

A grayscale micrograph showing a complex metal microstructure. The image features a variety of grain shapes and sizes, with some grains appearing as large, irregular polygons and others as smaller, more rounded features. The grain boundaries are clearly visible as darker lines separating the lighter-colored grains. The overall texture is highly detailed and characteristic of a solidified metal alloy.

# **Solidification of metals and alloys**

# System, components, phases.

A **system** is a part of the space separated for examination purposes.

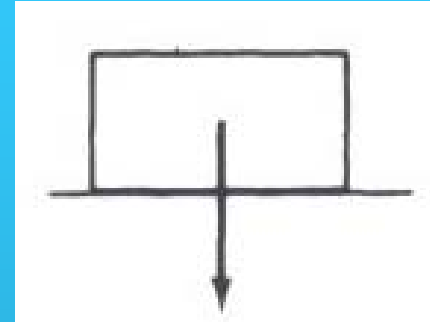
The substances forming a system are called **components**. An alloy system may contain any number of components.

A **phase** is a chemically homogeneous and physically distinct part of a system, which is separated from the other parts by an interface.

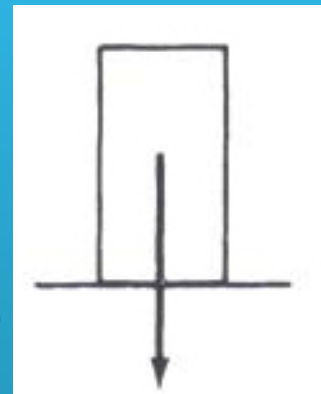
A system is in **equilibrium** if its **free energy** is minimal.

# The state of the system may be

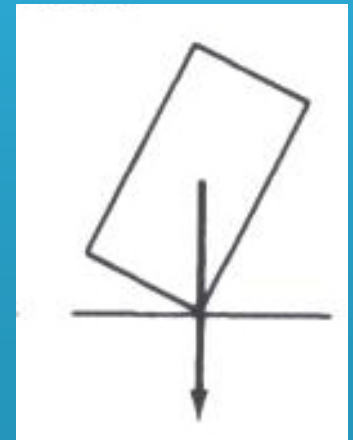
**stabil** (mimimal energy level)



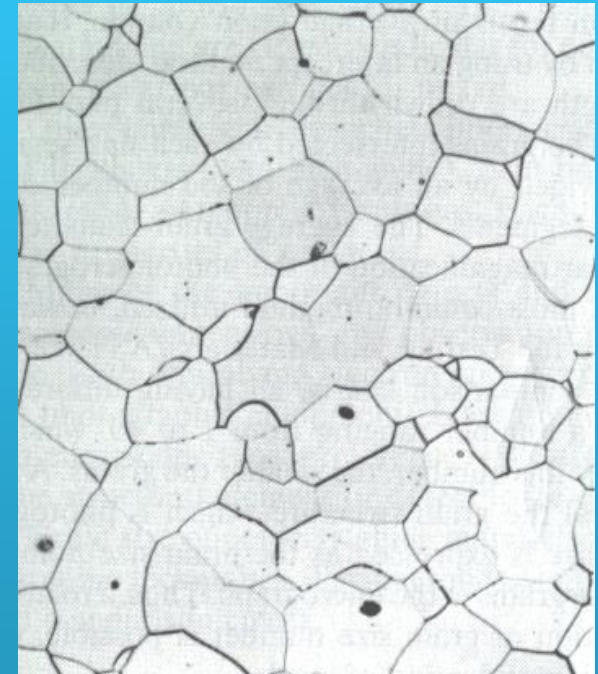
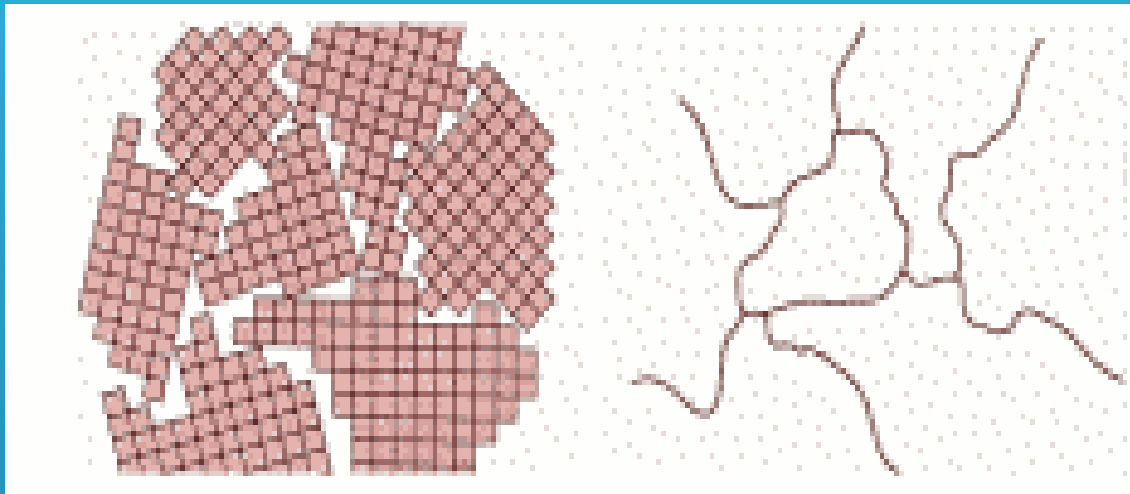
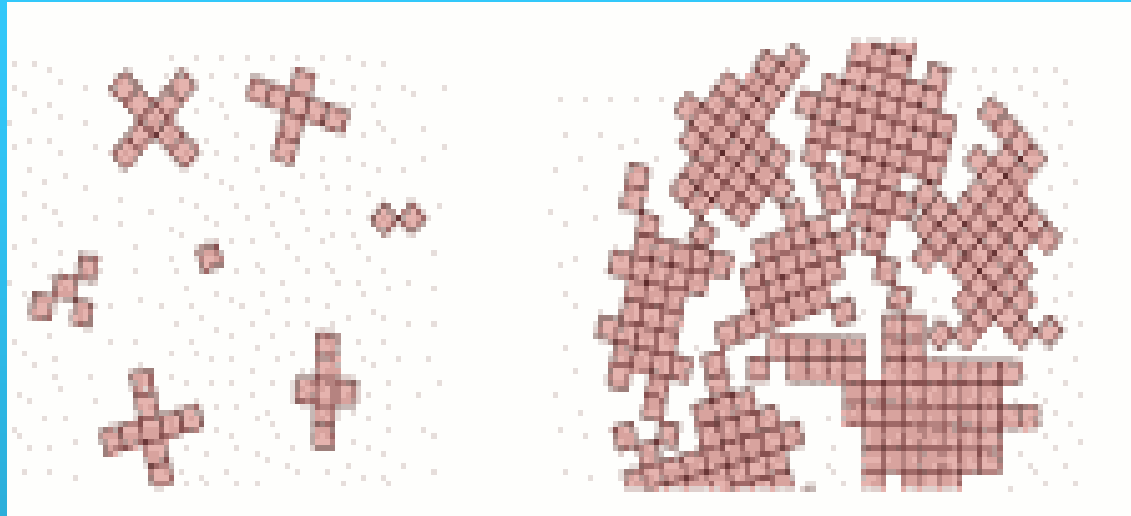
**metastabil** (the energy level of the phases are different from the minimal, bur they are able to stay in this state)



