Assessment of the Reusability of Pd Complexes Supported on Fluorous Silica Gel as Catalysts for Suzuki Couplings

Automated parallel Suzuki reactions with different catalysts

Carl Christoph Tzschucke, Vasyl Andrushko, Willi Bannwarth * Institut für Organische Chemie und Biochemie, Albert-Ludwigs-Universität Freiburg, Freiburg, Germany

ALBERT-LUDWIGS-UNIVERSITÄT FREIBURG

CHEMSPEED TECHNOLOGIES

Pharmaceuticals & Agrochemicals

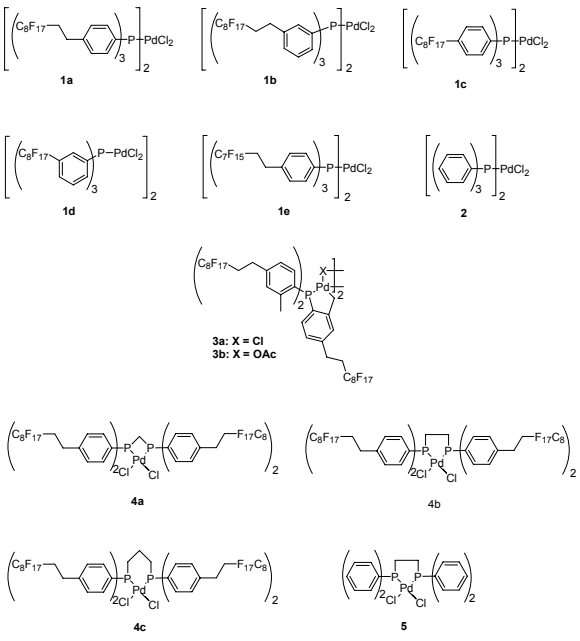
Introduction

- Investigation of different perfluoro-tagged Pd complexes supported on fluorous silica gel (FSG) as catalyst for Suzuki reactions.
- Evaluation of the re-usability of the catalyst by measurement of reaction rates upon recycling of the supported complexes.
- Comparison of perfluoro-tagged and untagged complexes adsorbed on FSG and unmodified silica gel.
- Experiments carried out on a Chemspeed Automated Synthesizer.

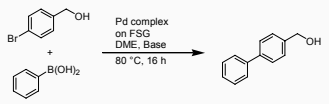
Objective

To present a detailed kinetic study of Suzuki reactions in organic solvents and water, as well as to compare different catalysts, also involving perfluoro-tagged diphosphane complexes and different support materials by the beneficial use of Chemspeed's automated synthesizer technology.

Palladium complexes employed in this study



Activity measurement of the catalyst and organic solvent



Scheme 1. Suzuki coupling of 4-bromobenzyl alcohol and phenylboronic acid

Table 1. Comparison of different supported catalysts, 4-bromobenzyl alcohol (0.3 mmol), phenylboronic acid (0.33 mmol), 0.1 mol-% Pd, K_2CO_3 (0.6 mmol), DME, 80 °C, 16 h.

Entry	Complex	Support	Conversion[a] [%]	Cumulative TON[b]	k_{app}[a] [Lmol^{-1}min^{-1}]
1	**2**	SG	63 (16, 10)	893	90 (1, 0)
2	**2**	FSG	82 (18, 4)	1042	313 (7, 0)
3	**1a**	SG	61 (19, 9)	886	67 (6, 1)
4	**1a**	FSG	71 (36, 13)	1205	111 (10, 1)
5	**1b**	FSG	44 (32, 27)	1029	35 (6, 1)
6	**1c**	FSG	40 (26, 8)	747	35 (1, 0)
7	**1d**	FSG	36 (4, 3)	422	39 (0, 0)
8	**1e**	FSG	70 (31, 7)	1073	76 (3, 1)
9	**3a**	SG	62 (54, 38)	1545	18 (14, 3)
10	**3a**	FSG	67 (37, 19)	1226	24 (9, 3)
11	**4a**	SG	66 (60, 35)	1607	39 (18, 8)
12	**4a**	FSG	66 (64, 50)	1809	27 (23, 15)
13	**4b**	SG	53 (13, 5)	700	25 (2, 1)
14	**4b**	FSG	75 (55, 49)	1786	42 (15, 8)
15	**4c**	SG	62 (48, 27)	1376	22 (13, 6)
16	**4c**	FSG	70 (35, 26)	1310	41 (10, 7)

[a] Values for recycling in brackets. [b] (mol product)/(mol Pd complex).

Picture 1: Chemspeed reactor array with 13 ml filtration kits, utilizing disposable filters.

Summary

In organic solvents, activity decreases upon recycling. Further experiments in water, with 4-brommandelic acid as a water soluble substrate with a reactivity similar to 4-bromo-benzyl alcohol, revealed significantly higher cumulative TONs, as well as that the activity remains at a high level upon re-use of the supported catalyst.

This clearly indicates that yields obtained in repetitive cycles alone are not appropriate to judge the re-usability of catalysts. Instead, it becomes obvious that the rates of reaction also have to be investigated in order to assess the true potential of a catalytic system.

[1] C. C. Tzschucke, V. Andrushko, W. Bannwarth, *Eur. J. Org. Chem.* **2005,** *11*, 5248-5261