

**AWS A5.21/A5.21M:2011**  
**An American National Standard**



# **Specification for Bare Electrodes and Rods for Surfacing**



**American Welding Society**

---



**AWS A5.21/A5.21M:2011  
An American National Standard**

**Approved by the  
American National Standards Institute  
December 23, 2010**

# **Specification for Bare Electrodes and Rods for Surfacing**

**5th Edition**

**Supersedes AWS A5.21:2001**

Prepared by the  
American Welding Society (AWS) A5 Committee on Filler Metals and Allied Materials

Under the Direction of the  
AWS Technical Activities Committee

Approved by the  
AWS Board of Directors

## **Abstract**

This specification prescribes the requirements for classification of bare electrodes and rods for surfacing. Solid surfacing electrodes and rods are classified on the basis of the composition of the material as manufactured. Metal cored and flux cored composite (tubular) surfacing electrodes and rods are classified on the basis of the chemical composition of the deposited weld metal. Tubular tungsten carbide bare rods are classified on the basis of the mesh range, quantity, and composition of the tungsten carbide granules. A guide is appended to the specification as a source of information concerning the characteristics and applications of the classified electrodes.



**American Welding Society**

550 N.W. LeJeune Road, Miami, FL 33126

International Standard Book Number: 978-0-87171-787-0

American Welding Society

550 N.W. LeJeune Road, Miami, FL 33126

© 2011 by American Welding Society

All rights reserved

Printed in the United States of America

**Photocopy Rights.** No portion of this standard may be reproduced, stored in a retrieval system, or transmitted in any form, including mechanical, photocopying, recording, or otherwise, without the prior written permission of the copyright owner.

Authorization to photocopy items for internal, personal, or educational classroom use only or the internal, personal, or educational classroom use only of specific clients is granted by the American Welding Society provided that the appropriate fee is paid to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, tel: (978) 750-8400; Internet: <[www.copyright.com](http://www.copyright.com)>.

## Statement on the Use of American Welding Society Standards

All standards (codes, specifications, recommended practices, methods, classifications, and guides) of the American Welding Society (AWS) are voluntary consensus standards that have been developed in accordance with the rules of the American National Standards Institute (ANSI). When AWS American National Standards are either incorporated in, or made part of, documents that are included in federal or state laws and regulations, or the regulations of other governmental bodies, their provisions carry the full legal authority of the statute. In such cases, any changes in those AWS standards must be approved by the governmental body having statutory jurisdiction before they can become a part of those laws and regulations. In all cases, these standards carry the full legal authority of the contract or other document that invokes the AWS standards. Where this contractual relationship exists, changes in or deviations from requirements of an AWS standard must be by agreement between the contracting parties.

AWS American National Standards are developed through a consensus standards development process that brings together volunteers representing varied viewpoints and interests to achieve consensus. While the AWS administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in its standards.

AWS disclaims liability for any injury to persons or to property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this standard. AWS also makes no guarantee or warranty as to the accuracy or completeness of any information published herein.

In issuing and making this standard available, AWS is neither undertaking to render professional or other services for or on behalf of any person or entity, nor is AWS undertaking to perform any duty owed by any person or entity to someone else. Anyone using these documents should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. It is assumed that the use of this standard and its provisions are entrusted to appropriately qualified and competent personnel.

This standard may be superseded by the issuance of new editions. Users should ensure that they have the latest edition.

Publication of this standard does not authorize infringement of any patent or trade name. Users of this standard accept any and all liabilities for infringement of any patent or trade name items. AWS disclaims liability for the infringement of any patent or product trade name resulting from the use of this standard.

Finally, the AWS does not monitor, police, or enforce compliance with this standard, nor does it have the power to do so.

On occasion, text, tables, or figures are printed incorrectly, constituting errata. Such errata, when discovered, are posted on the AWS web page ([www.aws.org](http://www.aws.org)).

Official interpretations of any of the technical requirements of this standard may only be obtained by sending a request, in writing, to the appropriate technical committee. Such requests should be addressed to the American Welding Society, Attention: Managing Director, Technical Services Division, 550 N.W. LeJeune Road, Miami, FL 33126 (see Annex B). With regard to technical inquiries made concerning AWS standards, oral opinions on AWS standards may be rendered. These opinions are offered solely as a convenience to users of this standard, and they do not constitute professional advice. Such opinions represent only the personal opinions of the particular individuals giving them. These individuals do not speak on behalf of AWS, nor do these oral opinions constitute official or unofficial opinions or interpretations of AWS. In addition, oral opinions are informal and should not be used as a substitute for an official interpretation.

