

ICS 77.040.10

CCS H 22



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 41154-2021

**Metallic materials - Multiaxial fatigue testing - Axial-torsional
strain-controlled thermo-mechanical fatigue test method**

金属材料 多轴疲劳试验 轴向-扭转应变控制热机械疲劳试验方法

Issued on: December 31, 2021

Implemented on: July 1, 2022

**Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC**

Table of Contents

- 1 Scope
- 2 Tensile Test of Metallic Materials Part 2: High Temperature Test Method
- 3 Terms and Definitions

Foreword

This document is in accordance with the provisions of GB/T 1:1-2020 "Guidelines for Standardization Work Part 1: Structure and Drafting Rules of Standardization Documents" drafted: Please note that some content of this document may be patented: The issuing agency of this document assumes no responsibility for identifying patents: This document is proposed by China Iron and Steel Association: This document is under the jurisdiction of the National Steel Standardization Technical Committee (SAC/TC183): This document is drafted by: Beijing University of Technology, Institute of Metallurgical Industry Information Standards, AVIC Shenyang Aircraft Design Institute, China Aviation Industry Corporation of China Beijing Aeronautical Materials Research Institute, China Aviation Development Commercial Aviation Engine Co., Ltd., China Machinery Testing Equipment Co., Ltd., Shenzhen Wan Testing Inspection Equipment Co., Ltd., Shanghai Ocean High-end Equipment Functional Platform Co., Ltd: The main drafters of this document: Shang Deguang, Li Daohang, Dong Li, Li Fangdai, Zuo Linxuan, Qu Linfeng, Liu Jianzhong, Chen Bo, Zhang Chengcheng, Yang Xiuguang, Huang Xing, Zhou Luhai, Sun Peng, Wang Hongbin, Hou Huining: Multiaxial fatigue testing of metallic materials Axial-torsional strain-controlled thermomechanical fatigue test method

1 Scope

China's national method for axial-torsional strain-controlled thermo-mechanical fatigue testing. It combines the two hardest fatigue tests into one: multiaxial loading, where axial and torsional strains are applied together and possibly out of phase, and thermo-mechanical cycling, where the temperature varies through the cycle rather than being held. That combination is not laboratory ambition - it is what a turbine blade root, an exhaust manifold or a piston actually experiences, where the mechanical cycle and the thermal cycle come from the same engine cycle and are locked to each other. The distinction between in-phase and out-of-phase thermo-mechanical loading is decisive: a component at peak strain when it is hottest behaves quite differently from one at peak strain when it is coldest, and the second is usually the more damaging. Nothing about that can be inferred from isothermal fatigue data, which is why the test exists despite its cost.

This document specifies the test apparatus, test specimens, test procedures, and test procedures for multiaxial thermomechanical fatigue tests of metallic materials under axial-torsional strain control: Test results and test reports: This document applies to thin-walled metal tube specimens under constant axial mechanical strain cycling, constant shear strain cycling, and constant temperature cycling conditions, corresponding to any constant cyclic strain ratio, constant axial mechanical strain-shear strain phase difference, and constant axial mechanical strain-temperature phase difference. The difference test:

Note 1: The cycle times usually consider the category of low cycle fatigue, that is, the fatigue life $N_f \leq 10^5$:

Note 2: The temperature of the test generally does not exceed 1200 °C:

2 Tensile Test of Metallic Materials Part 2: High Temperature Test Method

GB/T 6394 Metal Average Grain Size Determination Method

GB/T 7314 Room temperature compression test method for metallic materials

GB/T 10623 Terminology for Mechanical Properties Test of Metal Materials

GB/T 12443 Torque Control Fatigue Test Method for Metallic Materials GB/T 16825:

1 Inspection of static uniaxial testing machines Part 1: Inspection and calibration GB/T 25917:

3 Terms and Definitions

The terms and definitions defined in GB/T 10623, GB/T 33812 and GB/T 40410 and the following terms and definitions apply to this document: