Med Khider University – Biskra

Faculty of Exact Sciences and Natural and Life Sciences

Department of Material Sciences

Academic year: 2023/2024

L1professional

Materials and physicochemical control

TP 1 and 2 Crystallography

Crystallography		
First name	Last name	Group
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INTRODUCTION

We wish to study and compare the crystalline structure of copper which crystallises as FCC with SC, CC, HC

Copper identity card

- Chemical symbol: Cu
- Atomic molar mass: 63,5 g mol^{-1}
- Atomic radius: 127,6 pm

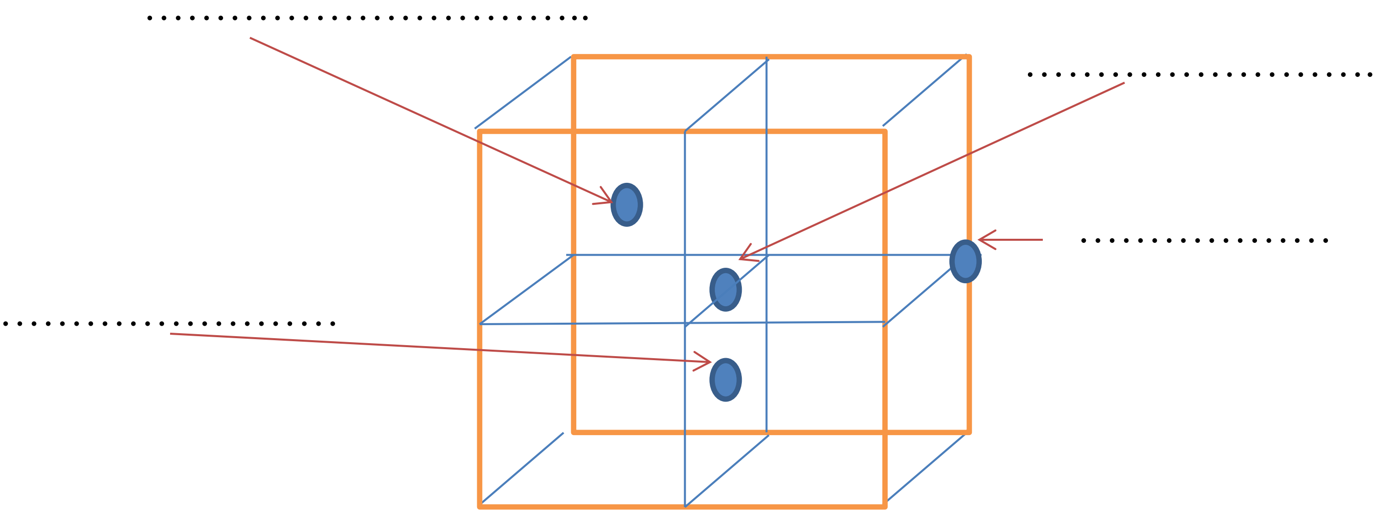
(1 pm=10^{-12} m)

I. Build the crystal

Build a face-centred cubic structure (FCC)

II. Determine the number of atoms in the cell

1. Determine the position of the pattern per cell



2. Determine the number of atoms actually in the cell……………………

III. Study of atomic tangency

Which placement of the atoms is favourable to their tangency

a. Tangency along the diagonal of the cube
b. Tangency along an edge of the cube
c. Tangency along the diagonal of the face
d. Tangency along the diagonal of the face and the diagonal of the cube

IV. Cell parameter

1. The edge of the cube is: a $\quad \frac{a}{2}$ $\quad a\sqrt{2}$ $\quad a\sqrt{3}$
3. The diameter of a face is : a $\quad \frac{a}{2}$ $\quad a\sqrt{2}$ $\quad a\sqrt{3}$

4. The diameter of a face is .... times the radius

5. The cell parameter is therefore: a = ………..

$$\frac{2r}{\sqrt{2}} \qquad \frac{4r}{\sqrt{3}} \qquad \frac{4r}{\sqrt{2}} \qquad \frac{r}{3\sqrt{3}} \qquad 2r$$

6. Using the numerical data from the copper identity card and the result from the previous question, the cell parameter is therefore:
   a = ……….pm

