Tetrahedron Letters 51 (2010) 935–938

Contents lists available at ScienceDirect

Tetrahedron Letters

journal homepage: www.elsevier.com/locate/tetlet

# Regio- and stereoselective microwave-assisted synthesis of 5-alkyl-4-alkenyl-4-phenyl-1,3-oxazolidin-2-ones

Marta Amador [a], Xavier Ariza [a,*], Jérémie Boyer [a], Lucia D'Andrea [b], Jordi Garcia [a,*], Jaume Granell [b]

[a] Departament de Química Orgànica and IBUB, Universitat de Barcelona, C/Martí i Franquès 1-11, E-08028-Barcelona, Spain
[b] Departament de Química Inorgànica and IBUB, Universitat de Barcelona, C/Martí i Franquès 1-11, E-08028-Barcelona, Spain

ARTICLE INFO

*Article history:*
Received 17 November 2009
Revised 3 December 2009
Accepted 8 December 2009
Available online 16 December 2009

*Keywords:*
Palladium catalysts
Nickel catalysts
Microwave-assisted synthesis
1,4-Diols
Quaternary α-amino acids

ABSTRACT

Chiral symmetrical alk-2-yne-1,4-diols have been stereoselectively transformed into 5-alkyl-4-alkenyl-4-phenyl-1,3-oxazolidin-2-ones, which are precursors of quaternary α-amino β-hydroxy acids. The key step was the cyclization of the bis(tosylcarbamates) of 2-phenylalk-2-yne-1,4-diols, easily obtained from the starting chiral diols. These cyclizations were accomplished with complete regioselectivity and up to 92:8 dr in the presence of catalytic amounts of Ni(0) or Pd (II) derivatives under microwave heating.



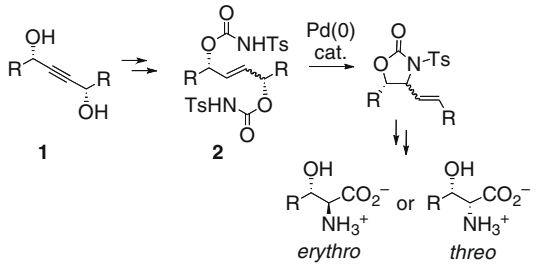
Enantioenriched 1,4-diols have been shown to be versatile synthons for asymmetric synthesis.[1] In the course of a project aimed to develop synthetic applications of unsaturated 1,4-diols,[2] we have recently reported the preparation of both *erythro* and *threo* β-hydroxy α-amino acids from a common precursor, namely a $C_2$-symmetrical alk-2-yne-1,4-diol (**1**) (Scheme 1).[3] The key step of our approach was a stereoselective Pd(0)-catalyzed intramolecular N-alkylation of the allylic (*Z*)- or (*E*)-1,4-dicarbamates (**2**) derived from **1**.[4] It should be noted that due to the $C_2$-symmetrical properties of the starting materials, only one regioisomer was possible in such processes.

Herein, we extend the scope of our work to allylic 1,4-dicarbamates **3**, in which symmetry is broken by an additional substituent R′ on the double bond. Cyclization on **3** is a challenging issue since two regioisomers, **4** and **5** are possible (Scheme 2). We were interested in the preferential formation of carbamates **4**, potential precursors of quaternary amino acids after the oxidative cleavage of the double bond. In particular, we envisaged that when R′ = Ph in **3**, the ionization of the carbamate group on C(4) leading to **4**, will be favored for steric and electronic reasons. Thus, the Ph group could better extend the conjugation of the transient π-allylic cations in a Pd(0)-catalyzed process.

Thus, we embarked on a study aimed to obtain compounds **3** (with R′ = Ph) and their further transformation into the quaternary carbamates **4**. We wish to report herein our findings in this connection.

