2022 Citation for Chemical Breakthrough Award Program Update (Up To and Including the 2021 Award Year)

Jeffrey I. Seeman
Award Committee Secretary

March 17, 2022

Summary

- Sixteen years of awards (2006 –2021) have been completed, including three awards for the 2021 award year.
- As of January 1, 2022, 79 CCB Awards have been presented to date at 94 sites (due to multiple collaborations and multiple locations for certain awards) in 14 countries. The countries are: Austria, Canada, England, France, Germany, Italy, Japan, Latvia, The Netherlands, Poland, Russia, Scotland, Switzerland, and the United States.
- Status for the 2022 award year: Nominations are due April 18, 2022.
- CCB Awards are plaques presented to the institutions from which the research was published.
- We assist with and generally participate in the award ceremonies.
- Because of COVID restrictions, no award presentations occurred in the past two years.
- Photographs and associated text dealing with the 16-years of award ceremonies are found on the CCB Award's web pages. http://www.scs.illinois.edu/~mainzv/HIST/awards/citations_chem-breakthroughs.php
- The CCB Award program now has many and an increasing number of links on Wikipedia.
- The CCB Award program also has a link and a large description of the program on the ACS National Historic Chemical Landmarks Program (see below).
- Carmen Giunta has developed an interactive geographical-based application for the CCB awards. This has been added to the CCB award's web-based home page.

https://www.google.com/maps/d/edit?mid=16VUl1_aYFk0s9nWfJDfP3P2xtfigyGzL&usp=sharing

Objectives, Strategies and Criteria of the Citations for the Chemical Breakthrough Award Program

The Citations for Chemical Breakthrough Award program is intended to honor and celebrate the achievements in chemistry and the molecular sciences in a publicly visible fashion. Through the involvement of the recipient institutions in the design of the plaques and in the organization and hosting of award celebrations, the program will "expand people's minds through the enlightening power of the history of chemistry. It will bring history of chemistry to scientists and bring scientists to the history of chemistry."

The Citations for Chemical Breakthrough award recognizes breakthrough publications, books and patents worldwide in the field of chemistry. The term "breakthrough" refers to advances in chemistry that have been revolutionary in concept, broad in scope, and long term in impact. The award consists of a very high-quality plaque, to be placed at a site selected by the recipient near the office or laboratory where the breakthrough was achieved. Each award will be made to the department or institution where the breakthrough occurred, not to the individual scientist(s).

Elaboration of criteria

- "Revolutionary" implies some sort of change in practice or theory after the appearance of the patent or publication.

- "Broad in scope" implies an advance that permeates a sub-discipline of chemistry, or that has applications in more than one sub-discipline, or that has a significant benefit to society.

- "Long-term" implies a minimum of twenty five years since the date of publication.

In 2021, three awards to six sites were made:

- Yale University, for J. Willard Gibbs's 1876 paper explaining the laws of thermodynamics.

- Graduate School of Engineering (with a duplicate plaque sent to the Graduate School of Science), Kyoto University, for Kenichi Fukui's 1952 paper on his discovery of frontier molecular orbital theory.

- Nagoya University, the Institute for Molecular Science at Myodaiji, Okazaki, and Takasago International Corporation, for the Ryoji Norori et al.'s discovery of chirally-catalyzed hydrogenations (1987).

In 2021, Carmen Giunta made two presentations about the CCB award program and the National Historical Chemical Landmarks program:

- May 20, 2021: At the EuChemS Working party on the history of chemistry program on Heritage and History of Chemistry
- Fall 2021: In the HIST general papers session at the ACS national meeting

Number of Citation for Chemical Breakthrough Award by Year*

	Award Year	Number of Awards**	Duplicate plaques due to multiple collaborative sites*	Duplicates due to researcher associated with other locations*
1	2006	10		
2	2007	6	1	2
3	2008	6		2
4	2009	5		1
5	2010	5		
6	2011	5		
7	2012	4		3
8	2013	4		
9	2014	4		
10	2015	5		
11	2016	4		
12	2017	4		
13	2018	6		
14	2019	4		
15	2020	4	1	2
16	2021	3	2	1
	Total	79 in 14 countries	4	11

* Thanks to Carmen Giunta for his review of these data.

** For instances in which the award publication resulted from a collaboration at two or more institutions, the "Number of Awards" represents one award for the collaborative publication.

The members of the 2021 and 2022 Award Committees are listed below (next page). This information is also placed on the HIST website (with the Award Committee members from the earlier award years).

