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DEPARTMENT OF DEFENSE
HANDBOOK

TUNGSTEN CARBIDE-COBALT COATING, DETONATION PROCESS FOR

AMSC N/A AREA MFFP

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F O R E W O R D

1. This Military Standard is approved for use by the U.S. Army Tank- Automotive Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Tank-Automotive Command, ATTN: AMSTA-GDS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3. The procedure for applying tungsten carbide-cobalt coatings to metal parts by the detonation process and associated acceptance criteria are covered in this standard.

C O N T E N T S

1. SCOPE

1.1 Scope. This standard covers the procedure for applying tungsten carbide-cobalt coatings to metal parts by the detonation process and the acceptance criteria for the finished parts.

1.2 Application. This detonation process for applying tungsten carbide-cobalt coating provides a hard, wear-resistant surface on metal parts which do not operate at temperatures higher than 1,000 degrees Fahrenheit (°F) [538 degrees Celsius (538°C)]. The coating is not recommended for surfaces with deep v-shaped grooves, blind cavities, narrow holes, sharp corners, or where deformation of the base metal is expected.

2. APPLICABLE DOCUMENTS

2.1 Government documents. Not applicable.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B243	- Standard Terminology Used In Powder Metallurgy.
ASTM C633	- Standard Test Method for Adhesion or Cohesive Strength of Flame-Sprayed Coatings.
ASTM E3	- Standard Methods of Preparation of Metallographic Specimens.
ASTM E384	- Standard Test Method for Microhardness of Materials.
ASTM E407	- Standard Test Methods for Microetching Metals and Alloys.

(Copies of the above publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

SOCIETY OF AUTOMOTIVE ENGINEERS, INC. (SAE)

SAE J439	- Sintered Carbide Tools, Recommended Practice.

(Application for copies should be addressed to the Society for Automotive Engineers, Inc., 400 Commonwealth Avenue, Warrendale, PA 15096.)

(Nongovernment standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 Hardness. The value obtained by testing a sintered material with standard indentation hardness equipment. Since the reading is taken on a composite of pores and solid material, it is usually lower than that of solid material of the same composition and condition and is not to be confused with particle hardness, as specified in ASTM B243.

3.2 Porosity. Porosity, structure, and grain size shall be evaluated by metallographic examination. The term is applied to the inherent porosity, nonmetallic inclusions, and uncombined carbon as observed in the microstructure of the properly prepared surface of sintered carbides as specified in SAE J439.

4. GENERAL REQUIREMENTS

4.1 Equipment. The equipment shall consist of a device in which the particles of the coating material may be fed into the tube of a gun and suspended in a mixture of oxygen, acetylene, and nitrogen within the tube. The mixture is then detonated, heating the particles to plasticity and hurling the particles at high velocity out of the gun barrel onto the part to be coated.

4.2 Coating material. The coating material shall consist of a nominal chemistry as follows:

Tungsten Carbide	- 85 percent (%)
Cobalt	- 15 %

4.3 Procedure.

4.3.1 Surface preparation. Surface preparation shall include the following:

a. Surfaces to be coated shall be suitably machined to allow for finish thickness of the coating.
b. Processes such as heat treatment and shot peening shall be performed prior to coating.
c. All traces of dirt and foreign matter (water, oil, grease, scale, paint, etc.) shall be removed from surfaces of part to be coated.
d. Part surfaces not requiring coating shall be suitably masked or shielded.
e. When required to enhance adhesion of the coating, the part surfaces shall be grit blasted to produce a uniform matte finish.

4.3.2 Surface coating. The coating material shall be deposited on the part surfaces a sufficient thickness to permit finishing the part to engineering drawing dimensions.

4.3.2.1 Surface finishing. The procedures for grinding and lapping the surface shall be approved by the Government.

4.4 Tolerances. A tolerance of -0 and +0.125 inch [3.2 millimeters (mm)] shall be allowed along boundary of areas to be coated unless otherwise specified in the engineering drawing.

5. DETAILED REQUIREMENTS

5.1 Test methods.

5.1.1 Test specimen. Unless otherwise specified, the test specimen shall be cold rolled steel approximately 0.37 x 0.37 x 0.37 inch (9.5 x 9.5 x 9.5 mm) and shall be coated 8 to 10 mils (0.20 to 0.25 mm) thick on one surface.

