THE BECKMAN CENTER FOR THE HISTORY OF CHEMISTRY

HERMAN MARK

Transcript of Interviews
Conducted by

James J. Bohning and Jeffrey L. Sturchio

at

Polytechnic University, Brooklyn, New York

on

3 February, 17 March, and 20 June 1986

(With Subsequent Corrections and Additions)

CENTER FOR HISTORY OF CHEMISTRY

Oral History Program

RELEASE FORM

I hereby certify that I have been interviewed on tape on 3 Feb, 17 MAR 1986 by J. BOHNING AND J. STURCHIO, representing the Center for History of Chemistry. It is my understanding that this tape recording will be transcribed, and that I will have the opportunity to review and correct the resulting transcript before it is made available for scholarly work by the Center. At that time I will also have the opportunity to request restrictions on access and reproduction of the interview, if I so desire.

If I should die or become incapacitated before I have reviewed and returned the transcript, I agree that all right, title, and interest in the tapes and transcript, including the literary rights and copyright, shall be transferred to the Center, which pledges to maintain the tapes and transcript and make them available in accordance with general policies for research and other scholarly purposes.

(Signature) H. F. Mark

(Date) March 18, 1986

(Revised 6 February 1986)

Herman Mark

E BECKMAN CENTER FOR THE HISTORY OF CHEMISTRY

Oral History Program

RELEASE FORM

This document contains my understanding and agreement with the Beckman Center for the History of Chemistry with respect to my participation in a tape-recorded interview conducted by Dr. James J. Bohning and Dr. Jeffrey L. Sturchio on 2/3, 3/17, and 6/20/86. I have read the transcript supplied by the Beckman Center and returned it with my corrections and emendations.

1. The tapes and corrected transcript (collectively called the "Work") will be maintained by the Beckman Center and made available in accordance with general policies for research and other scholarly purposes.

2. I hereby grant, assign, and transfer to the Beckman Center all right, title, and interest in the Work, including the literary rights and the copyright, except that I shall retain the right to copy, use and publish the Work in part or in full until my death.

3. The manuscript may be read and the tape(s) heard by scholars approved by the Beckman Center subject to the restrictions listed below. The scholar pledges not to quote from, cite, or reproduce by any means this material except with the written permission of the Beckman Center.

4. I wish to place the following conditions that I have checked below upon the use of this interview. I understand that the Beckman Center will enforce my wishes until the time of my death, when any restrictions will be removed.

   a. _____ No restrictions for access.

   b. _____ My permission required to quote, cite, or reproduce.

   c. _____ My permission required for access to the entire document and all tapes.

This constitutes our entire and complete understanding.

(Signature) Herman F. Mark

(Date) 11/20/89

(Revised 20 February 1989)

Chemical Heritage Foundation
Oral History Program
315 Chestnut Street
Philadelphia, Pennsylvania 19106

HERMAN MARK

1895 Born in Vienna, Austria on 3 May

Education

1921 Ph.D., chemistry, University of Vienna

Professional Experience

1921-1922	Instructor in Organic Chemistry, University of Berlin
1922-1926	Research Fellow, Kaiser Wilhelm Institute of Fiber Chemistry, Berlin-Dahlem
1927-1928	Research Chemist, I.G.Farben Industrie
1928-1930	Group Leader, I.G.Farben Industrie
1930-1932	Assistant Research Director, I.G.Farben Industrie
1927-1932	Associate Professor, Karlsruhr Technical University
1932-1938	Professor of Chemistry and Director, First Chemical Institute, University of Vienna
1938-1940	Canadian International Paper Company, Hawkesbury, Ontario
1940-1942	Adjunct Professor, Polytechnic Institute of Brooklyn
1942-1964	Professor, Polytechnic Institute of Brooklyn
1946-1964	Director, Polymer Research Institute
1961-1964	Dean of Faculty, Polytechnic Institute of Brooklyn
1965-	Dean and Professor Emeritus, Polytechnic University

