

Editorial

Special Issue Editorial: Eutectic Solvents

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Introduction

Ionic liquids (ILs) is an umbrella term covering a variety of sub-definitions that focus on more specific subjects. This general research area encompasses more than a hundred thousand of papers published since the first discovery of a low melting-temperature organic salt formed by ethanalammonium nitrate in 1888 by German scientists Gabriel and Weiner [1]. Some [2,3] have attributed the starting point to the more recent finding by Paul Walden [4], who discovered the low room temperature melting point of $[\text{EtNH}_3][\text{NO}_3]$. Regardless of the information's actual origin, the potential benefits of lowering the melting points of molten salts was very soon recognized, appreciated, and followed world-wide. Therefore, papers focusing on ionic liquids projects have been repeated like a mantra, thus leading to an explosion of interest in the subject. This explosion becomes immediately understandable when inspecting of the number of papers published every year in the field. Figure 1a documents this eruption of interest in ionic liquids in the 21st century. Additionally, it is worth mentioning the linear growth of the accumulated knowledge over the last decade, as illustrated in Figure 1b. The current year seems to break the trend, but this is probably mainly due to the still-ongoing processing of many papers and omnipresent pandemic restrictions.

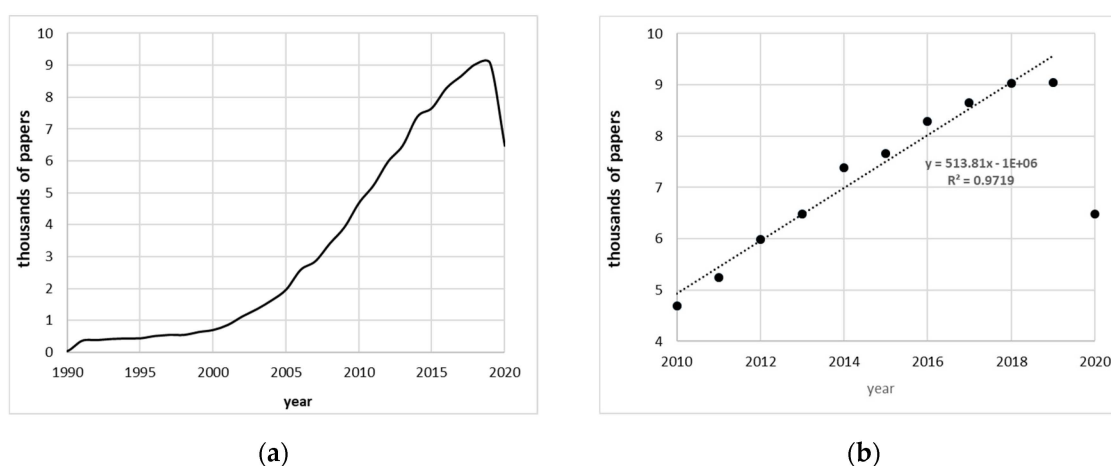


Figure 1. Time evolution of published papers with keyword “ionic liquid” according to Web of Science (updated September 2020) expressed in thousands of papers yearly during (a) the last three decades and (b) the last decade.

The general explanation for why about 55,900 authors have published more than two papers in the field—written in 23 languages (fortunately with English predomination), coming from 621 countries,

founded by over 61 thousand grants, and covering 183 Web of Science Categories—is, of course, the unique properties of ILs. Compared to others in the large liquidus range, these ILs have a high ionic conductivity, high thermal stability, extremely low vapor pressure, high electrical conductivity, large electrochemical window, and the ability to solvate compounds of widely varying polarity [5]. These properties have led to a variety of practical applications in many different industrial branches and research areas. The accumulated data on many physical properties for over two thousand available ILs are now freely available in open databases, e.g., ILThermo (v2.0) [6,7].

The first term used in the two-word title of this special issue covers both the outline of the potential systems under interest and the scope of their possible application areas. However, neither are strictly and univocally defined. Indeed, eutectic solvents (ESs), eutectic mixtures (EMs), deep eutectic solvents (DESs), and natural deep eutectic solvents (NADESs) share some physicochemical properties and similar structural foundations. First of all, any eutectic system is a homogeneous mixture of substances melting or solidifying at a lower temperature than the one characterizing any of the constituents and their composition in multicomponent systems. On the other hand, the constituents formulate an eutectic mixture due to mutual interactions between Lewis or Brønsted acids and bases, which are organic or organometallic compounds that adopt anionic and/or cationic forms. Additionally, this is, *par excellence*, the very definition of ionic liquids. On the other hand, the second term in the title reflects applicability domains as promising functional liquid media (FLM); green, sustainable, and nanostructured ionic solvents (NISs); and neoteric solvents (NSs). From this perspective, the attractiveness of these kind of research topics can be confirmed by the collection of published papers, as exemplified by Figure 2.