This standard is subject to revision at any time by the AWS A5 Committee on Filler Metals and Allied Materials. It must be reviewed every five years, and if not revised, it must be either reaffirmed or withdrawn. Comments (recommendations, additions, or deletions) and any pertinent data that may be of use in improving this standard are required and should be addressed to AWS Headquarters. Such comments will receive careful consideration by the AWS A5 Committee on Filler Metals and Allied Materials and the author of the comments will be informed of the Committee's response to the comments. Guests are invited to attend all meetings of the AWS A5 Committee on Filler Metals and Allied Materials to express their comments verbally. Procedures for appeal of an adverse decision concerning all such comments are provided in the Rules of Operation of the Technical Activities Committee. A copy of these Rules can be obtained from the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

This page is intentionally blank.

## Personnel

### AWS A5 Committee on Filler Metals and Allied Materials

J. S. Lee, Chair	<i>Chevron</i>
H. D. Wehr, 1st Vice Chair	<i>Arcos Industries, LLC</i>
J. J. DeLoach, Jr., 2nd Vice Chair	<i>Naval Surface Warfare Center</i>
R. K. Gupta, Secretary	<i>American Welding Society</i>
T. Anderson	<i>ESAB Welding &amp; Cutting Products</i>
J. M. Blackburn	<i>Naval Sea Systems Command</i>
J. C. Bundy	<i>Hobart Brothers Company</i>
D. D. Crockett	<i>The Lincoln Electric Company</i>
R. V. Decker	<i>Weldstar</i>
D. A. DelSignore	<i>Consultant</i>
J. DeVito	<i>ESAB Welding &amp; Cutting Products</i>
H. W. Ebert	<i>Consultant</i>
D. M. Fedor	<i>The Lincoln Electric Company</i>
J. G. Feldstein	<i>Foster Wheeler North America</i>
S. E. Ferree	<i>ESAB Welding &amp; Cutting Products</i>
D. A. Fink	<i>The Lincoln Electric Company</i>
G. L. Franke	<i>Naval Surface Warfare Center</i>
R. D. Fuchs	<i>Böhler Welding Group USA, Incorporated</i>
R. M. Henson	<i>J. W. Harris Company, Incorporated</i>
S. D. Kiser	<i>Special Metals</i>
P. J. Konkol	<i>Concurrent Technologies Corporation</i>
D. J. Kotecki	<i>Damian Kotecki Welding Consultants</i>
L. Kvidahl	<i>Northrop Grumman Ship Systems</i>
A. Y. Lau	<i>Canadian Welding Bureau</i>
T. Melfi	<i>The Lincoln Electric Company</i>
R. Menon	<i>Stoody Company</i>
M. T. Merlo	<i>RevWires LLC</i>
B. Mosier	<i>Polymet Corporation</i>
A. K. Mukherjee	<i>Siemens Power Generation Incorporated</i>
T. C. Myers	<i>American Bureau of Shipping</i>
C. L. Null	<i>Consultant</i>
K. C. Pruden	<i>Hydril Company</i>
S. D. Reynolds, Jr.	<i>Consultant</i>
K. Roossinck	<i>Northrop Grumman Ship Systems</i>
P. K. Salvesen	<i>Det Norske Veritas (DNV)</i>
K. Sampath	<i>Consultant</i>
W. S. Severance	<i>ESAB Welding &amp; Cutting Products</i>
M. J. Sullivan	<i>NASSCO—National Steel &amp; Shipbuilding</i>
R. Sutherlin	<i>ATI Wah Chang</i>
R. A. Swain	<i>Euroweld, Limited</i>
K. P. Thornberry	<i>Care Medical, Incorporated</i>
M. D. Tumuluru	<i>U.S. Steel Corporation</i>
H. J. White	<i>HAYNES International</i>

