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Replacing GB/T 5193-2007

Method of ultrasonic inspection for wrought titanium and titanium alloy products

钛及钛合金加工产品超声检验方法

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Foreword

This Standard was drafted in accordance with the rules given in GB/T 1.1-2009.

This Standard replaces GB/T 5193-2007 “Method of ultrasonic inspection for wrought titanium and titanium alloy products”.

Compared with GB/T 5193-2007, in addition to the editorial modifications, the main technical changes in this Standard are as follows:

- the scope of application is expanded from "cross-sectional thickness is greater than 6mm~230mm" to "cross-sectional thickness is 6mm~500mm" (see Clause 1 of this Edition, Clause 1 of Edition 2007”;

- added the element “Principle” (see Clause 3 of this Edition);

- added the element “Test conditions” (see Clause 4 of this Edition);

- in the requirement for testing personnel, added “carry out technical qualification training and appraisal according to relevant requirements of GB/T 9445 or corresponding standards” (see 4.2 of this Edition, 3.3 of Edition 2007);

- added the requirements such as “high frequency electric pulse that the pulse reflection ultrasonic flaw detector can generate, receive and display to meet the frequency and energy level requirements, can work between 2.25MHz~10MHz and 1MHz~20MHz bandwidth” (see 5.1 of this Edition, 4.1 of Edition 2007);

- modified the probe working frequency and recommended products to be inspected (see 5.2 of this Edition, 4.2 of Edition 2007);

- modified the diameter of the bar that prefers the water immersion focusing method from "Φ6mm~Φ45mm" to "Φ6mm~Φ80mm" (see 5.2 of this Edition, 3.2 of Edition 2007);

- added the requirements for testing system (see 5.4 of this Edition);

- modified the requirements for the burial depths of contract blocks and flat holes (see Clause 7 and Table 2 of this Edition, Clause 5 and Table 1 of Edition 2007);

- added the table note: For the partitioned flooding detection of products larger than 120mm, the longitudinal wave calibration reflector can be determined according to the number of partitions (see Table 2 and Annex B of this Edition);

Method of ultrasonic inspection for wrought titanium and titanium alloy products

1 Scope

This Standard specifies the principle, test conditions, instruments and equipment, samples, contrast test blocks, test procedures, evaluation of test results, test records and reports for ultrasonic inspection for titanium and titanium alloy products.

This Standard is applicable to the ultrasonic inspection for titanium and titanium alloy products of which the cross-section thickness is 6mm~500mm. The titanium and titanium alloy products of other specifications may refer to this Standard for implementation.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 9445, *Non-destructive testing - Qualification and certification of personnel*

JB/T 10061, *Commonly used specification for A-mode ultrasonic flaw detector using pulse echo technique*

3 Principle

Ultrasound generated by the sound source enters the inspected workpiece and propagates forward with a certain direction and speed. Part of the sound wave is reflected when it encounters an interface with different acoustic impedances. The reflected ultrasonic waves are processed and analyzed after being received by the testing equipment, so as to evaluate whether there are defects in the workpiece and the characteristics of the defects. It is mainly used to detect internal defects of titanium and titanium alloy products, such as cracks, pores, looseness and other discontinuities on exposed or unexposed tissues.

				Circular products with a diameter of 80mm~500mm
Double crystal probe	8~10	2.5~5.0	Contact test method	Flat products with a thickness of 6mm~20mm
[a] When the supplier and the purchaser agree, it is allowed to use the probe with a frequency lower than 2.0MHz or a special type. [b] For circular products with a diameter of 6mm~80mm, it is recommended to prefer the water immersion focusing method.				

5.3 Coupling agent

5.3.1 Water can be used as a coupling agent during the water immersion testing. Wetting agent can be added in water. There shall be no visible bubbles or other suspended matter in the water that interfere with the ultrasonic inspection.

5.3.2 During the contact method testing, water, motor oil, glycerin, transformer oil, water glass can be used as coupling agents.

