

Book reviews

A LITTLE BOOK ABOUT BIG CHEMISTRY – THE STORY OF MAN-MADE POLYMERS, Jim Massy, Springer, 2017, 82 pp., ISBN: 978-3-319-54830-2

This new contribution to the well-known SpringerBriefs Series in Materials, whose mission is to present highly relevant, concise monographs on a wide range of topics covering fundamental advances and new applications in the field, summarizes various aspects from the history of the man-made polymers, their general properties and conventional uses.

Polymers are substances composed of large molecules that can be considered as one big molecule or macromolecule. Polymers, both natural and synthetic, are made up of long covalently bonded molecules, produced *via* polymerization of many small molecules, known as monomers. Polymers are used in a wide variety of products, which include plastics, rubber, fibers, foams, coatings and adhesives, and have displaced other conventional materials, such as wood, natural fibers, metal and glass.

The book contains 12 chapters to introduce the readers to the polymer science with key moments in the history of big molecules and lots of examples on the properties and application of natural and man-made polymers in everyday life, plus a final chapter with a summary and conclusions.

The book is written for those with a basic background in chemistry, starting with the first use of the term *macromolecules* – in *Chapter 1 – Big Molecules* – with the meaning of a molecule of a covalently bonded compound of very high molecular weight, by a German chemist called Hermann Staudinger. It is worth mentioning that, in a scientific paper dating back to 1920, he suggested, for the first time, that natural and synthetic polymers are, in fact, giant molecules, which he named *macromolecules*, and he presented several reactions forming high-molecular-weight molecules by covalently linking monomer molecules *via* a polymerization process. Later, in August 1943, he founded the *Journal für Makromolekulare Chemie* (today known as *Macromolecular Chemistry and Physics*), the first journal devoted exclusively to polymer research. For his pioneering research and his contribution to the understanding of macromolecular chemistry, he received the Nobel Prize in Chemistry in 1953. Without making the chapter too sophisticated, it should have been mentioned that:

- polymers are large molecules built up from numerous smaller molecules, known as monomers;
- monomers are the building blocks and can form linear and/or branched macromolecules;
- the size of a polymer molecule is defined either by its mass (relative molar mass) or by the number of repeating units in the molecule (degree of polymerization).

The story of natural polymers is treated in *Chapter 2 – Rubber in the 19th Century* and *Chapter 3 – Cellulose and Casein in the 19th Century*, where the first developments are outlined, together with the exploration of the first ideas and applications in product development. Mackintosh, Hancock, Goodyear, Parkesine, Xylonite, Celluloid, Cellophane, Lyocell are not just labels, and the author shortly presents the story behind them, as starting points for the synthetic polymer industry of the 20th century.

Returning to the pioneering work of Hermann Staudinger in polymer chemistry, *Chapter 4 – Macromolecules in the 20th Century*, presents the struggle of the German chemist mainly with the orthodox scientific community, who authoritatively postulated that such large molecules do not exist. It is pointless to say that time proved who was right.

Thermoplastic and Thermosetting Polymers, two separate classes of polymers, differentiated based on their behavior in the presence of heat, are discussed in *Chapter 5*. The difference between the two is that thermoplastics can be remelted, while thermosetting remain in a permanent solid state once hardened. Due to these physical qualities, their different properties make them suitable for various applications; thermoplastic materials have low melting points, while thermosetting products can withstand high temperatures without losing integrity.

A very short chapter, *Chapter 6 – The Burgeoning of Modern Plastics*, highlights the strong points that made possible the rapidly increasing uses and types of man-made polymers in the 20th century: strength, cheapness and availability, unrivaled by any other natural polymer.

Besides stress–strain relationships, in *Chapter 7 – Physical Properties of Polymers*, the author evaluates four factors that have a profound effect on the physical properties of polymers: crystallinity of molecular

structures, intermolecular bonding by hydrogen bonds, filler and fiber reinforcement, and changes in the thermal and mechanical properties by plasticization.

The relationships between chemical structure, properties and applications are of obvious importance to chemists and engineers working in the polymer industries, and are decisive for the consumer. A glimpse from the point of view of the functional groups is presented in *Chapter 8 – Chemical Properties of Polymers*, knowing that the chemistry of repeating units is valuable in assessing polymer properties, and it predicts the domains for which the polymers are suitable, as well as their potential further chemical transformations.

Techniques for polymer synthesis are described in *Chapter 9 – Initiation of Polymerization*, where fine points are given on the distinctions between catalyst and initiators, while free radical, cationic, anionic and organometallic initiators are treated in a little more detail.

Chapter 10 – Copolymers discusses the basics of copolymerization and the reactivity ration, and presents the cases in which two or more different monomers are reacted together to polymerize in an alternating sequence already presented in the book.

