books

A classic reference in solid state

Semiconductors and Semimetals, Vol 6: Injection Phenomena
K. Willardson, A. C. Beer, *eds.*
359 pp. Academic, New York, 1970. $19.50

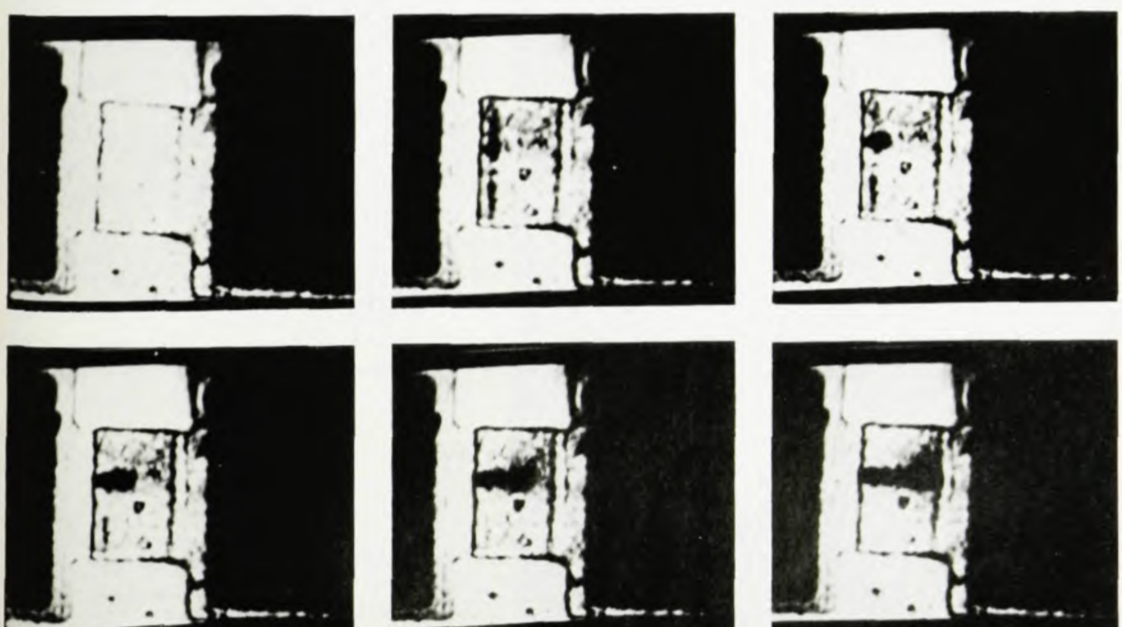
Reviewed by Albert Rose

There is no doubt that volume 6 of Semiconductors and Semimetals on injection phenomena will remain a classic reference for many years. The field of injected currents is relatively new; it is multidimensional and expanding. The authors of the five chapters are in large part responsible for the early key contributions in their fields.

The delicate role that electrical contacts play in the observation of Ohm's law has long been overlooked. These contacts must supply a reservoir or an abundance of carriers ready to enter the intervening space precisely at the rate needed to service the ohmic currents. In the limit of low fields, the balance is maintained by dielectric relaxation. At high fields, departures from this nice balance lead, in the case of one sign of carrier, to emission-limited currents at the one extreme and to space-charge-limited currents at the other. In the case of both signs of carriers, the departures take on a rich variety of behavior dependent on sample lengths, carrier densities and mobilities, recombination lifetimes and the complete specifications of trap distributions. Conversely, the unravelling of a given current–voltage curve can illuminate all of these parameters. The understanding of injected currents bears directly on a large array of devices including rectifiers, amplifiers, oscillators, switches, light generators and light detectors. In brief, the field has a generous component of solid-state science as well as solid-state applications.

