SUMMARY OF DOCTORAL DISSERTATION

Design and development of highly active and selective acidic catalysts

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One of the primary challenges, also for processes conducted on an industrial scale, lies in the development of catalysts that combine high activity, selectivity, and stability, facilitating recovery and multiple reuse in subsequent processes. The use of traditional acids as catalysts exhibits several difficulties, including complex separation of the catalyst from the reaction mixture, the inability to recycle the catalyst, and limited selectivity, which leads to reduced efficiency and the formation of impurities that complicate product purification. Therefore, the implementation of modern and efficient solutions should incorporate considerations of sustainability and environmental impact.

The aim of the doctoral dissertation was to develop new acidic ionic liquids and apply them as catalysts characterized by high activity and selectivity in selected chemical processes. An important aspect was the stability of the proposed systems, which allowed the recovery of the catalyst from the post-reaction mixture and their repeated reuse in catalytic cycles.

In the doctoral thesis the innovative catalytic systems were developed in the form of ionic liquids with Lewis acid properties as well as ionic liquids with Brønsted acid characteristics. Systems based on the concept of solvate ionic liquids were synthesised using Lewis acids in the form of aluminum(III) and gallium(III) triflates, while the protic ionic liquids representing Brønsted acids were based on sulfuric acid(VI). A range of Lewis acid-based systems was investigated using nuclear magnetic resonance spectroscopy (^{1}H, ^{13}C, ^{19}F, ^{27}Al, ^{71}Ga NMR) and infrared spectroscopy with Fourier-transform (FT-IR). Additionally, the acidity of all synthesised systems was determined by measuring Gutmann acceptor numbers (AN). The activity of the prepared alternative catalysts was demonstrated in processes such as cycloaddition [4+2], cycloaddition [3+3], and esterification.

Following the trends in green chemistry and the economic aspects of the developed methods, particular attention was paid to the possibility of isolation, regeneration and recycling of catalysts, and the research included the identification of optimal reaction conditions. The catalytic systems obtained as a part of the doctoral thesis have been successfully applied to selected reactions from the *fine chemicals* sector. The catalysts have been reused multiple times. Moreover, the selection of favourable reaction conditions, such as process temperature, reagents ratio, catalyst type and loading enabled very high process efficiencies to be achieved. The research carried out in doctoral dissertation extends the range of known acidic ionic liquids and confirms their potential as alternative catalysts, particularly in the context of industrial applications, such as the production of high-value speciality products.