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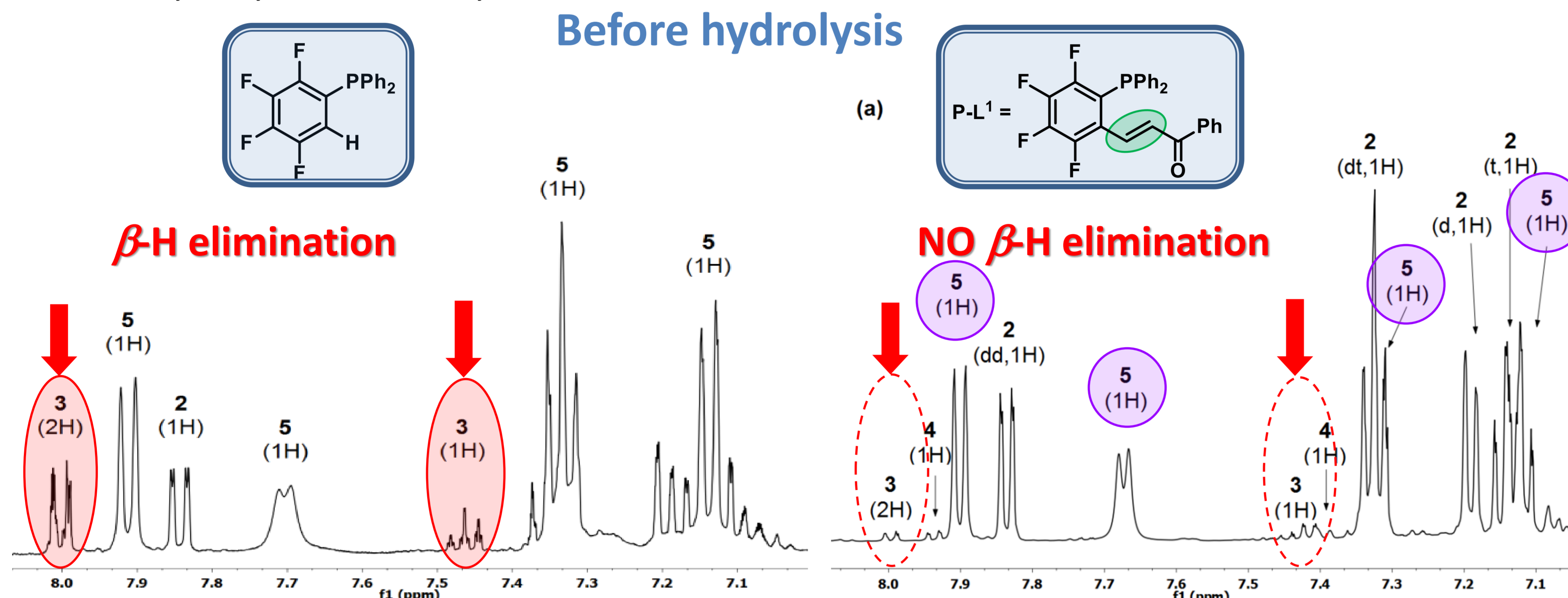
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## INTRODUCTION

A few years ago Lei et al.<sup>1</sup> reported an efficient Pd-catalyzed Negishi-coupling of aryl halides with alkylzinc reagents using the hybrid phosphine/olefin ligand  $\text{PPh}_2(2\text{-RC}_6\text{H}_4)$  ( $\text{R} = \text{CH}=\text{CHCOPh}$ ). Similar results were reported recently by our group<sup>2</sup> using the related phosphine/olefin  $\text{PPh}_2(2\text{-RC}_6\text{F}_4)$  ligand in **Table 1** (**entry 5**) ( $\text{R} = \text{CH}=\text{CHCOPh}$ ) and other  $\text{PPh}_2(2\text{-RC}_6\text{F}_4)$  ligands with different R groups (**entries 3 and 4**). The selectivity toward C–C cross-coupling product **2** was highly improved with the former phosphine (**entry 5**), but decreased substantially with ligands without the electron withdrawing olefin fragment (EWO), and important proportions of Ar–H **3** are formed. In this work<sup>3</sup> we undertake further studies on the **Reaction (1)** to definitely confirm or discard the involvement of  $\beta$ -H elimination in the formation of the undesired reduction product **3**, and to better understand the steps involved in this catalysis.

