

MSE-204 Thermodynamics for Materials Science

L0. INTRODUCTION

DISCUSSION ON WHAT IS THERMODYNAMICS | COURSE DETAILS

Francesco Stellacci

ESSENTIAL INFORMATION ABOUT THIS COURSE

MSE 204: Thermodynamics for Materials Science (4 credits) | Course Details

Instructor:

Francesco Stellacci

Teaching Assistants:

Quy Ong, Ding Ren

How the class works:

I teach

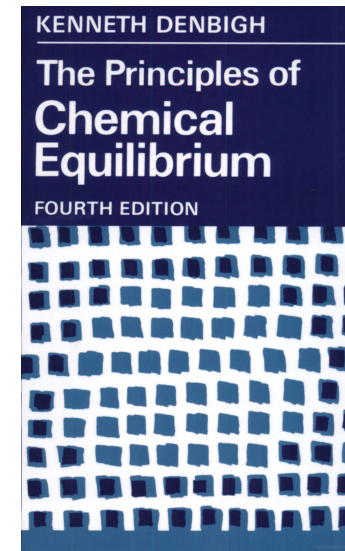
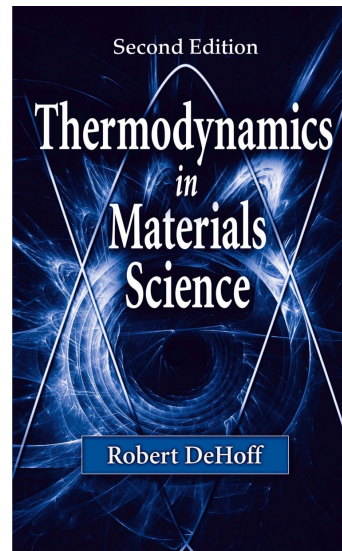
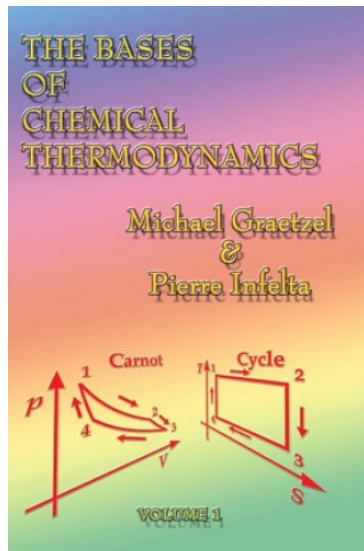
↳ unannotated slides

→ Exam at the end → DIFFICULT

ESSENTIAL INFORMATION ABOUT THIS COURSE

Reference Books

- The Bases of Chemical Thermodynamics, M. Graetzel & P. Infelta, Universal Publishers, 2000. | (two volumes in English, one volume in French)
- Thermodynamics for Materials Science, R. DeHoff, CRC Press, 2006.
- The Principles of Chemical Equilibrium, K. Denbigh, Cambridge University Press, 1981



WHY DO WE STUDY THERMODYNAMICS?

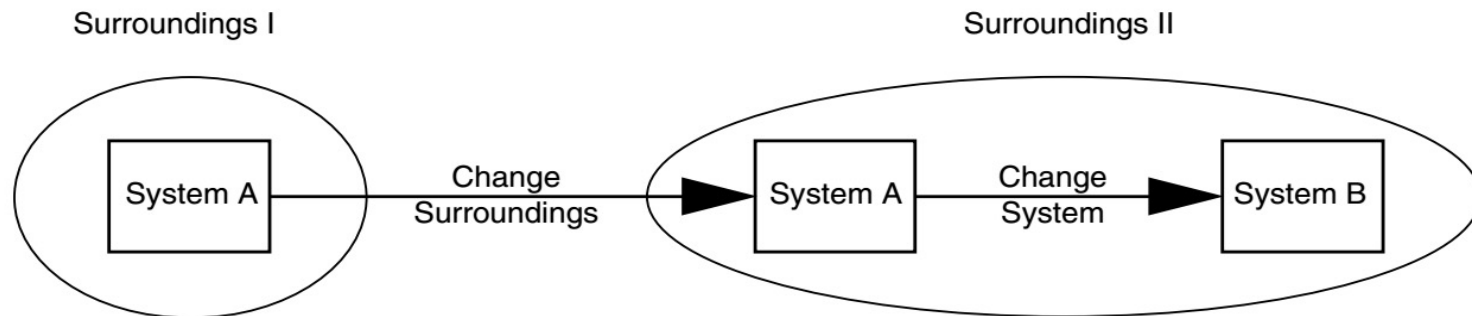
1. It applies... *to everything*
2. It is capable... *predicting equilibrium*
3. It is well established... *~ 1900 // 1920*
4. ...