**instabil**

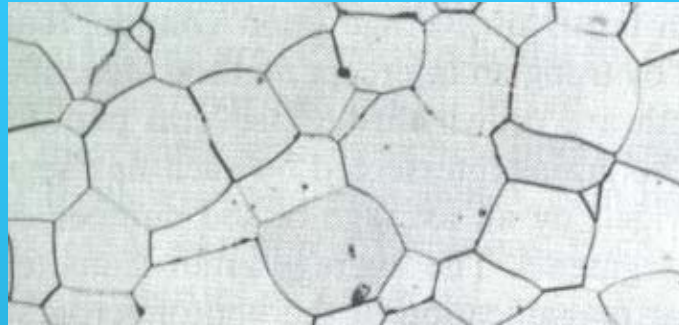


# The process of solidification

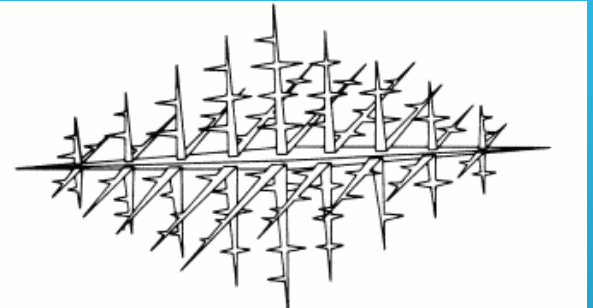
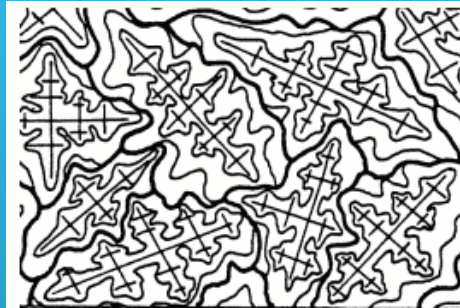


