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REVIEW ARTICLE

Tris(pentafluorophenyl)borane [$B(C_6F_5)_3$]-catalyzed Organic Transformations: A Triennial Update (2021 Onwards)

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Abstract: Although a number of Lewis acids based on boron have been identified thus far, tris(pentafluorophenyl) borane [$B(C_6F_5)_3$] (henceforth, BCF) has drawn the greatest interest from the synthetic chemistry community. Due to its commercial availability and thermal stability, BCF has been thoroughly investigated in organic and materials chemistry for its potential as a Lewis acid catalyst. The last two decades have witnessed the majority of BCF chemistry research in organic synthesis, and numerous novel catalytic reactivities are presently being studied. In this triennial update, which covers the period from 2021 to the present, we have thoroughly and critically reviewed the most representative applications of tris(pentafluorophenyl)borane in organic synthesis. Mechanistic studies are presented together with the scope of the catalyst.

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Keywords: Boranes, tris(pentafluorophenyl)borane [$B(C_6F_5)_3$], lewis acid, organic synthesis, thermal stability, organoboron derivatives.

1. INTRODUCTION

For more than six decades, boron compounds have been widely employed in chemical synthesis [1-3]. Herbert C. Brown (1912-2004) was awarded the 1979 Nobel Prize in Chemistry for the use of boron reagents in organic synthesis [4]. Since then, this relatively uncommon element has continued to be at the forefront of contemporary synthetic chemistry. Organoboron derivatives are involved in some of the most well-known chemical processes, including the Suzuki-Miyaura coupling reaction and hydroboration [5-7]. Furthermore, organoboron compounds have been used in materials research, molecular imaging, the pharmaceutical industry, and as agents for neutron capture treatment [8-10].

Over the past few decades, the catalytic potential of boron-based compounds has been extensively investigated; nevertheless, due to its varied utility in both synthetic and material chemistry, tris(pentafluorophenyl)borane, or BCF, has emerged as a front-runner among them in recent years. When BCF was initially introduced in 1963, Massey and associates synthesized it [11]. It was found to be a potent Lewis acid that combined with other Lewis bases, such as triphenylphosphine, to generate adducts. Using the approach proposed by Childs *et al.*, the Lewis acidity of BCF is halfway between that of BF_3 and BCl_3 [12, 13]. BCF was "rediscovered" decades after it was first mentioned in the literature when it was found to have the perfect qualities for use as an activator component for homogenous metallocene Ziegler-Natta catalysts for olefin polymerization and the chemistry involved [14]. Tris(pentafluorophenyl)borane was long associated with homogenous Ziegler-Natta catalyst activation; nevertheless, in recent years, a growing number of reactions utilizing the unique properties of BCF outside of polymerization catalysis have been reported in the literature [15]. Due to its strong ability to abstract anions, particularly carbanion equivalents, its steric bulk combined with high Lewis acidity, and the persistence of the resulting anions, BCF is a valuable catalyst or stoichiometric reagent that can be used to initiate a variety of specific reactions in organic and organometallic chemistry as well as open synthetic pathways to novel compounds with unusual structures. BCF exhibits remarkable thermal stability; unlike many fluorinated boron compounds, which break down by removing BF_3, it remains stable for many days at temperatures as high as 270°C. It can also withstand water and is resistant to oxidation by molecular oxygen.

$B(C_6F_5)_3$, a Lewis acid, is important in many different catalytic reactions. Although it was utilized in the 1990s as an activator for catalysts used in olefin polymerization, Piers demonstrated in 1996 that it was also a potent catalyst for the hydrosilylation of ketones [16]. BCF has been extensively used to mediate the hydrogenation of a wide range of substrates and in the activation of a variety of small molecules since the introduction of frustrated Lewis pairs (FLPs) in 2006. In recent times, organic chemists have been paying more attention to this Lewis acid due to its practical applications in organic synthesis [17-19]. Piers and Chivers traced the rise of pentafluorophenyl boron compounds from curiosities to important commodities [20]. Erker, in 2005, reviewed its applications for special reactions [21]. McGrath and Hackel showed the utility of

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