The volume opens fittingly with a contribution by Murray A. Lampert and Robert B. Schilling. Lampert's papers in the late 1950's and early 1960's laid the theoretical foundations for current injection into insulators and long semiconductors (long compared with a diffusion length). He also proposed at that time the widely quoted double-injection model for switching via a current-controlled negative resistance. The chapter outlines an analytic procedure (the method of regional approximation) for coping with a large variety of otherwise almost intractable problems of single and double injection. This chapter forms the theoretical backdrop for the elegant series of experiments on double injection reported by R. Baron and J. W. Mayer. Their confirmation of the V^3 current–voltage relation for double injection in the insulator regime is impressive. Allen M. Barnett makes an equally convincing presentation of the evidence for the current-controlled negative resistance switching in silicon and in gallium arsenide, among other materials. The attendant filamentary pattern of the current in the high-current regime is analysed and photographically documented. Both these contributions stand in high contrast to the recent qualitative discussions of possible models for double-injection switching in amorphous materials.

Richard Williams brings together the now extensive literature on the spectroscopy of energy levels at metal–insulator and metal–semiconductor interfaces derived from the injection of photocurrents at the interfacial boundary. The tool is powerful; much of the work comes from Williams's pioneering papers. The presentation is a model of expository style. In the last chapter, Wolfgang Ruppel threads



Injection Phenomenon: Stroboscopic photographs of a developing current filament in a silicon-on-sapphire avalanching *diode at constant current.* From R. A. Sunshine, M. A. Lampert, Appl. Phys. Lett. *18*, 468 (1971).

his way through the wide-ranging and complex literature on the role of metal (and other) contacts in the performance of photoconductors. It is, indeed, helpful to have so great a variety of experiments assembled in one chapter. The discussion reflects his own broad experience in this field.

The editors of *Semiconductors and Semimetals* have carried out a responsible service to the solid-state community in assembling this volume.

* * *

Albert Rose's early work was central to the development of TV. He is a fellow at RCA Laboratories, Princeton, N.J.

Crystals and the Polarising Microscope

By N. H. Hartshore, A. Stuart
4th ed. 614 pp. American Elsevier New York, 1970. $29.50

This edition (as well as the previous editions) is intended mainly to teach students of chemistry how to use the polarizing microscope in the identification of substances. As the authors point out, very little material is needed and the analysis is often quick and clear.

The authors first build a fairly good base of classical crystallography such as mineralogy texts generally present. This seems quite complete, although they say that beginners might do well to consult their more elementary work *Practical Optical Crystallography*. This basis for crystallography is done with a minimum of mathematics. This reviewer also recommends Elizabeth A. Wood's *Crystals and Light* for background.

In brief, the method of identification consists of observing many physical properties and then determining what substances have matching physical properties. To this end, one observes crystal shape (including symmetry), color, fracture, cleavage, refractive index or indices, dispersion, optical sign, whether isotropic, uniaxial or biaxial (if biaxial, the angle between axes) and pleochroism, among other properties. The effects of temperature changes should also be noted.

The authors have added much material on supplementary equipment and how to use it. They discuss microtomes, optical compensators (quartz wedges, Berek and Ehringhaus compensators), immersion media, spindle stages, hot and cold stages, universal stages and other equipment.

The section on the mesomorphic state (liquid crystals) has been amplified and some odd effects are explained in detail. The section on "organic fibres" has been replaced by one entitled "Polymers and Biological Materials."

One naturally compares this book with the *Handbook of Chemical Microscopy* by E. M. Chamot and Clyde Mason. Chamot and Mason are stronger on straight microscopy, but Norman Holt Hartshorne and Alan Stuart are stronger on crystallography.

I differ with the authors on a few minor points. They give calcite and diamond as examples of perfect crystals. Today, carefully grown silicon crystals having certified very low dislocation counts are on the market. This is not true of calcite or diamond.

The authors say the polymorphic series in descending temperatures are α, β . . . and illustrate with silicon dioxide. In the US, α quartz is the room-temperature form which converts to β quartz at 573°C. The authors list quartz as pyroelectric, but symmetry considerations show this to be impossible. However, temperature gradients could produce a similar effect.

