

Development of Fluorous Lewis Acid-Catalyzed Reactions

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Abstract

Green Sustainable Chemistry (GSC) is a major objective for chemical companies in the twenty-first century, and we can assume that GSC will become a big goal for chemical companies in the future. The major goal of synthetic organic chemistry is to produce waste-free and ecologically friendly commercial processes that use Lewis acids such as aluminium chloride. A primary technological goal of our work in this subject has been the creation of a "catalyst recycling system that exploits the high activity and structural features of fluorous Lewis acid catalysts." As a result, we've developed a new class of fluorous Lewis acid catalysts, such as bis (perfluoroalkanesulfonyl) amides or tris (perfluoroalkanesulfonyl) methides of ytterbium (III), scandium (III), tin(IV), or hafnium (IV). In supercritical carbon dioxide, in a Fluorous Biphasic System (FBS),

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Introduction

In addition to the desired product, Lewis acid-mediated processes involving aluminium chloride produce a lot of acidic waste (s). With this in mind, we set out to develop new reaction procedures catalysed by highly active, selective, and recyclable Lewis acids that would significantly reduce acidic waste while also having the potential to replace current aluminium chloride approaches. This paper describes a series of fluorous biphasic reactions catalysed by fluorous Lewis acids with a large number of fluorine atoms, heterogeneous Lewis acid-catalyzed reactions using fluorous silica gel-supported fluorous Lewis acids, and fluorous Lewis acid-catalyzed reactions in supercritical CO₂. Fluorous Lewis acid catalysts have been discovered to be both beneficial and recyclable in carbon-carbon bond generating reactions such as the Diels-Alder reaction, Mukaiyama aldol reaction, and Friedel-Crafts acylations [1]. Friedel-Crafts acylation of anisole and related aromatic compounds, in particular, necessitates an equimolar or greater amount of a catalyst, such as aluminium chloride, whereas Friedel-Crafts acylation of anisole and related aromatic compounds was successful. It was a win-win situation because this catalyst was also recyclable. Toluene and even chlorobenzene could be used as both nucleophilic aromatics and solvents. Fluorous Lewis acid catalysts, which catalyse several activities at the organic/fluorous interface, are water stable due to their high water repellency. As a result, fluorous Lewis acid catalysts were assumed to be suitable for use in water-based reaction systems. The use of Hf[N(SO₂-n-C₈F₁₇)₂]₄ as a catalyst in direct esterification processes was studied. The catalytic reactions of an equimolar quantity of carboxylic acid and alcohol were carried out at a low temperature (less than 100°C) without distilling the water produced as a by-product. As expected, the hafnium (IV) catalyst was recyclable. Because water is immiscible in both the organic and fluorous phases, it was assumed that water rapidly flowed out of the reactive site at the organic/fluorous interface. The Baeyer-Villiger reaction is a useful process for converting ketones into esters or lactones. Ketones are often treated with a stoichiometric dose of a potentially explosive concentrated organic peracid such as peracetic acid or perbenzoic acid to carry out this reaction [2]. Utilizing our fluorous catalysts, we devised an environmentally friendly Baeyer-Villiger oxidation using commercially available and less explosive 35 percent aqueous hydrogen peroxide solution. Sn[N(SO₂-n-C₈F₁₇)₂]₄ was discovered to be the most effective catalyst for lactonization of cyclic ketones such as 2-adamantanone after

testing other catalysts. Fluorous solvents have a higher density than conventional organic solvents. We constructed an unique continuous-flow reaction apparatus based on this principle, which comprised of a reactor with a mechanical stirrer and a decanter. The fluorous solvent is put into the reactor, then a fluorous catalyst such as $\text{Yb}[\text{N}(\text{SO}_2\text{-C}_{10}\text{HF}_{20}\text{O}_3)_2]_3$ is added, which is immobilised in the fluorous solution due to its insolubility non normal organic solvents. The mobile organic phase, which contains organic substrates and reagents, continuously flows into the reactor and is violently agitated with the stationary fluorous phase. The emulsion mixture is automatically fed to the decanter after the reaction, where the organic and fluorous phases are separated. The upper organic phase, which contains the product(s), overflows and is collected, while the lower fluorous phase is recycled, allowing the substrates to be easily converted to products in this continuous-flow system. The application of this method to industrial operations is critical [3].

Conclusion

In a fluorous biphasic system, immobilised on fluorous silica gel, and in supercritical carbon dioxide, we established a number of useful reactions catalysed by novel fluorous Lewis acids $\text{M}(\text{N}(\text{SO}_2\text{-n-C}_8\text{F}_{17})_2)_n$. In many situations, the catalysts were recyclable, allowing for the decrease of acidic waste. For industrial applications, we developed a continuous-flow reaction system based on the fluorous biphasic system. Fluorous catalytic reaction methods can be used to synthesise a variety of products, including fine chemicals, pharmaceutical and pesticide intermediates, and are projected to become a viable technology for reducing acidic wastes in the near future.

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