## Why phosphine-olefin ligands perform better?

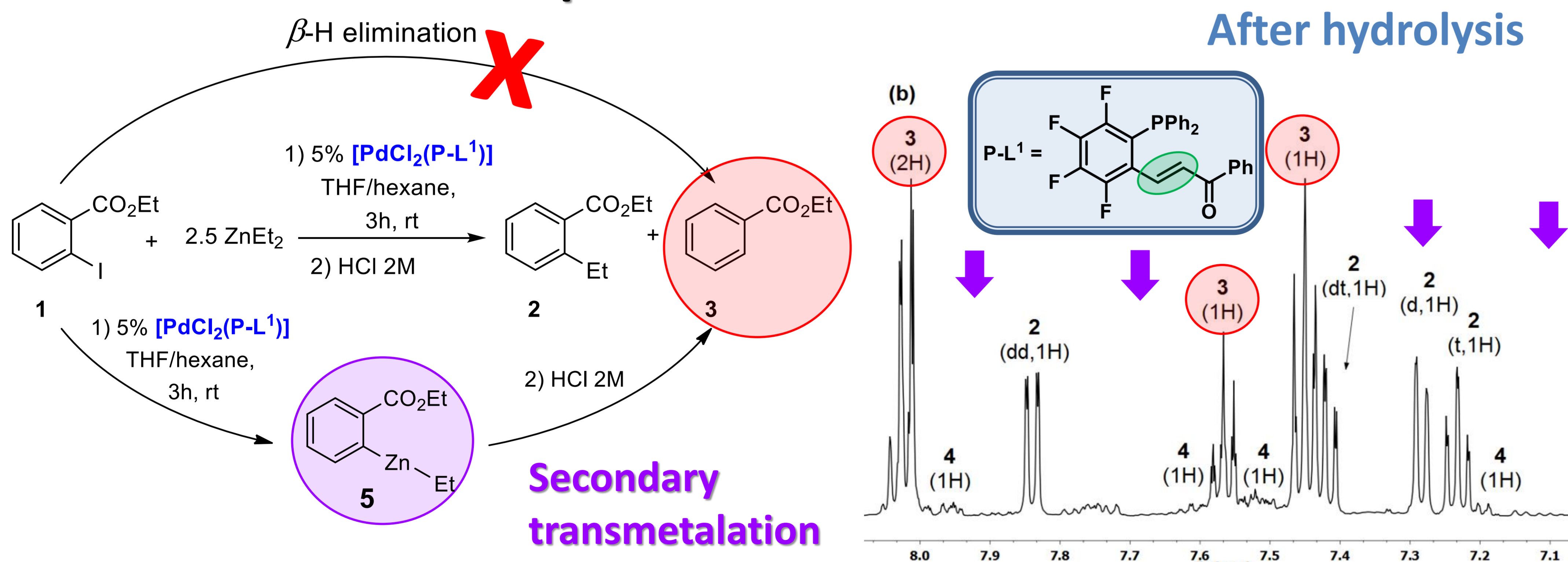
Lei had proposed that there is a blocking effect where the olefin remains attached to Pd(II) blocking the site that  $\beta$ -H elimination needs to proceed. **Reaction (1)** was run with isolated  $[\text{PdCl}_2\text{L}]$  complexes bearing two different ligands, one without olefin (**ligand in entry 3**) and the other with olefin (**ligand in entry 5, P-L<sup>1</sup>**). <sup>1</sup>H NMR spectra once the reaction had finished but before hydrolysis were analyzed.



Reduction product **3** coming from  $\beta$ -H elimination is absent with the phosphine-olefin ligand **P-L<sup>1</sup>** but in contrast, appears when using monophosphines which are even strongly coordinated to Pd (compared with olefins).

Therefore **NO blocking effect** is occurring. Improvements in selectivity should be associated to an acceleration on the desired reductive elimination step caused by our ligand which can adopt a phosphine-olefin quelate coordination (**Figure 1**).

## Where the reduction product comes from?



Comparing the spectra before and after hydrolysis is possible to observe that product **3** appears after hydrolysis when a complete consumption of **5** is observed.