As expected starting chiral diols **1** were readily desymmetrized by reaction with phenylboronic acid in the presence of $[Pd(PPh_3)_4]$.[5] As observed in Scheme 3, diols **6a–d** were isolated in 50–78% yield with complete *Z* selectivity using 2 mol % of Pd catalyst and 10 mol % of AcOH in dioxane.[6] Diols **6** were quantitatively transformed into dicarbamates **3** by treatment with tosyl isocyanate (2 equiv) in $CH_2Cl_2$.

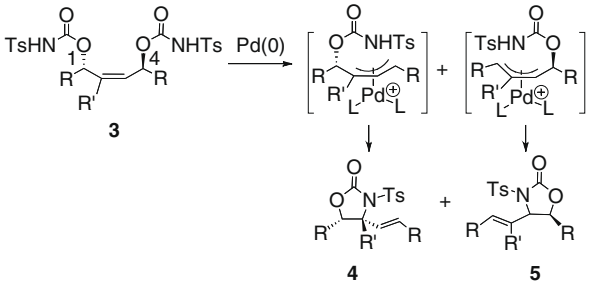
We chose **3b** as a representative model to test the cyclization step. We first applied the experimental conditions used for the Pd(0)-catalyzed intramolecular N-alkylation of **2**.[3a] Unfortunately, the expected quaternary compound **4b** was not observed or appeared just as a minor component in a mixture (Table 1, entries 1 and 2). A series of experiments were then undertaken in which



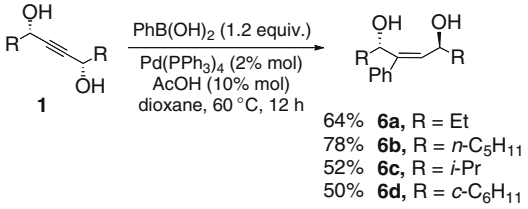

**Scheme 1.** Reported synthesis of *erythro* and *threo* β-hydroxy α-amino acids.

* Corresponding authors. Tel.: +34 934034819; fax: +34 933397878 (J.G.).
*E-mail addresses:* xariza@ub.edu (X. Ariza), jordigarciagomez@ub.edu (J. Garcia).

0040-4039/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.tetlet.2009.12.036



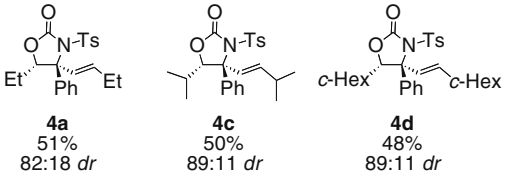
**Scheme 2.** Cyclization of dicarbamates **3**.



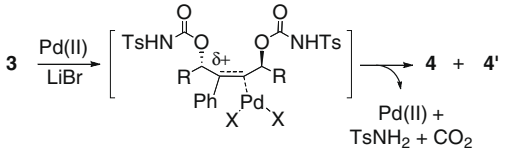
**Scheme 3.** Preparation of 2-phenylalk-2-ene-1,4-diols, **6**.

we changed the solvent (DMF, DMSO, mixtures with THF, and $CH_3CN$), the source of palladium ($[Pd(Ph_3P)_4]$, $[(C_3H_5)ClPd]_2$), additives [$(PhO)_3P$, dppe, dppp], and temperatures (rt to 80 °C) without success.[7] Although in some cases the overall yields of cyclic carbamates were acceptable, mixtures of regio- and stereoisomers were always obtained.

We then moved to other low-valent metal complexes that were able to give allylic alkylation via π-allyl complexes looking for a better control of regioselectivity. Among others, Mo,[8] Ir[9] or Ni[10] derivatives are less efficient catalyst for allylic substitution than Pd(0)-complexes. As a result, high temperatures and longer reactions times are usually required. However, these complexes often showed regio- and stereoselectivities quite different from those recorded in palladium complex-catalyzed allylic aminations.[11] In practice, the treatment of **3b** with 20 mol % of $[Mo(CO)_6]$ in refluxing toluene afforded preferentially isomer **5b** in low yields (Table 1, entry 3).[12] The use of an Ir(0)-catalyst generated as described in the literature in some examples of intermolecular allylic amination[9b,9c] gave only the undesired isomer **5b** (entry 4).[13]