# The forms of solidification

- Polyedric

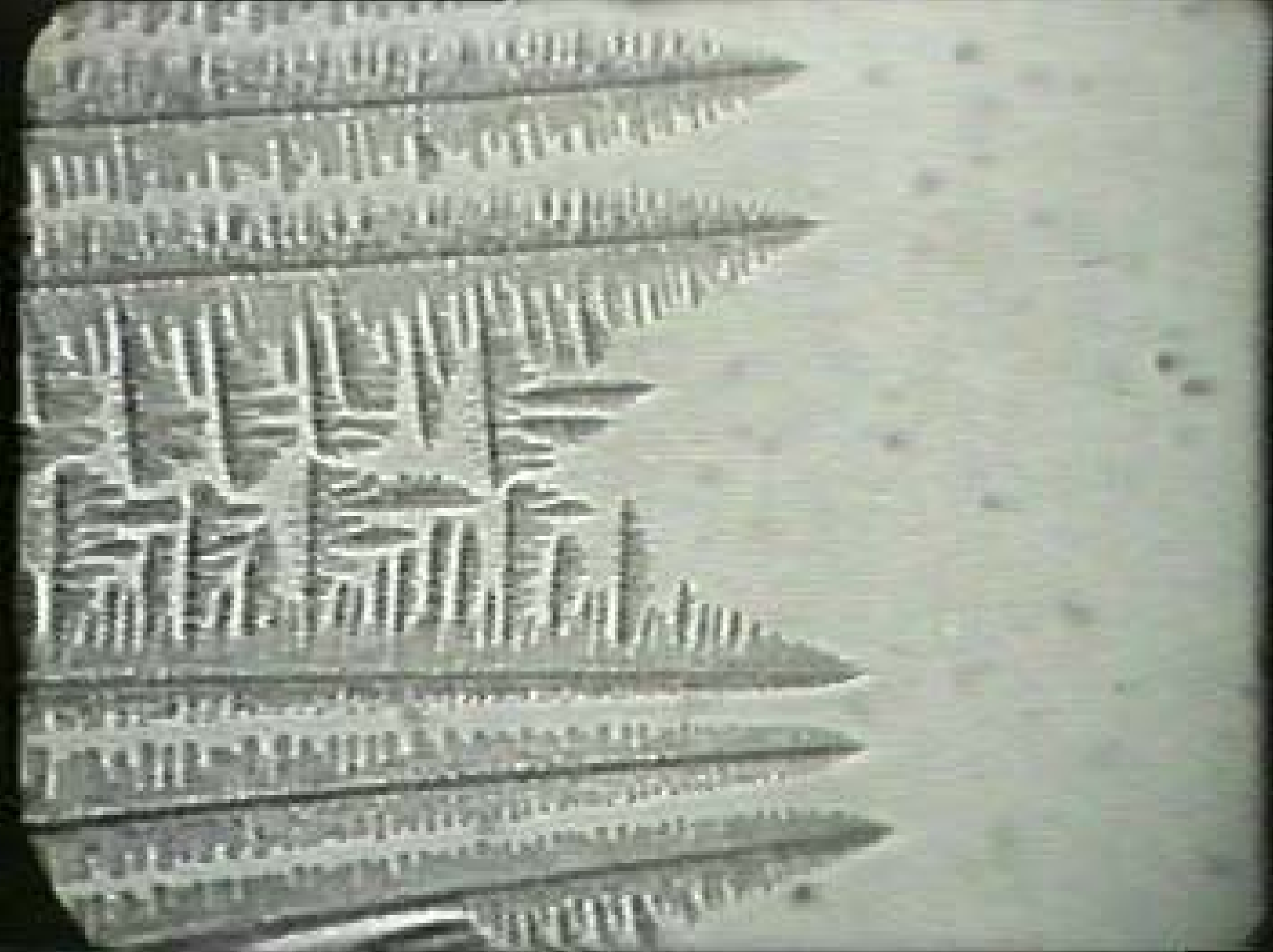


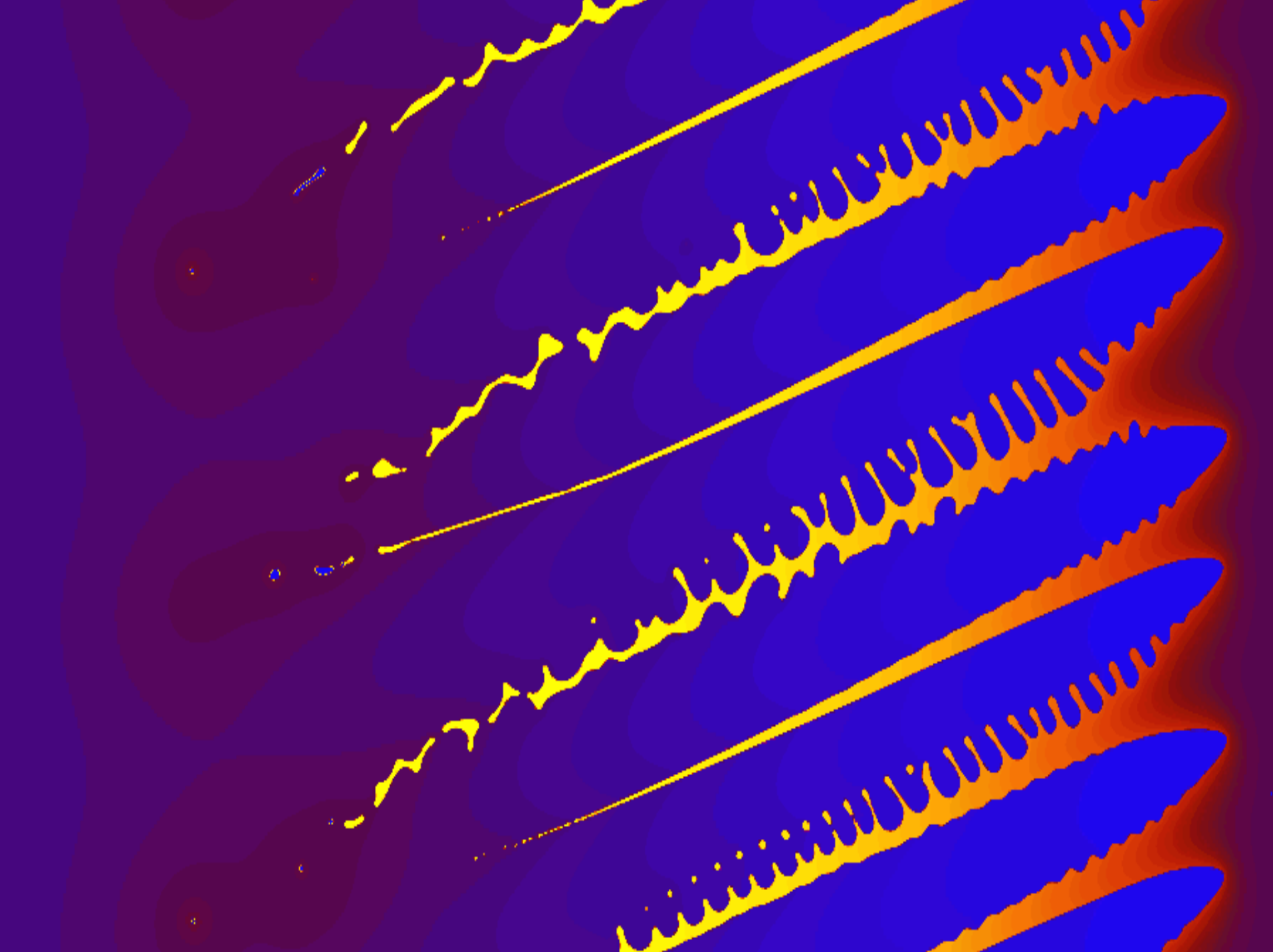
- Dendritic



- Spheroidal







