



**UNIVERSITÀ  
DI TORINO**

# **METALS FOR SUSTAINABLE MANUFACTURING**

## **An introduction**

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# METALS FOR SUSTAINABLE MANUFACTURING

## An introduction

The course lectures (48h) provide:

- i) a **quantitative basis** for microstructural design (thermodynamic and kinetic models). A detailed description of **phase transformations** in alloys used in industry and under development and some metallurgical processes
- ii) a **quantitative treatment** of (some) mechanical properties of metallic materials
- iii) Fundamental concepts related to **the sustainability of metals production and use** will be described, including green production, recycling, life cycle analysis, scraps treatment
- iv) **Examples of metallic materials and novel production techniques** (additive manufacturing)

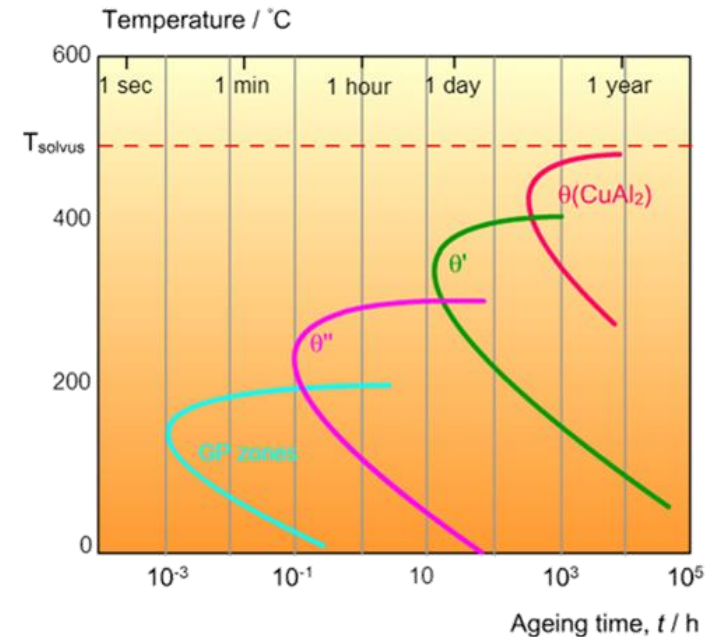
# METALS FOR SUSTAINABLE MANUFACTURING

## An introduction

After completing the course, students will have learnt concepts on **alloy design**, **methods of processing**, **properties of alloys**.

They will have acquired skills on **industrial metals in relation to composition**, **thermal treatment** and **properties**.

They will understand the **basic concepts** for a sustainable metal production and use.



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## An introduction

### What should I use for studying?

- D. A. Porter, K. E. Easterling, M. Y. Sherif - "Phase Transformations in Metals and Alloys" - Van Nostrand Reinhold Pub. (2009)
- J.-P. Birat, Sustainable Materials Science – Environmental Metallurgy vol. 1 – Edp Sciences (2020)
- **Teacher's notes (available on Unito website, campusnet)**
- Also useful: any book dealing with Mechanical Metallurgy.