**Scheme 4.** Ni(0)-catalyzed cyclization of dicarbamates **3**.



**Scheme 5.** Pd(II)-catalyzed transformation of **3** into **4**.

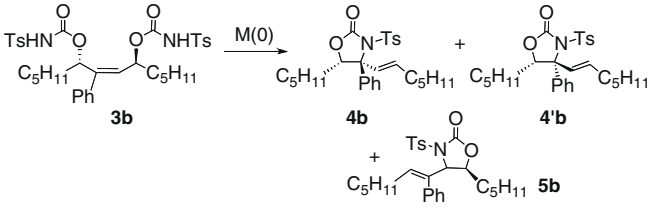
The most favorable results were obtained with Ni(0) catalysts. To our knowledge only a few Ni(0)-catalyzed allylic aminations have been reported[14] and none of them related with the creation of quaternary centers. After a few preliminary experiments with $[Ni(COD)_2]$,[15] we achieved more reliable results with the Ni(0) catalyst generated in situ from $[NiCl_2(PPh_3)_2]$ and *i*-PrMgCl, following a protocol described by Cuvigny and Julia.[10b]

In sharp contrast with our previous attempts, the quaternary carbamates **4** were readily obtained with complete regioselectivity and high stereoselectivity,[16] albeit in low yield (entry 5). With Ni(0) catalyst showing promise, we performed the reaction heating in a microwave oven to accomplish the consumption of the starting material.[17] To our satisfaction, **4b** was isolated in 58% yield and a remarkably 92:8 diastereomeric ratio (entry 6).[18] In an additional experiment in which the addition of *i*-PrMgCl was omitted neither **4** nor **5** was observed. Thus, the possibility that a Ni(II) species acts as the true catalyst was ruled out.

As shown in Scheme 4, this new Ni(0)-catalyzed process was extended to dicarbamates **4a**, **4c**, and **4d** with complete regioselectivity but in moderate yields. As far as the diastereoselectivity is concerned, a similar trend of ~9:1 ratio was observed when R was α-branched and slightly lower for a smaller R (**4a**).

We then considered using $Pd(AcO)_2$ and LiBr in THF to promote the cyclization,[19] according to a protocol recently described by Lu et al. for the cyclization of allylic dicarbamates.[20] We presumed

**Table 1**
M(0)-catalyzed cyclization of **3b**



| Entry | Catalyst, additive | Solvent, T | Time (h) | Yield (%) | Ratio **4b**:**4′b**:**5b** |
|---|---|---|---|---|---|
| 1[a,b,c] | $Pd_2(dba)_3{\cdot}CHCl_3$ (*i*-PrO)$_3$P | THF, MW | 2 | 80 | 0:0:100 |
| 2[a] | $Pd_2(dba)_3{\cdot}CHCl_3$ (*i*-PrO)$_3$P | $CH_3CN$, rt | 4 | 89 | 41:0:59 |
| 3[d] | $[Mo(CO)_6]$ | Toluene, reflux | 12 | 20 | 15:8:77 |
| 4[a,c] | $[Ir(COD)Cl]_2$ $(PhO)_3P$ | EtOH, reflux | 20 | 35 | 0:0:100 |
| 5[d] | $[NiCl_2(PPh_3)_2]$ *i*-PrMgCl | THF reflux | 20 | 15 | 83:17: 0 |
| 6[b,d] | $[NiCl_2(PPh_3)_2]$ *i*-PrMgCl | THF, MW | 2 | 58 | 92:8: 0 |

[a] 5 mol % catalyst was used.
[b] MW heating at 120 °C.
[c] $^1H$ NMR of **5b** indicated a mixture of 2:1 *cis*/*trans* oxazolidinones.
[d] 20 mol % catalyst was used.

