

REVIEW

P. V. HOBBS. *Ice physics*. Oxford, Clarendon Press, 1974. xvii, 837 p. £29.

DURING the last two decades a large number of studies concerned with the properties of ice have been published in many different scientific journals, in the proceedings of conferences and in reports of research institutions. This book provides a comprehensive survey of all the data of an experimental or theoretical nature on the physics and chemistry of ice which are widely scattered in the literature. It appears just at the right time, when its subject, ceasing to be only of mere academic interest, becomes relevant to other disciplines. In more than 800 pages with 318 figures, 69 tables and many numerical data scattered in the text, it covers not only what might be called the standard physical properties of ice, i.e. structure, mechanical, electrical, optical and thermal properties, but half of it deals also with surface properties, nucleation, growth and atmospheric ice. The bibliography is exhaustive until 1970 and extends to partial coverage between 1971 and 1973, with about 1 300 references. Beside a subject index with more than 2 500 entries, the book contains also an index to tabulated and graphic data with about 100 entries. An addendum reports on some results from the Symposium on the Physics and Chemistry of Ice, held in Ottawa in 1972.

Beginning with a description of the water molecule according to the different models and theories, the first chapter treats the crystallographic structure of all the known solid phases, with considerations on proton disorder, zero-point entropy, molecular electric dipole moments in the crystal, hydrogen bonding, mainly for the Ih phase. Electrical properties are the subject of the second chapter, which begins with an account of experimental studies of the dielectric and conduction parameters at low and high frequencies, the influence of impurities (HF, NH₃, NH₄OH, NH₄F, etc.), pressure and deformation, and a discussion on the nature, concentration and mobility of the charge carriers. These data are discussed in the light of the theories based on ionic and valence defects. Experimental and theoretical accounts are also given for the thermoelectric effect and for charge storage. In the third chapter, optical refraction, absorption and reflection are reviewed, as well as emissivity, luminescence, thermoluminescence, Rayleigh scattering and colour centres. This is completed by an interpretation of the infra-red and Raman spectra of hexagonal ice and of the polymorphs. Then follows in the next chapter a survey of the elastic and anelastic properties, and a discussion of the plastic deformation of single crystals and of polycrystalline samples. In the fifth chapter (on thermal properties) the author reviews experimental results on pressure-volume relationships and thermal conductivity. He gives then the current theoretical interpretations of these properties and an account of the volume diffusion. Ch. 6 deals with all the phenomena and parameters involving the surface: structure, energies, sintering, adhesion and friction, etching figures, electrical potentials and charge separation by rubbing. The next three chapters are concerned with the mechanisms required by ice-crystal formation. There is first an extensive account of theories and experiments on homogeneous and heterogeneous nucleation. Then studies are reported on the growth of ice crystals from the vapour phase, namely on the habit, as a function of external parameters such as temperature and supersaturation, on the growth rate, and on step propagation on the surface. Finally the growth from the liquid phase is treated, with sections on habits and rates, on segregation of impurities, freezing potentials and the freezing of water drops. The tenth and last chapter is devoted to atmospheric ice, the author's main subject of investigation during the last decade. Ice particles in clouds are examined with respect to their origin, their growth, their relationship to solid precipitation, their interaction with visible and infra-red radiation and their electrification. Several chapters terminate with a brief account of applications pertaining to engineering, biology, and especially geophysics, glaciology and snow physics, with a final section on extraterrestrial ice.

Written in a clear style and providing the first comprehensive survey on the physics and chemistry of ice, this book constitutes a first-order reference work not only for the physicist and the chemist, but also for all those who are concerned with glaciology, hydrology and meteorology as well as for the biologist, and it gives a well-founded base of knowledge to every investigator who is new to the field.

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