Michael Polanyi, the father of catalytic surface reaction mechanisms and the mentor of Hungarian scientists abroad

GABOR A. SOMORJAI

University of California Berkeley
Department of Chemistry,
and Lawrence Berkeley National Laboratory

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Michael Polanyi is one of the great physical chemists with seminal contributions in many areas of that field of chemistry. I met him in 1968 when he was a visiting lecturer at the University of California in Berkeley. The lecture series covered both humanities and sciences and Michael olanyi was the ideal person to deliver them. His focus by that time was on Philosophy and the title he gave to the lectures: "Science and Society" clearly reflected that.

I had dinner with him and he charmed both my wife and I. His Hungarian was impeccable, he was most polite, witty and showed great enthusiasm for Hungarian food; clearly he liked to cook himself.

There is one aspect of his science I would like to focus on; his contribution to the field of heterogeneous catalysis, which culminated at the time when Hitler took over in Germany; 1933—1934.This field of physical chemistry is close to my heart and in some ways I am following his footsteps with all the techniques of modern surface science that Polanyi certainly did not have at his disposal. Michael Polanyi suggested the first mechanisms of catalytic reactions that involve hydrogen exchange and hydrogeneration of ethylene based on his careful isotope exchange studies. His results were published in the *Transactions of the Faraday Society* **30**, 1164 (1934). With a combination of careful experiments, impeccable logic and superb intuition he suggested elementary reaction steps that stood the tests of time. These was; a) atomization of molecular

hydrogen on the metal surface; b) sequential hydrogenation of ethylene, C_2H_4 to C_2H_5 (ethyl) and then to ethane (C_2H_6). Step a) also provides a mechanism for orthopara hydrogen conversations. He also argues that opening af the ethylene duoble bond upon chemisorption leads to cis-trans transformation on a catalyst which is yet to be confirmed by surface spectroscopies.

In these experiments Juro Horiuti was Michael Polanyi's co-worker who went on to establish a school of catalysis upon his return to Japan. While the paper describing these studies was submitted to the journal in October of 1934, the research was undoubtedly carried out in Berlin at the Kaiser Wilhelm Institute. The political conditions could not have been any worse for continued creative research. Hitler took over as Chancellor in January 1933. By March the civil service purge laws were passed. By April both Haber, the Director and Polanyi, Head of the department for reaction kinetics, resigned their positions at the Institute. By August Poanyi arranged shipment to Manchester, most of his Berlin laboratory equipment and personal belongings of his family. What appears to be an almost seamless transition Michael Polanyi transplanted his research from Berlin to Manchester andcontinued his pioneering studies in spite of the turmoils of political changes and immigration. To me this represents the triumph of human spirit and science over destructive politics.

In 1996 we detected the presence of C_2H_5 (ethyl) reaction intermediate during steady state ethylene hydrogeantion over the platinum (111) single srystal surface by sum frequency generation (SFG) — vibrational spectroscopy. Polanyi's predictions of sequential hydrogenation of ethylene were correct. We detected several other species as well on the metal catalyst surfaces by surface vibrational spectroscopy, that were totally out of Polanyi's experimental reach; some of these species are reaction intermediates others are mobile spectators during the catalytic turnover. I am continually amazed by Michael Polanyi's ability to combine careful experiments with scientific intuition and careful reasoning to arrive at realistic molecular models that explain his kinetic data.

One of our Berkeley greats, Melvin Calvin was a postdoctoral fellow in Manchester with Michael Polanyi. He arrived there in 1935 and using deuterium exchange and chemiluminescence, studied hydrogen activation by phthalocyanine (Trans Faraday Soc. 32, 1436 and 32, 1443 (1936)). When Calvin joined G. N. Lewis in the Chemistry department in Berkeley, the skills he learned in Polanyi's laboratory led to the discovey of the triplet state in organic molecules. It also started Calvin on his

research of photosynthesis using carbon isotopes that gave him the 1961 Nobel Prize in Chemistry.

Finally I would like to comment on Michael Polanyi as a mentor of scientists coming to Berlin. He was the research advisor of Eugene Wigner who worked with him on the theory of reaction rates of colliding atoms before turning to quantum mechanics. Wigner's first jobs that ultimately took him to Princeton were all because of professional recommendations from Polanyi. Similarly he helped Leo Szilard, Henry Eyring, John van Neuman, Juro Horiuti, Andreas Szabo, Mwelvin Calvin and Meredith Evans to name a few of his students and coworkers.

Michael Polanyi trough his research and the scientists he trained left his indelible stamp on Physical Chemistry.