**Advisors to the AWS A5 Committee on Filler Metal and Allied Material**

R. L. Bateman	<i>Electromanufacturas, S. A.</i>
J. E. Beckham	<i>Chrysler LLC</i>
R. A. Daemen	<i>Consultant</i>
C. E. Fuerstenau	<i>Lucas-Milhaupt, Incorporated</i>
J. P. Hunt	<i>Consultant</i>
S. Imaoka	<i>Kobe Steel Limited</i>
W. A. Marttila	<i>Chrysler LLC</i>
D. R. Miller	<i>ABS Americas</i>
M. P. Parekh	<i>Consultant</i>
M. A. Quintana	<i>The Lincoln Electric Company</i>
E. S. Surian	<i>National University of Lomas de Zamora</i>

**AWS A5G Subcommittee on Hardfacing Filler Metals**

R. Menon, Chair	<i>Stoody Company</i>
R. K. Gupta, Secretary	<i>American Welding Society</i>
F. Broshjeit	<i>Farrel Corporation</i>
J. Dezelle	<i>Kennametal Energy Mining</i>
S. P. Iyer	<i>Weartech International, Incorporated</i>
W. E. Layo	<i>Midalloy</i>
J. G. Postle	<i>Postle Industries, Incorporated</i>
V. B. Rajan	<i>The Lincoln Electric Company</i>
A. P. Yelistratov	<i>Caterpillar, Incorporated</i>

**Advisor to the AWS A5G Subcommittee on Hardfacing Filler Metals**

J. B. Wu	<i>Deloro Stellite Group</i>
----------	------------------------------

## Foreword

This foreword is not part of AWS A5.21/A5.21M:2011, *Specification for Bare Electrodes and Rods for Surfacing*, but is included for informational purposes only.

The method of manufacture of the core wire was the prime consideration for earlier revisions of AWS A5.21. All electrodes and rods included composite (tubular) cores. Both bare and covered electrodes were included in the same specification.

The previous revision of A5.21:2001, like that of A5.13: 2000, departed from the earlier format by eliminating the method of manufacture of the core wire as a factor for classification. All electrodes and rods now classified in accordance with A5.21:2001 are uncoated. Covered electrodes previously included, were then classified in accordance with the revision of A5.13:2000. Some solid bare electrodes and rods previously classified in accordance with A5.13-80 had been incorporated into the previously revised A5.21:2001.

This document is the first of the A5.21 specifications which makes use of both U.S. Customary Units and the International System of Units (SI). The measurements are not exact equivalents; therefore each system must be used independently of the other, without combining values in any way. In selecting rational metric units, AWS A1.1, *Metric Practice Guide for the Welding Industry*, and ISO 544 *Welding consumables — Technical delivery conditions for welding filler materials — Type of product, dimensions, tolerances and marking*, are used where suitable. Tables and figures make use of both U.S. Customary and SI Units, which, with the application of the specified tolerances, provides for interchangeability of products in both the U.S. Customary and SI Units.

*This newly metricated edition has a new "Rounding-off Procedure." AWS F3.2, Ventilation Guide for Weld Fume, has been referenced in A5.2. Detailed safety information in the annex has been replaced by reference to the AWS Safety and Health Fact Sheets. Detailed information about standard sizes and packaging has been replaced with reference to AWS A5.02/A5.02M. Added subclause 2(d) in A2.5 regarding requesting of new classifications. Significant changes such as these are shown in Italic font.*

Historical background for the document is as follows:

ANSI/AWS A5.21-70    *Specification for Composite Surfacing Welding Rods and Electrodes*  
ANSI W3.21-73

ANSI/AWS A5.21-80    *Specification for Composite Surfacing Welding Rods and Electrodes*

AWS A5.21:2001        *Specification for Bare Electrodes and Rods for Surfacing*

Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary, AWS A5 Committee on Filler Metals and Allied Materials, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.



This page is intentionally blank.