5.4 Testing system

During the automatic water immersion testing, the testing system shall ensure that the change of the water distance during the testing does not exceed ±6mm. The range of incidence angle does not exceed ±1°. The deviation of multiple repeatability testing for the same regular reflector does not exceed ±1.5dB.

6 Samples

6.1 The surface roughness of the tested product Ra≤3.2μm. If it needs to process, it can use a round head tool for machining, grinding or polishing. The surface shall be free of machined or polished particles, oil, grease, cutting mixture. For products with higher inspection requirements, higher surface roughness requirements may be required.

6.2 The tested product shall have a common geometric cross section, such as round, square, polygon. Flat products shall ensure the straightness of each surface.

7 Contrast test blocks

7.1 The contrast test block shall be made of titanium and titanium alloy materials that are the same as or similar to the acoustic performance and surface condition of the product under test. The difference in sound transmission characteristics between the two shall be within 12dB. If the difference in sound transmission characteristics is less than or equal to 12dB, the sensitivity of the

c) Pulse repetition frequency is not less than 600Hz;

d) Choose the best water distance according to the probe and the metal sound path during testing. The change of water distance during testing shall meet the requirements of 5.4;

e) The testing interval shall not be greater than 70% of the effective beam diameter;

f) For distance-amplitude correction, electronic distance-amplitude correction method is recommended. If the minimum echo signal amplitude is not less than 20%, the distance-amplitude curve drawn on the fluorescent screen can also be used. The curve is drawn with a distance-amplitude calibration test block. When the noise level does not obscure the required reflected signal, the highest sensitivity of the distance-amplitude calibration test block can be used for testing. Use appropriate metal sound path for evaluation.

8.5 Contact method testing shall meet the following requirements:

a) When the contact method is used for calibration and testing, good coupling shall be ensured;

b) The testing interval shall not be greater than 50% of the probe wafer diameter or 50% of the effective sound beam diameter. Choose the smaller of the two.

8.6 The measurement of the bottom wave loss shall be performed on the surfaces of the tested products parallel to each other.

8.7 The allowable background noise shall not exceed 50% of the reflection height of the reference flat bottom hole in the contrast test block. If the background noise exceeds the reference level, the cross-section involved shall be re-examined to ensure that the product meets the specified requirements.

8.8 The scanning speed during testing shall not be greater than the scanning speed that can distinguish the flat-bottomed hole in the contrast test block. For manual scanning without an alarm system, the recommended scanning speed shall not be greater than 127mm/s. For manual or automatic scanning with an alarm system, the recommended scanning speed shall not be greater than 500mm/s.

8.9 The setting position of the instrument control knob and the parameters determined during calibration must not be changed during product testing.

8.10 The testing plane shall meet the requirements of Table 3.

reflection signal of the reference flat bottom hole with the same depth as the discontinuity point.

9.3 For bottom wave loss inspection, when the bottom reflected signal is compared with the same or similar non-defective products of the same kind, there is an unsaturated bottom wave loss greater than 50%, and at the same time, there is an increase in signal between the incident surface and the bottom surface (at least twice the normal background noise signal), the product must not be accepted.

9.4 The noise level that exceeds the specified value in 8.7 is unacceptable.

9.5 The product that the reflected signal exceeds the determined standard through evaluation, but the defect can be eliminated during the manufacturing process, can be decided by the supplier and the purchaser through consultation.

9.6 When special contrast test blocks or levels not listed in Table 4 are used for inspection, the acceptance criteria shall be determined by consultation between the supplier and the purchaser.

10 Testing record and report

10.1 The testing record shall at least contain the following information:

a) Workpiece name, material, furnace number, batch number, specifications, material designation;

b) Reference to this Standard and level;

c) Testing instrument model, probe frequency, probe wafer size, focusing type;

d) Contrast sample pore size and burial depth;

e) Coupling agent;

f) Testing results such as testing scan sensitivity, defect position, defect indication length and echo height;

g) Testing date, testing personnel signature.

10.2 The testing report shall include the appropriate content in the testing record and the signature of the issuing reporter.

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