### Exam: written test, 2 h (3 questions, open answers)

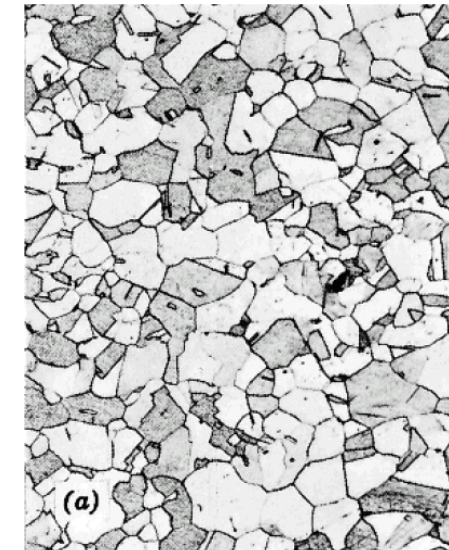
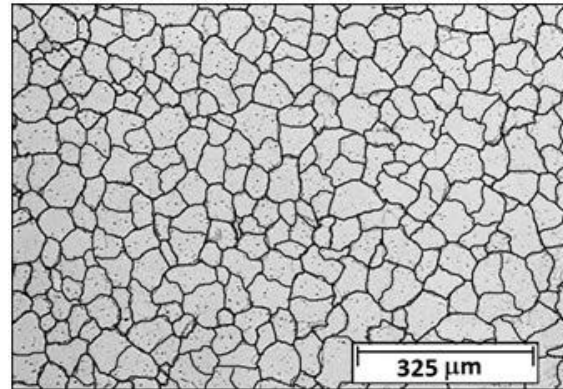
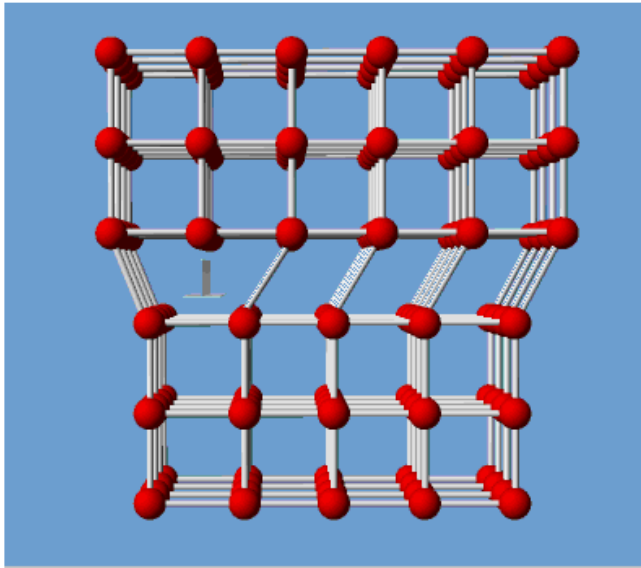
Important note: equations and graphs in the answer must be properly described and commented. The more complete is the answer the better will be the evaluation.

# METALS FOR SUSTAINABLE MANUFACTURING

## Pre-requisites

Knowledge on metallic materials as provided in Bachelor Courses in Materials Science

- Atomic structures of metals. Dislocations, boundaries and other defects. Their importance for the mechanical properties.