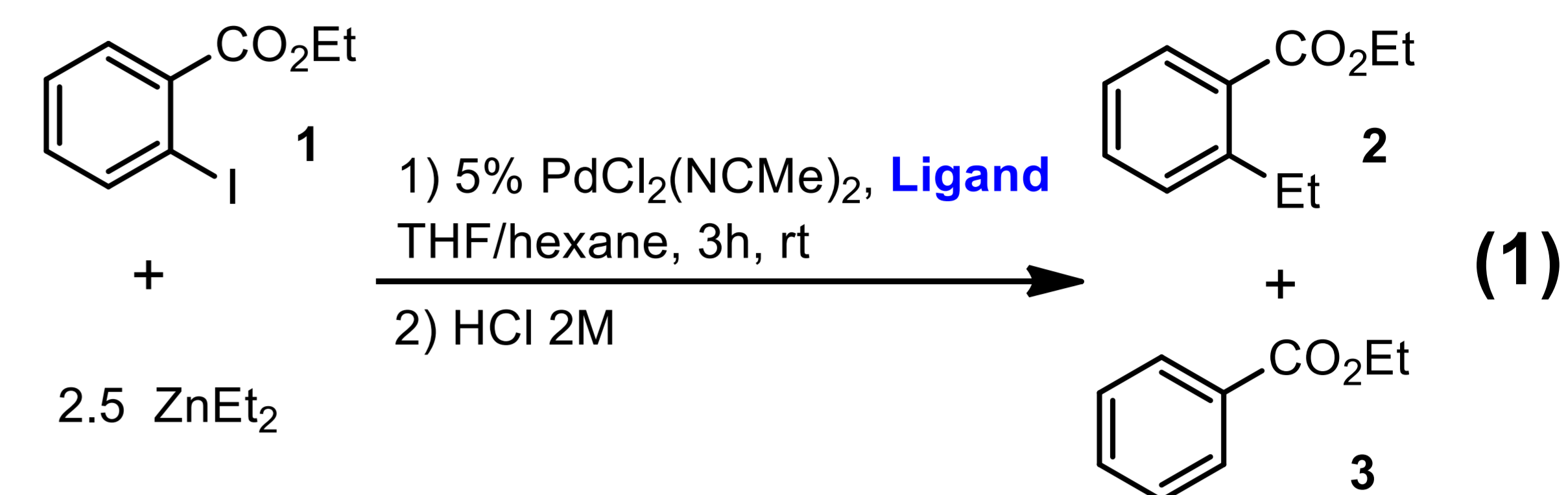
## How to diminish secondary transmetalation?

At the early stages of the reaction, when there is a high amount of  $\text{ZnEt}_2$ , this highly nucleophilic species tends to rapidly transmetalate and retrotransmetalate to Pd leading to the  $\text{ArZnEt}$  product **5** observed, which decrease the selectivity toward the desired product **2** (**Figure 2**).

Other ethylating agents such as  $\text{ZnEtI}$  or  $\text{ZnEtCl}$  are less nucleophilic than  $\text{ZnEt}_2$  and exchanges bringing Ar from Pd to Zn are less efficient. Using  $\text{ZnEtCl}$  the selectivity increases highly.

Nucleophile	2 : 3
$\text{ZnEt}_2$	46 : 53
$\text{ZnEtCl}$	94 : 6

Selectivity increases markedly



Entry	Ligand (Pd:L)	2 : 3
1	Without Pd	- : -
2	$\text{PPh}_3$ (1:2)	7:93
3	$\text{PPh}_2(2\text{-FC}_6\text{F}_4)$ (1:2)	15:85
4	$\text{PPh}_2(2\text{-PhC}_6\text{F}_4)$ (1:2)	42:58
5	<b>P-L<sup>1</sup></b> ( $\text{PPh}_2(2\text{-PhC}_6\text{F}_4)$ ) (1:2)	<b>90:10</b>