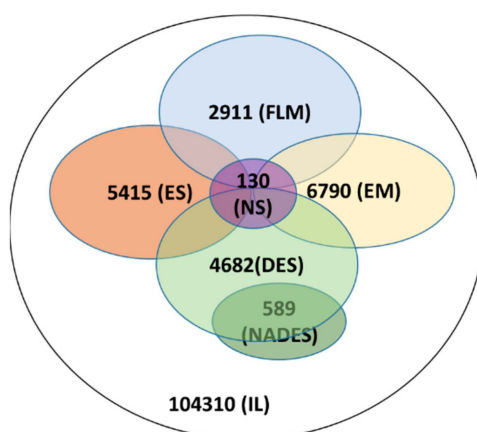


Figure 2. Schematic representation of interests in the specified fields by the overall number of published papers (updated September 2020) focusing on ionic liquids (ILs), functional liquid media (FLM), eutectic solvents (ESs), eutectic mixtures (EMs), and neoteric solvents (NSs).

This special issue represents only a small portion of available topics, but it offers two interesting reviews, one mini-review, and one original paper. Laboratory research was significantly prohibited due to global pandemic restrictions. Thus, the collection of new experimental data accumulated despite this disastrous time is of special value. This is why the contribution of Michal Jablonsky is greatly appreciated. I hope that this contribution attracts the attention of a broad range of readers, so I invite open discussion on these new, interesting trends in the field of eutectic mixtures that are practically used as eutectic solvents.

In the first manuscript, which documents the original research of Jablonsky et al. [8], the applicability of deep eutectic solvents for phenolic compound extraction from spruce bark is demonstrated. The authors applied spectrophotometric measurements to quantify the total phenolic content (TPC) and antioxidant activities in extracts of selected eutectic solvents. The extensive set of solvents comprised a variety of molar ratio combinations of choline chloride with lactic acid augmented

with 1,3-propanediol, 1,5-pentanediol, 1,4-butanediol, or 1,3-butanediol and water. It was documented that the highest antioxidant activity and radical scavenging activity were found in choline chloride, lactic acid, 1,3-butanediol, and water in a 1:5:1:1 molar ratio. Radical scavenging activity as high as 95% was determined for this eutectic solvent, which was also associated with the highest content of polyphenols in its respective extracts.

Another interesting perspective of eutectic solvent applicability is raised by Xue et al. [9]. In this interesting review, the authors share their perspective on the development and potential benefits of DES-based resin composites. This approach not only adheres to green chemistry policy but can also be used for the further improvement of resin composites. The authors emphasize the necessity of in-depth studies on the intermolecular forces that stabilizing DESs introduce to polymeric matrices. The comprehensive summary of research on the processing of composite resins with DESs is especially valuable from the perspective of low-cost technology for the processing of high-tech products that utilize DES-based composite materials.

The interdisciplinary and far-reaching applications of eutectic solvents are reviewed by Jablonský Šima [10]. Due to the enormous number of experiments on extraction processes, the systematization of the accumulated knowledge of eutectic solvents in the synthetic form is of particular importance. The authors do an excellent job of presenting an organized overview of the use of DESs as extraction agents for the recovery of valuable substances and compounds from original plant biomass. They include waste from its processing and waste from the production and consumption of plant-based food. The alphabetical ordered lists make the data more accessible when information on the extracted particular substances is needed. Furthermore, additional information can be retrieved from provided compilations, including a description of the extracted phytomass, DES composition, extraction conditions, and, of course, all literature sources.

The final article in the issue [11] deals with the subdomain of the extractions represented by molecularly imprinted polymers (MIPs). The authors advocate the application of DESs for the preparation of MIPs by summarizing contemporary achievements in the field. It is of particular importance that the new DESs' applicability is outlined, with focus on potential new breakthrough technology in greener separation, analytical techniques, and the production of MIPs.

In conclusion, it is worth emphasizing the extremely broad and unpredictable span of the potential applications of eutectic solvents in areas that were unimaginable for the pioneers mentioned in the introduction of this editorial. The papers included in this issue are just a few exemplary steps in the ever-expanding possibilities, insights, understandings and inspirations.

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Conflicts of Interest: The author declares no conflict of interest.

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