*Before*



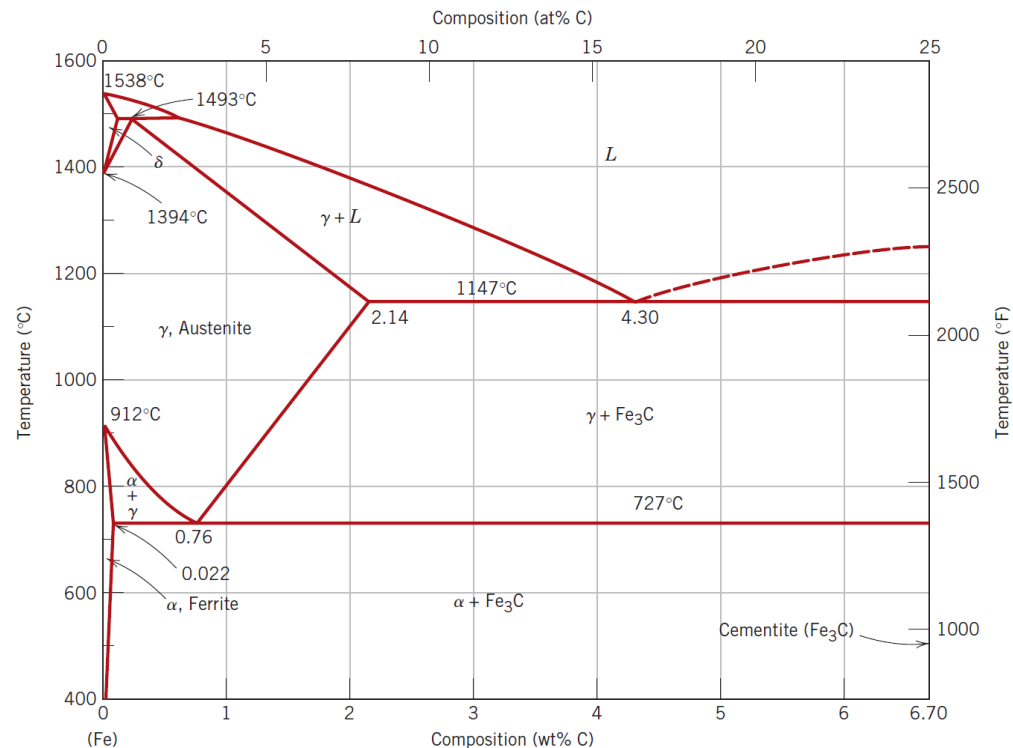
*After*



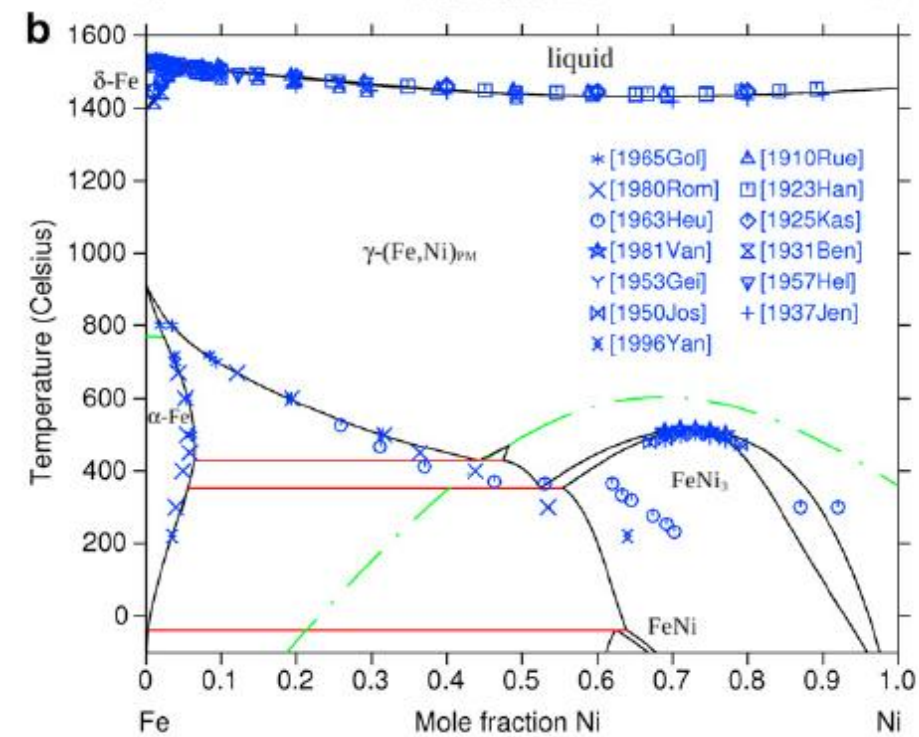
# METALS FOR SUSTAINABLE MANUFACTURING

## Pre-requisites

- Reading and understanding phase diagrams



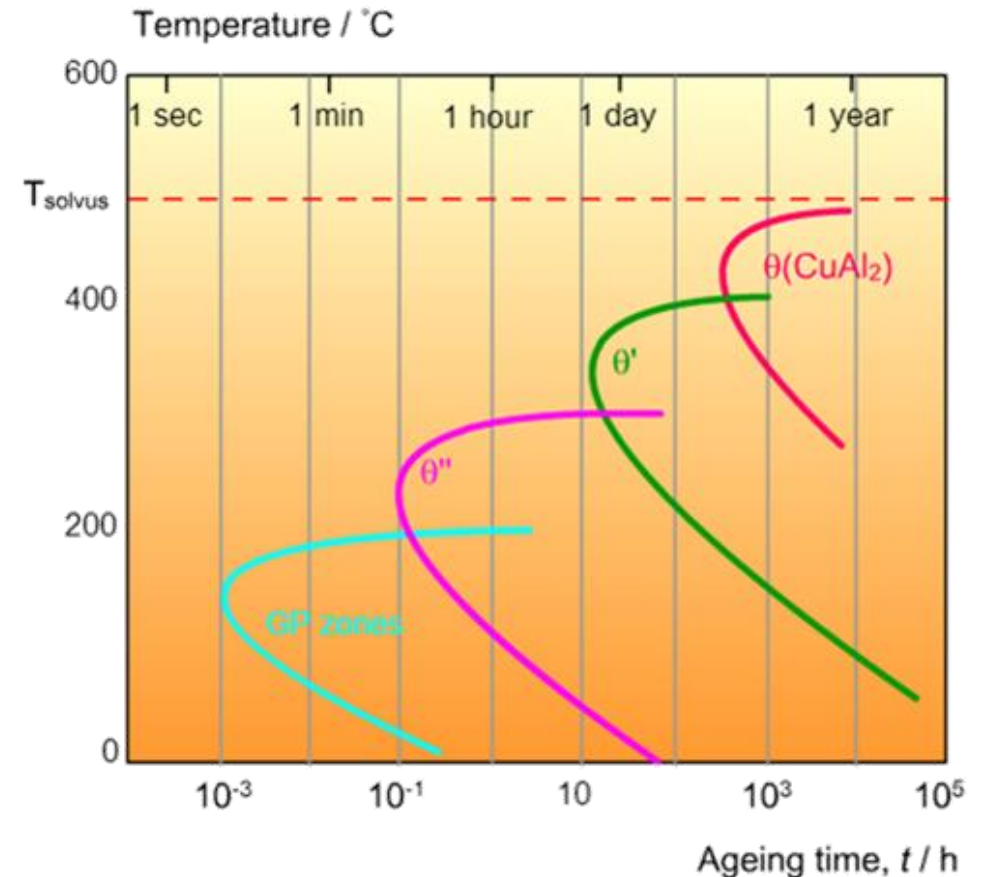
