Dislocations in Solids, Volume 8 — Basic Problems and Applications

Edited by F.R.N. Nabarro
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In contrast to several of the earlier volumes in this series edited by F.R.N. Nabarro, no single theme seems to unite the book's six substantial chapters. Nevertheless, the volume contains six excellent review articles, authored by recognized experts in their field, on topics as diverse as the crystallography of line defects in interfaces, the role of the dislocation cores in plasticity, electron scattering from dislocations, misfit dislocations in epitaxy, microstresses in crystals under plastic flow, and electrical-current enhanced plasticity of metals.

The book begins with an excellent review by R.C. Pond (University of Liverpool) on the mathematical characterization of the possible line defects in bicrystalline interfaces. In various cases a connection with actually observed line defects is made. Pond cautions, however, that his strictly crystallographic treatment may not be applicable to the arrays of line defects often encountered in crystalline interfaces, and that his terminology may not necessarily be useful for describing their physical properties.

In an interesting chapter, entitled *The Dislocation Core and Plasticity,* M.S. Duesbury (NRC, Ottawa) reviews how the mobility of dislocations is largely controlled by their detailed core structure rather than by the dislocation strain field. In contrast, for example, with electrical and thermal properties of dislocations, the mobility thus stands out as strongly dependent on crystal structure. The chapter extensively compares atomistic computer simulations of the core structure with the classical combination of continuum elasticity and hard-sphere stacking. This review of theoretical methods is complemented by a critical review of the experimental evidence, and the conclusion that Schmid's law is, at best, only a crude approximation in most crystal structures.

This chapter is followed by a lengthy chapter by B.R. Watts (University of East Anglia) on conduction-electron scattering by dislocations in metals. It contains an in-depth critical survey of electrical-resistivity and de Haas-van Alphen effect data in dislocated metals, and two experimental methods providing complementary information on the atomic displacements near the dislocation core and in the long-range strain field, respectively. The theory of the de Haas-van Alphen effect due to the long-range strain fields is presented in considerable detail. This is followed by a critical review of existing theories of the electrical resistivity of dislocations, from which it is concluded that any physically realistic model must include the atomic positions near the core.

Chapter 4, entitled *The Prediction of Critical Misfit and Thickness in Epitaxy*, contains a very useful and timely overview of the present state of theoretical understanding of misfit accommodation in epitaxial interfaces. Based largely on much of their own work, W.A. Jesser (University of Virginia) and J.H. van der Merwe (University of Pretoria), two veterans in the field, derive the conditions under which the natural misfit between two crystals is accommodated by either misfit strains or misfit dislocations. The coherency-incoherency transition is discussed, based on clearly defined basic physical principles, founded in equilibrium and non-equilibrium thermodynamics. A comparison with experimental observations of the critical thickness and lattice mismatch demonstrates both the validity and limitations of the approach, as well as the importance of kinetic phenomena, particularly in covalently-bonded semiconductors.

In the next chapter, *Microstresses and the Mechanical Properties of Crystals*, P.J. Jackson (University of Natal) reviews models for the development of internal stresses as a result of plastic flow in well-defined two-phase materials, with particular emphasis on Eshelby's concept of the accommodation factor. Unfortunately, due to the complexity of the underlying physical processes, only a few cases, such as the cyclic flow in crystals that have been fatigued into saturation, can be treated in detail.

The volume concludes with a timely account by H. Conrad and F. Sprecher (North Carolina State University) of the electroplastic effect (i.e., the enhancement of dislocation mobility in metals by electrical current). In contrast to the well-understood enhancement of the mobility of *atoms* by electrical current (termed electromigration), the underlying causes for this less well-known phenomenon are more obscure, although the authors manage to disentangle the mobility-enhancing effect of the electron wind on dislocation motion from frictional forces arising from either the elastic interaction of the moving dislocation with crystal defects, or the interactions with phonons and other elementary excitations. As the extensive comparison with experiments demonstrates, however, only a semi-quantitative explanation of the effect is available.

If there is a theme common to this collection of excellent review articles, it is, in the editor's words, the recognition ".... that a knowledge of esoteric topics such as interfacial dislocations and the detailed structure of the cores of dislocations in unusual crystal structures has been essential in the development of semiconductor devices and superalloys." Hence, although the book lacks coherency, many members of the dislocation and interface communities will find at least some of the overviews presented here useful to their particular research interests.

Reviewer: Dieter Wolf is a senior physicist in the Materials Science Division at Argonne National Laboratory. He and his group are investigating physical properties of solid interfaces by means of atomistic computer simulations.

Natural Fiber Reinforced Cement and Concrete

Concrete Technology and Design, Volume 5

Edited by R.N. Swamy

(Blackie and Son Ltd., 1988), *approximately 287 pages*

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The use of wood fibers for composite reinforcement dates back nearly 100 years, while cellulose has been used as an asbestos substitute for almost 50 years. Currently, however, a new potential for such materials exists worldwide, particularly because of their special relevance to developing countries. This book examines the applications, science, and numerous technologies of such materials, beginning with a discussion of the background and chronological development of natural fibers; and provides descriptions of fiber types. It also discusses specific properties and applications, and the advantages, disadvantages, and appropriate uses for certain fiber types. Methods of pulp production, fiber processing techniques, materials properties, and fabrication criteria are discussed.

In one chapter, R. Coutts provides a general and historical treatment, and describes wood structure and properties, principles of fiber reinforcement, and fabrication processes. He also discusses bonding and microstructure of wood fiber cementitious composites and factors affecting their durability. At least some supporting evidence is supplied for long-term durability of the composites. A. Sarja uses the term wood fiber reinforced concrete to include composites containing sand-size inorganic particles, and also discusses wood-wool, and wood-chip composites. L. Robles-Austricao and R. Parma deal with the use of bamboo reinforcement for cement and concrete. The low bond of bamboo with cement appears to provide some limitations; nevertheless, bamboo use as reinforcement appears to be gaining acceptance and creating confidence in its use. H.-E. Green discusses the durability of natural fibers, especially axial fibers, in concrete—particularly the response to the alkaline pore solution of the cement matrix. Various fiber bonding and fiber impregnation methods to improve the durability are discussed.

Other chapters, by Z. Fordos, deal with natural or modified cellulose fiber reinforcement. Fordos discusses a large variety of fibers and fiber processing. Strain capacity of some cellulose-cement sheets is shown to be significant, and the dry strength levels have been found to be similar to asbestos-cement sheets. V. Agopyn discusses vegetable fiber reinforced composites in Latin American countries, where such fibers as coir, henequan, malva and disintegrated newsprint have been emphasized. The potential for low-cost buildings is again detailed. Natural fiber concrete has also been developed in India, according to S. Rehsi, who extended the list of potentially suitable fibers for these composites. Finally, H.-E. Gram describes the use of natural fiber in concrete roofing products for which there seems to be considerable potential.

The overall thrust of the book provides sufficient scientific and technical evidence to emphasize the potential of natural fiber reinforced cementitious materials in the future (particularly low-cost) building materials, and suggests an important area for research.

Reviewer: Della M. Roy is a professor of materials science, Materials Research Laboratory, at the Pennsylvania State University, where her research emphasizes the areas of advanced cementitious materials and chemically bonded ceramics. □

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