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# Palladium supported on natural phosphate: Catalyst for Suzuki coupling reactions in water

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ABSTRACT

The Suzuki–Miyaura coupling reaction is one of the most important synthetic catalytic reactions developed in the 20th century. However, the use of toxic organic solvents for this reaction still poses a scientific challenge and is an aspect of economical and ecological relevance. The use of water as a reaction medium overcomes this issue. In the present work, we described efficient Suzuki coupling reactions in water, without any phase transfer reagents and it is possible to couple challenging substrates like aryl chlorides. Notably, this protocol also works with ultra-low loading of catalyst with high turnover numbers.



## 1. Introduction

Palladium-catalyzed reactions are of utmost importance in synthetic organic chemistry [1,2]. The industrial synthesis of many aryl-containing pharmaceuticals such as anti-inflammatory drugs and blood-pressure regulators include one or several steps of palladium-catalyzed carbon–carbon cross coupling [3–8]. The Suzuki reaction is one of the most important organic transformations developed in modern synthetic organic chemistry in the 20th century [9,10]. The popularity of this reaction is attributable to a variety of factors, such as the commercial availability of a large number of boronic acids, as well as their nontoxic nature and stability to heat, air, and moisture. These reactions are usually catalyzed with palladium in presence of auxiliary ligands using homogeneous catalytic systems. This process is favorable due to its high reactivity, high turnover numbers, milder reaction conditions, and the potential to couple with widely available and inexpensive aryl chlorides [11–15]. However, traditional homogeneous catalysis poses significant issues related to product purification and toxic waste produced after separation of palladium catalyst. These problems are a significant environmental and economic concern in large scale-synthesis. One of the most favorable ways to overcome these problems is the use of heterogeneous catalysis because of its easy recovery and reusability by simple filtration, decantation, and recently by magnetic altercations [16]. Palladium can be immobilized on several solid supports such as activated carbon silica and organic polymers [14–28]. In an efforts to develop a new heterogeneous system, we have initiated a program aimed at introducing natural phosphate (NP) as it is or conveniently modified phosphate that can catalyze several organic transformations. Some examples include Michael-addition, Knoevenagel, Claisen–Schmidt condensation, Friedel–Crafts alkylation, alkene epoxidation, nitrile hydration, and transesterification reactions [29–35]. The use of toxic organic solvents remains a scientific challenge of economic and environmental relevance. It is now widely accepted that their use is considered to be one of the major sources of waste in fine chemical industries and poses serious health as well as environmental hazards. Hence, the need for alternative reaction

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