The problems that affect the well-being of humans or of the environment arising from the use of polymers are considered and addressed briefly in *Chapter 11 – Ethical Issues*. When considering environmental damage, biodegradability, air pollution, toxicity or recycling, appropriate and practical examples of polymers are given so that the reader can understand the details of the case and evaluate as right (ethical) or wrong (unethical) use in everyday life.

The timeline presented in *Chapter 12 – The Chronology of Polymers* reflects the developments and various applications of major polymers in the order they were first made available on a large scale. At the beginning, modified and processed natural polymers were manufactured from natural rubber, cellulose and casein as raw materials. The first synthetic polymeric material, Bakelite, developed and patented by Belgian-American chemist Leo Baekeland in 1907-1909, had as starting point tests on wood and cotton (cellulosic fibers), impregnated with a synthetic resin made from phenol and formaldehyde.

The final *Chapter 13 – Summary and Conclusions* resumes and highlights the main topics of the book for the reader to reinforce the knowledge accumulated and the understanding of the polymer science, with an extra personal advice “*enjoy your chemistry and don’t forget the people who invented and developed synthetic polymers*”, valid for every specific subject.

Overall, this book represents an essential source of information, with many examples of the most widely used and important type of materials today, the polymers, for the reader to appreciate and understand their essential role in everyday life. Thus, the book is a very useful tool for students and scientists from different disciplines, as well as for lay readers interested in the interdisciplinary field of materials science.

Bogdan Marian Tofanica

ISTORIA CHIMIEI ROMÂNEȘTI (HISTORY OF ROMANIAN CHEMISTRY), edited by Petre T. Frangopol, Romanian Academy Publishing House, 2018, Bucharest, 457 pp.

The current editorial project is part of the “Romanian Civilization” collection, an ambitious project undertaken by the Romanian Academy to support and promote the Romanian culture and science, in the year that marks the Centenary of the Great Union from 1918. The editor set the aim of filling the gap in the scientific literature and informing the readers from a wide audience on the history and development of chemistry in Romania.

The perspective on the history of chemistry integrates the story of chemical science with that of chemical industry to sum up on three layers: the growth of the main chemistry domains (inorganic, organic, analytical, hydrocarbons chemistry *etc.*), the contribution of chemistry to the national economy and the development of the chemical industry after the Second World War.

In the introductory chapters, *The role of chemistry in industry*, *Introduction to the history of chemistry in Romania* and *Romanian exceptional contributions in chemistry*, the editor Petre T. Frangopol (Member of

the Romanian Academy) suggests that a new approach is needed to better understand the emergence of chemical science and chemical industry, and this book is an initial step in creating such a synthesis.

The following chapters, on the chemistry of petroleum and natural gas (Gheorghe Ivănuș), organic chemistry (Petru Filip, Michaela-Dina Stănescu and Ioan Grosu), inorganic chemistry (Marius Andruh, Cristian Silvestru and Anca Silvestru), physical chemistry (Nicolae I. Ionescu and Petre T. Frangopol), analytical chemistry (Victor David and Andrei Florin Dăneț), fertilizers (Mircea Turtureanu), pesticides (Sanda Velea), dyes (Angela Anca-Athanasiu), food chemistry (Daniela Borda), biochemistry (Carmen Socaciu), pharmaceutical industry (Petre Pănculescu and Elisabeta Amăriuței), military chemistry (Ioan Savu), textile chemistry (Laura Chiriac, Adriana Subțirică, Marian-Cătălin Grosu and Maria-Iuliana Bârliba), pulp, paper and fibers (Valentin I. Popa), soaps and surfactants (Aurelia Piscureanu), catalysis (Vasile I. Pârvulescu), heavy water (Mircea Turtureanu), ferrous and non-ferrous metals (Florentina Potecașu), cement-ceramic-glass (Doru Valentin Pușcașu and Maria Georgescu), tires and technical rubber articles (Gheorghe Ivănuș, Corneliu Ionescu and Constantin Drăguș), offer a thorough examination of the diverse products and technologies that have transcended academic research into industrial reality. These chapters are not only overviews of the different branches of the chemical industry, but also investigations of the historical, economic, technological, organizational and educational factors that determined the industrial growth rates.

The third part of this book, including chapters *Chemistry at the Institute of Stable Isotopes* (Damian Axente), *Radiochemistry at Romanian universities* (Karin Popa), *Chemistry at the Institute of Atomic Physics*, *Radiation chemistry and the preservation of national cultural heritage* and *Chemical engineering* (Petre T. Frangopol), describes the role of some individual scientists and research institutes that have been involved in fundamental and theoretical research. Along with the recognition of some remarkable academically trained chemists that used their skills as managers, consultants, analysts and researchers, this section also discusses the role of scientist networks, including both academic and non-academic institutions, as well as the special role played by chemical engineering education in the history of the Romanian chemical industry.

