



AEROSPACE MATERIAL SPECIFICATION

AMS2548™

Issued

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Laser Beam Machining

RATIONALE

AMS2548 is a new specification to cover laser beam machining.

NOTICE

ORDERING INFORMATION: The following information shall be provided to the processor by the purchaser:

1. Purchase order shall specify not less than the following:

- AMS2548
- Quantity of pieces to be machined
- Material type and heat-treatment condition
- Classification (see 1.4)
- If specimens are allowed for periodic testing (see 4.2.2 and 4.3.3)

2. Parts manufacturing operations such as heat treating, forming, joining, and media finishing can affect the condition of the substrate for laser machining or, if performed after laser beam machining, could adversely affect the processed part. The sequencing of these types of operations should be specified by the cognizant engineering organization (CEO) and is not controlled by this specification.

1. SCOPE

1.1 Purpose

This specification covers the engineering requirements for laser beam machining, such as cutting and drilling.

1.2 Application

This process is typically used for finishing operations where subsequent metal removal operations are not performed.

1.3 Laser beam machining introduces defects into the surface of the part being machined. As a result, the laser cutting and drilling processes are controlled, and parts are tested for any such effects.

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SAE WEB ADDRESS:

Full document details: SAE AMS2548

For more information on this standard, visit
<https://www.sae.org/standards/content/AMS2548/>

Documents

Standard Sharing Hub

1.4 Classification

Class 1: Flight-critical or rotational parts.

Class 2: Non-flight-critical or non-rotational parts.

Class 3: Parts that have all aspects of laser beam machining removed by conventional machining.

1.4.1 If no classification is specified, Class 2 shall apply.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AS2390 Chemical Process Test Specimen Material

AS7766 Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E3 Preparation of Metallographic Specimens

2.3 Definitions

Terms used in AMS are defined in AS7766 and as follows:

2.3.1 ADEQUATE LIGHTING

Shall be uniform with white light intensity greater than 1000 lx or greater than 93 foot-candles at the part. No shadows or bright spots shall be present on the parts during inspection.

2.3.2 ASSIST GAS

Assist gas, or cutting gas, in laser beam machining is a jet of gas that effectively blows away the molten material to create the cut and disperses the heat around the laser head. A clean cut requires high-purity gas. The gas will often need to be delivered at a high pressure and at a set flow rate. These parameters will be determined by the specific model of laser used. It minimizes achieving a better laser result. It also helps to remove debris while avoiding burning the product.

2.3.3 HEAT-AFFECTED ZONE (HAZ)

The layer just below the recast layer created by the high temperature of the laser beam. It exhibits a different microstructure (grain size, precipitate size, precipitate morphology, or precipitate distribution) than the base material. HAZ could weaken prematurely and cause the material to develop stress fractures that could lead to anything from a minor malfunction to a catastrophic failure. Typically, the HAZ is about half the thickness of recast layer.

2.3.4 LASER BEAM MACHINING

Laser beam machining is a form of machining that uses heat directed from a laser beam. This process uses thermal energy to remove material from metallic or nonmetallic surfaces. The high frequency of monochromatic light will fall on the surface, thus heating, melting, and vaporizing the material due to the impinge of photons.

2.3.5 MICROCRACK

A crack, break, or separation on the surface of the surface. Microcracks have sharp edges and can develop in any direction.

2.3.6 PROCESS PROCEDURE

A document that contains, at a minimum, all applicable parameters in accordance with this specification. It can include operation sheets, shop routers, and/or work instructions.

2.3.7 RECAST LAYER

A layer of material created by localized melting of the workpiece material, which solidifies before being removed and has different physical and mechanical properties than the base material. The recast layer is attached to the base metal and may contain microcracks. Recast layer may be brittle or cracked, and its inclusion may lead to fracture initiation or propagation during use of the part. The HAZ formed underneath the recast layer is not considered part of the recast layer.

3. TECHNICAL REQUIREMENTS

3.1 Equipment

Laser machines shall be capable of producing features that meet the requirements of this specification.

3.1.1 Calibration

All gauges, indicators, and inspection fixtures shall be under calibration per processor quality management system control procedures.

3.1.1.1 Where indirect calibration is used, the procedure shall be defined and documented by the processor.

3.1.2 Tooling and Fixturing

All tooling and fixtures used to load and secure parts on the machine shall be clearly identified and documented in the process procedure either by generic names, identifying numbers, or drawings. In case of identifying numbers, the engineering drawings describing the tooling and fixtures shall be maintained.

3.1.2.1 The fixture loading, part loading, and verification method shall be documented.

3.1.2.2 Tooling and fixtures used for inspection of parts shall be such that they leave no visible residue on parts when evaluated by visual examination under adequate lighting with no magnification.

3.1.2.3 Tooling and fixtures used to locate and manipulate parts shall not leave any visible residue on parts. The machine tool and fixture shall provide automatic part position error compensation such as auto focus or part mapping if needed to maintain specific tolerances.

3.2 Processing

Each part shall be laser beam machined using an approved process procedure (see 3.2.4).

3.2.1 Cleanliness

3.2.1.1 Parts shall be visually inspected prior to laser beam processing.

3.2.1.2 Visible contaminants, when observed by inspection using visual examination under adequate lighting with no magnification, such as burrs and chips from previous processing, surface oxides, grease, and oils shall be removed from part surfaces prior to laser beam machining.

3.2.2 Heat Treatment

If the processor is responsible for the heat treatment of parts that are to be laser machined, the heat treatment shall be performed after laser beam processing is completed.

3.2.3 Protective Coatings

Protective coatings (stop-off), when used, shall be applied as documented in the process procedure.

3.2.4 Process Procedure

A documented process procedure shall be established for each part to be laser beam machined.

3.2.4.1 The procedure shall include, as a minimum, the following:

Laser machining control factors (see 4.4.3)

Work and shop router instructions

Method of cleaning (see 3.2.1.2)

Fixtures used, listed by identification number, code, or description

Part and fixture loading and verification method

Application and removal of any protective coatings (see 3.2.3 and 3.2.6.2)

Use of beam blockers

Any special requirements

3.2.4.2 Process procedures shall also cover the following:

CEO approval and reference to qualification test results/records

Revision control on procedure modifications

Statistical process control data gathering and storage for any engineering key characteristics

3.2.5 Class 3 Parts

For Class 3 parts where the recast layer, microcracks, and HAZ are not allowed, laser beam machining shall be used for preliminary metal removal only. The following conditions apply:

3.2.5.1 The laser beam process shall be established in accordance with this specification.

3.2.5.2 The maximum thickness of the recast layer shall be determined by metallographic analysis as in 3.3.3.

3.2.5.3 The laser beam process shall be followed by conventional machining with at least two times the thickness of maximum recast removed from all laser beam machining surfaces.

3.2.5.4 After conventional machining, metallographic analysis per 3.3.3 shall be carried out to ensure that all effects produced by laser beam have been removed.

3.2.5.5 Properties in 3.3 do not apply to Class 3 parts.

3.2.6 Post-Laser Beam Machining Processing

3.2.6.1 Provided that the surface finish, dimensional, and surface integrity requirements are met, redeposited globules and flash shall be removed by documented processes. Residue and foreign material introduced by such processes shall be cleaned from the parts.

3.2.6.2 Any protective coatings (see 3.2.3) shall be removed without affecting the surface finish of the part.