

Chemical Milling of Metals, Specification for

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1. SCOPE:

- 1.1 This specification covers the requirements for surface metal removal of ferrous and non-ferrous metals by milling processes using controlled immersion of parts in chemical etching solutions.

2. APPLICABLE DOCUMENTS:

The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

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2.1 U.S. Government Publications:

Available from DODSSP Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-S-5002	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems
MIL-I-6866	Inspection, Penetrant, Method of
MIL-I-6870	Inspection Requirements, Nondestructive, For Aircraft Materials and Parts
MIL-T-9046	Titanium and Titanium Alloy, Sheet, and Plate
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
FED-STD-151	Metals; Test Methods

2.2 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 5545	Plate, Sheet and Strip, Alloy-Nickel Base, 19 Cr, 11 Co, 10 Mo, 3 Ti, 1.5 Al, Vacuum Melted, Solution Heat Treated
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2.3 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117	Salt Spray (Fog) Testing
ASTM E 8	Tension Testing of Metallic Materials
ASTM E 290	Semi-Guided Bend Test for Ductility of Metallic Materials

2.4 ANSI Publications:

Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI B 46.1	Surface Texture
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3. REQUIREMENTS:

3.1 Materials:

- 3.1.1 Etchants: Etchants, their compositions and control temperatures, are usually considered proprietary information. The criteria for an etchant shall be a uniform reaction on the work piece, good surface finish, reasonable temperature range and a feasible analytical control. The etchants may be modified by additives, concentration, and temperature to provide the best results for a particular metal or metallurgical condition. The etchants shall not downgrade the chemical and mechanical properties of the parts.

- 3.1.2 Maskants: Any suitable masking material may be used provided no detrimental effects are produced on the work and complete protection is provided in the masked areas from etchants. After processing, the maskant material shall be capable of complete removal without leaving any discoloration or residue.
- 3.2 Chemical milling application:
- 3.2.1 Metal preparation: Heat treatments and mechanical operations such as shearing and forming should be performed before articles or parts are chemically milled. Normally sufficient trim should be allowed on each part for handling lugs or tooling holes common for chemical milling and for post chemical milling operations. Holes that would add to the complexity of processing should be avoided. All burrs and sharp corners shall be removed from parts to prevent mask failure.
- 3.2.2 Cleaning: The surfaces and adjacent areas of all parts to be chemically milled shall be thoroughly cleaned to remove all oil, grease, paint, pencil markings, drawing or cutting lubricants, dirt, scale, artificial oxide, rust film, and other foreign substances. Cleaning shall be in accordance with MIL-S-5002. The cleaning materials and processes shall not damage the metal to be cleaned, shall perform their intended function and shall not interfere with subsequent operations.
- 3.2.3 Masking: After all metal preparation and cleaning operations, the articles or parts shall be masked. Maskants shall be applied to provide a continuous, impermeable chemical resistant coating free from air bubbles, pinholes, cuts and other defects. The masked parts shall be cured and cooled to room temperature prior to scribing or cutting through the masked area with a tool. A templet may serve as a guide. Care should be taken to avoid cutting the mask beyond the area to be etched. The depth of the basis metal cut, caused by scribing, shall be kept to an absolute minimum. Cutting the basis metal to any great depth can result in ridging at the base of the undercut fillet during etching. This condition shall be avoided to prevent rejection. The masking material shall then be stripped or removed from the areas to be chemically milled or etched.
- 3.2.3.1 Other masking techniques: Screening or photoresist techniques should be used for shallow milling of relatively small parts that require greater dimensional accuracy or finer detail than that of the scribe-and-peel maskant method.
- 3.2.4 Application: Parts shall be etched or chemically milled by controlled time of immersion in solutions that are controlled for their chemical reaction with the various metals (see 3.1.1). Parts shall be positioned, racked or suspended in such a manner as to avoid entrapment of gases, which can prevent attack on the areas to be etched or which can interfere with dissipation of heat from masked areas, to prevent sludge settlement on the parts, and to allow good solution circulation over the parts.