Walter L. Bond
Los Altos, California

Aristotle's Physics I, II

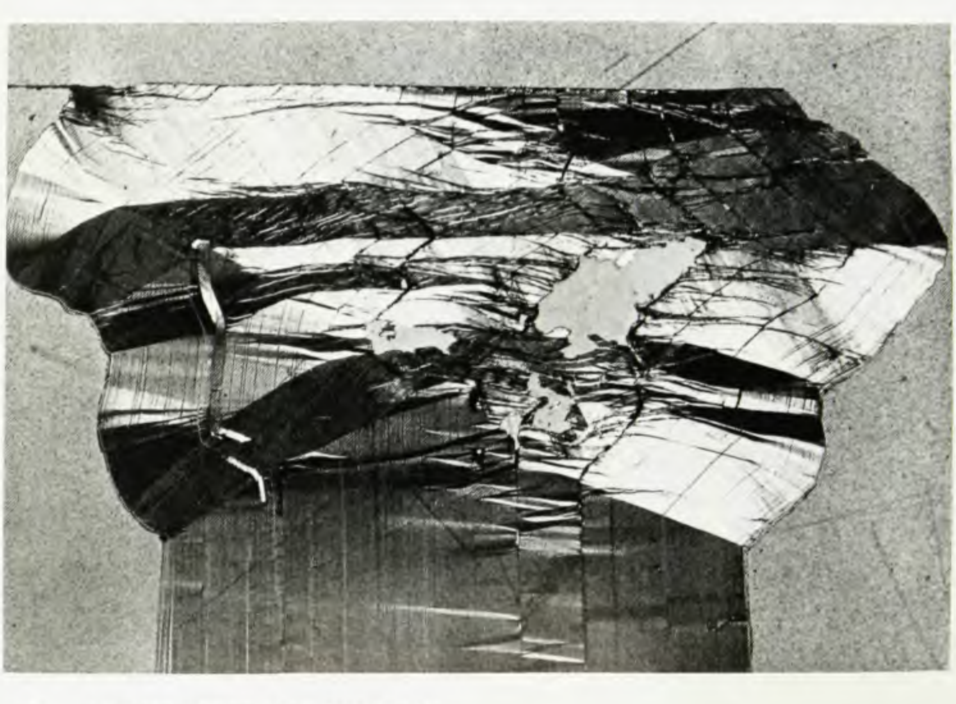
***Trans. by* W. Charlton**
151 pp. Oxford U.P., New York, 1970. Cloth $5.50; paper, $2.85

Poor Aristotle!

Imagine what it will be like for Einstein, two thousand years from now, when his physical works will be handled by scholars trained in the long-since-dead German language, or long-since-obsolete 20th-century philosophy. When this day comes, surely nothing of Einstein's physics will be comprehensible to anyone trained in the natural sciences.

Such has been the fate of Aristotle, now owned lock, stock and barrel by classicists and students of ancient philosophy. Aristotle—author of the earliest known textbook of physics, which was "must" reading for all serious students of the field for some two millenia after it was written; architect of concepts that still underlie much of current physical thought, a fact rarely appreciated today. One would expect his works to be approached with awe by modern scholars, and with at least as much scientific training and understanding as we take for granted when approaching the works of comparable figures such as Newton, Maxwell, Einstein or Bohr.

Unfortunately, all we get these days is books like the one under review, which open with the words "The first two books of Aristotle's *Physics* do not deal with problems in what we today call physics." Some idea of W. Charlton's sophistication in matters scientific can be garnered from the Appendix, entitled "Did Aristotle Believe in Prime Matter?" In fact, Aristotle's struggle with the concept of prime matter was a complex one, identical in its scientific and philosophic content to recent struggles with the concepts of matter conservation, energy conservation and (in general) conservation laws governing physical entities that never change in some important respect. Aristotle's com-



Polarizing microscope view of kink bands in natural biotite. Photo courtesy of Neal Carter, Earth and Space Sciences Department, SUNY at Stony Brook.