Table 1. Catalytic results for the Ar-Et coupling

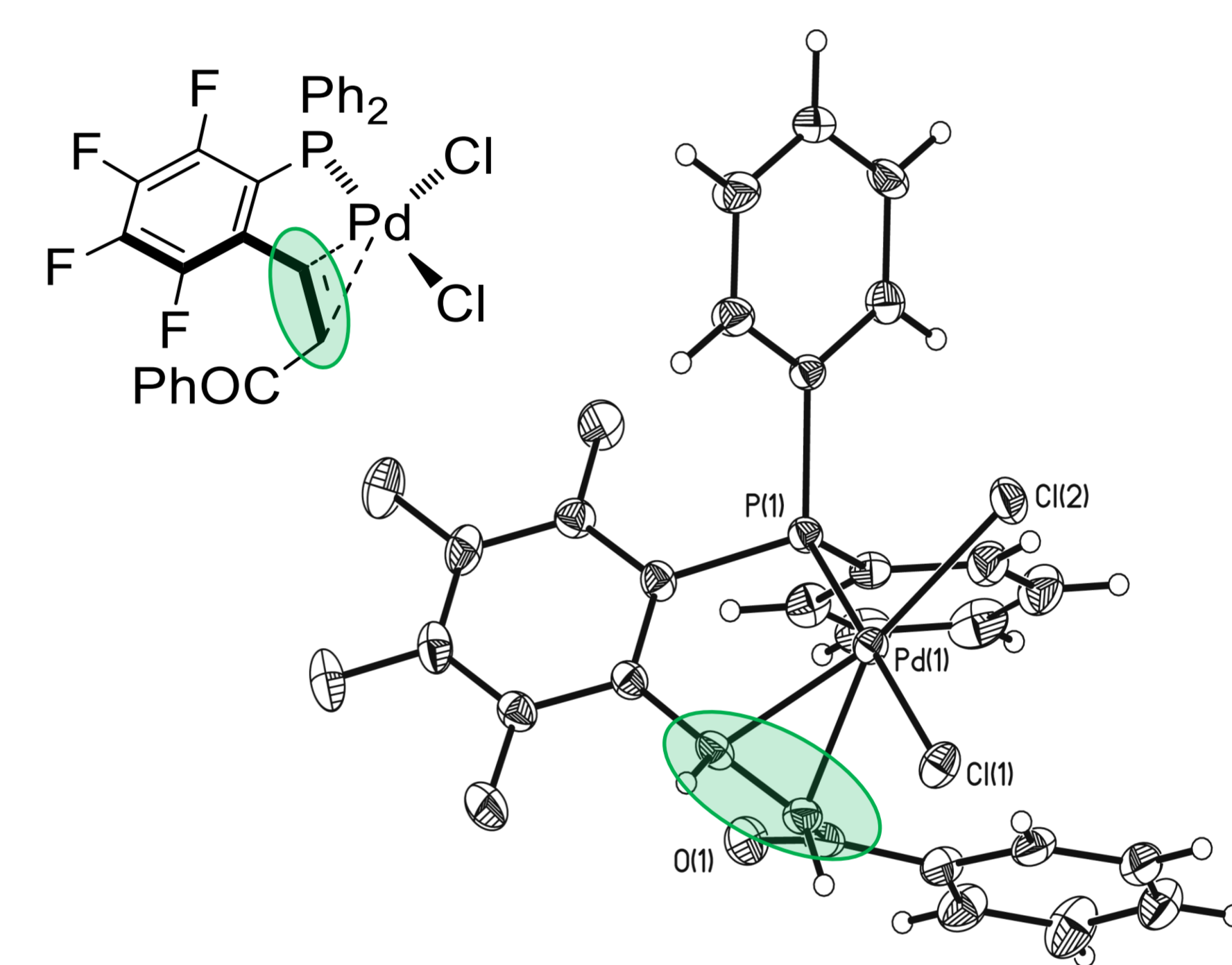


Figure 1. Phosphine-olefin (**P-L<sup>1</sup>**) coordinated to Pd(II)