- The program has received excellent responses in the USA and Europe. To date, no awards have been presented to institutions in the Middle East or South America.
- Nominations are open to all and are advertised on HIST's website and in an announcement in *C&EN*.
- The plaque-design process is much more difficult than anticipated. It is often hard to obtain the required high-quality scans of original publications from the 19th Century. There have been design issues with the recipient organizations.
- We have received extraordinary cooperation from the plaque manufacturer, Stellar Kent (http://www.stellarkent.com/index.php). In fact, in 2014, HIST Certificate of Appreciation Awards were given to Carol Hall, Linda Mason, and the Stellar Kent Corporation for their work on the CCB award program.

- As of past years, the Linda Hall Library of Science, Engineering and Technology (Kansas City, MO) has donated several high-quality images of journal articles, if available, at no charge for the award program.

Award Committee Members
2021 – 2022

Anthony G. M. Barrett, F.R.S. (Imperial College of Science, Technology and Medicine)
Michael Bowers (University of California, Santa Barbara)
Carmen Giunta (Le Moyne College, retired)
Harry Gray (Caltech)
Catherine M. Jackson (University of Oxford, England)
Peter Morris (Science Museum London, retired)
Mary Virginia Orna (College of New Rochelle, retired)
Amos Smith (Penn)
Jeffrey I. Seeman, Committee Secretary (Non-voting) (University of Richmond)

Finances and Donations

- The plaques cost ca. $400 each including artistic design costs and shipping to the USA. Shipping to Europe or Asia is another $75 - $100.
- Initial funding
    - $10K from ACS DAC Innovative Grant
    - $10K from ACS Corporate Associates
    - $6K from ACS DAC Innovative Grant for Local Section travel
    - Funds from individual donors (donations continue to this day)

- HIST currently provides 50% matching. In 2020, a donation in the amount of $16,500 was given to HIST. With this donation and with HIST's 50% matching of this gift, HIST has guaranteed funding for the CCB award program up to and including its 25th year.
- Annual costs ca. $1700 - $2200/year.
- As of March 4, 2021, $15,780.76 is available for the plaque program excluding HIST's 50% annual match and excluding travel (see bullet statement immediately below).
- Based on the latest update available for HIST Treasurer Vera Mainz, there is $4103.16 available for travel support for local section and related representations (ACS Innovative Grant Program).

Website

The HIST website contains high quality images of the plaques and much supplementary information, including photographs of many awards ceremonies, ceremony agenda, and related materials.

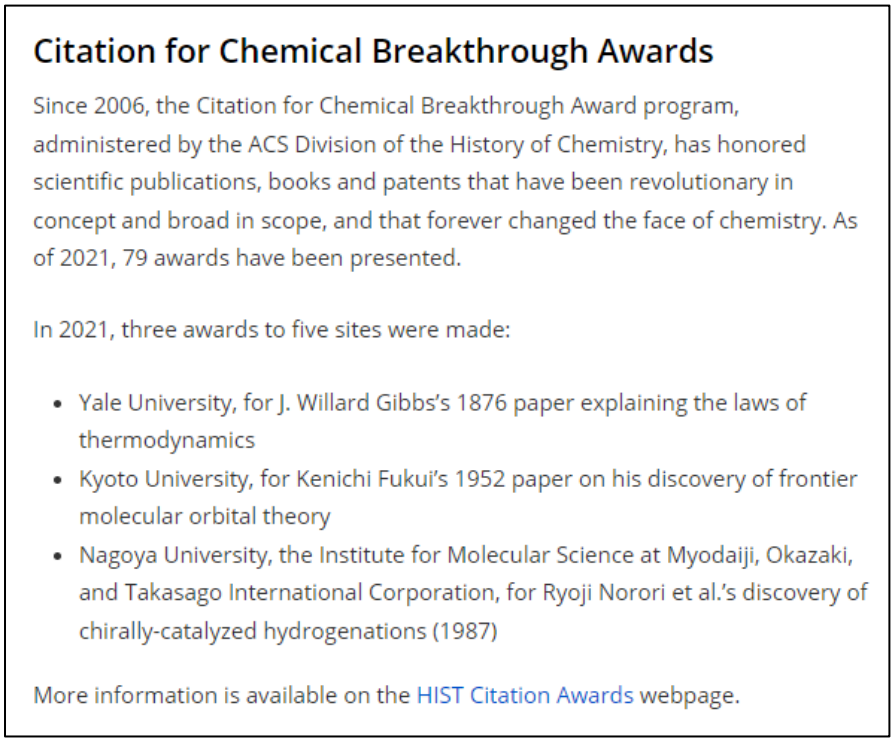
http://www.scs.illinois.edu/~mainzv/HIST/awards/citations_chem-breakthroughs.php

The CCB award program's website is exceptional and expanding, thanks to the continuing excellent participation and ingenuity of Vera Mainz. The website is organized by award year. Originally, there was only a table of all award winners for each year (from 2006 when the first awards were presented). From that page, one could and can see the award plaques for each winner as well as the supplementary material associated with that award. In 2014, several new pages were added that provide the visitor with rapid access to the awardees, organized by name OR location OR date of the awardee's publication.