WHAT DETERMINES HOW MATTER BEHAVES?

There are three approaches

1. Classical $\rightarrow$ system is a black box
 $\frac{T}{P^2} \rightarrow \text{III} \rightarrow \frac{W}{\Phi}$
2. $\hookrightarrow$ statistical mechanics $\rightarrow$ matter is made of atoms
3. $\hookrightarrow$ quantum — + particles

THE GENERIC QUESTION ADDRESSED BY THERMODYNAMICS

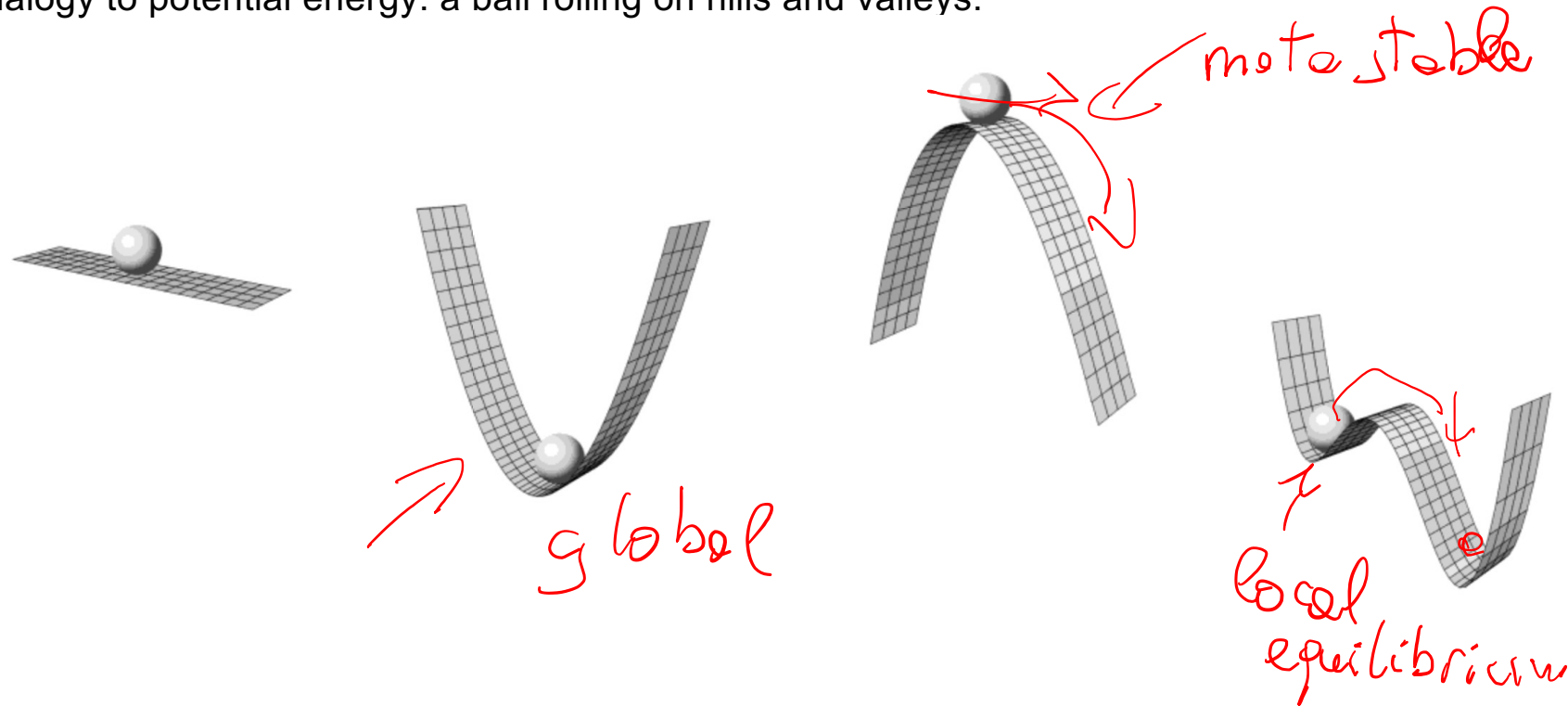


The design of materials has to do with how the properties of material will change with response to the environment. These responses will determine how we can synthesize or fabricate the materials and how the devices will operate in a given application.

