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William F. Hosford  
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## Iron and Steel

Modern civilization as we know it would not be possible without iron and steel. Steel is essential in the machinery necessary for the manufacture of all our needs. Even the words themselves have come to suggest strength. Phrases such as *iron willed*, *iron fisted*, *iron clad*, *iron curtain*, and *pumping iron* imply strength. A *steely glance* is a stern look. A *heart of steel* refers to a very hard demeanor. The Russian dictator Stalin (which means “steel” in Russian) chose the name to invoke fear in his subordinates. This book is intended both as a resource for engineers and as an introduction to the layman about our most important metal system. After an introduction that deals with the history and refining of iron and steel, the rest of the book examines their physical properties and metallurgy.

William F. Hosford is Professor Emeritus of Materials Science at the University of Michigan. He is the author of numerous research publications and the following books: *The Mechanics of Crystals and Textured Polycrystals* (1993); *Physical Metallurgy* (2005); *Materials Science: An Intermediate Text* (2007); *Materials for Engineers* (2008); *Reporting Results: A Practical Guide for Scientists and Engineers* with David C. Van Aken (2008); *Mechanical Behavior of Materials*, 2nd edition (2009); *Wilderness Canoe Tripping* (2009); *Solid Mechanics* (2010); *Physical Metallurgy*, 2nd edition (2010); and *Metal Forming: Mechanics and Metallurgy*, 4th edition, with Robert M. Caddell (2011).

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## PREFACE

Modern civilization would not be possible without iron and steel. Steel is an essential component of all machinery used for manufacture of all our goods. The words *iron* and *steel* have come to suggest strength as evident in the following terms: *iron willed*, *iron fisted*, *iron clad*, *iron curtain*, and *pumping iron*. A *steely glance* is a stern look. A *heart of steel* implies a very hard demeanor. The Russian dictator Joseph Stalin (which means “steel” in Russian) chose that name to invoke fear in his subordinates.

This book is intended both as a resource for engineers and as an introduction to the layman to our most important metal system. The first few chapters cover the history and refining of iron and steel; the rest of the book covers physical properties and physical metallurgy.

I have drawn heavily on material from *Physical Metallurgy of Steels* by W. C. Leslie and *Steel Metallurgy for the Nonmetallurgist* by J. D. Verhoeven. However, this book includes material not covered in either of those.

Professors Robert Pehlke, Ronald Gibala, John Keough, and Paul Trojan were very helpful. Kathy Hayrynen supplied a number of micrographs.

The reader is assumed to have had a course in materials science and to be familiar with phase diagrams, Fick’s laws of diffusion, and the concept of free energy.