



Standard Practice for Investigating the Effects of Neutron Radiation Damage Using Charged-Particle Irradiation¹

This standard is issued under the fixed designation E521; 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 using charged-particle irradiation to investigate neutron radiation damage mechanisms as a surrogate for neutron 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, although many of the methods may also be applied to ceramic materials. It is generally confined to studies of microstructural and microchemical changes induced by 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 Where it appears, the word “simulation” should be understood to imply an approximation of the relevant neutron irradiation environment for the purpose of elucidating damage mechanisms. 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:

	Section
Apparatus	4
Specimen Preparation	5 – 10
Irradiation Techniques (including Helium Injection)	11–12
Damage Calculations	13
Postirradiation Examination	14 – 16
Reporting of Results	17
Correlation and Interpretation	18 – 22

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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:²

- [C859 Terminology Relating to Nuclear Materials](#)
- [E170 Terminology Relating to Radiation Measurements and Dosimetry](#)
- [E821 Practice for Measurement of Mechanical Properties During Charged-Particle Irradiation](#)
- [E910 Test Method for Application and Analysis of Helium Accumulation Fluence Monitors for Reactor Vessel Surveillance, E706 \(IIC\)](#)
- [E942 Guide for Simulation of Helium Effects in Irradiated Metals](#)

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 Oct. 1, 2016. Published December 2016. Originally approved in 1976. Last previous edition approved in 2009 as E521 – 96 (2009)^{ε2}. DOI: 10.1520/E0521-16.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.