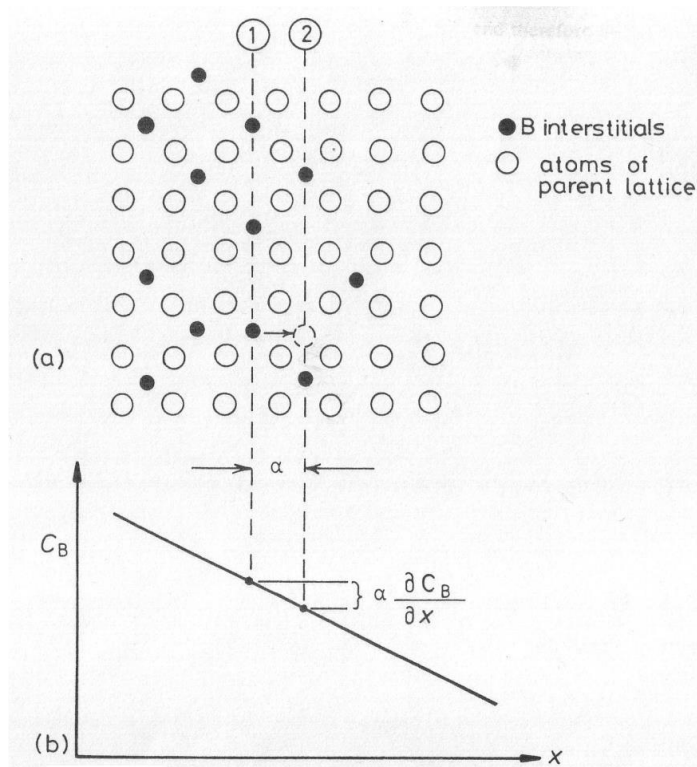
**Figure 9.24** The iron-iron carbide phase diagram. [Adapted from *Binary Alloy Phase Diagrams*, 2nd edition, Vol. 1, T. B. Massalski (Editor-in-Chief), 1990. Reprinted by permission of ASM International, Materials Park, OH.]



