Berglund C N. Surface states at steam-grown silicon-silicon dioxide interfaces. *IEEE Trans. Electron Devices* **ED-13**:701-5, 1966.
[Bell Telephone Laboratories, Murray Hill, NJ]

A simple method of determining the density and energy distribution of surface states at the silicon-silicon dioxide interface is described in this paper. The technique has the advantages of being easy to instrument, easy to interpret, and of allowing accurate relative measurement of the silicon surface potential through a graphical integration. [The *SCI*® indicates that this paper has been cited over 195 times since 1966.]

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"Following graduation from Stanford University, I joined Bell Laboratories, Murray Hill, New Jersey, in the fall of 1964. This was my first project and I was fortunate to have as colleagues Edward H. Nicollian and Adolph Goetzberger, both well-known experts in the field of silicon and silicon dioxide surface physics. They were deeply involved at the time in characterizing the dynamics of surface state generation and recombination. While they were accordingly not strongly interested in low-frequency measurements such as those I was working on, they had the foresight to recognize their importance and they provided me with both encouragement and advice during the course of the work. I am very grateful to Ed and Adolph for their support since it helped me launch a satisfying and rewarding eight years of research at Bell Laboratories.

"The approach I took was a logical extension of my graduate research work at Stanford. There I had used low-frequency conductance measurements to analyze energy distributions of photoemitted electrons and was familiar with the subtleties of small-signal measurements. As a result, the observation that silicon surface potential could be determined through a simple graphical integration was relatively straightforward. It took me several years to recognize that this simple concept was the most important feature of the work, and it is a major reason why this paper is one of the most-cited items in its field.

"When the paper was submitted for publication there was a delay in response from *IEEE Transactions on Electron Devices* due to a tardy reviewer. At a Device Research Conference in mid-1966, Adolph and I accidentally met the editor of *IEEE Transactions* and questioned him as to when a publication decision would be made. He too was frustrated by the delay in the review and asked Adolph what he thought of the paper. On being told by Adolph that it was a good paper, he accepted that as a review and went ahead with publication. In a few minutes of conversation, we had resolved what had appeared to be an indefinite and possibly permanent delay in publication!

"In retrospect, the growth in importance of this paper mirrored the growth in the large-scale integrated circuit industry and its dependence on the properties of the silicon-silicon dioxide interface. It is interesting to note that today, 15 years later, the physics of the silicon-silicon dioxide interface are still not fully understood despite the enormous amount of research that has been carried out. An excellent bibliography of references is given in *MOS Physics and Technology*."[1]

1. **Nicollian E H & Brews J R.** *MOS (metal oxide semiconductor) physics and technology.* New York: Wiley, 1982. 1104 p.