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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Measuring Fast-Neutron Reaction Rates by Radioactivation of Titanium¹

This standard is issued under the fixed designation E 526; 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 covers procedures for measuring reaction rates by the activation reactions $^{46}\text{Ti}(n, p)^{46}\text{Sc} + ^{47}\text{Ti}(n, np)^{46}\text{Sc}$.

NOTE 1—Since the cross section for the (n,np) reaction is relatively small for energies less than 12 MeV and is not easily distinguished from that of the (n,p) reaction, this test method will refer to the (n,p) reaction only.

1.2 The reaction is useful for measuring neutrons with energies above approximately 4.4 MeV and for irradiation times up to about 250 days (for longer irradiations, see Practice E 261).

1.3 With suitable techniques, fission-neutron fluence rates above $10^9 \text{ cm}^{-2} \cdot \text{s}^{-1}$ can be determined. However, in the presence of a high thermal-neutron fluence rate, ^{46}Sc depletion should be investigated.

1.4 Detailed procedures for other fast-neutron detectors are referenced in Practice E 261.

1.5 *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 170 Terminology Relating to Radiation Measurements and Dosimetry²
- E 181 Test Methods for Detector Calibration and Analysis of Radionuclides²
- E 261 Practice for Determining Neutron Fluence Rate, Fluence, and Spectra by Radioactivation Techniques²
- E 262 Test Method for Determining Thermal Neutron Reaction and Fluence Rates by Radioactivation Techniques²
- E 844 Guide for Sensor Set Design and Irradiation for Reactor Surveillance, E 706 (IIC)²
- E 944 Guide for Application of Neutron Spectrum Adjustment Methods in Reactor Surveillance, (IIA)²
- E 1005 Test Method for Application and Analysis of Radiometric Monitors for Reactor Vessel Surveillance, E 706 (IIIA)²

¹ This test method is under the jurisdiction of ASTM Committee E-10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.05 on Nuclear Radiation Metrology.

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² Annual Book of ASTM Standards, Vol 12.02.

E 1018 Guide for Application of ASTM Evaluated Cross Section Data Files, Matrix E 706 (IIB)²

3. Terminology

3.1 Definitions:

3.1.1 Refer to Terminology E 170.

4. Summary of Test Method

4.1 High-purity titanium is irradiated in a fast-neutron field, thereby producing radioactive ^{46}Sc from the $^{46}\text{Ti}(n, p)^{46}\text{Sc}$ activation reaction.

4.2 The gamma rays emitted by the radioactive decay of ^{46}Sc are counted in accordance with Methods E 181 and the reaction rate, as defined by Test Method E 261, is calculated from the decay rate and the irradiation conditions.

4.3 The neutron fluence rate above about 4.4 MeV can then be calculated from the spectral-weighted neutron activation cross section as defined by Test Method E 261.

5. Significance and Use

5.1 Refer to Guide E 844 for the selection, irradiation, and quality control of neutron dosimeters.

5.2 Refer to Test Method E 261 for a general discussion of the determination of fast-neutron fluence rate with threshold detectors.

5.3 Titanium has good physical strength, is easily fabricated, has excellent corrosion resistance, has a melting temperature of 1675°C, and can be obtained with satisfactory purity.

5.4 ^{46}Sc has a half-life of 83.81 days.³ The ^{46}Sc decay⁴ emits a 0.8893 MeV gamma 99.984 % of the time and a second gamma with an energy of 1.1205 MeV 99.987 % of the time.

5.5 The isotopic content of natural titanium recommended for ^{46}Ti is 8.012 %.⁵

5.6 The radioactive products of the neutron reactions $^{47}\text{Ti}(n, p)^{47}\text{Sc}(T_{1/2} = 3.35 \text{ d})$ and $^{48}\text{Ti}(n, p)^{48}\text{Sc}(T_{1/2} = 1.82 \text{ d})$, might interfere with the analysis of ^{46}Sc .

5.7 Contaminant activities (for example, ^{65}Zn and ^{182}Ta) might interfere with the analysis of ^{46}Sc . See Section 7.1.2 and 7.1.3 for more details on the ^{182}Ta and ^{65}Zn interference.

³ Nuclear Wallet Cards, National Nuclear Data Center, prepared by Jagdish K. Tuli, July 1990.

⁴ Evaluated Nuclear Structure Data File (ENSDF), maintained by the National Nuclear Data Center (NNDC), Brookhaven National Laboratory, on behalf of the International Network for Nuclear Structure Data Evaluation.

⁵ *Isotopic Compositions of the Elements 1983*, International Union of Pure and Applied Chemistry, Vol. 56, Pergamon Press, 1984.