# Dislocations in Metals

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*Published by*
THE INSTITUTE OF METALS DIVISION
THE AMERICAN INSTITUTE OF MINING AND
METALLURGICAL ENGINEERS, INC.
29 WEST 39th STREET
NEW YORK, N. Y.
1954

PRINTED IN THE UNITED STATES OF AMERICA

THE MAPLE PRESS COMPANY, YORK, PENNA.

# Preface

It is becoming increasingly evident that dislocation theory must be brought into the teaching-core of physical metallurgy. Deviations from crystalline perfection seem to play a prominent role in the behavior of metals, and dislocations constitute a most important class of imperfections about which calculations and predictions can be made. At first, the postulation of edge and screw dislocations appeared somewhat arbitrary, leaving the metallurgist with the uncomfortable feeling that they lacked reality and merely provided an amusing toy for the mathematician. However, the picture has been broadened considerably by the concept of a dislocation loop which comprises varying combinations of edge and screw elements. Thus, if slip spreads along a glide plane, the lattice discontinuity between the slipped and unslipped regions is inevitably a dislocation, no matter how curved the advancing front may be.

Dislocations have proved quite versatile in accounting for many aspects of the mechanical behavior of metals. By the same token, the theory has been criticized as being somewhat too flexible in its ability to fit the facts. During recent years, however, three striking predictions of dislocation theory have been confirmed by experiment: (*a*) the role of dislocations in the growth of crystals from the vapor phase and dilute solutions, (*b*) the calculation of low-angle grain-boundary energies as a function of the degree of disorientation, and (*c*) the movement of low-angle grain boundaries under stress. As a result of these triumphs, dislocation theory is now on such a firm footing that physical metallurgists will find it advantageous, if not essential, to become thoroughly conversant with dislocations and their manifestations.

As a step in this direction, a Seminar on "Dislocations in Metals" was held by the Institute of Metals Division, AIME, at its fall meeting in October 1951. Three outstanding survey lectures were given, by J. S. Koehler, W. T. Read, Jr., and E. Orowan. The presentations were educational in nature, and were purposely not intended to take the form of original papers. The response of the audience of 400 was so enthusiastic that the Executive Committee authorized the publication of the lectures as a separate volume. In the preparation of the manuscripts, F. Seitz and W. Shockley joined the authorship. Much additional material has been included that could not be treated in the original lectures. A number of new ideas, not previously published, are also contained herein.

In Chapter 1, Professors Koehler and Seitz discuss the "need" for dislocations, and outline the various phenomena in which they come into play. The geometry, stress-fields, energetics, and interactions of dislocations are reviewed in considerable detail.

Chapter 2, by Dr. Read and Dr. Shockley, is devoted primarily to those aspects of the subject in which definite predictions of dislocation theory have been subsequently verified by experiment. Emphasis is placed on the problems of crystal growth, low-angle grain-boundary energies, and the movement of these boundaries under stress.

The prodigious task of surveying the field of mechanical behavior in terms of dislocation theory is handled by Professor Orowan in Chapter 3. The thoroughness and clarity with which he has covered this complex subject will be appreciated by students of metallurgy for many years to come.

The Institute of Metals Division is deeply indebted to the five authorities on dislocation theory who have participated in the present undertaking. It is hoped that the reader response will demonstrate the importance of these IMD Seminar volumes in which overall perspective, rather than original research, is the keynote.

It is also a pleasure to acknowledge the fine cooperation of Dr. Ernest Kirkendall and Miss K. S. Lovell, who helped in many ways to bring this book to the public.

MORRIS COHEN, *Editor.*

CAMBRIDGE, MASSACHUSETTS
*July* 15, 1953

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