V. Determination of structure compactness

1. Literal expression of the cell volume is :

$$a^2 \qquad a^3 \qquad a\sqrt{2} \qquad a\sqrt{3}$$

2. Calculate the volume of the mesh: V = …………….pm^3
3. The volume actually occupied by atoms is:

$$2\pi r^3 \qquad 2\frac{4}{3}\pi r^2 \qquad 2\frac{4}{3}\pi r^3 \qquad 4\frac{4}{3}\pi r^3 \qquad \frac{4}{3}\pi r^2$$

4. Calculate the volume actually occupied by atoms: V_{at} = ……………pm^3
5. We can therefore deduce the compactness of the structure: C = ……………
   0.48 0.51 0.68 0.74

6. Calculate the density

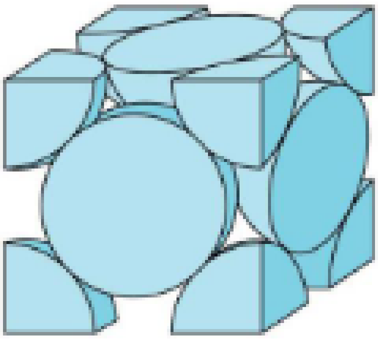
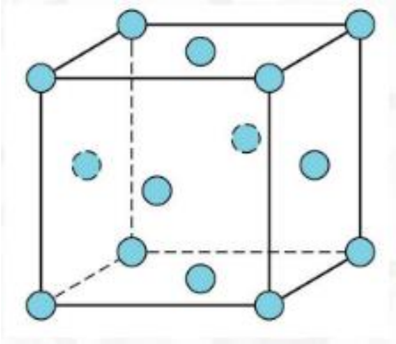
VI. Density

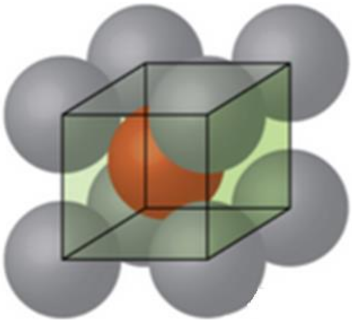
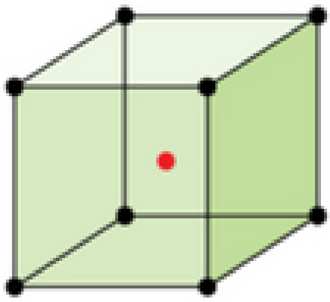
1. The cell mass is:

$$\frac{4M(Cu)}{NA} \qquad \frac{M(Cu)NA}{4} \qquad 4M(Cu)NA \qquad \frac{\frac{M(Cu)}{NA}}{4}$$

2. Calculate the cell mass: M_m = ………………..g
3. Calculate the copper density: ρ = ……………..gcm^{-1}

4. Observe the cells and colour the atoms which are in contact

5. Deduce the relationship between the cell parameter (a) and the radius (r) for each structure

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6. Calculation of the compactness of each structure
   Complete the following table:

Structure	Simple cubic	Centred cubic	Face centred cubic
Multiplicity			
Volume occupied by atoms (V_{at})			
Cell volume (V)			

Cell parameter (a)			
Compactness (C) or Packing efficiency			

7. Give examples of metals: CC and FCC

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Conclusion:

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TP3 and TP 4;5 : METALLOGRAPHY

Aim

Preparation of metallic specimen for metallographic study by grinding, polishing and etching.

Objectives

1. Familiarization with the procedure for preparation of material specimen for microscopic examination.

2. Examination of surface characteristics of engineering materials.

3. Grain size determination of metals.

Introduction

In macroscopy the examination of structural characteristic or chemical characteristic of metal or an alloy is done by unaided eye or with aid of low power microscope or binocular usually under 10X.

In microscopy similar examination is done with prepared metal specimens, employing magnifications with optical microscope of from 100X to as high as 200X. Apart from observation of micro structural details in a metal or alloy, other defects such as grain boundaries, twins, precipitates can be observed readily in microscopic examination.

The preparation of metallurgical specimen generally can be divided into series of stages sectioning/sampling, mounting, grinding, polishing and etching.

