

SEMI F119-1121

TEST METHOD FOR DETERMINING THE CRITICAL PITTING TEMPERATURE OF STAINLESS STEEL SURFACES USED IN CORROSIVE GAS SYSTEMS BY USE OF A FERRIC CHLORIDE SOLUTION

This Standard was technically approved by the Gases Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on August 12, 2021. Available at www.semiviews.org and www.semi.org in November 2021. Previously published as SEMI C92.

NOTICE: This Document replaces SEMI C92-0216.

NOTICE: Paragraphs entitled ‘NOTE:’ are not an official part of this Standard or Safety Guideline and are not intended to modify or supersede the official Standard or Safety Guideline. These have been supplied by the global technical committee to enhance the usage of the Standard or Safety Guideline.

NOTICE: The section symbol (§) is used to reference a numbered section, paragraph, or header and all subordinate paragraphs, headers, and embedded material (i.e., EXCEPTIONs, lists) therein. The paragraph symbol (¶) is used to reference a particular numbered paragraph and embedded material therein. When duplicated (i.e., §§ and ¶¶) the symbols are used to reference more than one section or paragraph, respectively.

1 Purpose

1.1 The purpose of this Test Method is to determine the relative resistance to pitting corrosion of the wetted surfaces of components intended for use in corrosive gas distribution systems for semiconductor manufacturing. This Test Method is an adaptation of ASTM G48 and is intended to differentiate between stainless steels of differing compositions or processing that may affect the corrosion performance of the wetted surfaces. Detailed information on the method is found in ASTM G48.

2 Scope

2.1 This Test Method describes a procedure which may be used to rank the pitting corrosion resistance of wetted surfaces of tubing or components of finished surfaces intended for use in corrosive gas systems. Pitting corrosion is a potential corrosion failure mechanism in semiconductor gas delivery systems, particularly in welded components or tubing exposed to corrosive gases with moisture present.

2.2 This Test Method is an adaptation of ASTM G48 Method E, Critical Pitting Temperature Test for Stainless Steel. The adaptation describes a method for performing the Test Method on coupons or wetted surface sections cut from gas supply system components or tubing. It is an aqueous immersion method in an acidified ferric chloride solution.

2.3 This Test Method is reproducible and provides a metric (i.e., critical pitting temperature) in addition to a qualitative (i.e., visual) evaluation of corrosion resistance.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 The test conditions of this Test Method do not simulate actual service in a corrosive gas supply system. Thus the test results may not correlate to relative corrosion resistance in a specific corrosive gas or corrosive gas supply system.

3.2 The critical pitting temperature (CPT) is valid only in a range of 10°C to 95°C. A CPT result greater than 95°C is not considered to be valid since it is approaching the boiling point of the solution. A CPT below 10°C shall only be reported as <10°C and may be an indication of crevice corrosion, which renders the test invalid.

3.3 Since alloy composition and surface parameters can affect the results of the test, all variables other than the one being tested must be fixed during the test in order to obtain reproducible and comparable results.

3.4 The test is destructive of the component tested. The component should not be placed in service following test.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI F19 — Specification for the Surface Condition of the Wetted Surfaces of Stainless Steel Components

4.2 ASTM Standards¹

ASTM G15 — Standard Terminology Relating to Corrosion and Corrosion Testing

ASTM G48 — Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

NOTE 1: Unless otherwise stated, the terminology relating to corrosion and corrosion testing is as defined in ASTM G15.

5.1 Abbreviations and Acronyms

5.1.1 *AISI* — American Iron and Steel Institute

5.1.2 *ASTM* — American Society for Testing and Materials

5.1.3 *CPT* — critical pitting temperature

5.1.4 *GP* — general purity

5.1.5 *HP* — high purity

5.1.6 *UHP* — ultra-high purity

5.2 Definitions

5.2.1 *crevice corrosion* — corrosion at a cavity between adjoining pieces or at the edge of a seal or masking paint. The chemical mechanism of crevice corrosion is similar to that of pitting, the cavity being a ‘preformed’ pit. As corrosion is initiated at the cavity, the critical temperature for crevice corrosion is always lower than the critical pitting temperature.

5.2.2 *critical pitting temperature (CPT)* — the lowest temperature at which pitting occurs on the test surface under the specified test conditions.

5.2.3 *pitting* — corrosion of a metal surface, confined to a point or small area, that takes the form of cavities.

5.2.4 *wetted surface* — surfaces of a component in contact with the contained fluids.

6 Summary of Test Method

6.1 The test specimen is immersed in a ferric chloride test solution of 6% FeCl₃ and 1% HCl at 10°C (see ¶ 10.2) for 24 hours followed by visual examination for pitting. If pitting is not present the test is repeated at 5°C higher temperature increments until pitting is observed. The temperature at which pitting is observed is reported as the CPT.

7 Possible Interferences

7.1 A possible interference is failure by crevice corrosion in which case the test is considered invalid.

7.2 Crevice corrosion can occur at any point of contact of the area under test with another object, such as a specimen holder or container, or at the edge of the masking media. The crevice corrosion sites exist at the contact sites or the masking boundaries. Figure 1 gives an example of the typical appearance of crevice corrosion sites from a critical pitting test performed on type 316 stainless steel using masking.

¹ ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA; Telephone: +1.610.832.9585, Fax: +1.610.832.9555, <http://www.astm.org>