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Non-destructive testing - Testing method of small-angle neutron scattering

无损检测 中子小角散射检测方法

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Foreword

This standard was drafted in accordance with the rules given in GB/T 1.1-2009. This standard is proposed and managed by the National Non-destructive Testing Standardization Technical Committee (SAC/TC56). This standard was drafted by: Institute of Nuclear Physics and Chemistry, Chinese Academy of Engineering Physics, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Shanghai Institute of Materials Science, University of Science and Technology of China, Institute of High Energy Physics, Chinese Academy of Sciences, China Academy of Atomic Energy, Shanghai Jiaotong University Institute of Metal Research, Chinese Academy of Sciences. The main drafters of this standard. Yan Guanyun, Chen Jie, Chen Bo, Sun Guangai, Huang Chaoqiang, Liu Dong, Qian Dazhi, Liu Yaoguang, Gong Jian, Men Yongfeng, Ding Jie, Li Liangbin, Cheng He, Wang Fangwei, Li Tianfu, Zhong Shengyi, Cai Guixi.

Small angle neutron scattering is caused by structural inhomogeneities in the nanometer to submicron scale in the sample and is located near the incident neutron beam (usually less than 10°) coherent scattering. The neutron small angle scattering test refers to measuring the coherent scattering signal near the incident neutron beam using a neutron small angle scattering spectrometer, And data processing and analysis, in order to obtain the nano-submicron scale structure information inside the sample test method, typical measurable structure contains Precipitated phases, bubbles in metal samples, holes in ore samples, ceramics, polymers, and aggregates in solution samples, etc. The second-phase particles are used in the standard to refer to the above-mentioned characteristic structure. The neutron small angle scattering test can give the content, size distribution and ratio of the second phase particles The surface area and other information can also analyze the

shape of the second phase particles under specific conditions. With the construction of large-scale neutron scattering research facilities in my country and Development, the user group for research work with the help of neutron small angle scattering experiments will continue to expand, so the development of relevant non-destructive testing methods can be used for inspection Provide technical specifications for measuring the second phase particles in the sample. The data obtained by the neutron small angle scattering test is reciprocal space information, and the second phase of the sample in real space can be given by data inversion analysis The structural information of particles, its data analysis and interpretation are often combined with other observation methods such as scanning electron microscope, transmission electron microscope, atomic force microscope, etc. use. Non-destructive testing neutron small angle scattering detection method Warning-This standard does not involve any security issues, even if there is any content in this regard, it is related to its application. Safety of use And healthy behavior norms are established by users of this standard, and should be observed when using this standard.

1 Scope

China's national standard for small-angle neutron scattering as a non-destructive testing method. It specifies the terms and definitions, the symbols, the method summary and the testing. Neutrons interact with atomic nuclei rather than with electron clouds, and two consequences follow that make them uniquely useful. They penetrate metals for centimetres, so a bulk sample can be examined rather than a surface; and their scattering strength varies erratically between elements rather than with atomic number, so hydrogen is visible and neighbouring elements can be distinguished. Small-angle scattering probes structures between roughly one and a hundred nanometres, which is the size range of the precipitates, voids and clusters that determine the strength and the embrittlement of engineering alloys. The application that matters most is reactor pressure vessel steel: the nanometre-scale copper-rich clusters that irradiation produces are what embrittle it, and this is the technique that sees them.

This standard specifies the detection of second-phase particles (micropores, precipitated phases, Fillers, etc.) Size distribution, content and specific surface area. This standard applies to statistically isotropic sparse sample systems with a second phase particle size in the nanometer to submicron range. This standard applies For the detection of solid samples such as metals, ceramics, polymers, minerals, etc., for liquid samples, refer to the implementation.The appropriate sample thickness is about 0.5mm~ 10mm (for example, polymer samples are about 0.5mm~3mm, ceramics and minerals are about 0.5mm~5mm, commonly used metal materials are about 0.5mm~ 10mm).

2 Normative references

The following documents are essential for the application of this document. For dated

reference documents, only the dated version applies to this article Pieces. For the cited documents without date, the latest version (including all amendments) applies to this document.

GB/T 12604.8 Non-destructive testing term neutron testing

GB/T 12604.11 Non-destructive testing term X-ray digital imaging testing

GB/T 26140 neutron diffraction method for measuring residual stress by nondestructive testing

GB/T 30705 Microbeam analysis electronic probe microanalysis spectroscopy experimental parameter determination guide

GB/T 36053 X-ray reflection method for measuring film thickness, density and interface width Instrument requirements, collimation and positioning, data acquisition Collection, data analysis and reporting

3 Terms and definitions

GB/T 12604.8, GB/T 26140, GB/T 12604.11, GB/T 36053, GB/T 30705 and the following terms and The definition applies to this document.

3.1 Sparse system The concentration of the particles to be measured is low (such as metals and polymer materials with a volume ratio of the second phase within 1%), and the interaction between particles can be Ignore the system.

3.2 Neutron scattering length The probability that a neutron is scattered by a nucleus has a dimension of length.

3.3 Neutronscatteringlengthdensity The total probability of all atoms in the unit volume interacting with neutrons and scattering, which is equal to the neutron scattering length of all atoms in the unit volume