



# Standard Test Method for Determination of Transformation Temperature of Nickel- Titanium Shape Memory Alloys by Bend and Free Recovery<sup>1</sup>

This standard is issued under the fixed designation F2082/F2082M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method describes a procedure for determining the martensite-to-austenite transformation temperatures of either fully annealed or heat-treated nickel titanium alloys by measuring the deformation recovered during the thermal transformation.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with this standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
- E220 Test Method for Calibration of Thermocouples By Comparison Techniques
- E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
- F2005 Terminology for Nickel-Titanium Shape Memory Alloys

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee F04 on Medical and Surgical Materials and Devices and is the direct responsibility of Subcommittee F04.15 on Material Test Methods.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

## 3. Terminology

### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *Definitions*—Specific technical terms used in this test method are found in Terminology F2005.

3.1.2 *free recovery*—unconstrained motion of a shape memory alloy upon heating and transformation to austenite after deformation in a lower temperature phase.

3.1.3  $A_{f-95}$ —austenite finish temperature of a finished wire, tube, or component measured by bend and free recovery using the 95 percent recoverable deformation methodology.

3.1.4  $A_{f-tan}$ —austenite finish temperature of a finished wire, tube, or component measured by bend and free recovery using the tangent methodology.

### 3.2 Abbreviations:

3.2.1 LVDT—linear variable differential transducer.

3.2.2 RVDT—rotary variable differential transducer.

## 4. Summary of Test Method

4.1 This test method involves cooling a test specimen to its nominally fully martensitic phase, deforming the specimen, and heating the specimen to its fully austenitic phase. During heating, the motion of the specimen is measured and plotted versus the specimen temperature. For a two-stage transformation, the  $R'_s$ ,  $R'_f$ ,  $A_s$ , and  $A_f$  as defined in Terminology F2005, are determined using the tangent methodology. For a single-stage transformation, the  $A_s$  and  $A_f$  are determined using the tangent methodology. Alternatively, for either single or two-stage transformation material, the  $A_f$  may be measured using the 95 percent recoverable deformation methodology.

## 5. Significance and Use

5.1 This test method provides a rapid, economical method for determination of transformation temperatures.

5.2 Measurement of the specimen motion closely parallels many shape memory applications and provides a result that is applicable to the function of the material.

5.3 This test method uses wire, tube, or strip samples; thus, it is able to provide an assessment of the product in its semifinished form.