



Designation: F 2082 – 01

Standard Test Method for Determination of Transformation Temperature of Nickel- Titanium Shape Memory Alloys by Bend and Free Recovery¹

This standard is issued under the fixed designation F 2082; 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 (ϵ) 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 nickel titanium alloys by measuring the deformation recovered during the thermal transformation.

1.2 The values in SI units are to be regarded as the standard. The values given in inch-pound units are provided for information only.

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:

- E 220 Test Method for Calibration of Thermocouples by Comparison Techniques²
- F 2005 Terminology for Nickel-Titanium Shape Memory Alloys³

3. Terminology

3.1 **Definitions**—Specific technical terms used in this test method are found in Terminology F 2005.

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 transforma-

tion, the R'_s , R'_f , A_s , and A_f as defined in Terminology F 2005, are determined. For a single-stage transformation, the A_s and A_f are determined.

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.

5.4 This test method may be used on annealed samples to determine the transformation temperatures and assure the alloy formulation, since chemical analysis is not precise enough to determine adequately the nickel-to-titanium ratio of shape memory alloys.

5.5 Transformation temperatures derived from this test method may differ from those derived from other methods as a result of effects of strain and load on the transformation temperature.

5.6 The test method is applicable to shape memory alloys with A_f temperatures in the range of approximately -25 to $+90^\circ\text{C}$.

6. Apparatus

6.1 LVDT, with range greater than half the mandrel diameter (see 9.2), with power supply, mounted in an appropriate fixture with counterbalanced probe (see Fig. 1); or RVDT with range greater than 45° , with power supply, mounted in an appropriate fixture (see Fig. 2).

6.2 *Thermocouple and Indicator*, with resolution of 0.1°C (0.2°F) or better.

6.3 *XY Chart Recorder*, or equivalent manual or automated data acquisition system.

6.4 *Hot Plate and Stirrer*.

6.5 *Denatured Alcohol Bath*, or water bath.

6.6 *Mandrel*, for deforming the sample in the martensitic state.

6.7 *Fixture*, for holding the sample during recovery.

¹ 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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² *Annual Book of ASTM Standards*, Vol 14.03.

³ *Annual Book of ASTM Standards*, Vol 13.01.

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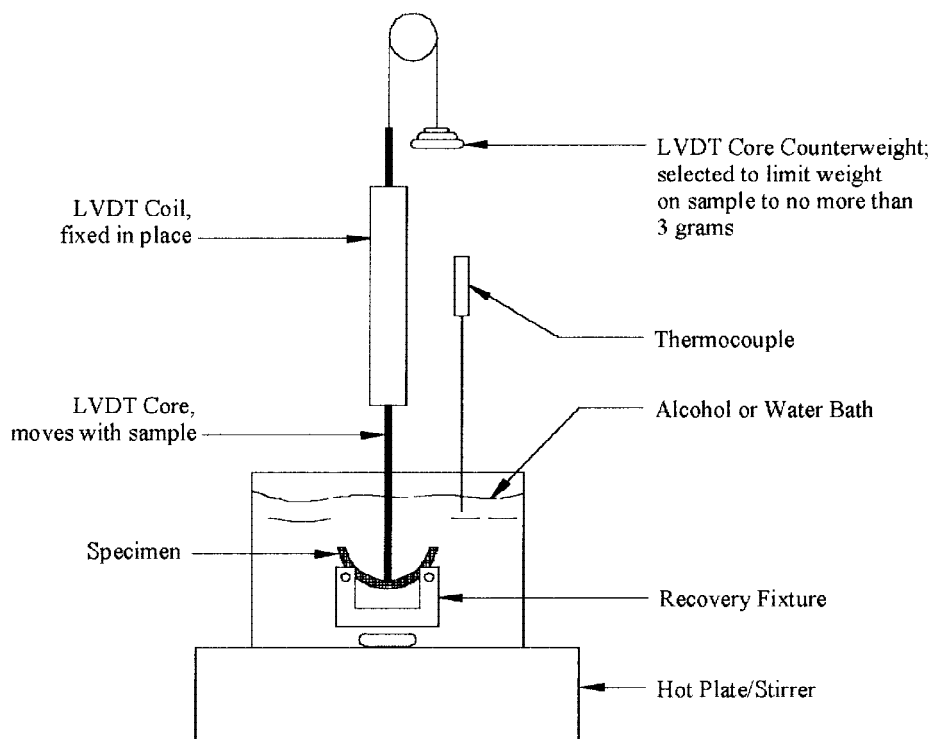


FIG. 1 Schematic Showing Side View of Test Apparatus Using a Vertically Mounted and Counterbalanced LVDT (LVDT Power Supply, Thermocouple Indicator, and Data Acquisition System Are Not Shown)

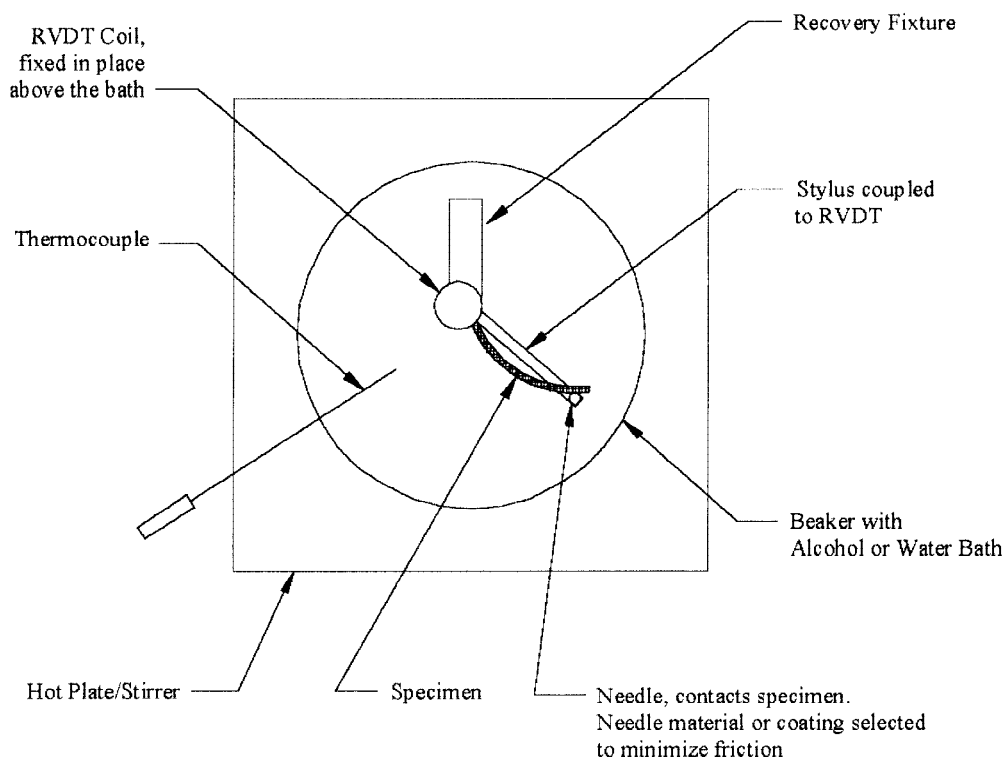


FIG. 2 Schematic Showing Top View of Test Apparatus Using an RVDT (RVDT Power Supply, Thermocouple Indicator, and Data Acquisition System Are Not Shown)

6.8 *Probe or Needle*, for contacting and moving with the sample during recovery.

6.9 *Liquid Nitrogen*, or dry ice.