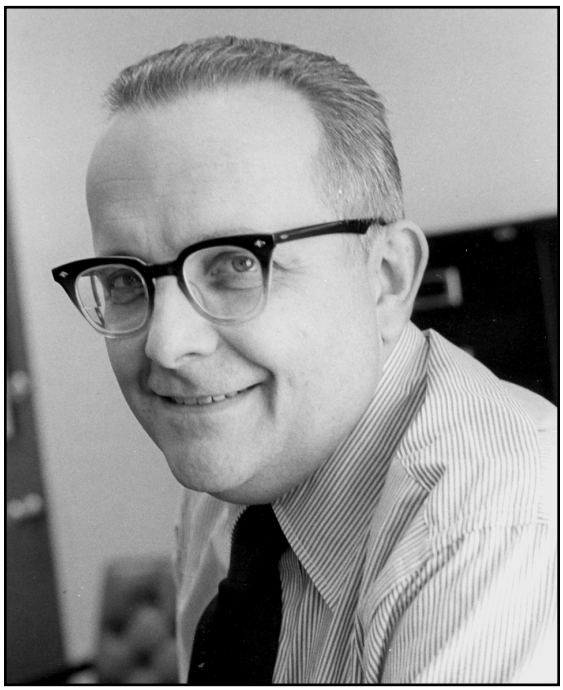
JOHN H. SINFELT



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JOHN SINFELT was a chemist and chemical engineer wrapped up in one. He brought the approach of an academic scientist probing fundamental issues to bear on challenging technical problems of great practical import. In so doing, he led and inspired small technical groups, many of whose members went on to be leaders themselves. Over his career, he made discoveries that had major benefit to society and brought him high honors.

Sinfelt was born in the hamlet of Munson in Clearfield County, which is near the geographic heart of Pennsylvania. Both his father and grandfather were coal miners. As a child, he was initially taught in a two-room schoolhouse in Munson, where his intellectual abilities were apparent at an early age. Following a short spell at a high school in Philipsburg, Pennsylvania, where he excelled at baseball and American football, he entered Pennsylvania State University at 16 years old, and he earned a bachelor's degree in chemical engineering in 1951.

He then transferred to the University of Illinois at Urbana-Champaign, where he earned a master's degree in 1953 and a Ph.D. in 1954, both in chemical engineering. His thesis advisor was Harry Drickamer, who at that time was interested in rates of diffusion of molecules across liquid-liquid interfaces. In 1952, Drickamer and his student Tang had begun studying diffusion using radioactive tracers, a method that gave clean, precise results. With Drickamer, Sinfelt continued using this method to investigate the effect of molecular properties on the resistance of a liquid-liquid interface. Drickamer, who later received the U.S. National Medal of Science, was an exceptionally versatile practical scientist who occupied chairs in chemistry, physics, and chemical engineering at Illinois. As illustrated by the diffusion studies, Drickamer employed basic physical methods to study fundamental questions of chemistry. Sinfelt and Drickamer were true kindred spirits. Indeed, Sinfelt's research style, seeking to understand the fundamental science of chemical processes, characterized his work and was responsible in large measure for the major advances Sinfelt brought about. Sinfelt never ceased to sing Drickamer's praises and acknowledge his powerful intellectual influence (which lasted more than 30 years after Sinfelt joined the Esso [Exxon] Research and Engineering Company).

In practical scientific terms, the greatest contribution that Sinfelt made was to facilitate the more rapid introduction of lead-free petrol (gasoline), which earned him the U.S. National Medal of Science (presented by Jimmy Carter in 1979). It is relevant to recall that, up to some 20 years ago, massive quantities of a volatile compound, *tetraethyl lead*, were used as additives to boost the octane rating of

petrol to prevent its premature detonation (known as *knocking*). But the toxicity associated with lead pollution from engine exhaust is so serious that its use was first discouraged and later banned in most countries.