# METALS FOR SUSTAINABLE MANUFACTURING

## Pre-requisites

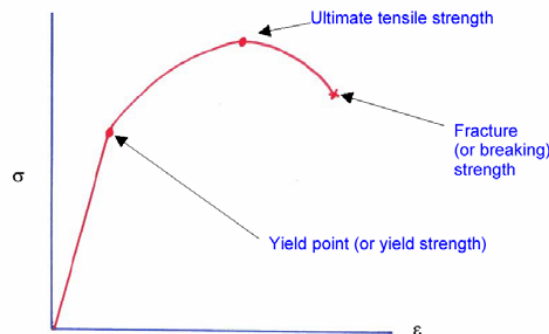
- Diffusion (basic laws) and the concept of phase transformations



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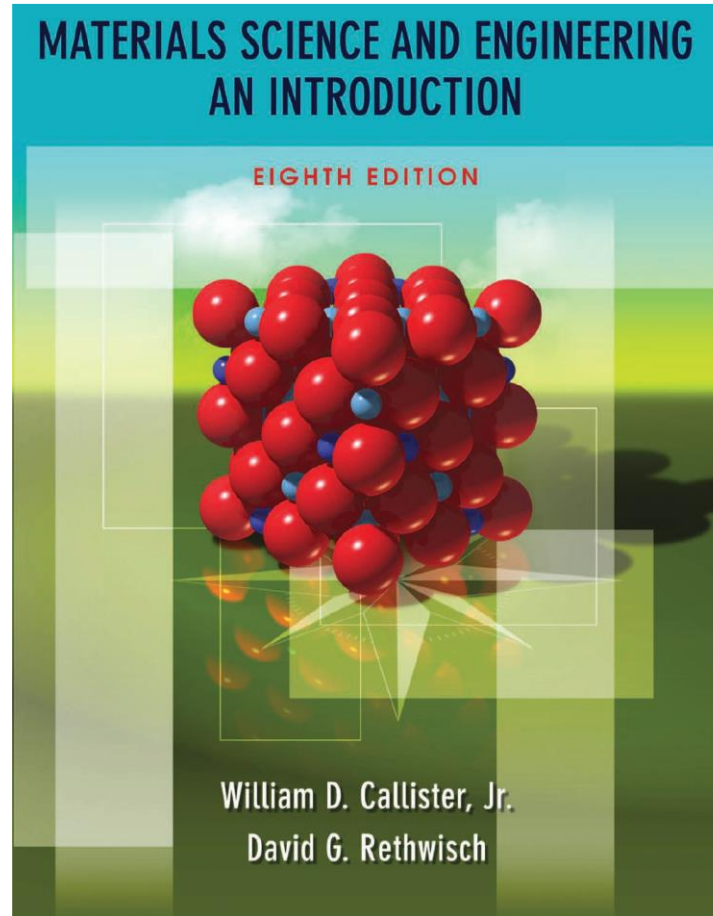
## Pre-requisites

- Basics of thermodynamics and kinetics
- Mechanical properties of metals: mechanical tests, stress-strain curves: elastic and plastic properties. Concept of relationship between microstructure and mechanical properties.
- Ferrous alloys. Steel definition: carbon steels, stainless steels and others. Use of TTT and CCT curve for thermal and thermochemical treatment.
- Definition of non-ferrous alloys: light alloys, brasses and bronzes.
- Definition of metallurgical processes: e. g. deformation, casting.





## Pre-requisites



Chapters 1-7, 9-11