Procedure of Test

In this work, you will report the microstructures of prepared samples in specific formats. You will be expected to sketch the microstructure that you see under the microscope by hand, in sketching the microstructure, there are several things to keep in mind. First, the magnification that you use depends upon the scale of the microstructure you are looking for. It is important to know in advance what the expected microstructure for your samples are and at what scale they should appear. In sketching the microstructure, you should indicate only the important features of the structure that you observe - don't make a photographic reproduction of the microstructure.

1. Sectioning / Sampling-

The choice of sample for microscopic study may be very important. If a failure is to be investigated the sampling should be chosen as close as possible to the area of the failure & should be compared with one taken from the normal section. If the material is soft, such as nonferrous metals or alloy and non-heat treated steels, the section is obtained by manual hack sawing /power saw. If the material is hard, the section may be obtained by use of an abrasive cut off wheels. This wheel is thin disk of suitable cutting abrasive rotating at high speed. The specimen should be kept cool during the cutting operation.

2. Grinding

Whenever possible the specimen should be of a size and shape that is convenient to handle. The sample may be rough ground on a belt sander with specimen kept cool by frequent dipping in water during the grinding operation. In all polishing operation, the specimen should be moved perpendicular to the existing scratches this will facilitate, recognition of stage when the deeper scratches are replaced by shallower one characteristic of the finer abrasives. The grinding is continued until the surface is flat and free from all scratches due to hacksaw or cut-off wheel.

3. Intermediate Polishing

After the previous processes the specimen is polishing on a series of emery paper containing successively finer abrasive (Si-C). The intermediate polishing operation using emery paper is usually done dry. However, in certain case such as preparation of soft material, Silicon Carbide has greater removal rate, can be used with a lubricant, which minimizes shearing of soft metals and also provides to flush away surface removal product.

4. Fine polishing

The time consumed and the success of fine polishing depends largely on the case that we exercised during the previous polishing processes. The final approximation to the flat, scratch free surface is obtained by the use of a wet rotating wheel covered with a special cloth that is charged by carefully sized abrasive particles. A wide range of abrasive is available for final polishing. Aluminium-oxides ($Al2O3$), for ferrous and copper based materials and Cerium oxide for Aluminium, Magnesium and their alloys, other final polishing abrasives often used are diamond, chromium oxide and magnesium oxide etc. A choice of proper polishing cloth depends upon the particular material being polished and the purpose of metallographic study.

5. Etching

The purpose of etching is to make the many structural characteristics of the metal or alloy visible. The process should be such that the various parts of the microstructure may be clearly differentiated. This is to subject the polished surface to chemical action. In the alloys composed of two or more shapes. The competent are revealed during etching by a preferential attack of one or more of the constituents by the reagent because of difference in chemical composition of the phases. In uniform single phase alloy contact is obtained and the grain boundaries are made visible because of difference in the rate at which various grains are attacked by the reagent.This difference in the rate of attack by reagent which is mainly associated with angle of the different grain structure section to the plane of the polished surface. Because of chemical attack of the chemical reagent the grain boundary appears as valleys in the polished surface light from the microscope hitting the side of these valleys will be reflected but of the microscope making the grain boundaries appears dark lines. The section of the appropriate etching reagent is determined by metal or alloys and the specific structure desired for viewing.

Etching Reagent	Composition	Use
Nitric Acid	Nitric acid 1 to 5 ml ethyl or methyl alcohol (95%) 100 ml	Carbon steels and cast iron
Picric acid	Picric acid 49% ethyl or methyl alcohol 1L	Carbon steels
Nital	Nitric Acid (2-4) cm^3 ethyl or methyl alcohol (96-98) cm^3	Carbon steels
Ferric chloride and hydrochloric	Ferric chloride and hydrochloric acid 50 ml water 100 ml	Structure of austenitic nickels stainless steel
Ammonium hydroxide and hydrogen	Ammonium hydroxide 90 parts water 5 parts hydrogen peroxide 2 to 5	Copper and its alloys
Ferric chloride and Chloric acid	Ferric chloride 5g Chloric acid 10 cm^3 Water 100 cm^3	Copper and its alloys