# Cooling curves and equilibrium diagrams

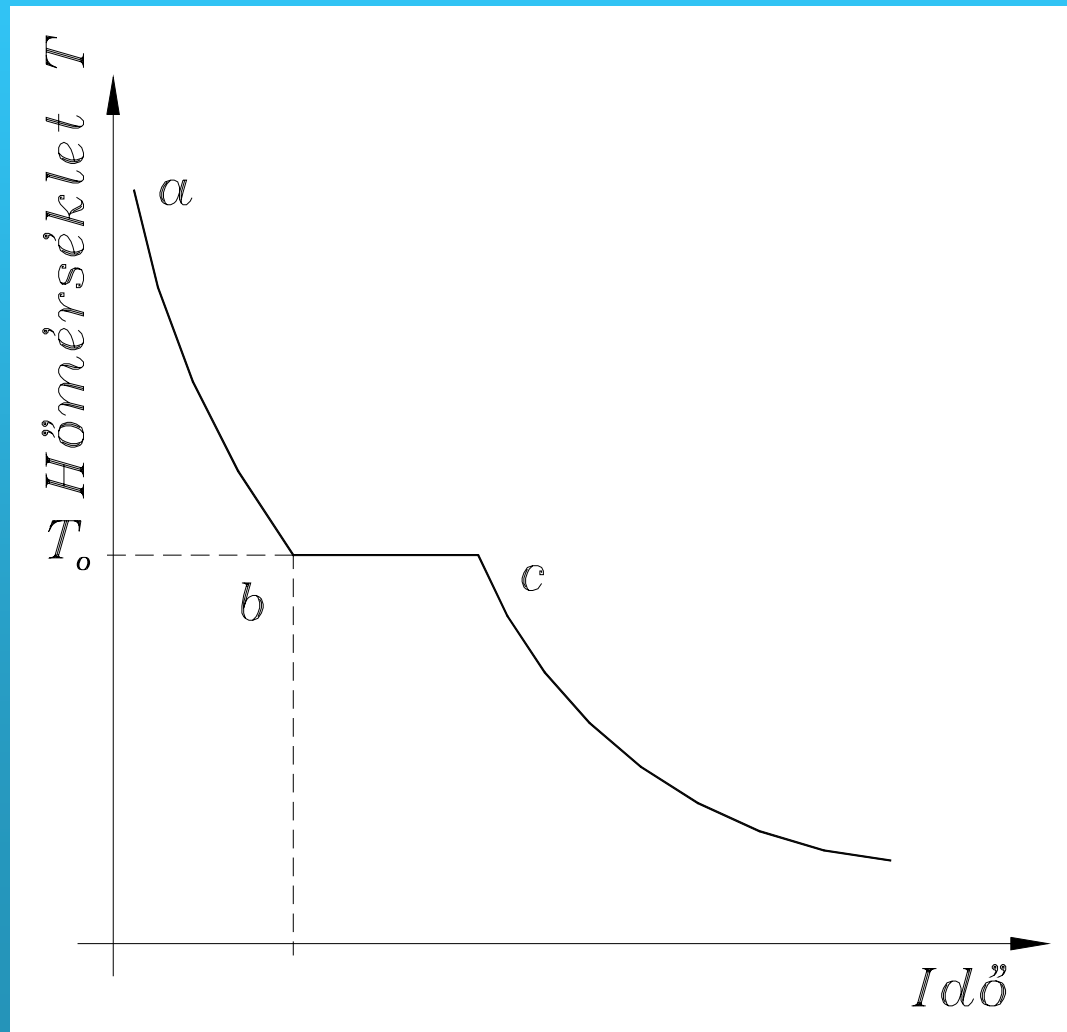
**the relationship between the composition, temperature and microstructure of alloys are illustrated by equilibrium diagrams**