We are fortunate that most of the recipients have provided photographs and other information about their presentation ceremonies, etc. for use on our website.

CCB Award on the ACS Historic National Historic Chemical Landmarks Program Website

On the "About the ACS Historic National Historic Chemical Landmarks Program" web page, https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/about.html the following text and link appear (screen shot):



Citation for Chemical Breakthrough Awards

Since 2006, the Citation for Chemical Breakthrough Award program, administered by the ACS Division of the History of Chemistry, has honored scientific publications, books and patents that have been revolutionary in concept and broad in scope, and that forever changed the face of chemistry. As of 2021, 79 awards have been presented.

In 2021, three awards to five sites were made:

- Yale University, for J. Willard Gibbs's 1876 paper explaining the laws of thermodynamics
- Kyoto University, for Kenichi Fukui's 1952 paper on his discovery of frontier molecular orbital theory
- Nagoya University, the Institute for Molecular Science at Myodaiji, Okazaki, and Takasago International Corporation, for Ryoji Norori et al.'s discovery of chirally-catalyzed hydrogenations (1987)

More information is available on the HIST Citation Awards webpage.

I apologize for the small size of the following graphics. Please go to the CCB award website to see these in larger font.

On the CCB Award's website, the following appears for the National Historical Chemical Landmark awards:

The National Historical Chemical Landmarks (NHCL) program, administered by the American Chemical Society, honors "seminal achievements . . . to chemistry and society in the U.S."

In 2017, two Landmarks were awarded:

- **Infrared Spectrometer and the Exploration of Mars**
- **Chlorofluorocarbons and Ozone Depletion**

In 2018, one Landmark was awarded:

- **Plutonium-238 Production for Space Exploration**

In 2019, three Landmarks were awarded:

- **St. Elmo Brady, the First African-American Ph.D. in Chemistry**
- **Innovation in Steroid Medicines at Upjohn**
- **The Combination of Gas Chromatography and Mass Spectrometry at Dow Chemical**

No Landmarks were awarded in 2020.

In 2021, two Landmarks were awarded:

- **Saul Hertz and the Medical Uses of Radioiodine**
- **Birth of the Petrochemical Industry**

The first NHCL was awarded in 1993 for Bakelite: The World's First Synthetic Plastic.

From: http://acshist.scs.illinois.edu/awards/citations_chem-breakthroughs.php

On the CCB Award's website, the following appears for the 2021 CCB awards:

Scientists/Inventors	Breakthrough Publication (If text is in color, this is a live link to the plaque.)	Location of Award (If text is in color, this is a live link to photographs and other materials related to the presentation.)
J. Willard Gibbs	"On the Equilibrium of Heterogeneous Substances," *Transactions of the Connecticut Academy of Arts and Sciences* **1876**, *3*, 108 - 248; **1878**, *3*, 343 - 524.	Yale University
Kenichi Fukui, Teijiro Yonezawa, and Haruo Shingu	"A Molecular Orbital Theory of Reactivity in Aromatic Hydrocarbons," *The Journal of Chemical Physics* **1952**, *20*, 722 - 725.	Kyoto University
R. Noyori, T. Ohkuma, M. Kitamura, H. Takaya, N. Sayo, H. Kumobayashi, and S. Akutagawa	"Asymmetric Hydrogenation of β-Keto Carboxylic Esters. A Practical, Purely Chemical Access to β-Hydroxy Esters in High Enantiomeric Purity," *J. Am. Chem. Soc.* **1987**, *109(10)*, 5856 - 5858.	Nagoya University Institute for Molecular Science, Myodaiji, Okazaki, Japan Takasago International Corporation

From: http://acshist.scs.illinois.edu/awards/CCB-2012_Awardees.php

The 2021 award plaques are shown at the very end of this report. Photographs of all plaques are also found on the HIST website under HIST Awards, Citation for Chemical Breakthrough Award. The blue link in the second column of each year's award listing leads the web visitor to that award's plaque.

For the 2021 awards: http://acshist.scs.illinois.edu/awards/CCB-2021_Awardees.php

The three 2021 award plaques are shown on the next pages.

