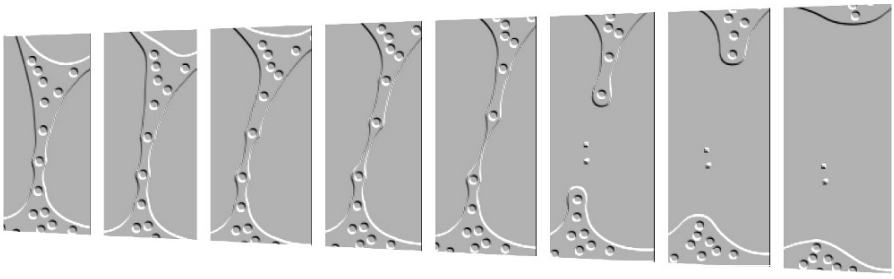
Part II
PHYSICS



Die Physik ist für die Physiker eigentlich viel zu schwer.
David Hilbert

Integral foam molding as proposed in Chap. 2 raises fundamental questions:

- Is foam evolution possible within the available foaming time of a fraction of a second or hampered by inertia, viscous or capillary forces?
- What is the role of gas diffusion? Is there a possibility to compensate inhomogeneities of the distribution of the blowing agent particles by diffusion?
- Might foam formation be hampered by the gas solubility of the metal?
- How is – if at all – foam stabilization realized? For all known metal foaming processes conditioned melts have to be used in order to stabilize the foam structure.
- What are the main structure characteristics of the resultant cell structures?
- Is there – analogous to well-known foaming processes – an intimate relation between mean cell size and relative density?
- What is the influence of the initial bubble nuclei density?

In order to find answers to these questions we have to have a closer look on the fundamental physical foaming mechanisms with special emphasis on the actual situation during IFM.

The first chapter of this part is a short introduction into the basic governing equations, bubble dynamics and foam stabilization mechanisms, especially the stabilization of metal foam.

The second chapter is devoted to generally valid foam evolution laws. It is shown that the evolution of the cellular structure is determined by very simple rules. These rules allow to extract important information from experimental results about the presence or absence of foam stabilization. In addition, the role of the initial bubble nuclei density on the foam structure is revealed.

The last chapter is concerned with foam stabilization during IFM. The grain nuclei present in the melt during endogenous solidification of the casting act as obstacles in cell walls. This obstacle effect generates a stabilizing force, the disjoining pressure, which is responsible for foam stabilization and the characteristic foam structure.

The derivation of the evolution laws and the discussion of foam stabilization by particle confinement is based on analytical and numerical approaches. The details of the numerical approach, which would be hindering here, are presented in Part III.