dynamical theory of X-ray diffraction and the large number of practical applications makes the book very useful for newcomers to the field of X-ray topography.

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Current topics in materials science, Vols. 5 and 6. Edited by *E. Kaldis*. Vol. 5: pp. vi + 617; Vol. 6: pp. vii + 481. Amsterdam: North-Holland, 1980. Price: Vol. 5, US $87.75; Vol. 6, US $97.50.

These two volumes are more-or-less concerned with electronic materials. Therefore, they are reviewed together in one single article from the standpoint of solid-state electronics.

In solid-state electronics, the improvements or the new functions of electronic device characteristics are driven forward by refinements of the present materials or developments of new electronic materials, respectively. This being so, electronic materials engineers must always challenge the development of new materials for electronic use, giving attention to the physical properties, the crystal growth, the reaction with the other materials, and so on.

These two volumes seem to present the answers to many questions asked by the electronic-materials engineers. Generally speaking, the essential points of materials research for electronics are described under a good combination of selected processes and selected materials, though a wide range of subject matters is put in order. Ten articles in all are reviewed one after another as follows.

The first two reviews of Vol. 5, that is *The preparation of gallium arsenide*, by L. Hollan & J. P. Hallais, and *Application of the theory of rate processes in the CVD of* GaAs, by R. Cardoret, are focused on GaAs and related compounds, which are very important materials for the future of solid-state electronics. The following are some of the reasons for this: (1) In the field of integrated circuits, the higher mobility of the electrons in GaAs leads to faster circuits compared with Si; (2) GaAs has a direct bandgap which makes it suitable for integrated-optic devices including light emitters, receivers and guide; (3) As seen in the study of the GaAs–AlAs superlattice, the series of these compounds is expected to have new physical properties which may lead to new functional devices. GaAs crystals have an advantage in the ease of obtaining semi-insulating materials as a substrate for thin-film integrated circuits, whilst with Si this cannot be done unless insulating substrates, such as sapphire and spinel, are used. For this to be realized for the above mentioned devices, however, there are many problems on material preparations and processes to be solved.

From these two articles, we can obtain a knowledge of GaAs covering all aspects from the growth of the bulk crystal, liquid-phase and vapour-phase epitaxy (including MOCVD), molecular beam epitaxy, characterizations, and materials properties, to applications. Following this, the theoretical considerations of GaAs CVD processes are treated in regard to two kinds of growth, that is growth by layers and direct or continuous growth, referring to the recent fundamental investigations of the transition between these two growth modes by statistical methods and by simulation on computers.

A. A. Chernov & V. V. Sipyagin review *Peculiarities in crystal growth from aqueous solutions connected with their structures*. The relationship between the aggregating state in a liquid phase and the perfection of the grown crystal is a subject still to be made clear. Progress in this field will greatly contribute to solid-state electronics in the matter of obtaining more-perfect crystals from aqueous solutions. The authors of this article attempt to summarize this important problem by referring to associations in aqueous solutions and crystal growth, anomalous temperature dependence of growth rates, investigation of films of solution by NMR methods and temperature dependence of viscosity (although electronic materials, in the narrow sense, are not involved here).

The following chapter, written by H. K. Cammenga, is devoted to *Evaporation mechanism of liquids*. This article is mainly concerned with the theoretical and the experimental aspects of liquid evaporation and condensation at solid surfaces. In the field of electronic materials, there are many opportunities to meet with exchange phenomena. That is, in the chemical vapour deposition, including epitaxial growth, many kinds of liquids are utilized as source materials, which are evaporated directly or bubbled to transport material to the crystal wafer surface. From this point of view, it is valuable for the electronic-materials engineer to understand the thermodynamics and the kinetics of these phenomena fundamentally, as touched on in this article.

The final chapter of Vol. 5, by A. Baronnet, discusses *Polytypism in micas: a survey with emphasis on the crystal growth aspect*. Micas have been utilized for electronic materials from the old days and they have excellent electrical characteristics as many kinds of capacitors in the respects of long life, high breakdown voltage, and insensitivity to temperature variations. On the other hand, polytypism is also observed in other crystals, such as SiC, ZnS, and so on. From the standpoint of electronic materials, there are two points to emphasize in regard to polytypism. One of them is that polytypism obstructs the perfection of single crystals by acting as a kind of physical contamination. The other, however, is that, if the polytypism can be controlled artificially and precisely, new electronic materials may be prepared. An example is given by Dr L. Esaki of IBM, in the GaAs–AlAs superlattice. The reason for the appearance of huge periodicities in natural crystals is one of the most prominent questions generated by the polytypism phenomenon. This chapter reviews what is known about polytypism in micas: (1) by showing in detail how complex the structural aspect of this phenomenon is; (2) by discussing the stability of polytypes; and (3) by focusing attention on the relationship between crystal growth conditions and polytypism. These three aspects are also common to other polytypic crystals.