Division of the History of Chemistry
American Chemical Society

Citation for Chemical Breakthrough

Explaining the Laws of Thermodynamics

Transactions of the Connecticut Academy of Arts and Sciences
1876, *3, 108-248;* **1978**, *3, 343-524.*

V. On the Equilibrium of Heterogeneous Substances.
By J. Willard Gibbs.

"Die Energie der Welt ist constant.
Die Entropie der Welt strebt einem Maximum zu."
Clausius.*

The comprehension of the laws which govern any material system is greatly facilitated by considering the energy and entropy of the system in the various states of which it is capable. As the difference of the values of the energy for any two states represents the combined amount of work and heat received or yielded by the system when it is brought from one state to the other, and the difference of entropy is the limit of all the possible values of the integral $\int \frac{dQ}{t}$, (dQ denoting the element of the heat received from external sources, and t the temperature of the part of the system receiving it,) the varying values of the energy and entropy characterize in all that is essential the effects producible by the system in passing from one state to another. For by mechanical and thermodynamic contrivances, supposed theoretically perfect, any supply of work and heat may be transformed into any other which does not differ from it either in the amount of work and heat taken together or in the value of the integral $\int \frac{dQ}{t}$. But it is not only in respect to the external relations of a system that its energy and entropy are of predominant importance. As in the case of simply mechanical systems, (such as are discussed in theoretical mechanics,) which are capable of only one kind of action upon external systems, viz., the performance of mechanical work, the function which expresses the capability of the system for this kind of action also plays the leading part in the theory of equilibrium, the condition of equilibrium being that the variation of this function shall vanish, so in a thermodynamic system, (such as all material systems actually are,) which is capable of two different kinds of action upon external systems, the two functions which express the twofold capabilities of the system afford an almost equally simple criterion of equilibrium.

*Pogg. Ann. Bd. cxlv (1865), S. 400; or Mechanische Wärmetheorie, Abhand. ix., S. 44.

Presented to Yale University, 2021.

Division of the History of Chemistry
American Chemical Society

Citation for Chemical Breakthrough

Journal of Chemical Physics **1952**, *20*, 722-725.

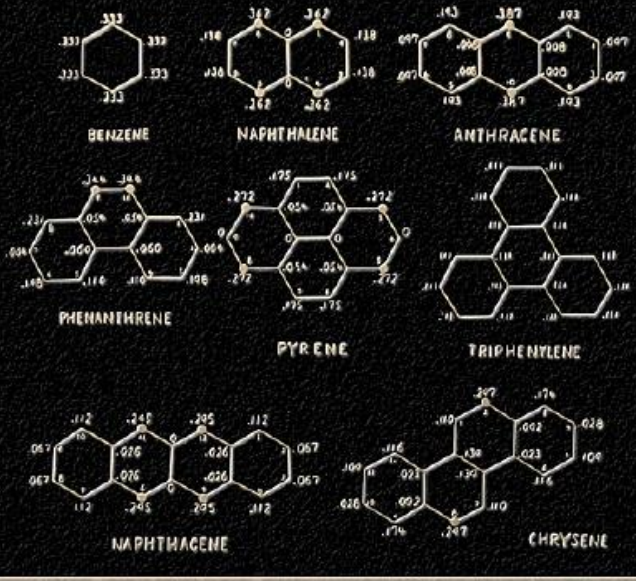
A Molecular Orbital Theory of Reactivity in Aromatic Hydrocarbons

KENICHI FUKUI, TEIJIRO YONEZAWA, AND HARUO SHINGU
Faculty of Engineering, Kyoto University, Kyoto, Japan

(Received October 29, 1951)

In the present paper it is shown that on the ground of the latter method, if we distinguish the pair of π-electrons in the highest occupied orbital in the ground state from the others and assume that this pair of π-electrons plays a decisive role in the reaction in question, we can obtain an illuminating explanation of the difference of reactivity at each position in a molecule.

In the first place we will report on the treatment of nonsubstituted aromatic hydrocarbons. The orienting effect of substituents in aromatic nuclei will be treated in the next publication.



Presented to the Faculty of Engineering, Kyoto University, 2021.

Division of the History of Chemistry
American Chemical Society

Citation for Chemical Breakthrough

Journal of the American Chemical Society **1987**, *109*, 5856-5858.

Asymmetric Hydrogenation of β-Keto Carboxylic Esters. A Practical, Purely Chemical Access to β-Hydroxy Esters in High Enantiomeric Purity

R. Noyori,* T. Ohkuma, and M. Kitamura

Department of Chemistry, Nagoya University
Chikusa, Nagoya 464, Japan

H. Takaya

Institute for Molecular Science
Myodaiji, Okazaki 444, Japan

N. Sayo, H. Kumobayashi, and S. Akutagawa*

R & D Institute, Takasago International Corporation
Kamata, Tokyo 144, Japan

Received June 8, 1987

Optically active β-hydroxy carboxylic esters are an extremely important class of compounds for natural product synthesis. Access to such compounds has so far relied mainly on biological or biochemical transformations.[1] Asymmetric hydrogenation of the keto esters is an alternative complementary methodology, and the purely chemical means should allow even easier control of the chiral outcome at will, giving both antipodes with equal ease.

Presented to Nagoya University, the Institute for Molecular Science, and Takasago International Corporation, 2021.