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Book review

# Chemistry under extreme or non-classical conditions

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Greener processes serve as a main target of any chemical/physical transformation on an industrial scale, due to increased waste policy regulations and public health awareness. The current need for greener processes stresses the importance of the development of more intensified and cleaner alternatives to "traditional" chemistry. The utilization of extreme conditions, such as high pressure, microwave and sonochemistry, along with supercritical, and plasma applications, constitutes non-classical, alternative chemistry tools. "Extreme conditions", being a rather relative term varying from reaction to reaction, implies performing the reaction under harsh conditions attained by increased temperature and pressure in various media. The current book presents the status, milestones, and theoretical background of every "extreme tool" available so far. The title concerns chemistry under extreme or non-classical conditions. Under the term "chemistry", examples of organic, inorganic as well as organometallic syntheses are comprised. Moreover, a clear illustration of the techniques used in every particular sub-field is provided, along with experimental methodology and required analytics. Great and careful balance is given in terms of the mathematical description of the discussed effects, allowing every reader to make basic, yet fundamentally necessary, calculations. Thus, this book is perfect for newcomers to the field looking for the fundamentals as well as for already accustomed "fish" looking for the answers to the specific questions, or to fill up the blanks in the existing knowledge.

High temperature (HT) species synthesis and its application constitute chapter 1. A clear, simplified and well-organized demonstration of experimental techniques, such as resistive and electron beam heating, utilization of static and rotating reactor systems, along with some additional reactor designs in the generation of HT species, is presented. Applications of those are then summarized through versatile assembly of chemical reaction examples. Catalytic species synthesized as such are utilized in hydrogenation, Fischer-Tropsch and polymerization reactions, etc.

High pressure applications in inorganic and organic reactions are discussed in chapters 2 and 3, respectively. Presentation of the available high pressure withstanding equipment, discrimination of techniques applied, along with the corresponding operating conditions and required analytics, is given first, followed by the representation of pressure effects on chemical reactions via mathematical equations. Here, a clear distinction, usually lacking in the related reviews in between intrinsic, solvation and other types of volume changes taking place along the reaction coordinate, is presented. The information given describes the kinetic acquisition methods and reaction mechanism determination for the high pressure studies. Reactions are discussed separately with respect to their types in a greater detail with accompanying examples, which makes it easy to follow throughout, as well as to use as a reference material for the specific type concerned. More in-depth knowledge in organic chemistry synthesis under high pressure is given in chapter 4. Successful cross-reference to chapter 3 eliminates the repetition of the related mathematical description, introducing solely a further derivation. An extremely relevant and most interesting type, provided by high pressure non-conventional effects, is that of regio- and enantioselectivity enhancement. Related examples are presented, providing an overview of achievements in the synthetic organic chemistry.

Supercritical fluids (SCFs) used in inorganic and organic synthesis are discussed in chapters 5 and 6, respectively. The theoretical background and properties of SCFs are presented with the support of concise tabulated data and clear schemes. Changes in physical properties of the medium, taking place in the supercritical region, such as in density, solubility, surface tension and viscosity, are discussed along with the related synthetic applications. Industrial and environmental applications of SCFs are presented in chapter 7. Although relevant to the topic discussed, the chapter content would be better appreciated by an environmental or chemical engineer, rather than by a synthetic chemist; this is not the case with the following chapters.

Ultrasound, as a tool in chemical synthesis, is discussed in chapter 8. Once again, a basic description of the technique is given, along with a discussion of the highly important role and the effect of cavitations in various systems. Examples of reacting systems ultrasonically intensified are given for organic, inorganic and organometallic syntheses, as well as for sonocatalysis. Polymer processing, approached through ultrasound utilization, is proposed in chapter 9. Sonochemical polymerization results in the intensified initiation process, controlled propagation and thus lower polydispersity index, which is an ultimate aim of every polymer synthesis. Ultrasonic degradation of the polymers, through the chain breakage, is shown to be responsible for the discrepancies in molecular weights of polymers when prepared sonochemically, rather than conventionally, under otherwise similar conditions. Chapter 10 gives

an overview on water induced electrohydraulic cavitation and pulsed-plasma discharges. Here, unique study results are summarized and the high efficiency of sonochemical degradation is discussed. Extremely fast degradation of hazardous waste can be achieved in industrial applications in the order of seconds when electrohydraulic discharge is utilized.

Microwave dielectric heating, as a way of introducing thermal energy into the reacting system, is presented throughout chapter 11. Starting with the dielectric and interfacial polarization and conduction effects, the authors continue with the presentation of microwave equipment, with detailed description of constituting equipment parts. Means of temperature data acquisition are followed by examples of related applications, concluded by microwave syntheses involving solids and organic reactions in dry media.

Extreme conditions applied to biomolecules are summarized in chapter 12. The effects of high pressure and temperature on phospholipids, proteins and microorganisms are discussed, along with the specific examples. The denaturation of proteins studied and followed by IR and high-pressure NMR constitute a very unique example leading to the discussion of limits of corresponding extreme conditions. Industrial application is concentrated on killing the microorganisms within the media, with the aim of preservation.

All in all, the piece introduces the subject, to deepen the reader's knowledge quite systematically, be it an experienced researcher in the related field or a research student in the need for a good head-start. Upon reading the content, it almost feels as though the book was written by the same author throughout, despite some inconsistencies in the layout of some chapters in comparison to others. The reference format is not obeyed for some entries, however, the version of citation is still sufficient to find the article sought. Included reactor designs and process flow diagrams throughout the discussions suggest that with a little bit more focus, the book could be easily converted to the handbook of "Extreme and Non-Classical Processes" to be used by chemical and process engineers. Future prospects and challenges presented in almost every chapter inspire the reader to work on the development of a greater future with minimal waste generation and effect on the public health.

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