**Table 2**
Pd(II)–Catalyzed cyclization of **3**

| Entry | **3** R | Catalyst, additive | Solvent T | Time (h) | Yield (%) ratio **4**:**4′** |
|---|---|---|---|---|---|
| 1[a] | **3b** $C_5H_{11}$ | $Pd(AcO)_2$ LiBr | THF, reflux | 15 | 52 56:49 |
| 2[a,b] | **3b** $C_5H_{11}$ | $Pd(AcO)_2$ LiBr | THF, MW | 2 | 50 80:20 |
| 3[c] | **3b** $C_5H_{11}$ | **7** LiBr | THF, reflux | 15 | 55 80:20 |
| 4[c] | **3b** $C_5H_{11}$ | **8** LiBr | THF, reflux | 15 | 48 80:20 |
| 5[c] | **3b** $C_5H_{11}$ | **9** LiBr | THF, reflux | 15 | 36 78:22 |
| 6[b,c] | **3b** $C_5H_{11}$ | **7** LiBr | THF, MW | 2 | 61 80:20 |
| 7[b,c] | **3c** *i*-Pr | **7** LiBr | THF, MW | 2 | 40 92:8 |
| 8[b,c] | **3d** *c*-Hex | **7** LiBr | THF, MW | 2 | 52 91:9 |

[a] 10 % Pd(II) catalyst was used.
[b] MW heating at 120 °C.
[c] 8 mol % Pd(II) catalyst was used.

that in compounds **3**, the Ph group could act as directing group by stabilizing the positive charge in the benzylic position (Scheme 5).

As expected, treatment of **3c** with $Pd(AcO)_2$ and LiBr in refluxing THF yielded the expected product **4** with total regioselectivity but low stereoselectivity (entry 1, Table 2). Once again, the use of microwave heating was beneficial since the ratio **4b**/**4′b** was improved to 80:20 (entry 2).

We also attempted the use of palladacycles **7**–**9** as a source of (Fig. 1) Pd(II).[21] Palladacycles are organometallic compounds of growing interest in catalysis.[22] Remarkably, the performance of **7** was comparable to or even slightly better than that obtained with the above-mentioned Ni(0) catalyst (Table 2, entries 7 and 8). These positive preliminary results and the structural variety of palladacycles indicated that there is a room for future improvements in this field.

Finally, in order to demonstrate the value of compounds **4** in synthesis, we successfully transformed **4c** into quaternary amino acids **11** and **14** (Scheme 6). Thus, ozonolysis of **4c** followed by oxidation of the crude aldehyde **10** with $NaClO_2$[23] gave protected α-amino α-phenyl β-hydroxy acid **11**. On the other hand, aldehyde **10** was reduced and then the resulting primary alcohol **12** was protected as acetate **13**. Ruthenium-mediated oxidation[24] of the phenyl group afforded the α-amino β,β′-dihydroxy acid **14**. It should be noted that the substructure of the α-amino α-hydroxymethyl β′-hydroxy acid is present in a number of bioactive natural products such as myriocin, mycesterycins, and sphingofungins.[25]

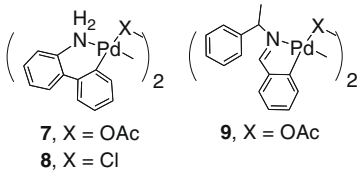
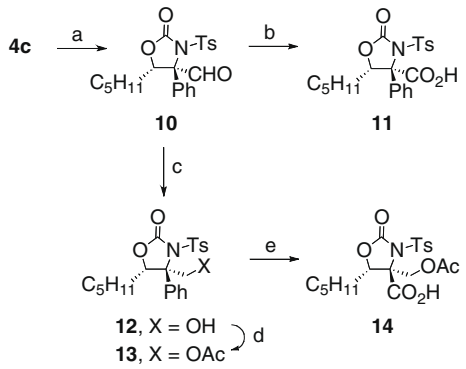



