

Will F G & Knorr C A. Untersuchung des Auf- und Abbaues von Wasserstoff- und Sauerstoffbelegungen an Platin mit einer neuen instationären Methode. (Investigation of hydrogen and oxygen adsorption layers on platinum electrodes with a new non-steady state method.) *Z. Elektrochem.* 64:258-69, 1960. [Inst. for Phys. Chem., Technical Univ., Munich, Federal Republic of Germany]

A new electrochemical technique for the study of electrode surfaces and their reactions is described, involving the application of potential sweeps with an electronic potentiostat. Hydrogen and oxygen layers on platinum are determined with a precision of a few percent of a monoatomic layer. [The *SCF*[®] indicates that this paper has been cited in over 300 publications since 1960.]

Fritz G. Will
Corporate Research and Development
General Electric Company
Schenectady, NY 12301

February 24, 1984

"In the mid-1950s, the Electrochemistry Laboratory at the Technical University of Munich, Federal Republic of Germany, under the direction of C.A. Knorr, was one of the leading laboratories in electrode kinetics. Joining the laboratory in 1953, my thesis topic was the development and application of an electronic potentiostat to electrode studies.

"When studying the reaction of hydrogen and oxygen on platinum with a potentiostat point-by-point, I observed that steady state currents were rarely obtained. It occurred to me that sweeping the potential at various rates with an electronic sweep generator would determine current-potential curves much more quickly and possibly reveal information about the reactions responsible for the non-steady state behavior.

"While the application of potential sweeps for the study of electrode surfaces was new at the time, potential sweeps had been applied for years in polarography to determine the concentration of species in solution.¹

"The experimental results I obtained soon made it clear that the technique of sweeping the potential alternately in a positive- and negative-going direction, coupled with systematically varying the

sweep rate, yielded considerably more information than I had expected originally. The non-steady state current-voltage curves revealed details of the interaction between various noble metal electrodes and chemisorbed layers of hydrogen and oxygen² not yielded by existing techniques. Furthermore, surface coverages with hydrogen and oxygen were determined with a precision of a few percent of an atomic monolayer. Lastly, I found the technique to be ideally suited to study changes in the catalytic activity with time and the growth of oxide films on noble metal electrodes.

"When I joined the General Electric Research Laboratory in 1960, I became involved in studies of fuel cells and electrocatalysis. Our group and others established the potential sweep technique as a tool for the efficient evaluation of electrocatalysts and the study of electroorganic oxidations.³ The rapid increase in the number of industrial and academic laboratories involved in fuel cells and electrocatalysis, both in the US and abroad, led to widespread use of the potential scan method in the 1960s. The technique was variously called the potentiodynamic method, sweep voltammetry, or surface coulometry.

"In the years to follow, the applicability of the technique was broadened considerably: mathematical equations were derived that made it possible to determine electrode kinetic parameters;⁴ the effect of single crystal orientation on hydrogen bond strength was studied;⁵ battery electrochemists applied potential sweeps to investigate the redox mechanism of battery electrodes; and the underpotential deposition of submonolayers of metals on various substrate electrodes was investigated.⁶

"Why do I think the publication has been cited so often? The paper introduced a new technique that enabled studies of electrode surfaces with a degree of efficiency, accuracy, and flexibility not obtainable with other techniques. Application of the technique spread rapidly because of its inherent simplicity and adaptability to the needs of both scientists and technologists in various areas of electrochemistry."

1. Matheson L A & Nichols N. The cathode ray oscillograph applied to the dropping mercury electrode. *Trans. Electrochem. Soc.* 73:193-210, 1938.
2. Will F G & Knorr C A. Untersuchung von Adsorptionserscheinungen an Rhodium, Iridium, Palladium und Gold mit der potentiostatischen Dreiecksmethode. *Z. Elektrochem.* 64:270-5, 1960. (Cited 165 times since 1960.)
3. Breiter M W & Gilman S. Anodic oxidation of methanol on platinum. I. Adsorption of methanol, oxygen, and hydrogen on platinum in acidic solution. *J. Electrochem. Soc.* 109:622-7, 1962. (Cited 95 times.)
4. Gilhead E & Conway B E. Kinetic theory of adsorption of intermediates in electrochemical catalysis. *J. Chem. Phys.* 39:3420-30, 1963.
5. Will F G. Hydrogen adsorption on platinum single crystal electrodes. I. Isotherms and heats of adsorption. *J. Electrochem. Soc.* 112:451-5, 1965. (Cited 120 times.)
6. Kolb D M, Kotz R & Yamamoto K. Copper monolayer formation on platinum single-crystal surfaces—optical and electrochemical studies. *Surface Sci.* 87:20-30, 1979.