SEMI F81-0611
SPECIFICATION FOR VISUAL INSPECTION AND ACCEPTANCE OF GAS TUNGSTEN ARC (GTA) WELDS IN FLUID DISTRIBUTION SYSTEMS IN SEMICONDUCTOR MANUFACTURING APPLICATIONS

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1 Purpose

1.1 The purpose of this Specification is to provide visual inspection and acceptance criteria for gas tungsten arc (GTA) welds of stainless steel and other corrosion resistant metals and alloys (CRAs) in fluid (liquid or gas) distribution systems in semiconductor manufacturing applications. These criteria are meant to ensure that welds are of sufficient quality to provide the required system purity, weld integrity, and weld strength for use in semiconductor manufacturing applications.

2 Scope

2.1 This Specification defines inspection and acceptance criteria for GTA autogenous butt joint welds of stainless steel and other CRAs in fluid distribution systems. The fluid distribution system includes tubing, pipe, fittings, valves, subassemblies and components that contain and distribute fluid.

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 stainless steels covered by this Specification are limited to the austenitic and super austenitic grades of stainless steel.

3.2 Corrosion resistant metals and alloys covered by this Specification are limited to solid solution grades of nickel alloys and solid solution grades of titanium alloys.

3.3 This Specification applies only to autogenous GTA circumferential butt joint welds performed on fluid distribution system components 6 inches (150 mm) or less in diameter.

3.4 This Specification applies only to automatic, mechanized, or machine GTA welding processes.

3.5 This Specification applies only to welds performed with no fillers and no fluxes.

3.6 This Specification does not apply to pressure vessel or process chamber welds.

4 Referenced Standards and Documents

NOTE 1: The following documents become part of this Specification to the extent that they are included herein.

4.1 *SEMI Standards and Safety Guidelines*

SEMI F78 — Practice for Gas Tungsten Arc (GTA) Welding of Fluid Distribution Systems in Semiconductor Manufacturing Applications

4.2 *ASME Standard*[1]

ASME BPE — Bioprocessing Equipment Standard

[1] American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990, USA; Telephone: +1.973.882.1170, Fax: +1.973.882.1717, https://www.asme.org

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4.3 *ASNT Standard*[2]

ASNT SNT-TC-1A — Personnel Qualification and Certification in Nondestructive Testing

4.4 *AWS Standards*[3]

AWS QC-1 — Standard for AWS Certification of Welding Inspectors

AWS A3.0 — Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying

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

5 Terminology[4]

5.1 *Definitions*

5.1.1 *angular misalignment* — the condition that exists when the tubing angle is changed at the weld.

5.1.2 *autogenous weld* — a fusion weld made without filler metal.[2]

5.1.3 *automatic arc welding downslope* — the time during which the welding current is reduced continuously from the final level until the arc is extinguished.

5.1.4 *axial misalignment* — the distance between the axes of the two parts joined by a weld, measured perpendicularly to those axes.

5.1.5 *bead* — non-standard term for *weld bead.*[2]

5.1.6 *bead overlap* — in a pulsed weld the amount of coverage of a weld pulse of the previous weld pulse, usually measured in percentage of the diameter of the pulse.

5.1.7 *bead width* — the width of the weld bead on the ID, normally measured in units of *T*, where *T* is the nominal tube wall thickness.

5.1.8 *center line shrinkage* — a profile-reducing defect or discontinuity normally formed by shrinkage during solidification.

5.1.9 *concavity* — a condition in which the surface of a weld is depressed relative to the surface of the tube or pipe. Concavity is measured as a maximum distance from the outside or inside diameter surface of a weld along a line perpendicular to a line joining the weld toes.[3]

5.1.10 *convexity* — a condition in which the surface of a weld is extended relative to the surface of the tube or pipe. Convexity is measured as a maximum distance from the outside or inside diameter surface of a weld along a line perpendicular to a line joining the weld toes.[3]

5.1.11 *coupon* — weld sample which is inspected to insure that the weld meets specifications.

