN 10328	Iron and steel—determination of the conventional depth of hardening after surface heating
93/7105316 DC	Aerospace series. Test methods for aluminium and aluminium alloy products. Metallographic determination of cladding thickness and copper diffusion in the cladding for rolled products (prEN 2007)
94/710839 DC	Aerospace series. Test methods. Titanium alloy wrought products. Determination of primary α content. The point count method and line intercept method (prEN 3683)
94/710840 DC	Aerospace series. Test methods. Titanium alloy wrought products. Determination of β transus temperature. Metallographic method (prEN 3684)

Appendix II: Other Standards on Hardness Testing

A number of standards, other than ASTM, covering hardness testing from ISO (International Standard Organization) and a number of important industrial countries are listed below. The list is not complete.

ISO standards/National standards: The national standards, which are local versions of ISO standards, are not indicated below.

CEN (European Committee for Standardization) is involved in European Standards (EN), Technical Specifications (CEN TS), Technical Reports (CEV TR) and CEN Work Agreements (CWA). All documents are supplied by the national members of CEN.

ISO (International Standard Organization)

A number of standards covering hardness testing from ISO are listed below. The list is not complete.

ISO (INTERNATIONAL STANDARD ORGANIZATION)

ISO 48	Rubber, vulcanized or thermoplastic—Determination of hardness (hardness between 10 IRHD and 100 IRHD)
ISO 3738-1	Hard metals—Rockwell hardness test (scale A)—Part 1: Test method
ISO 3738-2	Hard metals—Rockwell hardness test (scale A)—Part 2: Preparation and calibration of standard test blocks
ISO 3878	Hard metals—Vickers hardness test
ISO 4384-1	Plain bearings—Hardness testing of bearing metals—Part 1: Compound materials
ISO 4384-2	Plain bearings—Hardness testing of bearing metals—Part 2: Solid materials
ISO 4498	Sintered metal materials, excluding hardmetals—Determination of apparent hardness and microhardness
ISO 4498-1	Sintered metal materials, excluding hardmetals—Determination of apparent hardness—Part 1: Materials of essentially uniform section hardness
ISO 4498-2	Sintered metal materials, excluding hardmetals—Determination of apparent hardness—Part 2: Case-hardened ferrous materials, surface enriched by carbon or carbon and nitrogen
ISO 4507	Sintered ferrous materials, carburized or carbonitrided—Determination and verification of hardening depth by a microhardness test
ISO 4516	Metallic and other inorganic coatings—Vickers and Knoop microhardness tests
ISO 4545	Metallic materials—Hardness test—Knoop test
ISO 4546	Metallic materials—Hardness test—Verification of Knoop hardness testing machines
ISO 4547	Metallic materials—Hardness test—Calibration of standardized blocks to be used for Knoop hardness testing machines
ISO 6506-1	Metallic materials—Brinell hardness test—Part 1: Test method
ISO 6506-2	Metallic materials—Brinell hardness test—Part 2: Verification and calibration of testing machines
ISO 6506-3	Metallic materials—Brinell hardness test—Part 3: Calibration of reference blocks
ISO 6507-1	Metallic materials—Vickers hardness test—Part 1: Test method
ISO 6507-2	Metallic materials—Vickers hardness test—Part 2: Verification of testing machines

ISO 6507-3	Metallic materials—Vickers hardness test—Part 3: Calibration of reference blocks
ISO 6508-1	Metallic materials—Rockwell hardness test—Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)
ISO 6508-2	Metallic materials—Rockwell hardness test—Part 2: Verification and calibration of testing machines (scales A, B, C, D, E, F, G, H, K, N, T)
ISO 6508-3	Metallic materials—Rockwell hardness test—Part 3: Calibration of reference blocks (scales A, B, C, D, E, F, G, H, K, N, T)
ISO 9015-1	Destructive test on welds in metallic materials—Hardness testing—Part 1: Hardness test on arc welded joints
ISO 9015-2	Destructive tests on welds in metallic materials—Hardness testing—Part 2: Microhardness testing of welded joints
ISO 9385	Glass and glass-ceramics—Knoop hardness test
ISO 14271	Vickers hardness testing of resistance spot, projection and seam welds (low load and microhardness)
ISO 14577-1	Metallic materials—Instrumented indentation test for hardness and materials parameters—Part 1: Test method
ISO 14577-2	Metallic materials—Instrumented indentation test for hardness and materials parameters—Part 2: Verification and calibration of testing machines
ISO 14577-3	Metallic materials—Instrumented indentation test for hardness and materials parameters—Part 3: Calibration of reference blocks
ISO 18571	Rubber, vulcanized or thermoplastic—Hardness testing—Introduction and guide
France	
NF A95-329	Powder metallurgy. Sintered metal materials excluding hardmetals. Measurement of Vickers microhardness
NF A95-348	Powder metallurgy. Sintered ferrous materials, carburized or carbonitried. Determination of effective case depth by the Vickers microhardness testing method.
Germany	
DIN EN 1043-2	Destructive test on welds in metallic materials—Hardness test—Part 2: Micro hardness testing on welded joints
DIN CEN/TS 1071-7	(Pre-standard) Advanced technical ceramics—Methods of test for ceramic coatings—Part 7: Determination of hardness and Young's modulus by instrumented indentation testing
DIN CEN/TS 1071-8	(Pre-standard) Advanced technical ceramics—Methods of test for ceramic coatings—Part 8: Rockwell indentation test for evaluation of adhesion
Japan	
JIS Z 2255	Method for ultra-low loaded hardness test
JIS Z 2255	Method for ultra-low loaded hardness test

JIS R 1623:1995	Testing method for Vickers hardness of fine ceramics at elevated temperatures
JIS B 7724:1999	Brinell hardness test—Verification of testing machines
JIS B 7726	Rockwell hardness test—Verification of testing machines
JIS B 7727:2000	Shore hardness test—Verification of testing machines
JIS B 7730	Rockwell hardness test—Calibration of reference blocks
United Kingdom	
BS DD ENV 843-4	Advanced technical ceramics—monolithic ceramics—mechanical properties at room temperature—Part 4. Vickers, Knoop and Rockwell superficial hardness tests
BS 1881 P 202	Recommendations for surface hardness testing by rebound hammer
BS 2782 P3 METH 3665 C	Determination of Rockwell hardness
BS 3900-E12.1	Methods of test for paints—determination of Knoop hardness by measurement of the indentation length using a microscope
BS 4443 P2	Method 7, indentation hardness tests
BS 5411 P6	Vickers and Knoop microhardness tests
BS 5600 P4 S4.5	Powder metallurgical materials and products—methods of testing and chemical analysis of hardmetals—Rockwell hardness test (scale A)
BS 6431 P13	Method for determination of scratch hardness of surface according to Mohs
BS 6617	Determination of decarburization in steel. Method for determining decarburization by microscopic and micro-hardness techniques
BS 7442 P3 S3.2	Determination of Shore hardness
BS EN 23878	Hardmetals—Vickers hardness test
BS EN 24428-1	Sintered metal materials, excluding hardmetals—determination of apparent hardness—Part 1. Materials of essentially uniform section hardness

Appendix III: Hardness Conversion Tables for Metals (E 140)

(Included on CD-Rom in back of this book.)

Appendix IV: SI Quick Reference Guide: International System of Units (SI)

(Included on CD-Rom in back of this book.)