THERMODYNAMICS IS LIMITED TO SYSTEMS IN EQUILIBRIUM

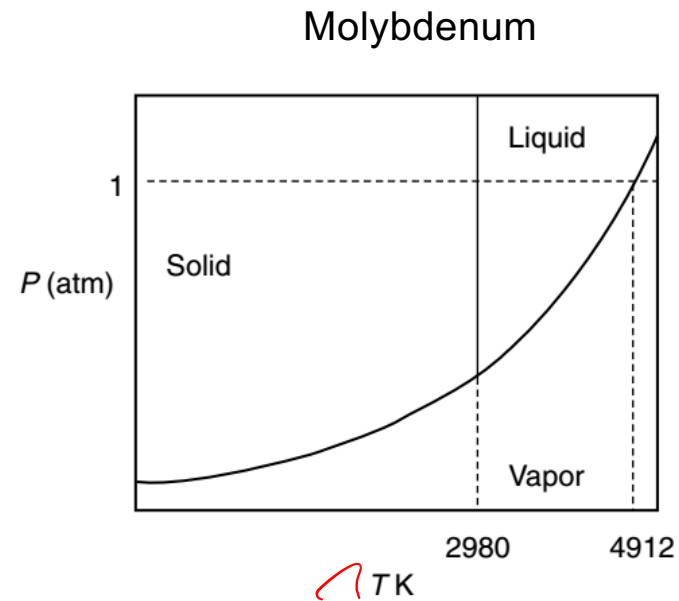
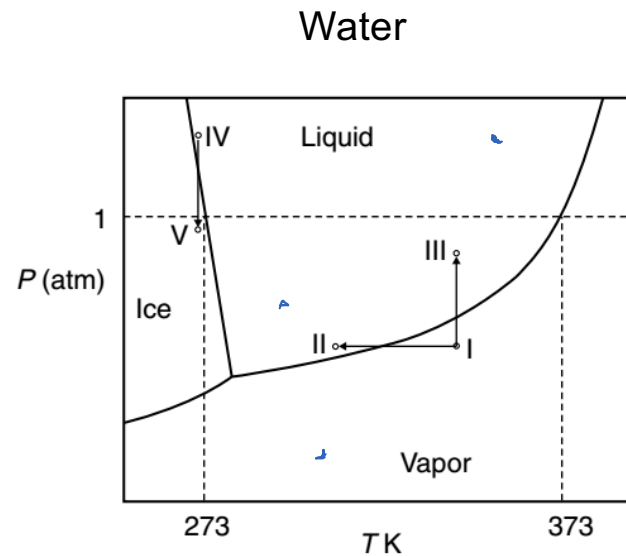
Thermodynamics is limited to the description of systems that are in equilibrium with their surroundings. It provides the basis for predicting what the properties of an equilibrated system will be as a function of the content of the system and the characteristics of its surroundings.

Analogy to potential energy: a ball rolling on hills and valleys:



