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Book Reviews

Radiation Damage in Crystals. By Lewis T. Chadderton. John Wiley & Sons Publisher (April 1965). Methuen's Monographs on Physical Subjects. 202 pp. $6.75.

It is stated in the Preface that the book was written for engineers, physicists, metallurgists, reactor technologists, final-year physics students, and scientists who would like to become familiar with present ideas in the field of radiation damage. This is the best book I have seen which presents the subject in an easily understood manner, and yet contains enough information to serve as a good starting point for a person wishing to pursue the subject of radiation damage more seriously. In particular, it summarizes and brings together the older (in this field, only about ten years old) reviews of radiation damage and adds new material that is difficult to find in one place.

The book is properly limited to radiation damage and gives little attention to the allied field of radiation effects. In this regard, the spatial arrangement of defects remaining after the irradiation is described as "radiation damage," and the physical property changes resulting from introduction of the damage are called "radiation effects."

The book starts out with a brief discussion of defects in crystals and the processes of atomic displacement. This is followed by a more-or-less "classical" but clear discussion of spike phenomena in solids. (The spike approach considers average effects of energy dissipation over a small volume of the crystal rather than individual atomic collisions.) Next there are two chapters covering important subject matter that is difficult to find in any one place. The first covers relatively recent work concerning the influence of crystal structure on the movement of energetic particles through the lattice and the final distribution of damage. The second discusses the useful, and not yet widely exploited, computer techniques for simulating radiation-damage processes. Following these is a very important chapter in which the significance and limitations of the assumptions made about various atomic interaction potentials are strongly emphasized. There is sufficient information to provide guidance in following the author's good advice, i.e., it will normally be advisable to approach the potential problem anew (for each type of material) and to establish a (potential energy) relation for the material under investigation from first principles.

The remaining important chapter deals with the rate of energy loss of energetic particles traveling through a lattice. This subject relates to calculations of the extent and distribution of damage caused by particles of different energies and types. There is an excellent summary table in this chapter. The final chapter covers special experimental topics and techniques for observing radiation damage and does not add significantly to the book.

Although the book necessarily contains a fair amount of relatively involved but not difficult mathematics, it is clearly written and can be read quite rapidly. A very strong point of the book is that, in almost all cases, the author follows the quantitative mathematical treatment with a qualitative explanation of the implications of the detailed approach. It is this feature that makes the book such easy reading. There were, however, in two sections of the book and in the final chapter, relatively involved discussions of data and experimental techniques that somewhat disrupted the continuous story the author built up on radiation-damage processes.

The only point on which I felt the book was incomplete was on the discussion of primary displacement events by neutrons. Fortunately, information on neutron scattering processes is well covered in texts on reactor physics, but the reader is not cautioned to examine the situation carefully. In particular, effects of inelastic scattering at high neutron energies have not been considered, although the effect has significant consequences in some materials. However, the book is still valuable in developing an understanding of damage originating from neutron bombardment since damage is primarily caused by knockon atoms.

I believe the book presents an excellent point of departure for those who wish to attack specific problems in radiation damage. Most importantly, it explains the limitations (i.e., the approximations involved) of approaches in common use. This latter information is often difficult to extract when studying published treatments of radiation damage, particularly those that have been developed for engineering purposes.

There are very few typographical errors and the illustrations are generally clear.

The book is recommended to those who wish to evaluate the usefulness of radiation-damage calculations, and to those who need a starting point to pursue a more serious study of radiation damage on their own.

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About the reviewer: Don R. de Halas is manager of the Materials Department at Battelle-Northwest and is a member of the Executive Committee of the Materials Science & Technology Division of the American Nuclear Society.

He received his PhD in chemistry from Oregon State University in 1960. de Halas first entered the nuclear field for General Electric at Hanford in 1952, and has since worked in the areas of corrosion, radiation damage to organic and ceramic materials, chemical and thermal properties of materials, and in the development of nuclear fuel elements. He authored a chapter on "Theory of Radiation Effects in Graphite" in the book Nuclear Graphite *(Academic Press, 1962).*