On the basis of prolonged and meticulous laboratory-oriented studies (carried out at Standard Oil Development Company, now ExxonMobil Research and Engineering), in which he used a combination of straightforward kinetic measurements and sophisticated synchrotron-based techniques, such as X-ray absorption spectroscopy, to characterize the catalysts that he devised, Sinfelt arrived at extremely efficient nanocatalysts. He called these *bimetallic catalysts* (they were not alloys in the conventional sense), and they proved highly efficient in the chemical process known as *reforming*, which generates a relatively high proportion of so-called branched hydrocarbons and aromatic molecules (such as benzene). These molecules elevate the octane rating of the resulting fuel and dispense with the need to use tetraethyl lead as an additive. A particularly powerful example of a bimetallic nanocatalyst is one in which platinum (Pt) and iridium (Ir) co-exist as minute particles supported on a high-area, acidic solid such as alumina. The Pt-Ir bimetallic catalyst invented by Sinfelt and his team (which included D. J. C. Yates, G. H. Via, and J. A. Cusumano) surpassed the performance of an earlier reforming catalyst, consisting of comminuted platinum on alumina, devised by the Russian-American Vladimir Haensel; it also paved the way for the introduction of unleaded petrol and significant reductions in air pollution caused by motor-vehicle exhausts.

Sinfelt was encouraged by the Exxon management to prepare a monograph describing the research that led to these catalysts. Titled "Bimetallic Catalysts, Discoveries, Concepts, and Applications," it launched a series of Exxon Monographs. In the foreword to Sinfelt's volume, E. E. David, president of the Exxon Research and Engineering Company, wrote:

> Exxon's scientists and engineers have a long tradition of significant inquiry and achievement. Their findings appear in the leading journals of the world, but until now no means existed to present their work in the context in which it was conducted. This and future Exxon Monographs are meant to provide a thorough look at how we address research problems and the results of such research.

It seems likely that launching this series was really conceived as a method to emphasize to the Exxon senior management the importance

of long-term basic research, a concept perhaps not central to the thinking of an organization in which successful oil prospecting was historically so important. The clear impact of Sinfelt's work on Exxon's success in the market must have been a major factor in inspiring David to launch the monographs.

The vice president of the Exxon Laboratory, P. J. Lucchesi, to whom Sinfelt used to report, recalls that part of the secret of Sinfelt's success was that his chemistry and chemical engineering skills were inextricably combined. He was both a pure academic investigator and an applied scientist. He was deeply aware of the work of preceding generations of catalyst experts (notably the Russian investigator Balandin), and he was an inspiring leader of a relatively small team of co-workers. One of these co-workers, Cusumano, had become a renowned U.S. pop star who wrote and recorded his own songs to pay his way through college. Sinfelt relished in telling the story of when he walked young Cusumano through his laboratories after recruiting him, his acolyte was pestered with requests for autographs from the young ladies working as technicians on the Sinfelt team: "I was nonplussed and sidelined on that occasion."

In addition to his development of powerful new nanocatalysts, Sinfelt produced with C. P. Slichter, a physics professor at Urbana and a specialist in magnetic resonance spectroscopy, a series of research papers that, *inter alia*, showed how to retrieve the nature of chemical bonding of carbon-rich hydrocarbons bound to the surfaces of nanoparticles of platinum. The technique, described as *spin-echo double resonance* (or SEDOR), elucidated the nature of and the bond distances associated with molecular fragments, such as CO and HCCH anchored to surface atoms of platinum. For example, by doing a double resonance between ^{13}C and ^{17}O nuclei of adsorbed, isotopically enriched CO molecules, they measured the CO bond distance of adsorbed CO. By doing double resonance between ^{13}C of adsorbed CO and ^{195}Pt, they could identify the nuclear magnetic resonance (NMR) frequency of the surface layer of Pt atoms of the Pt cluster. Although the expertise in NMR resided in Urbana, Sinfelt was in regular communication with Slichter and his students. The students found him to be readily accessible and found the interaction to be warm and friendly. This joint research demonstrated Sinfelt's talent as an educator. As an author, he was exacting in perfecting the use of words, frequently suggesting improved wording.

Sinfelt's scholarly papers and review articles, as well as his authoritative, understated lectures, earned him national and international recognition. He was elected to the National Academy of Sciences, the

National Academy of Engineering, the American Academy of Arts and Sciences, and the oldest academy in the United States, the American Philosophical Society, founded by Benjamin Franklin in 1743.

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