Honors

Honorary Degrees

1950	University of Liège, Belgium
1953	University of Uppsala, Sweden
1954	Free University of Berlin, West Germany
1955	Technical University of Berlin, West Germany
1956	Lowell Technological Institute
1960	Technical University of Munich, West Germany
1962	Gutenberg University, Mainz, West Germany
1964	Karl Franzens University, Graz, Austria
1965	Technische Hochschüle, Vienna, Austria
1965	Polytechnic Institute of Brooklyn
1965	Charles University, Prague, Czechoslovakia
1971	Jassy University, Rumania
1973	Universidad Autonoma Madrid, Spain
1975	Israel Institute of Technology, Israel
1976	Long Island University, New York
1976	Montan University, Leoben, Austria
1979	University of Nottingham, Great Britain
1980	University of Vienna, Austria
1982	University of Massachusetts
1987	Universite Claude Bernard, Lyon, France

Elected and Honorary Membership

1933	Austrian Academy
1934	Bucharest Academy
1936	Chemical Society of Madrid
1937	Chemical Society of Bucharest
1937	Austrian Society of Textile Chemists and Colorists
1937	Austrian Society for X-Ray Research
1938	Budapest Academy
1943	New York Academy of Science
1944	American Institute of Physics
1947	Royal Institution of Great Britain
1947	Max Planck Society
1949	American Leather Society
1949	Amsterdam Academy
1950	Vienna Physical Chemistry Society
1950	Textile Institute of Great Britain
1950	Indian Academy of Sciences
1951	Austrian Association of Paper Chemists
1952	Austrian Society for Wood Research
1952	National Institute of Science of India
1953	Weizmann Institute of Science
1954	Italian Chemical Society
1956	American Academy of Arts and Sciences
1961	National Academy of Science
1962	Phi Lamba Upsilon Honorary Chemical Society
1965	Plastics Institute of America
1965	Austrian Society for Plastics Technology
1965	The Fiber Society
1966	Soviet Academy of Sciences
1968	International Academy of Wood Science
1971	The Franklin Institute
1972	Society of Polymer Science of Japan
1973	Indian Chemical Society
1974	Croatian Society of Plastics Engineers
1976	Plastics Hall of Fame
1977	The Chemists Club
1977	The New York Academy of Sciences
1978	Chemical Society of Japan
1978	American Institute of Chemists
1979	Yugoslav Society of Plastics and Rubber Engineers
1979	Indian Society for Polymer Science
1979	The Royal Institute of Chemistry
1980	Gesellschaft für Chemiewirtschaft, Vienna
1981	American Society for Testing Materials
1985	The Textile Institute of Great Britain, Honorary Fellowship

Orders, Medals and Prizes

1928	Hertz Medal, Germany
1934	Exner Medal, Austria
1937	Medal of the Austrian Society of Textile Chemists

	and Colorists
1948	Harrison Howe Award, American Chemical Society
1948	Franqui Medaille, Belgium
1953	Honor Scroll of the American Institute of Chemists
1953	Legion d'Honneur
1954	Medal of Honor, Milan Polytechnic Institute
1955	Honorary Fellow, University of Vienna
1955	Golden Honor Medal, University of Vienna
1955	Trasenster Medal, Association of Belgian Engineers
1960	Nichols Medal, American Chemical Society
1961	Distinguished Service Medal, Syracuse University
1962	International Award, Society of Plastics Engineers
1962	Gold Medal, Indian Association for the Cultivation of Science
1965	Polymer Chemistry Award, American Chemical Society
1965	Olney Medal, American Chemical Society
1966	Austrian Honor Cross in Science and Arts
1966	Cresson Medal
1968	Swinburne Medal, Plastics Institute of Great Britain
1970	City of Vienna Prize for Natural Sciences
1970	Distinguished Service Award, Polytechnic Chapter Sigma Xi
1972	Scientific Achievement Medal Award, City College Alumni Association
1972	Chemical Pioneer Award, American Institute of Chemists
1975	Gibbs Medal, American Chemical Society
1975	Austrian Grand Silver Medal with Star
1975	150th Anniversary Prize, Aachen and Munich Insurance Association
1976	Plastics and Coatings Award, American Chemical Society
1976	Harvey Prize, Israeli Technion
1977	Distinguished Service Award, Polytechnic University of New York
1978	Humboldt Prize
1978	Plastics "Vision" Award, Society of Plastics Engineers
1979	Wolf Prize, Israel
1980	Perkin Medal, Society of Chemical Industry, Great Britain
1980	National Medal of Sciences
1980	Jabotinsky Centennial Medal, Israel
1980	Silver Medal, International Commission for Fiber Science Research, France
1980	Colwyn Medal, Plastics and Rubber Institute, Great Britain
1982	Gold Award, Society for Plastics Technology, Vienna
1982	Polymer Education Award, American Chemical Society
1984	30th Anniversary Lecture Medal, Milan Polytechnic Institute
1985	Gold Merit Medal, International Center for Research on Synthetic Fibers
1986	Mayor's Award of Honor for Science and Technology, City of New York

