ISO/ASTM TR 52905:2023-06 (E)

Additive manufacturing of metals - Non-destructive testing and evaluation - Defect detection in parts

Contents

Page

Foreword ..... **v**

Introduction ..... **vi**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **1**

4 NDT potential for authentication and/or identification **2**

5 List of abbreviated terms **3**

6 Typical flaws/defects in AM **4**
6.1 Flaw origins/causes 4
6.2 Flaw/defects classification 4
6.3 Defect classification strategies for AM 12

7 NDT standards review **13**
7.1 Post-process NDT standards 13
7.1.1 ISO review 13
7.2 In-process NDT review 15

8 Standard selection structure for AM **18**

9 NDT techniques potential for AM only defects **19**

10 AM artefacts **28**
10.1 Design 28
10.1.1 Star artefact 28
10.1.2 À la carte artefact 34
10.2 Manufacturing 36
10.2.1 Star artefact 36
10.2.2 À la carte artefact 37

11 NDT method trials and validation using star artefact **38**
11.1 Experimental trials 38
11.1.1 X-ray Computed Tomography – XCT (MTC & GE & EWI) 39
11.1.2 Neutron Imaging — NI and Synchrotron radiation — SX (HZB & ESRF) 43
11.1.3 Thermography Testing — TT (University of Bath) 50
11.1.4 Resonant Ultrasound Spectroscopy methods — RUS 59
11.1.5 Ultrasonic testing — UT and Phase Array UT — PAUT (EWI and NIST and LNE) 75
11.1.6 Residual stress — RS (ILL) 80

12 Defect built validation star artefact (Cut-off MTC) **85**
12.1 Summary of procedure by XCT 85
12.1.1 Apparatus 86
12.1.2 Significance of data/interpretation of results 87
12.2 Summary of procedure by metallography 90
12.2.1 Apparatus 91
12.2.2 Significance of data/Interpretation of results 91
12.3 Comments/observations 93

13 NDT trials for à la carte artefact **94**
13.1 Summary of procedure 94
13.2 Apparatus 94

13.3 Significance of data/interpretation of results 94
13.4 Comments/observations 97
14 Summary of the trials findings by material **97**
15 Main conclusions **101**
Annex A (informative) **Causes and effects of defects in wire DED and PBF process** **104**
Annex B (informative) **Review of existing NDT standards for welding or casting for application of post build AM flaws** **106**
Annex C (informative) **Star artefacts using during the trials** **111**
Annex D (informative) **Summary of star artefact manufacturing and NDT technologies for trials** **115**
Annex E (informative) **XCT parameters and XCT set up used for inspection and validation** **118**
Annex F (informative) **Parameters and set up for Neutron Image (NI) and Synchrotron (Sx) inspection** **135**
Annex G (informative) **Set up for PT and SHT inspection** **141**
Annex H (informative) **Ultrasonic test** **144**
Annex I (informative) **Residual stress characterisation of Ti6Al4V by Neutron diffraction** **155**
Bibliography **157**