

INTRODUCTION
TO
**MATERIALS
SCIENCE
AND
ENGINEERING**

Yip-Wah Chung



CRC Press
Taylor & Francis Group

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Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an informa business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

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CRC Press is an imprint of Taylor & Francis Group, an Informa business

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Printed in the United States of America on acid-free paper
10 9 8 7 6 5 4 3 2 1

International Standard Book Number-10: 0-8493-9263-2 (Hardcover)
International Standard Book Number-13: 978-0-8493-9263-4 (Hardcover)

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Library of Congress Cataloging-in-Publication Data

Chung, Yip-wah, 1950-
Introduction to materials science and engineering / Yip-Wah Chung.
p. cm.
ISBN-13: 978-0-8493-9263-4 (alk. paper)
ISBN-10: 0-8493-9263-2 (alk. paper)
1. Materials science. I. Title.

TA403.C475 2007
620.1'1--dc22

2006021809

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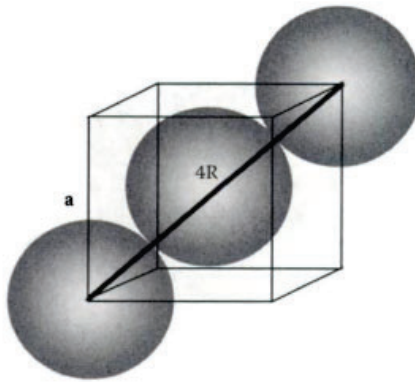


FIGURE 1.18 Atomic arrangements along the body diagonal of a body-centered cubic unit cell.

The total volume of the unit cell is a^3 . As discussed earlier, there are two atoms per unit cell. The volume of these two atoms is equal to $(8/3) \pi R^3$. The packing factor (PF) is given by the ratio of volume of atoms to volume of unit cell:

$$\begin{aligned}
 PF &= \frac{(8/3)\pi R^3}{a^3} \\
 &= \frac{8}{3} \pi \left(\frac{\sqrt{3}}{4} \right)^3 \\
 &= \frac{\pi\sqrt{3}}{8} \\
 &= 0.68.
 \end{aligned}$$

1.4.2 FACE-CENTERED CUBIC (FCC)*

An example of FCC is aluminum. This unit cell has eight atoms at the cube corners and six atoms at the cube faces. Since each atom at the cube face is shared by two cubes, the FCC unit cell contains four atoms. The coordination number is 12. Again, assuming close packing with nearest neighbors and spherical atoms, we can show that $a\sqrt{2} = 4R$. The packing factor is equal to $\pi\sqrt{2}/6$, or about 74%. Therefore, the FCC structure is more tightly packed than the BCC structure.

1.4.3 HEXAGONAL CLOSE PACKED (HCP)

An example of HCP is titanium below 882°C. The HCP structure can be obtained by stacking close-packed hexagonal planes of atoms on top of each other in the ABAB stacking sequence; that is, the stacking arrangement repeats every two layers. By convention, the unit vector along this packing direction is known as the c-axis, and the a- and b-axes are perpendicular to it. The FCC structure, on the other hand, can be obtained by stacking in the ABCABC sequence. Therefore, the nearest neighbor environments for HCP and FCC are similar. The coordination number (12) and packing factor (74%) for the HCP unit cell are the same as those for FCC.

* The diamond structure can be considered to be two interpenetrating FCC unit cells, with the second FCC unit cell displaced by one quarter of the way along the body diagonal.