5.1.12 *discoloration* — any change in surface color from that of the base metal. Usually associated with *oxidation* occurring on the weld and heat affected zone on the outside and inside diameter of the weld joint as a result of heating the metal during welding. Colors may range from pale bluish-gray to deep blue, and from pale straw color to a black crusty coating.[3]

5.1.13 *downslope* — see automatic arc welding downslope.

5.1.14 *electrode* — non-standard term for tungsten electrode.[2]

5.1.15 *examiner* — a person who performs examination of a particular object, or evaluates an operation, for compliance to a given standard. The examiner performs quality control for the manufacturer, fabricator, or erector.

[2] The American Society for Nondestructive Testing, PO Box 28518, 1711 Arlingate Lane, Columbus, OH 43228-0518, USA; Telephone: +1.800.222.2768; Fax: +1.614.274.6899; http://www.asnt.org

[3] American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33135, USA; Telephone: +1.800.443.9353; http://www.aws.org

[4] The terminology has been derived from the following sources: (1) Webster's New World College Dictionary Fourth Edition; (2) ANSI/AWS A3.0 Standard Welding Terms and Definitions; (3) ASME BPE Bioprocessing Equipment Standard.

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5.1.16 *fluid* — liquid or gas.[1]

5.1.17 *gas* — the fluid form of a substance in which it can expand indefinitely and completely fill its container; form that is neither liquid or solid.[1]

5.1.18 *gas tungsten arc welding (GTAW)* — an arc welding process that uses an arc between a tungsten electrode (nonconsumable) and the weld pool. The process is used with a shielding gas.[3]

5.1.19 *heat-affected zone (HAZ)* — the portion of the base metal whose mechanical properties or microstructure have been altered by the heat of welding.[2]

5.1.20 *inclusion* — entrapped foreign solid material, such as slag, flux, tungsten, or oxide.[2]

5.1.21 *inert gas* — a gas that normally does not combine chemically with materials. A protective atmosphere.

5.1.22 *liquid* — having its molecules moving freely with respect to each other so as to flow readily, unlike a solid, but because of cohesive forces not expanding infinitely like a gas.[1]

5.1.23 *meandering* — of or pertaining to a weld bead that deviates from side to side across the weld joint rather than tracking the joint precisely.[3]

5.1.24 *orbital welding* — automatic or machine welding of tubes or pipes in-place with the electrode rotating (or orbiting) around the work. Orbital welding, as it applies to this standard, is a fusion process without the addition of filler.[3]

5.1.25 *oxidation* — the formation of an oxide layer on a metal surface.[3]

5.1.26 *profile defect* — any defect or discontinuity that reduces the wall thickness below that of the parent metal.

5.1.27 *pulsed gas tungsten arc welding* — a gas tungsten arc welding process variation in which the current is varied in regular intervals.

5.1.28 *purge* — the application of an inert gas, or gas mixture, to the OD or ID surface of the weld joint to displace non-inert atmospheric gases. A block purge is a non-flowing purge with positive pressure.

5.1.29 *purge gas* — an inert gas, or gas mixture, used to displace the ambient atmosphere from the inside (ID) of the weld joint.

5.1.30 *root surface* — the exposed surface of a weld opposite the side from which the welding was done.[2]

5.1.31 *shield gas* — inert gas, or gas mixture, that protects the electrode and molten puddle from atmosphere and provides the required arc characteristics.

5.1.32 *slag* — a non-metallic product resulting from the mutual dissolution of non-metallic impurities in some welding processes.[2]

5.1.33 *tack weld* — a weld made to hold the parts of a weldment in proper alignment until the final welds are made.[2]

5.1.34 *tungsten* — non-standard term for tungsten electrode.

5.1.35 *tungsten electrode* — a non-filler electrode used in arc welding, made principally of tungsten.[2]

5.1.36 *undercut* — a groove adjacent to the base metal at the edge of the weld left unfilled by weld metal.[2]

5.1.37 *weld bead* — a weld resulting from a weld pass.[2]

6 Ordering Information

6.1 The purchase order for services to be supplied in compliance with this Specification shall include the following information:

6.1.1 Purchase order number.

6.1.2 Reference to applicable specifications.

6.1.3 Documentation and certification requirements.

6.1.4 Disposition of documentation and coupons.

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