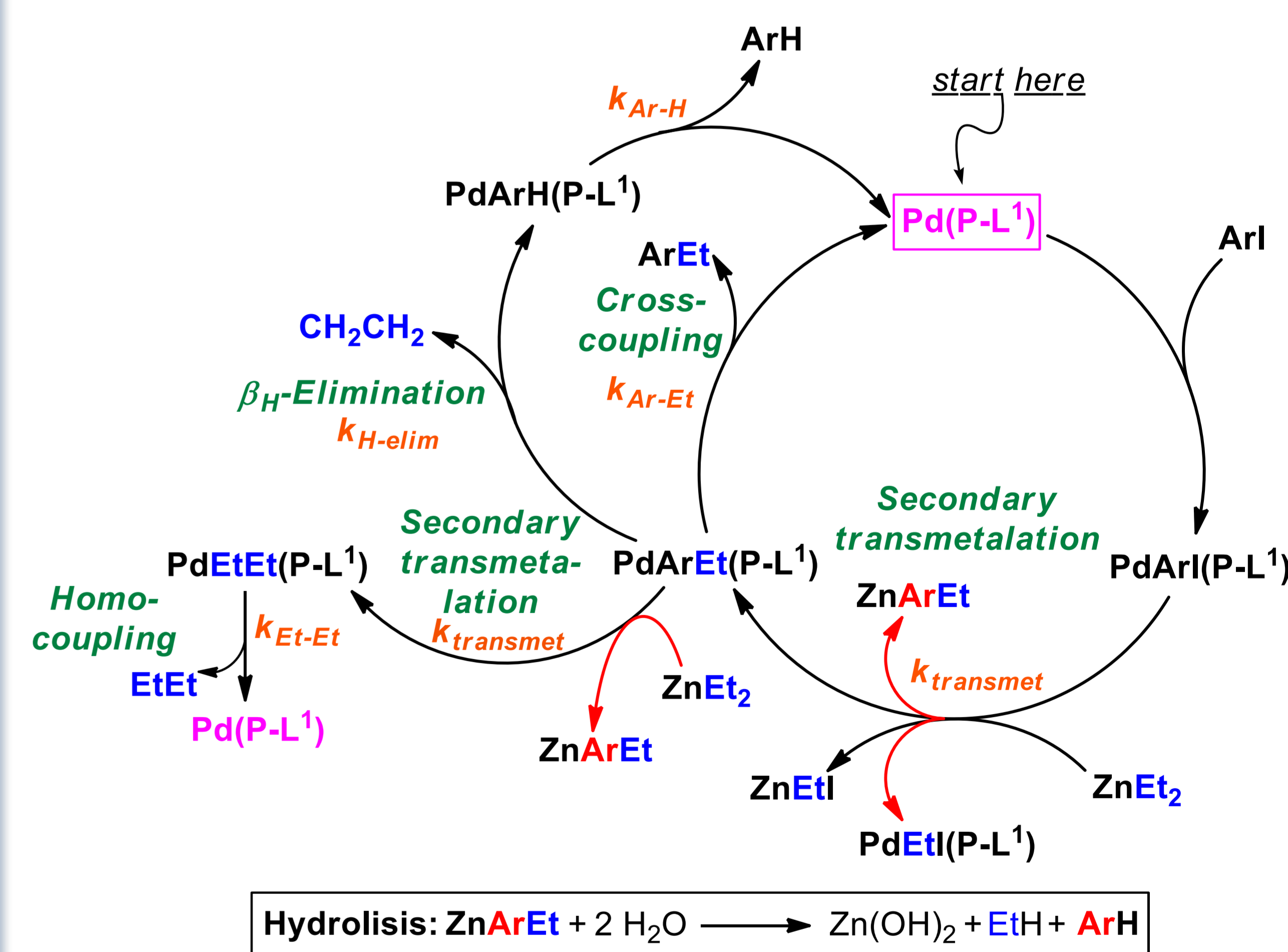


Figure 2. Proposed catalytic cycle

(1) Luo, X.; Zhang, H.; Duan, H.; Liu, Q.; Zhu, L.; Zhang, T.; Lei, A. *Org. Lett.* **2007**, *9*, 4571-4574.

(2) Gioria, E.; Martínez-Ilarduya, J.M.; García-Cuadrado, D.; Miguel, J.A.; Genov, M. and Espinet, P. *Organometallics* **2013**, *32*, 4255-4261.

(3) Gioria, E.; Martínez-Ilarduya, J.M.; Espinet, P. *Organometallics* **2014**, *33*, 4394-4400.

**Acknowledgements:** Financial support is gratefully acknowledged from the Junta de Castilla y León (Projects GR169 and VA256U13), the Spanish MINECO (CTQ2013-48406-P), and European Commission (2010-2401/001-001-EMA2; EU Mobility Program, EADIC II Erasmus Mundus Scholarship to E.G.).