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This Week's Citation Classic ®

Brillson L J. The structure and properties of metal-semiconductor interfaces. *Surf. Sci. Rep.* 2:123-326, 1982. [Xerox Webster Research Center, Webster. NY]

The chemical, geometrical, and electronic structure of metal-semiconductor interfaces was assessed in light of surface science experiments carried out under conditions of ultrahigh vacuum. These results emphasized the importance of atomic-scale chemical reactions and diffusion in forming the electrostatic barriers at semiconductor contacts. [The *SCI*® indicates that this paper has been cited in more than 560 publications, making it the most-cited paper published in this journal.]

The Chemical Dependence of Metal-Semiconductor Contacts

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This work was a synthesis of discoveries made in the preceding few years, when it was found that chemical reactions on a nanometer scale were common features of metal-semiconductor interfaces,[1] even at room temperature, that these reactions varied systematically according to thermodynamic principles,[1,2] and that these variations correlated with the rectifying (Schottky) barriers at the semiconductor contact.[1,3] Previous work on metal-silicon junctions by numerous authors had examined reaction and diffusion on a micron scale induced by elevated temperatures.[4]

By looking back over what turned out to be a massive cross-disciplinary literature of circumstantial evidence for such chemistry, I was able to find an overall pattern of such behavior which became more evident, the cleaner one prepared the initial interface and the more sensitive the analytical tools one had at one's disposal. This meant that the simple picture of atomically abrupt junctions found in most solid-state textbooks had to be replaced by that of a chemically extended junction in general. This was by no means evident at the time, as controversy raged during that period, especially at the Physics of Compound Semiconductor Interfaces (PCSI) conference, over whether the chemical structure of interfaces was important in understanding the properties of electronically active interfaces.

I owe a debt of gratitude to Charles B. Ouke, who encouraged me to synthesize this work for *Surface Science Reports.* Either because it was the first demonstration that chemistry was a primary factor at most electronic interfaces or because it marshaled over 1,000 references, the work has become the most-cited paper in this journal. (At the time, having such a large set of references nearly proved overwhelming after Charlie convinced me that the order of several sections in my initial draft ought to be changed.) I must also thank my postdoc at the time, Charles Brucker, who kept my research program going at Xerox as I labored at all hours and places through the better part of 1981. Likewise, Giorgio Margaritondo, then at the University of Wisconsin, Madison, helped me overcome the (considerable) obstacles in gaining access to a synchrotron radiation facility so I could obtain soft X-ray photoemission results I critically needed.

In the decade since this report was first published, the focus of much basic work on Schottky-barrier formation has shifted from mechanisms intrinsic to the semiconductor alone to processes which depend on the metal-semiconductor interaction. Indeed, even the PCSI conference changed its name to the Physics *and Chemistry* of Semiconductor Interfaces. The work helped me to become a Fellow of both the American Physical and American Vacuum Societies, and this year I served as chairman of the PCSI conference. Many of the ideas in the monograph have been further developed and applied to Schottky barrier modification, chemically dependent defect formation, and surface passivation.[5,6]

1. **Brillson L J.** Transition in Schottky barrier formation with chemical reactivity. *Phys. Rev. Lett.* 40:260-3. 197S. (Cited 185 times.)
2. **Brillson L J, Margaritondo G & Stoflel N G.** Atomic modulation of interdiffusion at Au-GaAs interlaces. *Phys. Rev. Lett.* 44:667-70, 1980.
3. **Brillson L J, Brucker C F, Katnani A D, Stoftel N G & Margaritondo** G. Chemical basis for InP-metal Schottky-barrier formation. *Appl. Phys. Lett.* 38:784-6, 1981.
4. **Poate J M, Tu K** N *&* **Mayer J M,** eds. *Thin films: interdiffusion and reaction.* New York: Wiley-Iiuerscience. 1978. 578 p.
5. **Monch W.** On the physics of metal-semiconductor interfaces. *Rep. Progr. Phys.* 53:221-78. 1990.
6. **LaFemina J P.** Total-energy calculations of semiconductor surface reconstructions. *Surj. Sci. Rep.* 16:133-260. 1992.

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