Clean Techn Environ Policy
DOI 10.1007/s10098-013-0658-7

ORIGINAL PAPER

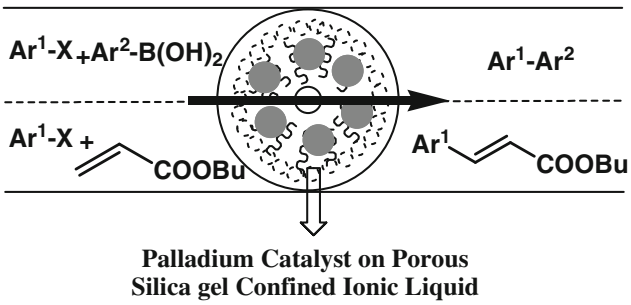
Palladium supported on silica gel confined ionic liquid as a reusable catalyst for carbon–carbon cross coupling reaction in water

Sudip Ghosh · Raju Dey · Sabir Ahammed · Brindaban C. Ranu

Received: 8 March 2013 / Accepted: 18 June 2013

Abstract We have developed an efficient method for carbon–carbon cross coupling reactions using a palladium-catalyst supported on porous silica gel confined ionic liquid, 1-decyl-3-methyl imidazolium fluoroborate ([dmim]BF_4) in water at 80 °C. A variety of substituted aryl bromides underwent Suzuki and Heck coupling with various boronic acids and acrylates respectively to produce a series of functionalized biaryls and cinnamates in high yields. The catalyst is stable, recyclable and it offers very high turnover numbers.

Graphical Abstract



Keywords Cross-coupling reaction · Palladium supported on silica gel confined ionic liquid · Recyclability · Reaction in water · Environment-friendly

S. Ghosh · R. Dey · S. Ahammed · B. C. Ranu (✉)
Department of Organic Chemistry, Indian Association for the Cultivation of Science, Jadavpur, Kolkata 700032, India
e-mail: ocbcr@iacs.res.in

Introduction

The palladium-catalyzed cross coupling reaction constitutes a useful tool for carbon–carbon bond formation (Tsuji 1969). Several important protocols such as Suzuki (1999), Miyaura and Suzuki (1995), Hatanaka and Hiyama (1988), Hiyama (2002), Stille (1986), Espinet and Echavarren (2004), Heck and Nolley (1972), Beletskaya and Cheprakov (2000), Sonogashira et al. (1975), Chinchilla and Najera (2007) reactions were discovered during past few decades, and these made tremendous advancement in organic synthesis. Because of the wide applications of these cross-coupling reactions, continuous renovations are going on towards design of better catalyst and experiment. The homogeneous Pd-catalysts are usually used because of a number of advantages such as uniform and accessible active sites imparting better selectivity and high yields, easy optimization of ligands etc. However, chance of contamination of metal in the product due to difficulty in separation of soluble metal complex and single use pose a serious limitation in its use in industry. The use of heterogeneous supported catalysts are receiving tremendous attention primarily because of their ease of separation, reusability and environmental acceptability, in spite of their limitations of less efficiency compared to homogeneous counterparts in certain reactions (Yin and Leibescher 2007). Various materials such as alumina, hydrotalcite, hydroxyapatite, modified silica, zeolites, cyclodextrins, polyamides and polyamines are used as the solid support. The comparatively high stability of a catalyst on solid support sometimes allows the reaction to be less sensitive to normal ambient conditions such as, without the exclusion of air, using water as reaction medium, etc., and hence makes it environmentally benign.

Thus, to have a balance, design of a catalyst containing a homogeneous active site inside the pores of a solid support

Published online: 05 July 2013