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(JWES)

**Test methods for lead-free solders—
Part 2 : Methods for testing
mechanical characteristics-tensile
test**

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from The Japan Welding Engineering Society (JWES), with a draft of Industrial Standard based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

Soldering is called HANDAZUKE (Japanese), a technique to be used for mounting electronic and electrical machinery and apparatus, communication equipment and the like and its use field is wide and expectation for high reliability of the connection is large.

Though there are standards inside and outside Japan as well as International Standards like IEC or ISO, this Standard uses results of "standardization of test methods and the like necessary for solder connection corresponding to the reduction of an environmental load" based on the research and development by contract of New Energy and Industrial Technology Development Organization.

This Standard concerns the methods for testing mechanical characteristics (tensile test) of lead-free solders which are environmentally friendly and is positioned as a standard for considering environment.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

JIS Z 3198 includes the following 7 parts with the general title *Test methods for lead-free solders*

Part 1 : Methods for measuring of melting temperature ranges

Part 2 : Methods for testing of mechanical characteristics—tensile test

Part 3 : Methods for spread test

Part 4 : Methods for solderability test by a wetting balance method and a contact angle method

Part 5 : Methods for tensile tests and shear tests on solder joints

Part 6 : Methods for 45° pull test of solder joints on QFP lead

Part 7 : Methods for shear strength of solder joints on chip components

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Test methods for lead-free solders— Part 2 : Methods for testing mechanical characteristics-tensile test

Introduction This Japanese Industrial Standard specifies the methods for testing mechanical characteristics of lead-free solders by tensile test or the like based on occupational results by contract of New Energy and Industrial Technology Department Organization concerning “the standardization of test methods and the like necessary for solder connection corresponding to the reduction of an environmental load” carried out in 2000 and 2001.

1 Scope This Standard specifies the tensile test piece (hereafter referred to as “test piece”) and the tensile test method used for the mechanical characteristic test of lead-free solders used principally for wiring connection, parts connection and the like of electrical machinery and apparatus, electronic apparatus, communication equipment and the like.

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7721 *Verification and calibration of the force measuring system of the tension/compression testing machines*

JIS B 7741 *Verification of extensometers used in uniaxial testing*

JIS G 0202 *Glossary of terms used in iron and steel (testing)*

JIS Z 2201 *Test pieces for tensile test for metallic materials*

JIS Z 2241 *Method of tensile test for metallic materials*

JIS Z 3001 *Welding terms*

JIS Z 3910 *Methods for chemical analysis of solder*

3 Definitions For the purposes of this Standard, the definitions given in **JIS G 0202**, **JIS Z 2241**, **JIS Z 3001** and the following definitions apply.

- a) **lead-free solder** It is the generic term of “a tin based solder” not containing lead as an alloy component. It is “a solder not containing lead” for a use corresponding to that of a “tin-lead based solder”, which is used for mounting an electrical, electronic, communication equipment and the like.

4 Test piece A test piece is sampled from a cast sample product by machining.

4.1 Casting of test piece The method for manufacturing a test piece shall be as follows:

- a) Melt a solder material (hereafter referred to as “solder”) to be applied to a test by a crucible furnace or a pot furnace or other suitable methods and cast into a mould given in Fig. 1.

- b) The metal casting temperature shall be a solidification start temperature of lead-free solder $+100\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. However, a mould temperature before casting shall be ordinary temperature.
- c) Casting a metal into a mould shall be quickly carried out.
- d) For a mould material, stainless steel, cast iron, carbon and the like are used.
- e) For a test piece, take one piece from each melting.
- f) When casting is continuously carried out, the cooling shall be carried out after cooling a casting mould to ordinary temperature by a suitable method of water cooling and the like.
- g) Dimensions of a machining allowance shall be $\geq +20\text{ mm}$ for the diameter of a gauge mark part and $\geq +30\text{ mm}$ for the length of a test piece.

4.2 Shape of test piece A test piece shall be a rod and conform to No. 4 test piece specified in **JIS Z 2201** and its shape and dimensions shall be as given in Fig. 2.

4.3 Heat treatment before test In the case where heat treatment is carried out, heating which is likely to cause material qualities of a test piece to change, shall be avoided.

4.4 Gauge mark When gauge marks are required, the gauge marks shall be marked by using an oil based ink pen or an adhesive. Do not injure the surface of the test piece with a punch, a striker or the like.

4.5 Quality The quality of a test piece shall be as follows:

- a) Castings applied to a test piece shall be uniform in quality and free from injurious flaws, a casting cavity and the like.
- b) Chemical components of a test piece shall be in accordance with chemical analysis tests specified in **JIS Z 3910** or as agreed between the manufacturer and the purchaser.