**equilibrium diagrams are constructed from cooling curves**

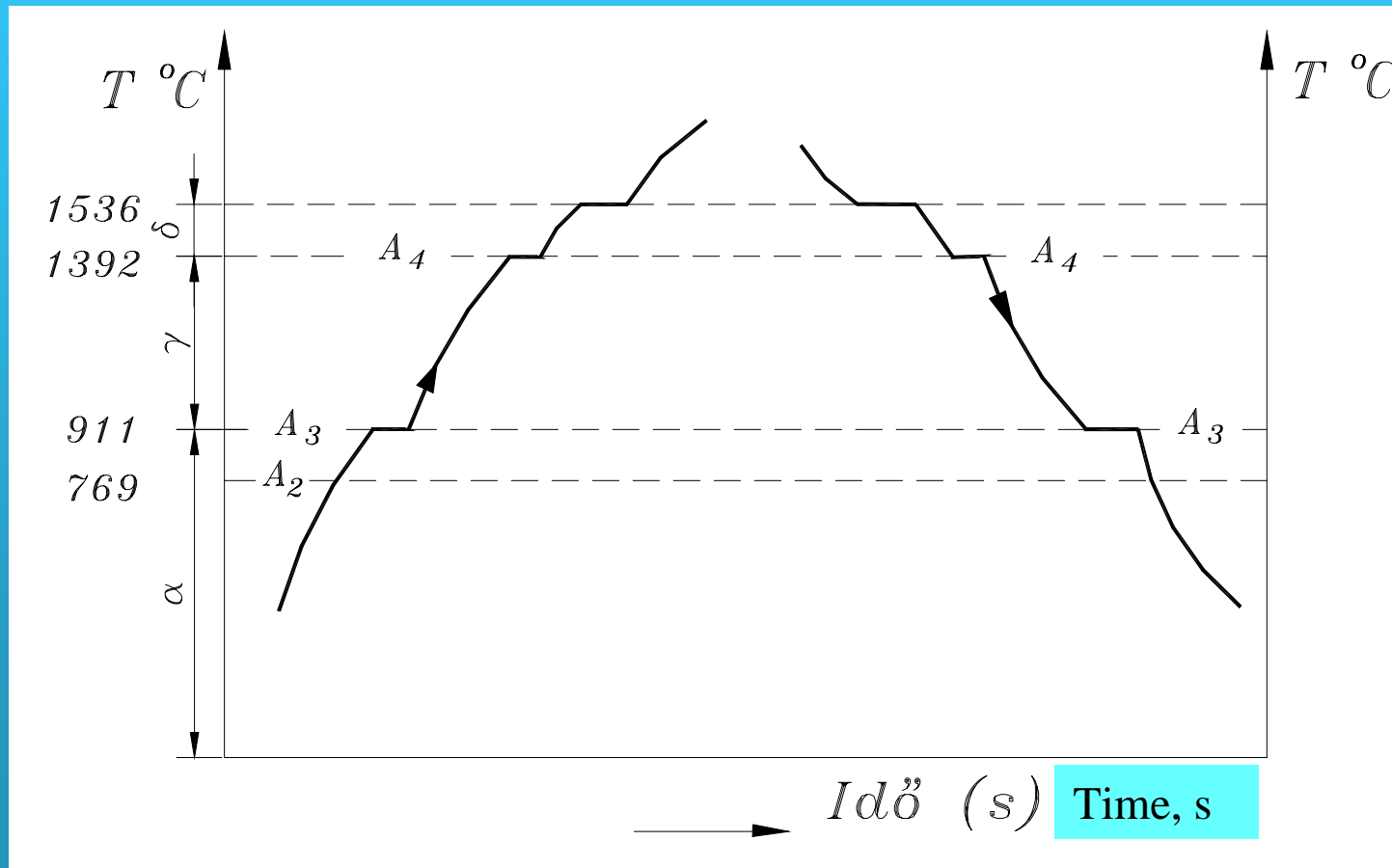
**cooling curves are determined by experiment applying thermocouples**



