Designation: E 521 – 96 (Reapproved 2003)

Standard Practice for Neutron Radiation Damage Simulation by Charged-Particle Irradiation[1]

This standard is issued under the fixed designation E 521; 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.

INTRODUCTION

This practice is intended to provide the nuclear research community with recommended procedures for the simulation of neutron radiation damage by charged-particle irradiation. It recognizes the diversity of energetic-ion producing devices, the complexities in experimental procedures, and the difficulties in correlating the experimental results with those produced by reactor neutron irradiation. Such results may be used to estimate density changes and the changes in microstructure that would be caused by neutron irradiation. The information can also be useful in elucidating fundamental mechanisms of radiation damage in reactor materials.

1. Scope

1.1 This practice provides guidance on performing charged-particle irradiations of metals and alloys. It is generally confined to studies of microstructural and microchemical changes carried out with ions of low-penetrating power that come to rest in the specimen. Density changes can be measured directly and changes in other properties can be inferred. This information can be used to estimate similar changes that would result from neutron irradiation. More generally, this information is of value in deducing the fundamental mechanisms of radiation damage for a wide range of materials and irradiation conditions.

1.2 The word simulation is used here in a broad sense to imply an approximation of the relevant neutron irradiation environment. The degree of conformity can range from poor to nearly exact. The intent is to produce a correspondence between one or more aspects of the neutron and charged particle irradiations such that fundamental relationships are established between irradiation or material parameters and the material response.

1.3 The practice appears as follows:

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Apparatus	4
Specimen Preparation	5-10
Irradiation Techniques (including Helium Injection)	11–12
Damage Calculations	13
Postirradiation Examination	14-16
Reporting of Results	17
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1.4 *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:*

C 859 Terminology Relating to Nuclear Materials[2]

E 798 Practice for Conducting Irradiations at Accelerator-Based Neutron Sources[3]

E 821 Practice for Measurement of Mechanical Properties During Charged-Particle Irradiation[2]

E 910 Test Method for Application and Analysis of Helium Accumulation Fluence Monitors for Reactor Vessel Surveillance, E706 (IIIC)[2]

E 942 Guide for Simulation of Helium Effects in Irradiated Metals[2]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 Descriptions of relevant terms are found in Terminology C 859 and Terminology E 170.

3.2 *Definitions:*

3.2.1 *damage energy, n*—that portion of the energy lost by an ion moving through a solid that is transferred as kinetic energy to atoms of the medium; strictly speaking, the energy

[1] This practice is under the jurisdiction of ASTM Committee E10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.08 on Procedures for Neutron Radiation Damage Simulation.

Current edition approved Jan. 10, 1996. Published March 1996. Originally published as E 521 – 76. Last previous edition E 521 – 89.

[2] *Annual Book of ASTM Standards*, Vol 12.01.

[3] *Annual Book of ASTM Standards*, Vol 12.02.

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