Unit : mm

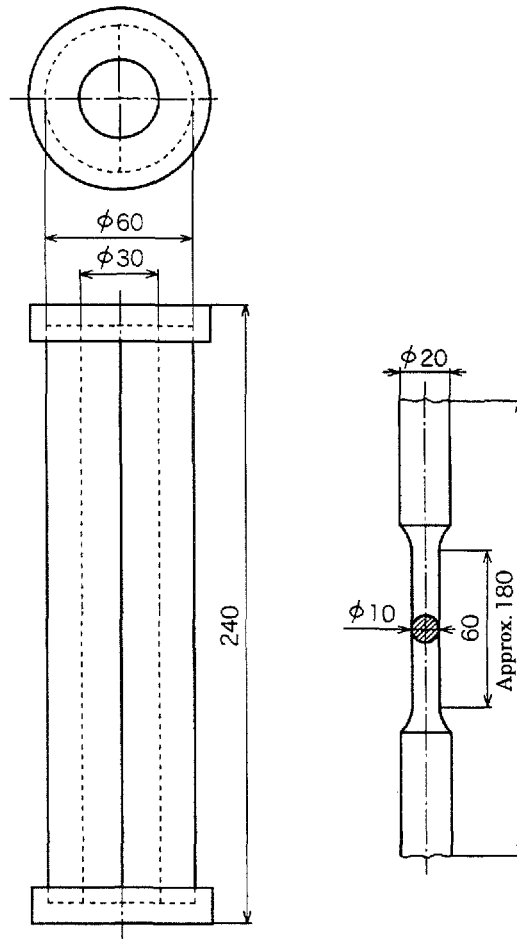
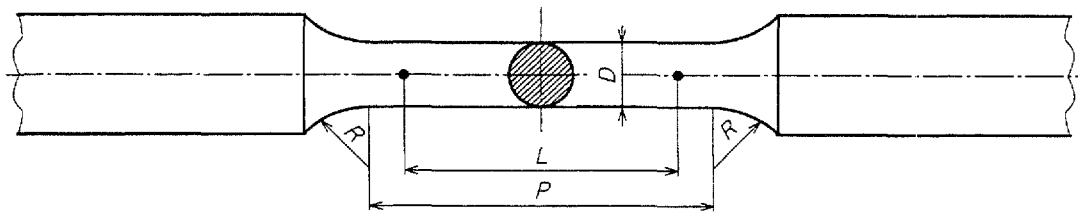


Fig. 1 Shape and dimensions of mould



Unit: mm

Diameter D	Gauge length L	Length of parallel part P	Radius of shoulder part R
10	50	approx. 60	≥ 15

- Remarks 1 The parallel part shall have a surface average roughness of $\leq 1.6 \mu\text{m}$ by machining finish.
- 2 The tolerance for dimensions of the diameter of a gauge mark part shall be $\leq 0.04 \text{ mm}$.
- 3 In the case where the dimension in Fig. 1 can not be applied, the gauge length may be $5D$ by making the diameter of the parallel part $\geq 6 \text{ mm}$. The length P of the parallel part shall be $P = L + 0.5D$ and larger.

Fig. 2 Shape and dimensions of test piece

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5 Tester The tester shall be in accordance with **JIS B 7721**.

6 Extensometer When an extensometer is used, it shall be class 1 or higher in grade in accordance with **JIS B 7741**.

7 Test The test shall be as follows:

- a) **Application of force** Application of a force shall be in accordance with **JIS Z 2241**.
- b) **Velocity for applying force** The velocity for applying a force shall be in accordance with **JIS Z 2241**.
- c) **Test temperature** The test temperature shall be $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. When a high temperature tensile test and a low temperature tensile test are carried out, a pyrostat is used. For the pyrostat, variation in the surface temperature of a test piece within the gauge length shall be $\leq 5\text{ }^{\circ}\text{C}$. When the high temperature tensile test and the low temperature tensile test are carried out, a test piece is attached to a gripper at an ordinary temperature, and heating or cooling should be preferably carried out to the test temperature. During heating or cooling, cares shall be taken, by using a test piece protecting function and the like, so that any force applied to the test piece does not exceed the force applied in attaching the test piece.

8 Method for obtaining of original sectional area, gauge length, proof stress, tensile strength, total elongation and area contraction of test piece parallel part The method of obtaining the original sectional area, gauge length, proof stress, tensile strength, total elongation and area contraction of a test piece parallel part shall be as follows:

- a) **Original sectional area of test piece parallel part** The method for obtaining the original sectional area of a test piece parallel part shall be in accordance with **JIS Z 2241**.
- b) **Gauge length** The method for obtaining the gauge length shall be in accordance with **JIS Z 2241**.
- c) **Proof stress** The method for obtaining the proof stress shall be in accordance with **JIS Z 2241**.
- d) **Tensile strength** The method for obtaining the tensile strength shall be in accordance with **JIS Z 2241**.
- e) **Total elongation** The method for obtaining the total elongation shall be in accordance with **JIS Z 2241**. However, when a test piece is ruptured outside the gauges and when an orange peel due to stress concentration is generated only in the rupture part, the total elongation is not calculated.
- f) **Contraction of area** The method for obtaining the contraction of an area shall be in accordance with **JIS Z 2241**. However, when a test piece is ruptured outside the gauges and when an orange peel due to stress concentration is generated only in the rupture part, the contraction of area is not calculated.

9 Test results Heat treatment conditions before a test, the test temperature and the strain rate (a cross head speed) are appended to the test result. Further, the rupture position of a test piece is classified by appending the following notation:

- A When ruptured within 1/4 of the gauge length from the centre between gauge marks
- B When ruptured over 1/4 of the gauge length from the centre between gauge marks and within the gauge marks
- C When ruptured outside the gauge marks

10 Recording When a test report is required, the following items shall be selected as the report items as agreed upon between the manufacturer and the purchaser.

- a) Date of test
- b) The symbol, number and name of standard
- c) Chemical components of a test piece
- d) Manufacturing day of test piece casting
- e) Solidification speed in casting a test piece
- f) Material of a mould
- g) Shape of a test piece
- h) Sampling of a test piece
- i) Sampling position of a test piece
- j) Test results
- k) Number of a test piece
- l) Name and type of a testing apparatus
- m) Name and type of an extensometer
- n) Name and type of a pyrostat

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association, and also provided to subscribers of JIS (English edition) in *Monthly Information*.

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