The first chapter of Vol. 6 presents *The characterization of semiconductor materials and structures using electrochemical techniques*, by M. M. Factor *et al.* The subjects of metal or semiconductor electrodes, electrical characterization of GaAs and other semiconductors, microstructural evaluation of semiconductor materials by electrochemical dissolution, and, additionally, further exploitation of electrochemical techniques in the analysis and fabrication of semiconductor materials and devices are concisely reviewed. Modern electronic devices using semiconductor materials are increasingly surface- and interface-layers dominated. The cleanliness and perfection of these layers is becoming more and more important for the fabrication of the devices. We must reveal, as the first step, the micro-inhomogeneities and the microstructural defects in these layers. The various electrochemical techniques, as described in this chapter, are indispensable for the characterization of semiconductor materials and devices. The etching method, for instance, is an inverse process to crystal growth and gives us the growth history, which leads to the elucidation of the origin of microdefects.

Properties and behaviour of the zinc oxide/electrolyte phase boundary are reviewed by W. Hirschwald. Zinc oxide is one of the oldest electronic materials and has a broad bandgap ($E_g = 3{\cdot}2$ eV). This article presents properties of the phase boundary, photoeffects on semiconductor surfaces, dissolution and decomposition, charge transfer, electrochemical and photochemical catalysis, tunnelling and electroluminescence, photoluminescence and so on. Among these subjects, the dissolution and the decomposition of zinc oxide are very interesting phenomena. In the case of dissolution under illumination, for instance, photoproduced holes reach the surface and can decompose the zinc oxide if no other oxidizable agent is present, generating a photocurrent at the same time. The rate of decomposition and the photocurrent are proportional to the intensity of the light. On the other hand, with respect to (0001) Zn, the $(000\bar{1})$ polar face dissolves faster in acid and slower in alkali solution.

In the following chapter, *Studies of epitaxial growth of thin films by in situ electron microscopy* are reviewed by G. Honjo & K. Yagi, who have, for many years, been developing methods for the *in situ* observation of thin epitaxial film growth in the electron microscope. In this article, too, many excellent electron micrographs are shown of Fe/MgO, Au/MoS_2, PbSe/PbS, and so on. The experimental results are compared with the existing theoretical models. Two fundamental growth modes, MO (monolayer-by-monolayer overgrowth) and NG (nucleation and growth) processes, are explained in detail. From the angle of solid-state electronics, heteroepitaxy between different kinds of crystals is very attractive because of its utility for functional devices. SOS (Si on sapphire or Si on spinel), for instance, is a hopeful material for higher-speed devices or higher-integrated C-MOS, compared with Si devices. This is due to the perfect electrical isolation between the active layer (surface) and the substrate (bulk). Moreover, the characteristics, stability and reliability have increased considerably in laser diodes, such as GaAlAs, InGaAsP, by the realization of double hetero structures, in which active layers are placed between the other two inactive and different compositional layers. In this regard, the fundamental work in this article is highly commendable.

The microstructure of vapor deposited thin films, by H. J. Leamy, G. H. Gilmer & A. G. Dirks, refers to 'columnar microstructure' observed in metallic, semiconducting, and insulating thin films of both crystalline and amorphous materials. The microstructure consists of low-density material that surrounds an array of parallel, rod-shaped or columnar regions of higher density. The effect of the structure upon the physical properties, that is magnetic, optical, electrical, and mechanical properties, of the film material is often remarkable. The formation mechanism of the structure, molecular dynamics model of vapor deposition, and elements of a theory for the structure are presented. Micrographs of the columnar structures observed by microfractography, TEM and small-angle electron scattering are shown on Gd–Co alloy film series, Al film and $Fe_{0{\cdot}8}B_{0{\cdot}2}$ film.

The last article has the title *Molecular species in high-temperature vaporization*, by K. A. Gingerich. The formation of a solid by condensation from the vapor phase is the most common method used for thin-layer growth of electronic materials. The emphasis is on the mode of vaporization and on the equilibrium vapor composition over elements and binary metal compounds. High-temperature mass spectrometry, plasma deposition mass spectrometry, high-temperature electron diffraction by gases, and other methods are introduced as tools for studying molecular high-temperature species. Recent kinetic studies of molecular species in high-temperature vaporization and some empirical correlations of bond energies are also outlined. For estimating the stability of materials in a vapor phase and for predicting the equilibria involved in crystal growth from the vapor phase, many thermodynamic data, that is dissociation energies, atomization energies, partial-pressure ratios, *etc.*, are tabulated for gaseous molecules of elements and binary compounds.

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Books Received

The following book has been received by the Editor. Brief and generally uncritical notices are given of works of marginal crystallographic interest; occasionally a book of fundamental interest is included under this heading because of difficulty in finding a suitable reviewer without great delay.

Liquid crystals of one- and two-dimensional order. Edited by *W. Helfrich* and *G. Heppke*. Pp. xii + 416. Springer-Verlag, 1980. Price DM69.00, US$39.50. A review of this book, by P. G. Barber, has been published in the January 1982 issue of *Acta Crystallographica*, Section B, page 348.