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This Week's Citation Classic

Mott N F. Electrons in disordered structures. *Advan. Phys.* **16**:49-144, 1967. [Cavendish Laboratory, Cambridge, England]

The theory developed from 1930-35 about the movement of electrons in crystals, with its concepts of conduction band, valence bands, and energy gaps, was not obviously applicable to non-crystalline materials. This paper was the first comprehensive attempt to see what the theory should look like for glasses, liquids, and other forms of non-crystalline condensed matter. The paper owed much to earlier work by Anderson, Kolomiets, and Ziman. [The *SCI*® indicates that this paper has been cited over 490 times since 1967.]

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"This was my first substantial paper on non-crystalline materials. I was led to write it for the following reasons. Some seven years earlier John Ziman, then a member of my department at Cambridge, brought out a highly successful theory of the resistivity of liquid metals, one of the first satisfactory treatments of electrons in a non-crystalline environment.[1] Experimental work in the Cavendish showed that the theory did not work in liquid mercury, and I wanted to understand why. My first guesses were wrong, but they led me to look at the whole problem of non-crystalline materials, and how one could have insulators and semiconductors. The theory of metals, insulators, and semiconductors accepted at that time was built up by F. Bloch, R. Peierls, and A.H. Wilson in the early 1930s and was based on the concept of electrons moving in a crystalline lattice and suffering Bragg reflection.[2-4] In non-crystalline materials there could be no sharp Bragg reflection; how then could there be an amorphous semiconductor? In trying to find an answer to this, I was much helped by the pioneering work of B.T. Kolomiets in Leningrad, who showed that certain amorphous semiconductors cannot be doped, and of course by the now well-known paper of P.W. Anderson.[5,6] I had been aware of this paper for some time, because of my ideas on metal-insulator transitions and my consequent interest in the movement of electrons on the impurity band of a doped semiconductor, in which the field is anything but periodic.

"I have written a great many papers on non-crystalline materials since 1967, and one book (with E.A. Davis).[7] A good many of the ideas which I have developed further are in the 1967 paper, including what has since been called a 'mobility edge.' The subject of all this work, in which quantum mechanics has to be combined with probability theory, is not one in which rigorous solutions are to be had easily, and my research combines simple methods, intuitive arguments, and appeals to experiment. As a consequence many of my concepts, such as the mobility edge and minimum metallic conductivity have rightly proved controversial, and accepted until recently more often by experimentalists who find them useful than by theorists.

"Since 1967 there has been an enormous increase in interest in this field, which could be ascribed to many causes: the importance of amorphous selenium in office copying (xerography), switches using amorphous semiconductors, the potentiality of amor-phous silicon for solar cells, and above all the sudden realisation by the solid state fraternity that here was a new branch of the subject almost unexplored, for which the current theoretical methods did not work and in which there was a free-for-all, with any theoretical idea, however wild, to be taken seriously for a time, and experimental work with standard equipment open to anyone.

"I have contributed several of the seminal ideas to this subject, and whether they appear in the paper cited or not, I guess people quote it to avoid looking too closely through the literature."

1. **Ziman J M.** *Phil. Mag.* **6**:1013-34, 1961.
2. **Bloch F. Z**. *Physik* **52**:555, 1928.
3. **Peierls R. Z**. *Physik* **80**:763, 1933.
4. **Wilson A H.** *Proc. Roy. Soc. A* **133**:458, 1931.
5. **Kolomiets B T.** *Phys. Status Sotidi* **7**:359, 1964.
6. **Anderson P W.** *Phys. Rev.* **109**:1492-505, 1958.
7. **Mott N & Davis E A.** *Electronic processes in non-crystalline materials.* Oxford: Oxford University Press, 1979. 590 p.