# Table of Contents

	<b>Page No.</b>
<i>Personnel</i> .....	v
<i>Foreword</i> .....	vii
<i>List of Figures</i> .....	x
<i>List of Tables</i> .....	x
<b>1. Scope</b> .....	1
<b>2. Referenced Documents</b> .....	1
<b>3. Classification</b> .....	2
<b>4. Acceptance</b> .....	2
<b>5. Certification</b> .....	2
<b>6. Rounding-Off Procedure</b> .....	2
<b>7. Summary of Tests</b> .....	7
7.1 Solid Electrodes or Rods .....	7
7.2 Metal Cored and Flux Cored Composite (Tubular) Electrodes and Rods .....	7
7.3 Tungsten Carbide Rods .....	7
<b>8. Retest</b> .....	9
<b>9. Chemical Composition Requirements</b> .....	9
<b>10. Method of Manufacture</b> .....	10
<b>11. Standard Sizes and Lengths</b> .....	10
<b>12. Finish and Uniformity</b> .....	10
<b>13. Standard Package Forms</b> .....	10
<b>14. Winding Requirements</b> .....	10
<b>15. Filler Metal Identification</b> .....	10
<b>16. Packaging</b> .....	12
<b>17. Marking of Packages</b> .....	12
Annex A (Informative)—Guide to AWS Specification for Bare Electrodes and Rods for Surfacing .....	13
Annex B (Informative)—Guidelines for the Preparation of Technical Inquiries .....	25
AWS Filler Metal Specifications by Material and Welding Process .....	27
AWS Filler Metal Specifications and Related Documents .....	29

## List of Tables

<b>Table</b>		<b>Page No.</b>
1	Solid and Cored Iron Base Electrodes and Rods—Chemical Requirements.....	3
2	Solid Cobalt and Nickel Base Bare Electrodes and Rods—Chemical Composition Requirements.....	4
3	Metal Cored and Flux Cored Composite Cobalt and Nickel-Base Bare Electrodes and Rods— Chemical Composition Requirements .....	5
4	Solid and Cored Copper Base Electrodes and Rods—Chemical Composition Requirements .....	6
5	Mesh Size and Quantity of Tungsten Carbide (WC) Granules in the Core of Tungsten Carbide Bare Rods and Electrodes .....	7
6	Chemical Composition Requirements for Tungsten Carbide Granules.....	7
7	Standard Sizes of Bare Electrodes and Rods Using Solid Drawn or Composite (Tubular) Wire.....	11
8	Standard Sizes for Cast Electrodes and Rods .....	11
9	Standard Sizes for Tungsten Carbide (WC) Rods .....	12
A.1	Discontinued and Transferred Electrode and Rod Classifications.....	22

## List of Figures

<b>Figure</b>		<b>Page No.</b>
1	Pad for Chemical Analysis of Undiluted Weld Metal.....	8

# Specification for Bare Electrodes and Rods for Surfacing

## 1. Scope

**1.1** This specification prescribes the requirements for the classification of bare electrodes and rods for surfacing. The specification does not provide for classification of electrode-flux combinations for submerged arc welding.

**1.2** Safety and health issues and concerns are beyond the scope of this standard and, therefore, are not fully addressed herein. Some safety and health information can be found in the nonmandatory annex Clauses A5 and A10. Safety and health information is available from other sources, including, but not limited to, ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*,<sup>1</sup> and applicable federal and state regulations.

**1.3** *This specification makes use of both U.S. Customary Units and the International System of Units (SI). The measurements are not exact equivalents; therefore, each system must be used independently of the other without combining in any way when referring to material. The specification with the designation A5.21 uses U.S. Customary Units. The specification A5.21M uses SI Units. The latter are shown within brackets [ ] or in appropriate columns in tables and figures. Standard dimensions based on either system may be used for sizing of filler metal or packaging or both under A5.21 or A5.21M specifications.*

## 2. Referenced Documents

The following documents are referenced within this publication. For undated references, the latest edition of the referenced standard shall apply. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply.

### 2.1 AWS Standards<sup>2</sup>

AWS A3.0M/A3.0, *Standard Welding Terms and Definitions*

AWS A5.01M/A5.01 (ISO 14344), *Procurement Guidelines for Consumables—Welding and Allied Processes—Flux and Gas Shielded Electrical Welding Processes*

AWS A5.02/A5.02M, *Specification for Filler Metal Standard Sizes, Packaging, and Physical Attributes*

AWS F3.2, *Ventilation Guide for Weld Fume*

### 2.2 ANSI Standards

ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*

### 2.3 ASTM Standards<sup>3</sup>

ASTM E 29, *Standard Practice of Using Significant Digits in Test Data to Determine Conformance with Specifications*

<sup>1</sup> ANSI Z49.1 is published by American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

<sup>2</sup> AWS standards are published by American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

<sup>3</sup> ASTM standards are published by ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.