

This Week's Citation Classic

Drickamer H G. The effect of high pressure on the electronic structure of solids. *Solid State Phys.—Adv. Res. Appl.* 17:1-133, 1965.
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A wide variety of high-pressure studies of electronic phenomena are presented. The unifying theme is that pressure tuning is a powerful and versatile variable for studying electronic properties, and is equally effective for phenomena associated with physics and chemistry. [The SC1® indicates that this paper has been cited in over 125 publications since 1965.]

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"In the 1950s, we conceived the idea that pressure should be a powerful tool for investigating electronic phenomena in solids. The paper, written at the urging of Fred Seitz, then professor of physics at the University of Illinois, but since president of the National Academy of Sciences and of Rockefeller University, reviews the first decade or so of these investigations.

"The optical, electrical, magnetic, and chemical properties of a solid depend on the interactions of the outer electrons on its constituent atoms or molecules. In particular, these properties are determined by the arrangement of the electrons in the ground state, and on the energy and electronic characteristics of various excited states. The effect of pressure is to decrease the volume and increase overlap among the electronic orbitals. Since these orbitals differ in their spatial properties (radial extent and shape), they are perturbed in different degrees by compression. It is this 'pressure tuning' of electronic orbitals that makes the use of pressure such a versatile approach to the investigation of electronic phenomena. (The phrase 'pressure tuning' was actually introduced much more recently, but it is such an

apt and graphic description of these observations that I use it here.)

"Three categories of studies are possible. One can characterize electronic states or excitations; one can perform critical tests of theories; and, upon occasion, one can induce an electronic transition to a new ground state with different physical or chemical properties. Examples of all three categories were included in the review, which covers optical studies of color centers in ionic crystals, ligand field effects, excitations in organic crystals, and band structure in solids. In addition, insulator-conductor transitions in a wide variety of elements and compounds and electronic transitions in metals are recorded, as well as a magnetic transformation in iron. The measurements were relatively crude, and the pressure scales, in particular those used for the electrical resistance work, are outmoded; nevertheless, the phenomena are real and have formed the basis of much further experimentation and a great body of theoretical analysis.

"The paper continues to be referenced, I believe, for reasons other than the quantitative value of the particular studies. In the first place, it is the pioneering effort in demonstrating the effectiveness of pressure tuning in studying electronic structure and it brings together a wide variety of physical and chemical phenomena under a single rubric, demonstrating the essential unity of physics and chemistry at the electronic level. In the second place, pressure is now widely recognized as a versatile and incisive tool in condensed phase science, and there are now hundreds of papers involving high-pressure studies, in many cases extending, amplifying, and improving on the results presented in this paper.

"I list here two recent reviews, the first of which is a comprehensive study of modern high-pressure physics;¹ the second puts pressure tuning in a modern context as regards both the physics and chemistry of condensed phases."²

1. Schilling JS & Shelton RN, eds. *Physics of solids under high pressure*. Amsterdam: North-Holland, 1981. 419 p.
2. Drickamer H G. Pressure tuning of electronic energy levels. *Int. Rev. Phys. Chem.* 2:171-96, 1982.