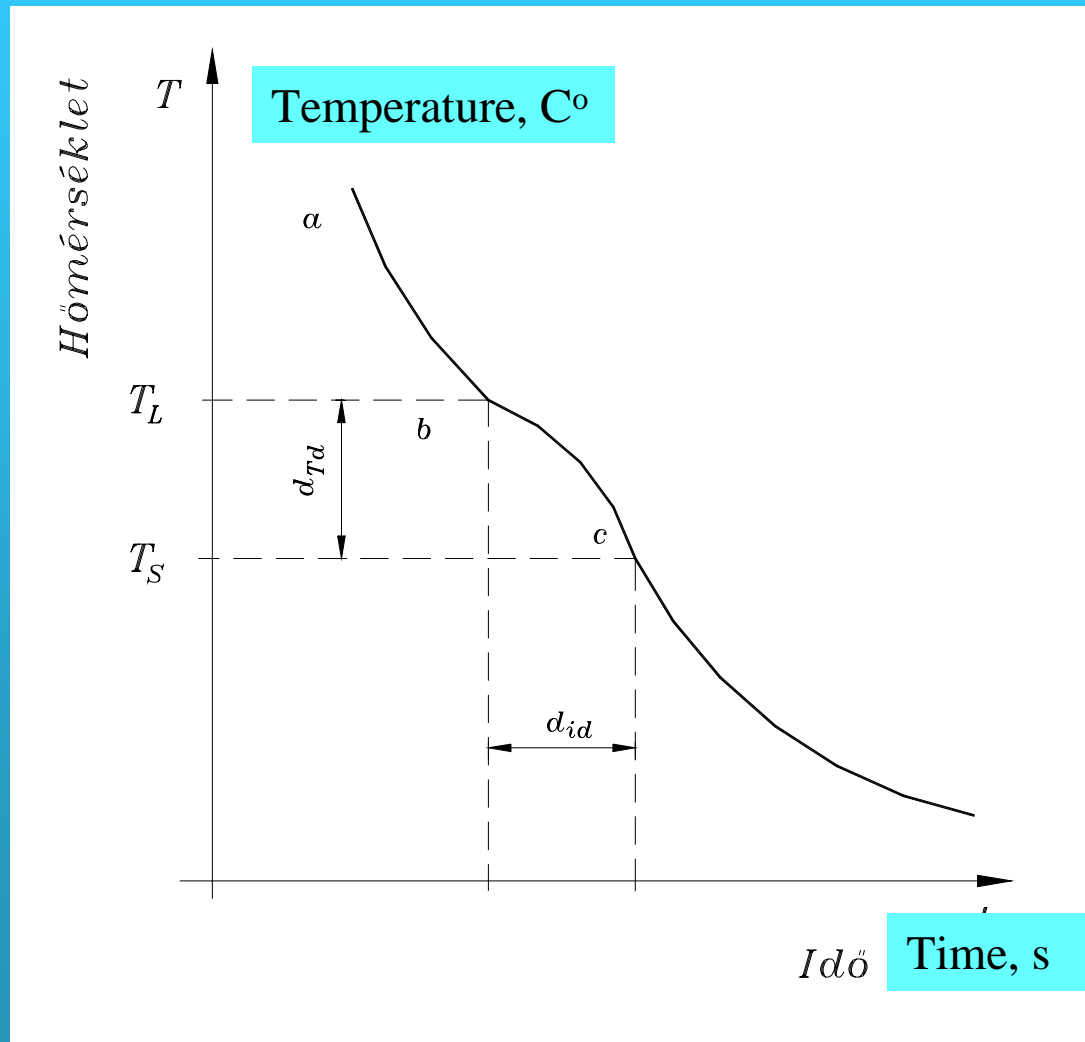
# The cooling curve of pure metal or metal compound



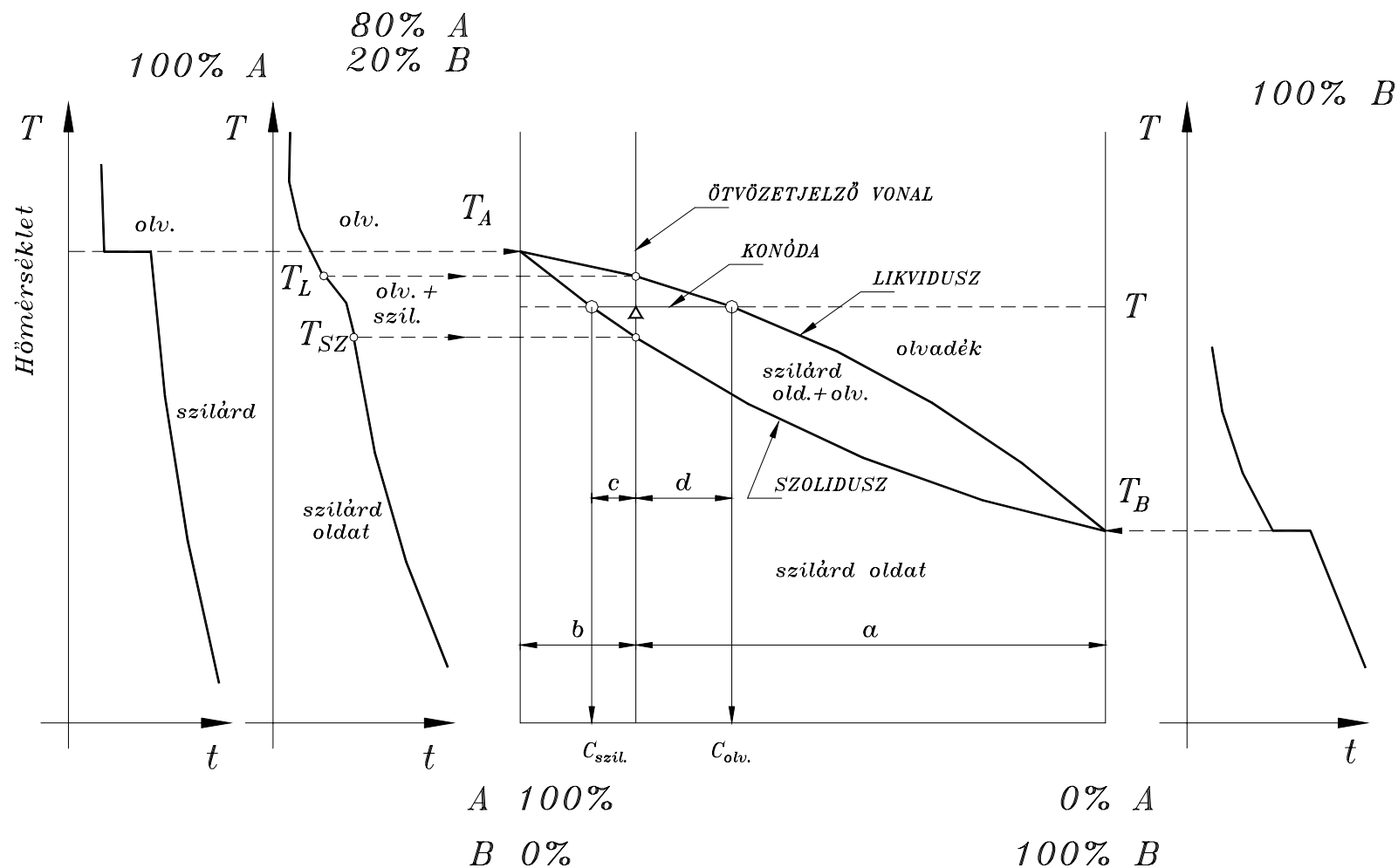
# The heating and cooling curve of pure iron