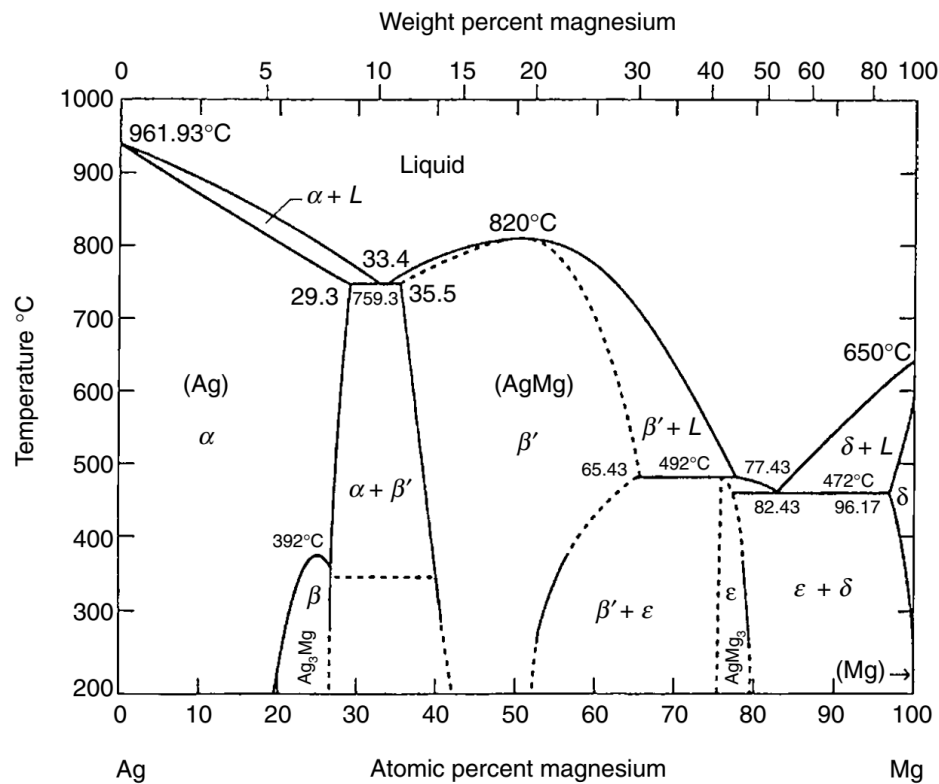
THERMODYNAMICS IS THE BASIS FOR EQUILIBRIUM MAPS

The real utility of thermodynamics lies in its ability to predict whole patterns of behavior for a range of systems in a range of surroundings. These patterns are conveniently presented in the form of maps of equilibrium states. The generation of these maps is the main topic of this course.



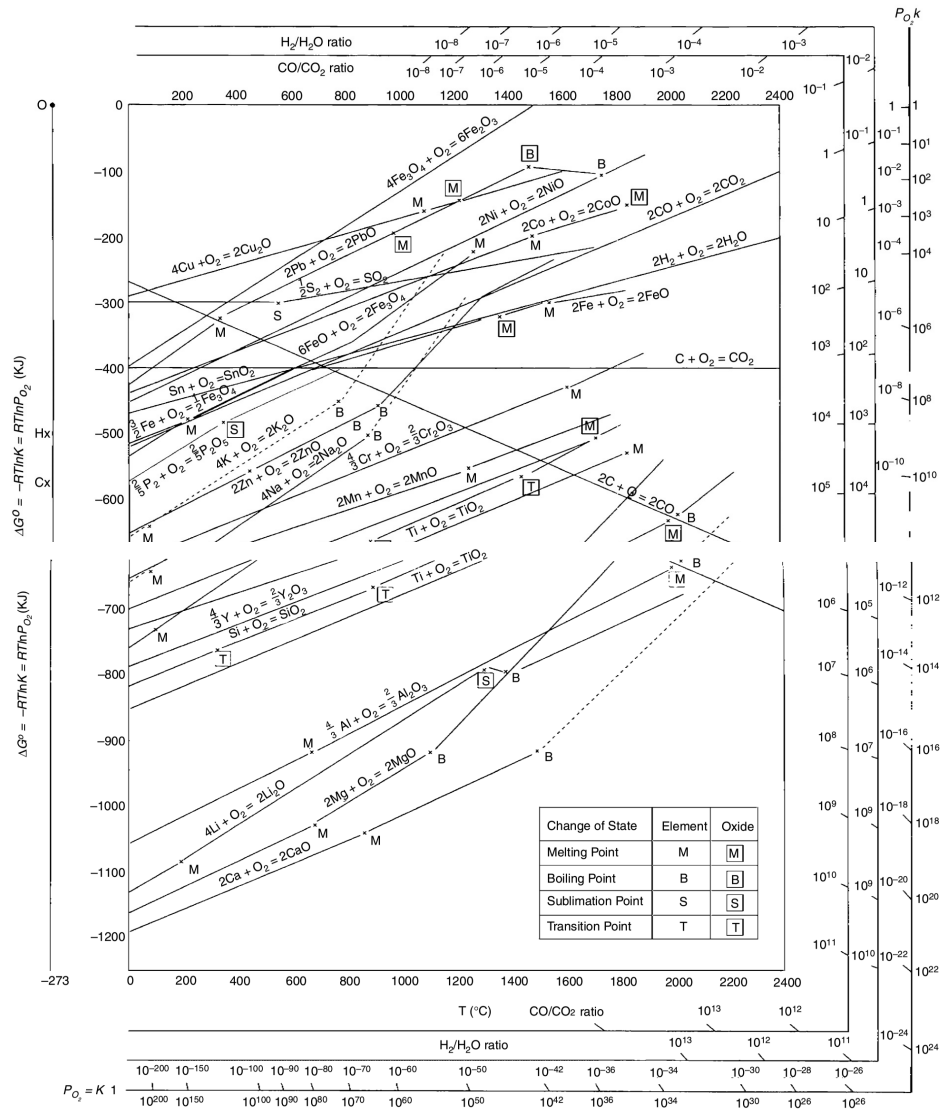
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Silver magnesium phase diagram at 1atm, each point represents the equilibrium structure of a particular Ag-Mg composition at a particular temperature

THERMODYNAMICS IS THE BASIS FOR EQUILIBRIUM MAPS



Used to:

- Determine the relative ease of reducing a given metallic oxide to metal;
- Determine the partial pressure of oxygen that is in equilibrium with a metal oxide at a given temperature; and

THE THERMODYNAMIC BASIS FOR EQUILIBRIUM MAPS