1987 Bronze Medal, Universite Claude Bernard, Lyon
1987 Medal of the City of Lyon, France
1987 Bronze Medal, Conseil General du Rhone, France
1987 Mayor's award of Honor for Science and Technology, City of Vienna, Austria
1988 Heyrovsky Medal, Czechoslovak Academy of Science
1988 Goodyear Medal, American Chemical Society

ABSTRACT

In this first of three interviews Herman Mark starts with his study of relatively stable free radicals under the direction of Wilhelm Schlenk, first in Vienna and then in Berlin. After a post-doctoral period at the University of Berlin, Mark was invited by Haber to join the Kaiser Wilhelm Institute at Dahlem. There Mark collaborated with Polanyi and other colleagues in using x-ray diffraction to establish the crystal structures of small organic molecules and metals. This work was extended to naturally-occurring organic materials such as cellulose and silk; as a consequence Mark was able to play an important role at the critical 1926 meeting in Düsseldorf which brought together Staudinger and the opponents of the macromolecular hypothesis.

Mark's next move was to I.G. Farben where he established a polymer laboratory and first collaborated with Kurt Meyer, with whom he published the pioneering x-ray crystallographic structure of cellulose. Mark describes the laboratories, research directions and colleagues during his stay at Ludwigshafen. The worsening political climate in Germany prompted Mark to accept a chair at his alma mater; back in Vienna he set up the first comprehensive polymer research and teaching institute. Mark concludes this interview by describing the circumstances of an approach from the Canadian International paper Company and his decision to leave Austria.

The second interview details his experiences in the Canadian paper industry and his early ventures into publishing with the first of the Polymer Monograph series. Mark explains how he was able to resume an academic career by starting the polymer program at Brooklyn Polytechnic Institute, which soon became world-renowned. The war-time years brought new projects and young faculty to Brooklyn. Mark briefly describes this period before going on to the immediate post-war era and the later expansion of the Polymer Research Institute, which forms the introductory section of the final interview. In this interview Mark tells of his part in the formation of the literature of polymer science and technology; journals, monographs, reference books and encyclopedias. Mark's many international collaborations are outlined, spanning a pre-war expedition to a Caucasian glacier to a demonstration of the nylon rope trick to Emperor Hirohito. Finally, Mark refers to his more recent research interests and describes the changes in research funding that have taken place during the past four decades.

INTERVIEWERS

Jeffrey L. Sturchio received an A.B. in history from Princeton University and a Ph.D. in the history and sociology of science from the University of Pennsylvania. He was Associate

Director of the Beckman Center for the History of Chemistry from 1984 to 1988, and has held teaching appointments at the New Jersey Institute of Technology, Rutgers University, and the University of Pennsylvania as well as a fellowship at the Smithsonian National Museum of American History. After a sojourn on the senior staff of the AT&T Archives, Dr, Sturchio joined Merck & Co., Inc. as Corporate Archivist in June 1989.

James J. Bohning holds the B.S., M.S., and Ph.D. degrees in chemistry, and has been a member of the chemistry faculty at Wilkes College since 1959. He was chair of the Chemistry Department for sixteen years, and was appointed chair of the Department of Earth and Environmental Sciences in 1988. He has been associated with the development and management of the oral history program at the Beckman Center since 1985, and was elected Chair of the Division of the History of Chemistry of the American Chemical Society for 1987.

TABLE OF CONTENTS

Second Interview

Third Interview

NOTES

1. H. Mark, "The Synthesis of Pentaphenylethyl," Ph.D. Thesis, University of Vienna, 1921.

2. W. Schlenk and H. Mark, "Nature of the Chemical Union. Free Pentaphenylethyl," Berichte, 55B (1922): 2285-2299. idem, "Analogs of Pentaphenylethyl," ibid, 55B (1922): 2299-2302.

3. H. Mark, M. Polanyi and E. Schmid, "Processes at the Stretching of Zinc Crystals," Zeitschrift für Physik, 12 (1923): 58-72, 78-110, 111-116. idem, "Investigations of Uni-Crystalline Wires of Tin," Naturwissenschaften, 11 (1923): 256.

