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Greener media for nano catalysts in Suzuki Miyaura reaction

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ABSTRACT

The exponential growth pertaining to the Suzuki–Miyaura(SM) reaction and its appliances in the last decade speaks volumes about its efficiency and effectiveness in the production of pharmaceuticals, polymers, materials, fine chemicals, and the total synthesis of natural products. The usage of less toxic, biocompatible, and common coinage metal catalysts; the deployment of supported catalysts and nano catalysts; the involvement of less toxic electrophilic partners; employment of biocompatible supports, and greener reaction media are prominent strategies for greener and sustainable SM reaction. Given the advantages for industry, the environment, and the public, and since solvents are used in larger quantities during organic synthesis, which contributes to a huge impact on the environment and health, a thorough grasp of the numerous greener approaches focused on a variety of newer supported nano catalytic systems and benign media for SM reaction need to be explored further. This review encompasses research published between 2020 and 2024, that discusses SM reaction with effectually supported nano catalysts in a range of greener reaction media.

1. Introduction

The discovery of transition metal-catalyzed cross-coupling processes in the latter quarter of the 20th century marked a major advancement in synthetic organic chemistry [1]. Amongst the most significant and frequently employed catalytic transformations in contemporary organic synthesis are carbon-carbon and carbon-heteroatom cross-coupling reactions that are enabled by palladium(Pd) [2–10]. A wide range of applications, from the bulk industrial production of active pharmaceutical ingredients, materials, agrochemicals, fine chemicals, and the total synthesis of natural products on a millimolar scale, have already been made possible by the ability to form new C—C, C—N, C—O, or C—S bonds between or within functionalized and sensitive substrates [11–18]. Midst the several cross-coupling reactions, C—C coupling reactions occupy an important position.

1.1. *C—C cross-coupling reactions*

Suzuki–Miyaura, Hiyama, Stille, Heck, Negishi, Kumada, and Sonogashira reactions are leading examples of C—C coupling reactions as attested by the 2010 Nobel Prize in Chemistry awarded to Professors Heck, Suzuki, and Negishi in view of their multifarious applications [19–26]. Most coupling reactions, till the late 1970s, deployed organometallic reagents encompassing Cu, Mg, Al, Zn, Zr, Hg, and Si. However, it was shown that alkenyl boranes or their -ate complexes remain inert during such reactions [27]. The Pd or $Pd(PPh_3)_4$ catalyzed stereoselective synthesis of arylated alkenes utilizing alkenyl boranes and aryl halides, was first reported by Professors Akira Suzuki and Norio Miyaura in 1979 (Scheme 1) [28] which led to the uncovering of SM.

1.2. *Suzuki–Miyaura(SM) reaction*

One of the more effective ways to create new C—C bonds is by SM reaction, which combines an aryl or vinyl (pseudo) halide with a boronic acid or ester in the presence of a catalytic quantity of Pd(0) [28–30]. The availability of innocuous, ubiquitous organoboron derivatives that are stable in aerobic and aqueous conditions, companionable with most functional groups, and produce non-toxic byproducts has been substantially responsible for the popularity of SM reaction. Its inherent versatility and ability to use a variety of solvents have also contributed to its popularity (Fig. 1) [30,31]. In fact, after the creation of amide bonds, the SM reaction is the second most commonly employed reaction

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