# The cooling curve of solid solution



# The construction of equilibrium diagrams

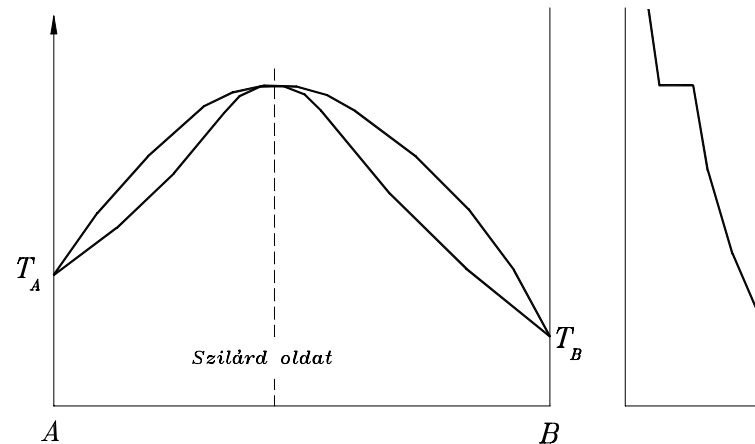
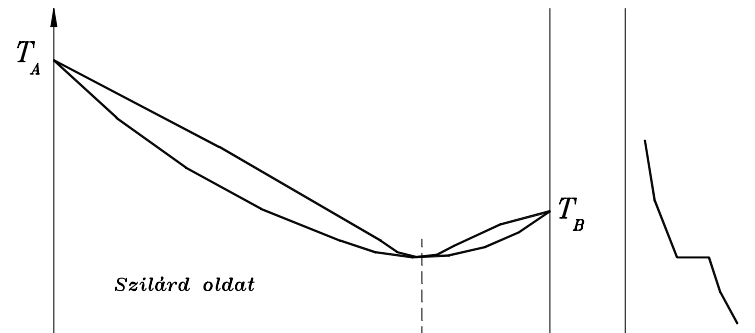
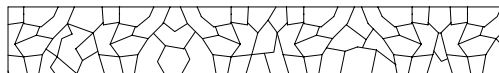
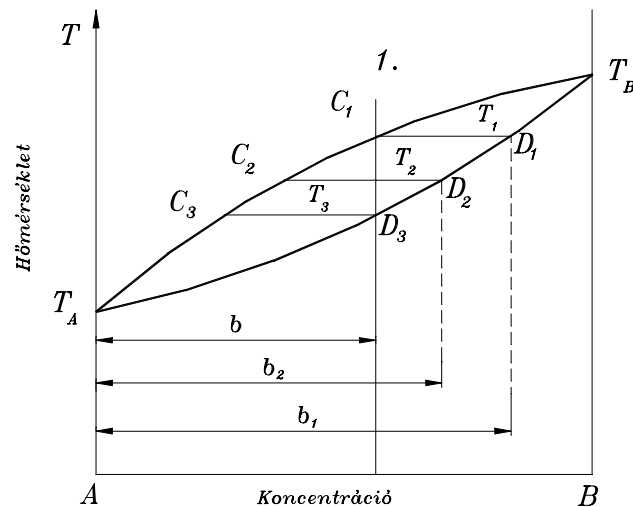