The last part, *The need to reindustrialize Romania* (Gheorghe Ivănuș), presents the conclusion of many national debates: the period from 1950 to 1989 was extremely important in the development of the Romanian chemical industry and in the professionalization of chemistry. Although there are many books on the history of Romanian chemistry, this is, surprisingly, one of the first books that actually document the developments in chemical engineering, together with a similar work published also in 2018, “Cartea Albă a reindustrializării României (Industria chimică, petrochimică și de petrol)” (White Book of Industrialization of Romania – Chemical Industry, Petrochemistry and Oil), edited by Gheorghe Ivănuș, AGIR, 2018, Bucharest.

Written by experts in their domain, who provide evidence-based information, as well as industry specific information, which cannot be found anywhere else in the literature, the work is well-written and easy to understand. The inclusion of such a broad range of industries makes this book a real contribution to the literature on the history of Romanian science, because all these industries share the common theme of having dedicated chemists and chemical engineers that faced the challenging to combine technology and science to transform Romanian chemistry in one of the most important industries worldwide.

Bogdan-Marian Tofanica

CARTEA ALBĂ A REINDUSTRIALIZĂRII ROMÂNIEI (INDUSTRIA CHIMICĂ, PETROCHIMICĂ ȘI DE PETROL) (WHITE BOOK OF INDUSTRIALIZATION OF ROMANIA – CHEMICAL INDUSTRY, PETROCHEMISTRY AND OIL), edited by Gheorghe Ivănuș, AGIR, 2018, Bucharest, 479 pp.

Globally, the need for chemicals has undergone a fundamental change over the past years and reflects the importance of this subject today. Even though environmental concerns have constantly increased worldwide, compared to other economic and social concerns, much more oscillating, the manufacture of chemical products is continuously expanding, compared to that of natural raw materials or natural products. The automotive, machinery and electronics industry, the furniture industry, constructions, agriculture, renewable energy, IT&C, fashion industry and even the food industry are based on chemical engineering to obtain products that provide us with comfort in our daily lives.

Discussing the technological supremacy of the chemical industry before the 1990s and the leading position it should adopt to solve some of the largest challenges Romanian industries have seen after the 1990s, this book discusses re-industrialization proposals, rebuilding existing plants and adding new industrial objectives, options and strategies for industrialization, domestic and export market issues, SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of different branches of the chemical industry.

In a short introduction, the editor tackles the problem of evaluating petroleum and natural gas resources as raw materials for the country's path to successful chemical industrialization.

The core of this book provides case studies on 12 of the largest chemical branches: hydrocarbons chemistry, natural, artificial and synthetic fibers, inorganic and organic chemistry, pharmaceuticals, tires and technical rubber articles, construction materials, catalysis, and biotechnologies. For each of the major sectors of the chemical industry, authors cover a short historical review of the industry, its origins, achievements and fundamentals, the most important products, processes, history and abundant, but relevant statistics. Each contributor draws on his/her extensive first-hand management experience to give a balanced coverage, which is both easy to read and authoritative, including their industrial relevance from an economic, technological and profitability point of view. The synthesis also presents new insights into quality, safety and environmental issues, and suggestions for new industrial developments and fundamental research at the level of today's technologies and knowledge in the specific fields.

A final concluding chapter summarizes the forthcoming megatrends and potential challenges, opportunities and the outlook of the educational, research and development in the chemical engineering sector as a whole. The importance of chemical science and chemical industries is increasing and, in theory, a country with enough raw materials should make use of this advantage. It is, unfortunately, not the case of Romania, where the education and the research-development sectors in chemistry have experienced a pronounced regression in recent years, after under-financing them to the level of the basic necessities and the demolition of the industrial base, there are no real possibilities for hiring graduates, who are forced to emigrate or to retrain for other professions.

It is an excellent complementary lecture to "Istoria chimiei românești" (History of Romanian Chemistry), edited by Petre T. Frangopol, Romanian Academy Publishing House, 2018, Bucharest, the two books being among the relatively few published studies on the development of the Romanian chemical industry during the 19th and 20th centuries, which also offer new perspectives on issues that are of interest to historians of science, involved in chemistry and chemical engineering.

This book is an excellent resource for undergraduates, graduates, professionals, academics, the public and the investors, which helps understand how modern Romanian chemical industry was created, with references and recommendations from various chapters, serving as a good reference on this subject.

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