4. H. Freundlich, Kapillarchemie, (Leipzig: Akademische Verlagsgesellschaft, 1922).

5. BCHOC Oral History file #0030.

6. H. Kallmann and H. Mark, "Some Properties of Compton Radiation," Naturwissenschaften, 13 (1925): 1012-1015. idem, "Some Properties of Compton Radiation," Zeitschrift für Physik, 36 (1926): 120-143.

7. H. Mark, "Atomic Structure and Quantum Theory. I," Zeitschrift für Angewandete Chemie, 40 (1927): 16-20. idem, "Atomic Structure and Quantum Theory. II," ibid, 40 (1927): 645-649. idem, "Atomic Structure and Quantum Theory. III," ibid, 40 (1927): 1497-1500.

8. H. Mark and L. Szilard, "A Simple Attempt to Find a Selective Effect in the Scattering of Roentgen Rays," Zeitschrift für Physik, 33 (1925): 688-691. idem, "The Polarization of Roentgen Rays by Reflection from Crystals," ibid, 35 (1926): 743-747.

9. H. Mark and E. Wigner, "Space Lattice of Rhombic Sulfur," Zeitschrift für Physikalische Chemie, 111 (1924): 398-414.

10. H. Mark and M. Polanyi, "The Space Lattice, Gliding Directions, and Gliding Planes in White Tin," Zeitschrift für Physik, 18 (1923): 75-96. idem, "The Lattice Structure of White Tin," ibid, 22 (1924): 200.

11. Special Meeting, Gesellschaft Deutscher Naturforscher und Ärtze, 23 September 1926.

12. See Berichte, 59 (1926): 2973, 2982, 3000, 3008, 3019.

13. K. H. Meyer and H. Mark, "The Structure of the Crystallized Components of Cellulose," Berichte, 61B (1928): 593-614.

14. O. L. Sponsler and W. H. Dore, "The Structure of Ramie Cellulose as Derived from X-Ray Data," Fourth Colloid Symposium Monograph, (1926): 179-202.

15. H. Mark, "Polymer Chemistry in Europe and America; How it All Began," Journal of Chemical Education, 58 (1981): 527-534.

16. For example: K. H. Meyer, H. Hopff and H. Mark, "The Constitution of Starch," Berichte, 62B (1929): 1103-1112. H. Mark and G. v. Susich, "The Orderly Micellar Structure of Rubber," Kolloid-Zeitschrift, 46 (1928): 11-21. H. Mark and K. Wolf, "Polarization of Characteristic X-Radiation," Zeitschrift für Physik, 52 (1928): 1-7. H. Mark and R. Wierl, "Intensity in the Hydrogen Stark Effect," ibid, 55 (1929): 156-163.

17. H. Morawetz, Polymers. The Origins and Growth of a Science (New York: John Wiley and Sons, 1985).

18. Herman Mark and Carl Wulff, "Styrene and its Homologues," German Patent550,055, issued 9 August 1929. Carl Wulff and Eugene Dorrer, "Continuous System for Polymerizing Styrene, Indene, Vinyl Esters and Like Unsaturated Compounds," German Patent 634,278, issued 22 August 1936.

19. K. H. Meyer and H. Mark, Aufbau der Hochpolymeren Substanzen (Berlin: Hirschwaldsthe Buchhandlung, 1930).

20. H. Staudinger, Die Hochmolekularen Organischen Verbindungen, Kautschuk und Cellulose (Berlin: Springer, 1932).

21. "Phenomena of Polymerization and Polycondensation", Faraday Society Discussion, Cambridge, 1935.

22. H. Mark, Die Chemie als Verbereiterin des Fortschrittes (Leipzig: Hoelder-Pichler-Tempsky, 1938).

23. K. H. Meyer and H. Mark, Hochpolymere Chemie (Leipzig: Akademische Verlagsgesellschaft, 1937).

24. H. Mark and R. Raff, High Polymers. III. High Polymeric Reactions, Their Theory and Practice (New York: Interscience Publishers, Inc., 1940.

25. K. H. Meyer and H. Mark, Der Aufbau der Hochpolymeren Organischen Naturstoffe (Leipzig: Akademische Verlagsgesellschaft, 1930).

26. H. Mark and G. S. Whitby, Collected Papers of W. H. Carothers on Polymerization (New York: Interscience, 1940).

27. I. Fankuchen and H. Mark, "Improved X-Ray Technique for the Study Of Natural and Synthetic Fibers," Record of Chemical Progress, 4 (1943): 54-57. idem, "X-Ray Study of

Chain Polymers," Journal of Applied Physics, 15 (1944): 364-370.