# Information content of equilibrium diagrams

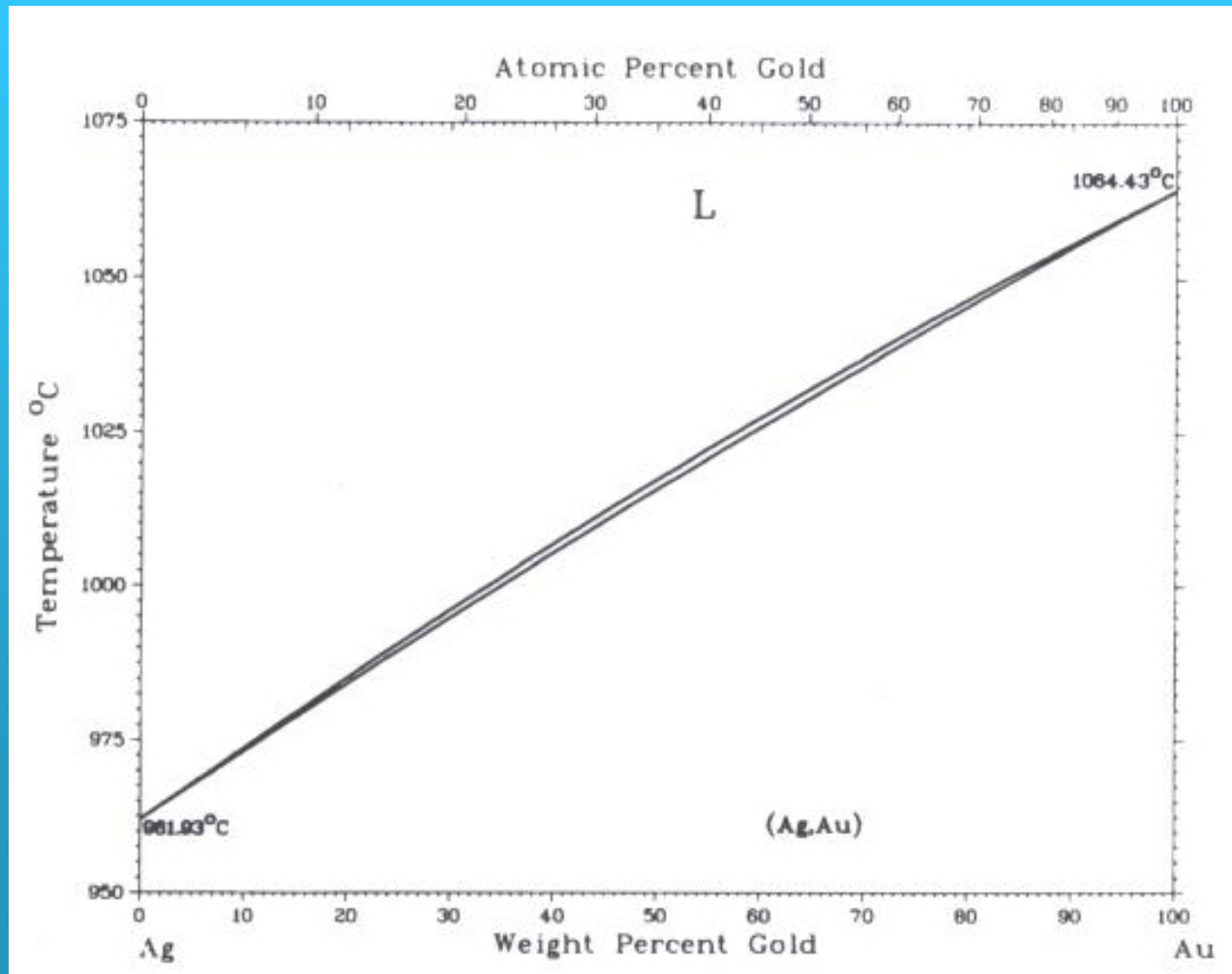
**at a given temperature and by a given composition:**

- **The number and type of phases**
- **The composition of phases**
- **The quantity of phases**

# Systems exhibiting complete solid solubility

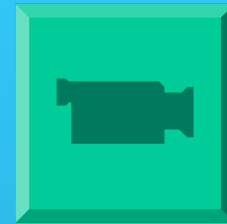
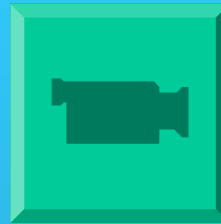


# Ag-Au equilibrium diagram

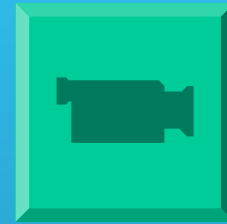
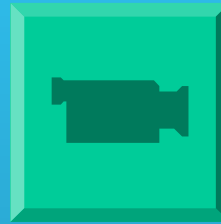


# Multimedia teaching materials

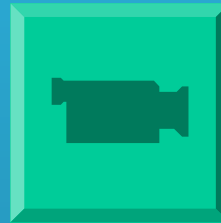
- Cooling process



- Lever rule



- Questions



Source: <http://www-g.eng.cam.ac.uk/mmg/teaching>