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Test method for measurement of hydrogen embrittlement threshold in steel by the incremental step loading method

逐级加力法测定钢中氢脆临界值试验方法

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Test method for measurement of hydrogen embrittlement threshold in steel by the incremental step loading method

1 Scope

This Standard specifies symbols and descriptions, principles, test equipment, samples, test procedures and test reports for a method that uses an incremental step loading method to measure hydrogen embrittlement threshold stress and threshold intensity in steel.

This Standard is applicable to quantitatively assess steel's hydrogen embrittlement sensitivity, or effect of residual hydrogen in steel and hydrogen outside the environment on steel performance during smelting, hot processing, surface treatment, etc.

2 Normative references

The provisions in following documents become the provisions of this Standard through reference in this Standard. For dated references, the subsequent amendments (excluding corrigendum) or revisions do not apply to this Standard, however, parties who reach an agreement based on this Standard are encouraged to study if the latest versions of these documents are applicable. For undated references, the latest edition of the referenced document applies.

GB/T 228, *Metallic materials - Tensile testing* (GB/T 228-2002, eqv ISO 6892: 1998)

GB/T 4161, *Metallic materials - Determination of plane-strain fracture toughness* (GB/T 4161-2007, ISO 12737:2005, MOD)

GB/T 15970.7, *Corrosion of metals and alloys - Stress corrosion testing - Part 7: Slow strain rate testing* (GB/T 15970.7-2000, idt ISO 7539-7:1989)

GB/T 16825.1, *Verification of static uniaxial testing machines - Part 1：Tension/compression testing machines - Verification and calibration of the force-measuring system* (GB/T 16825.1-12008, ISO 7500-1: 2004, IDT)

5 Test equipment

The force measuring system of the testing machine shall be calibrated in accordance with the requirements of GB/T 168.25.1. The accuracy shall be level 1 or better.

If testing is required under specified environmental conditions, the test equipment shall be able to provide the required test environment.

The test equipment shall be able to record the test force-time curve.

6 Samples

6.1 The sample is divided into fracture mechanical sample and physical sample.

6.1.1 The fracture mechanical sample shall meet the requirements of GB/T 4161.

NOTE: To ensure the accuracy of the test results, the maximum stress during prefabrication of fatigue cracks shall be less than 60% of the stress value of any measured hydrogen-induced crack propagation.

6.1.2 The physical sample is the actual product as a sample, such as fasteners.

NOTE: For physical samples, the test results of samples of the same material with different shapes or sizes shall be different.

6.2 The number of samples is generally 5~10.

7 Test procedures

7.1 Before the test, apply the test force to the sample at the test rate specified in GB/T 228 until it breaks. Measure the maximum force F_m.

7.2 When the test force is applied to the remaining samples by the incremental step loading method, the test force value added at each level shall be equal. For example, for a test with an accuracy of 5%, the test force added at each level is $5\%F_m$. The force shall be applied in 20 levels in total. The retention time of each level of test force of the 1# sample is generally 1h. The retention time of each level of test force for subsequent samples is generally twice that of the previous sample, as shown in Figure 1 for 2# and 3# samples. In order to save test time, it is recommended to double the test force retention time for each level when the test force exceeds $0.5F_{im}$, as shown in Figure 1 4# sample.

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