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Polyolefins—The History and Economic Impact

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Abstract

Olefins, or alkenes, are hydrocarbon molecules with at least one double carbon–carbon bond. Polyolefins are polymer molecules made in an addition (chain-growth) polymerization, producing essentially linear high molecular weight thermoplastic polymers. A global industry of almost 170 million tons and value around $200 billion, has been created and developed in about 80 years, since the serendipitous discovery of polyethylene in 1933 at the research laboratories of ICI [Imperial Chemical Industries) in the UK and the start of PE commercial production in 1938. These polyolefin polymers are now the major fraction (62 %) of the plastic materials which have transformed modern life. No other major material has appeared on the scene and achieved such a dominant and ubiquitous place in such a short time. As new materials, polyolefins have introduced new possibilities and benefits at attractive price points. Their annual growth rate remains exponential. Polyolefins are used in every sector of life and are processed by every significant polymer processing technology. The history of this polyolefin industry is inextricably linked with progress in the understanding and development of polymer science and technology, and the economic and commercial impact of this progress. Consistent themes in this history are serendipity, discovery, research, feedstock, capital intensity, intellectual property, globalisation, merger & acquisition, and product and application development. Polyolefins remain highly technology-driven; they are indispensable to modern life; their significant growth and economic impact will continue.

Keywords

Gulf Cooperation Council Metallocene Catalyst Cyclic Olefin Copolymer
Linear Polyethylene Gulf Cooperation Council Country
These keywords were added by machine and not by the authors. This process is experimental and the keywords may be updated as the learning algorithm improves.

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List of Patents Referenced in the Chapter

- US Patent 2816883
- Product and process of polymerizing ethylene
- Arthur W. Larcher and Donald C. Pease
- E. I. du Pont de Nemours & Co., Inc.
- Filed 2 August 1951, Published 17 December 1957
- *Continuation-in-part of application 739,264, filed 3 April 1947*

- US Patent 2153553
- Polymerization of olefins
- Eric William Fawcett, Reginald Oswald Gibson, Michael Willcox Perrin
- ICI Limited
- Priority date 4 February 1936, Published 11 April 1939

- US Patent 4076698

- *for what we now call LLDPE*

- Arthur William Anderson, Gelu Stoeff Stamatoff

- DuPont

- Filed 4 January 1957, Published 28 February 1978

- *Continuation-in-part of application 568,707, filed 1 March 1956*

- US Patent 3012023

- Production of Olefln Polymers

- John Macmillan Bruce, Nicholas George Merckling, William Lawrence Truett, Arthur William Anderson

- E. I. du Pont de Nemours and Company

- Filed 25 January 1955, Published 5 December 1961

- US Patent 3541074

- Olefin polymerization catalysts comprising divalent titanium and process for polymerization of ethylene therewith

- Arthur William Anderson, John Macmillan Bruce Jr, Nicholas George Merckling, William Lawrence Truett

- I. du Pont de Nemours and Company

- Filed 16 August 1954, Published 17 November 1970

- US Patent 2692257

- Ethylene polymerization with conditioned alumina-molybdena catalysts

- Alex Zletz

- Standard Oil Company of Indiana

- Filed 28 April 1951, Published 19 October 1954

- Max Fischer, German Patent 874,215, Published 20 April 1953

- US Patent 2699457
- Polymerization of ethylene
- Karl Ziegler, Hans-Georg Gellert
- Filing date 19 June 1951, Publication date 11 January 1955

- German Patent 973626
- Verfahren zur Herstellung von hochmolekularen Polyäthylenen
- Process for Preparing High-Molecular Polyethylenes
- Karl Ziegler, Heinz Breil, Erhard Holzkamp, Heinz Martin
- Filed 18 November 1953, Published 14 April 1960

- US Patent 2825721
- Polymers and production thereof
- John Paul Hogan, Robert L. Banks
- Phillips Petroleum Company
- *Continuation-in-part of application Serial No. 333,576, filed* 27 January 1953
- Publication date 4 March 1958

- US Patent Application WO 9623010

- The following US patents are all divisionals of that initial broad US filing.

- *As a result of the procedures to handle divisional cases in the US Patent Office, they all contain the same examples though the claims (which are of interest to the community of those who patent) will be different.*

- With some indication of the claims, the divisionals are as follows:

    1. (a)

       Arthur, S. D.; Bennett, A. M. A.; Brookhart, M. S.; Coughlin, E. B.; Feldman, J.; Ittel, S. D.; Johnson, L. K.; Killian, C. M.; Kreutzer, K. A. U.S. Patent 5866663, Feb 2, 1999 to DuPont (Polymerizations).

    2. (b)

       Brookhart, M. S.; Ittel, S. D.; Johnson, L. K.; Killian, C. M.; Kreutzer, K. A.; McCord, E. F.; McLain, S. J.; Tempel, D. J. U.S. Patent 5880241, May 3, 1999 to DuPont (Polymer compositions).

    3. (c)

       Brookhart, M. S.; Johnson, L. K.; Killian, C. M.; Wang, L.; Yang, Z.-Y., U.S. Patent 5880323, March 9, 1999 to DuPont (R-Olefins).

    4. (d)

       Arthur, S. D.; Bennett, A. M. A.; Brookhart, M. S.; Coughlin, E. B.; Feldman, J.; Ittel, S. D.; Johnson, L. K.; Killian, C. M.; Kreutzer, K. A.; Parthasarathy, A.; Tempel, D. J. U.S. Patent 5886224, March 23, 1999 to DuPont (Ligand compositions).

    5. (e)

       Arthur, S. D.; Brookhart, M. S.; Johnson, L. K.; Killian, C. M.; McCord, E. F.; McLain, S. J. U.S. Patent 5891963, April 6, 1999 to DuPont (Copolymers)

- US Patent 4376851

- High density, heat resistance polypropylene

- John P. Hogan, Robert L. Banks
- Phillips Petroleum Company
- *Continuation-in-part of applications Serial No. 333,576, filed 27 January 1953*
- Publication date 15 March 1983

- US 4342854
- Solid polymers of 4-methyl-1-pentene
- John P. Hogan, Robert L. Banks
- Phillips Petroleum Company
- Continuation-in-part of applications Serial No. 333,576, filed 27 January 1953
- Publication date 3 August 1982

- US Patent 3112300
- Isotactic polypropylene
- Natta Giulio, Pino Piero, Mazzanti Giorgio
- Montecatini-Societa Generale per lIndustria Mineraria e Chimica
- Priority date 8 June 1954 *on the basis of an Italian application filed on that date*
- Published 26 November 1963

- US Patent 3112301
- Prevailingly Isotactic polypropylene
- Natta Giulio, Pino Piero, Mazzanti Giorgio

- Montecatini-Societa Generale per lIndustria Mineraria e Chimica
- Filed 8 June 1954 *on the basis of an Italian application filed on that date*
- Published 26 November 1963

- US Patent 3113115
- Polymerization catalyst
- Ziegler Karl, Breil Heinz, Martin Heinz, Holzkamp Erhard
- Priority date 19 January 1954
- Published 3 December 1963

- US Patent 3715344
- Regular linear head-to-tail polymerizates of certain unsaturated hydrocarbons and filaments comprising said polymerizates
- G Mazzanti, G Natta, P Pino
- Priority date 8 June 1954
- Published 6 February 1973

- US Patent 2691647
- Conversion of ethylene and/or propylene to solid polymers in the presence of group 6a metal oxides and alkali metals
- Field Edmund, Feller Morris
- Standard Oil of Indiana
- Priority date 6 December 1952
- Published 12 October 1954

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