Designation: F 2004 – 00

Standard Test Method for Transformation Temperature of Nickel-Titanium Alloys by Thermal Analysis[1]

This standard is issued under the fixed designation F 2004; 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 defines procedures for determining the transformation temperatures of nickel-titanium shape memory alloys.

1.2 The values stated in SI units are to be regarded as the 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 to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 473 Terminology Relating to Thermal Analysis[2]

E 967 Practice for Temperature Calibration of Differential Scanning Calorimeters and Differential Thermal Analyzers[2]

E 1142 Terminology Relating to Thermophysical Properties[2]

F 2005 Terminology for Nickel-Titanium Shape Memory Alloys[3]

3. Terminology

3.1 Specific technical terms used in this test method are found in Terminologies E 473, E 1142, and F 2005.

4. Summary of Test Method

4.1 This test method involves heating and cooling a test specimen at a controlled rate in a controlled environment through the temperature interval of the phase transformation. The difference in heat flow between the test material and a reference material due to energy changes is continuously monitored and recorded. Absorption of energy due to a phase transformation in the specimen results in an endothermic peak on heating. Release of energy due to a phase transformation in the specimen results in an exothermic peak on cooling.

5. Significance and Use

5.1 Differential scanning calorimetry provides a rapid method for determining the transformation temperature(s) of nickel-titanium shape memory alloys.

5.2 This test method uses small, stress-free, annealed samples to determine whether a sample of nickel-titanium alloy containing nominally 54.5 to 56.5 % nickel by weight is austenitic or martensitic at a particular temperature. Since chemical analysis of these alloys does not have sufficient precision to determine the transformation temperature by measuring the nickel to titanium ratio of the alloy, direct measurement of the transformation temperature of an annealed sample of known thermal history is recommended.

5.3 This test method is useful for quality control, specification acceptance, and research.

5.4 Transformation temperatures derived from differential scanning calorimetry (DSC) may not agree with those obtained by other test methods due to the effects of strain and load on the transformation.

6. Interferences

6.1 Make sure the material to be tested is homogeneous since milligram sample quantities are used.

6.2 Take care in preparing the sample. Cutting and grinding can cause cold work, which affects the transformation temperature. Oxidation during heat treatment can change the thermal conductance of the sample.

6.3 Set the gas flow to provide adequate thermal conductivity in the test cell.

7. Apparatus

7.1 Use a differential scanning calorimeter capable of heating and cooling at rates up to 10°C/min and of automatically recording the differential energy input between the specimen and the reference to the required sensitivity and precision.

7.2 Use sample capsules or pans composed of aluminum or other inert material of high thermal conductivity.

7.3 Use nitrogen or helium gas purge supply. See 10.3.1.

7.4 Use an analytical balance with a capacity of 100 mg capable of weighing to the nearest 0.1 mg.

8. Sampling

8.1 Use a sample size of 20 to 50 mg. Cut the sample to

[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 14.02.

[3] *Annual Book of ASTM Standards*, Vol 03.01.