28. H. Mark and G. Saito, "Fractionation of Highly Polymerized Compounds by Chromatographic Adsorption Analysis," Monatshefte für Chemie., 68 (1936): 237-243.

29. F. Eirich and H. Mark, "Substances of High Molecular Weight in Solution," Ergebnisse Exact. Naturwissenschaften, 15 (1936): 1-35.

30. H. Mark, "Recent Developments in the Field of Synthetic Rubber," Chemistry and Industry, (1940): 89-90.

31. H. Mark, "X-Ray Investigations of Carbohydrates," Chemical Reviews, 26 (1940): 169-186.

32. H. Mark, "Elasticity of Natural and Synthetic Rubber," Trans. Inst. Rubber Ind., 15 (1940): 271-297.

33. H. Mark, "Composite Elasticity of Rubber," India Rubber World, 102 (1940): (3) 41-45, (5) 45-49.

34. G. Goldfinger, D. Josefowitz and H. Mark, "Heat of Polymerization of some Vinyl Compounds," Journal of the American Chemical Society, 65 (1943): 1432-1433.

35. H. Mark, The General Chemistry of High Polymeric Substances (Amsterdam: Elsevier, 1940).

36. H. Mark, Physical Chemistry of High Polymeric Systems (New York: Interscience, 1940).

37. T. Alfrey, Mechanical Behavior of High Polymers (New York: Interscience,1948).

38. W. P. Hohenstein, S. Siggia and H. Mark, "The Formation of Vinyl Polymers in Emulsions and Suspensions. II. Some Experiments on the Polymerization of Styrene in Emulsion." India Rubber World, 111 (1944): 173-177.

39. W. P. Hohenstein and H. Mark, "Polymerization of Olefins and Diolefins in Suspension and Emulsion," Journal of Polymer Science, 1 (1946): 549-580.

40. R. F. Boyer and H. Mark, Selected Papers of Turner Alfrey (New York: M. Dekker Inc., 1986), pp. 6-9.

41. H. Mark and S. Siggia, "Esters of Carboxymethylcellulose," U.S. Patent 2,379,917, issued 10 July 1945 (application filed 11 August 1942).

42. R. F. Boyer, "Herman Mark and the Plastics Industry," Journal of Polymer Science, Part C, 12 (1966): 111-118.

43. T. Alfrey, J. J. Bohrer and H. Mark, Copolymerizatio (New York: Interscience, 1952).

44. H. Mark, "Preparation and Properties of some Block and Graft Copolymers," Angewandte Chemie, 67 (1955): 53-56.

45. T. Alfrey, G. Goldfinger and H. Mark, "Apparent Second-Order Transition Point of Polystyrene," Journal of Applied Physics, 14 (1942): 700-705.

46. P. J. Flory, "Statistical Thermodynamics of Semi-Flexible Chain Molecules," Proceedings of the Royal Society, A234 (1956): 60-73. idem, "Phase Equilibriums in Solutions of Rod-Like Particles," ibid, A234 (1956): 73-89.

47. Morton M. Hunt, "Profile of Herman Mark," New Yorker, 34 (1958): 48-50 (Sept. 13), 46-79 (Sept. 20).

48. M. E. P. Friedrich and C. S. Marvel, "The Reaction between Alkali Metal Alkyls and Quaternary Arsonium Compounds," Journal of the American Chemical Society, 52 (1930): 376-384.

49. H. Mark, Das Schwere Wasser, (Leipzig, F. Deuticke: 1934).

50. E. Baroni and A. Fink, "Investigation of the Concentration of Deuterium Oxide in Natural Ice," II. Monatshefte, 67 (1936): 131-136. IV. ibid. 71 (1937): 128-130.

51. H. Mark, "Submicroscopic Structure of Wood Constituents," TAPPI, 32 (1949): 108-109.

52. E. H. Immergut, B. G. Ranby and H. Mark, "Recent Work on the Molecular Weight of Cellulose," Industrial and Engineering Chemistry, 45 (1953): 2483-2490.

53. H. Mark, Editor/Chairman, Fire Safety Aspects of Polymeric Materials, 10 vols. (Washington, D.C., National Academy of Sciences: 1977).

D

E

P