5.1.2 Visual examination. All part and test specimens shall be visually inspected after coating and evidence no cracking or spalling. There shall be no untreated areas and no significant differences in surface color indicative of uneven coating.

5.1.3 Apparent hardness. The average apparent hardness of the finished product shall be taken on a cross-sectional test specimen or finished part prepared in accordance with ASTM E3. The average hardness shall be 1,000 to 1,150 hardness Vickers (HV) (136° square based pyramidal diamond and a 300 gram load) or the equivalent taken using an approved alternate method as specified in ASTM E384. In either case, a minimum of ten microhardness readings shall be taken.

5.1.4 Apparent porosity. The average apparent porosity shall be determined on the same metallographic mount as used in 5.1.3. The porosity shall be less than 1% of coating cross section when examined microscopically at a magnification of 200X, unetched, and compared with approved porosity microstructure standards in accordance with SAE J439.

5.1.5 Inclusions. The coating cross section examined at 200X magnification unetched (see 5.1.4) shall evidence no foreign inclusions in excess of 1%.

5.1.6 Cracks and interface bond separation. There shall be no evidence of cracks or bond separation.

5.1.7 Coating thickness. Coating thickness shall be as specified in the engineering drawing.

5.1.8 Bond strength. The coating shall have a minimum bond strength of 10,000 pounds per square inch (psi) [69 mega Pascals (MPa)] when tested in accordance with ASTM C633 except that the coating thickness shall be 8 to 10 mils (0.20 to 0.25 mm). Epoxy failures below 10,000 psi (69 MPa) may be retested.

5.1.9 Metallurgical structure. When specified, the metallurgical structure shall be evaluated at 1,500X magnification after etching in appropriate etchant in accordance with ASTM E407. The structure shall be compared with standards as provided or that are shown in Figure 4b of SAE J439.

5.1.10 Finished parts. The properties of the coating as applied to actual parts are dependent on the part geometry and any tests other than those of 5.1.2 and 5.1.3 on test specimens shall be specified in the engineering drawings.

5.2 Sampling. Samples shall be taken for evaluation and test after any scheduled or unscheduled maintenance of the coating process equipment. These samples shall be processed in accordance with 5.1.

5.3 Process approval. The coating vendor shall use manufacturing procedures, processes, coating materials, and methods of inspection on production parts which are essentially the same as those used on the approved sample parts to determine conformance to this standard. If any change in type of equipment or operating conditions is necessary, the vendor shall submit samples for reapproval of the process. Unless the requirements for test specimens are waived in writing by the Government, production parts coated by the revised procedure shall not be shipped prior to approval of such procedure.

5.3.1 Coating powder. The vendor shall make no changes in chemical or mechanical composition of the coating powder which will result in change of applied coating without prior notification to the Government.

6. NOTES

6.1 Intended use. This standard is intended for use when metal parts are to be spray coated with a tungsten carbide-cobalt coating using the detonation process. It establishes the application and test procedures and acceptance criteria for the parts so treated.

6.2 Reports. When reports are required, the acquisition activity should specify the following information and the number of copies to be furnished:

a. Purchase order number.
b. Part number and revision letter.
c. Coating material and thickness as specified.
d. Conformance to this standard [MIL-STD-1886(AT)].

6.3 Supersession data. This standard supersedes Textron Lycoming Division, internal specification P6409A, dated 26 April 1982.

6.4 Subject term (key word) listing.

Bond strength
Coating powder
Coating thickness
Cracks
Hardness, apparent
Inclusions
Metallurgical structure
Porosity, apparent
Test specimen
Tolerances
Visual examination

Custodian:
Army - AT

Preparing Activity:
Army - AT

(Project MFFP-A490)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-STD-1886	2. DOCUMENT DATE *(YYMMDD)* 23 March 1886(AT)

3. DOCUMENT TITLE TUNGSTEN CARBIDE-COBALT COATING, DETONATION PROCESS FOR

4. NATURE OF CHANGE ***(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)***

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) AUTOVON *(If applicable)*	7. DATE SUBMITTED *(YYMMDD)*

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE *(Include Area Code)* (1) Commercial (2) AUTOVON
c. ADDRESS *(Include Zip Code)* Commander U.S. Army Tank-automotive and Armaments Command ATTN: AMSTA-TR-E/BLUE Warren, MI 48397-5000	(810) 574-8745 786-8745 IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403 Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340