Book Reviews

Works intended for notice in this column should be sent direct to the Book-Review Editor (R. F. Bryan, Department of Chemistry, University of Virginia, McCormick Road, Charlottesville, Virginia 22901, USA). As far as practicable, books will be reviewed in a country different from that of publication.

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Physics of crystal growth. By Alberto Pimpinelli and Jacques Villain. Cambridge: Cambridge University Press, 1999. Pp. xix + 377. Price £27.95 (paper), £65.00 (hardcover). ISBN 0 521 55855 7 (paper) ISBN 0 521 55198 6 (hardcover).

The book intends to introduce the physical principles of how and why crystals grow. 'Theory of crystal growth with atomic beams' would have been more appropriate as its title since it treats theoretical questions relating to the growth of thin films with 'beam techniques' by using methods of statistical thermodynamics and elasticity theory ('The book focuses on growth using molecular beam epitaxy', as the authors themselves state). The authors suggest that their book should be of interest to 'graduate students and researchers in statistical physics, materials science, surface physics and solid state physics' (not in crystal growth?).

The treatment is mainly theoretical with occasional experimental information on crystal and crystal-growth morphology, especially by atomic resolution scanning tunnelling microscopy. After three chapters on equilibrium properties of crystal surfaces, the main topic begins in Chapter 4: examples of growth, dissolution and equilibrium shapes of crystals. Simple models and basic concepts of crystal growth are described in the following six chapters: crystal growth *abc*, Frank's model of the self-similarity of faceted crystal shapes during growth and deviation from this behaviour during dissolution, growth and evaporation of a surface with atomic steps, including the Schwoebel effect, defects and atomic mobility at surfaces, surface melting, thermal smoothing of a surface, reconstruction of silicon surfaces. More complex topics are discussed in the remaining six chapters: growth instabilities of straight steps and planar surfaces (kinetic roughening), interface instabilities due to transport problems in the direction away from the interface, nucleation and its correlation with adatom diffusion, layer-by-layer surfactant-supported growth at low temperatures, growth roughness at long length scales, effect of fluctuations of the beam of source atoms, elastic interactions between surface defects, elastic solid model equations. The last chapter on 'technology, crystal growth and surface science' sketches semiconductor electronics. An extensive appendix contains sections on Coulomb gas, theorems by Wulff and Frank, Schwoebel effect on atomic step flow on surfaces, diffusion and elasticity effects. The references are well characterized, go back in time by nearly a century and also contain classical publications of the leading specialists on the subject, *e.g.* Ostwald, Frenkel, Frank, Herring and Tiller. At the end of many chapters are problems, mostly with solutions, which are useful to test one's understanding.

This is not a book for beginners, rather a book for theoretical connoisseurs who have already been initiated into crystal growth theory and who are critical enough to recognize and overlook the occasional mis-statements that can be found in the book [*e.g.* not all crystals contain dislocations, horizontal directional solidification also exists in reality, dislocations can also be abundant in molecular-beam epitaxially (MBE) deposited samples and can be rare or even non-existent in large crystals grown from the liquid phase, to correct just a few]. Often, arguments are too sketchy or difficult to understand, requiring patience, work and extensive use of the quoted references. The last chapter on electronics is superfluous in this book. The authors might more usefully have used the space for an introductory chapter on the general principles of crystal growth by using phase transformations between fluid and crystalline phases, usually close to thermodynamic equilibrium, to put their treatment of MBE topics into perspective.

There are many other books on crystal growth on the market which provide excellent information on all aspects of crystal growth. An outstanding series is the three volumes of *Handbook of Crystal Growth*, edited by D. T. J. Hurle, which contain reviews by specialists in all fields of crystal growth. With the help of such a guideline, this book by Pimpinelli & Villain can fulfil its purpose as an unusual compilation of discussions of fundamental theoretical questions relating to the statistical mechanics of solid surfaces with defects and to atomic models of crystal growth by the use of atomic beams.

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