**Figure 1.** Palladacycles **7**–**9**.




**Scheme 6.** Reagents and conditions: (a) $O_3$, $CH_2Cl_2$, −78 °C, then $Me_2S$, rt, 98%; (b) $NaClO_2$, $H_2O_2$, $NaH_2PO_4$, $H_2O/CH_3CN$, 95%; (c) $NaBH_4$, THF, 0 °C, 100%; (d) $Ac_2O$, $Et_3N$, 4-DMAP cat., $CH_2Cl_2$, 0 °C, 97%; (e) $RuCl_3$ cat., $NaIO_4$, $CH_3CN/CCl_4/H_2O$ 1:1:1.5, 45%.

In summary, we have developed a new, stereoselective approach to 5-alkyl-4-alkenyl-4-phenyl-1,3-oxazolidin-2-ones. The key step was either a Ni(0)- or Pd(II)-catalyzed cyclization in which the use of palladacycles and the microwave heating are pivotal. The cyclic carbamates obtained are precursors of quaternary α-amino β-hydroxy acids as demonstrated with the compound in which R = *n*-$C_5H_{11}$. Further applications, specially on palladacycle catalysts, will be reported in due course.

## Acknowledgments

This work has been supported by the Ministerio de Educación y Ciencia (BQU2003-01269 and CTQ2006-13249); We thank the Secretaría de Estado de Universidades e Investigación (MEC, Spain) for a postdoctoral fellowship to J.B. and to the Universidad de Barcelona for doctoral studentships to M.A. and L.D.

## References and notes

1. $C_2$-Symmetrical 1,4-diols and their derivatives have been used for the preparation inter alia of 2,5-disubstituted pyrrolidines: (a) Pichon, M.; Figadère, B. *Tetrahedron: Asymmetry* **1996**, *7*, 927–964; Thiolanes: (b) Otten, S.; Fröhlich, R.; Haufe, G. *Tetrahedron: Asymmetry* **1998**, *9*, 189–191; And phosphine ligands of interest for asymmetric hydrogenation: (c) Tang, W.; Zhang, X. *Chem. Rev.* **2003**, *103*, 3029–3070.
2. (a) Ariza, X.; Garcia, J.; López, M.; Montserrat, L. *Synlett* **2001**, 120–122; (b) Amador, M.; Ariza, X.; Garcia, J.; Ortiz, J. *Tetrahedron Lett.* **2002**, *43*, 2691–2694; (c) Ariza, X.; Garcia, J.; Ortiz, J. *Tetrahedron: Asymmetry* **2003**, *14*, 1127–1131; (d) Ariza, X.; Fernández, N.; Garcia, J.; López, M.; Montserrat, L.; Ortiz, J. *Synthesis* **2004**, 128–134; (e) Amador, M.; Ariza, X.; Garcia, J.; Ortiz, J. *J. Org. Chem.* **2004**, *69*, 8172–8175; (f) Boyer, J.; Allenbach, Y.; Ariza, X.; Garcia, J.; Georges, Y.; Vicente, M. *Synlett* **2006**, 1895–1898; (g) Ariza, X.; Garcia, J.; Georges, Y.; Vicente, M. *Org. Lett.* **2006**, *8*, 4501–4504; (h) Georges, Y.; Ariza, X.; Garcia, J. *J. Org. Chem.* **2009**, *74*, 2008–2012.
3. (a) Amador, M.; Ariza, X.; Garcia, J.; Sevilla, S. *Org. Lett.* **2002**, *4*, 4511–4514; Enantioenriched diols **1** are readily available by stereoselective reduction of the parent acetylenic diketones: (b) Bach, J.; Berenguer, R.; Garcia, J.; Loscertales, T.; Manzanal, J.; Vilarrasa, J. *Tetrahedron Lett.* **1997**, *38*, 1091–1094; (c) Ariza, X.; Bach, J.; Berenguer, R.; Farràs, J.; Fontes, M.; Garcia, J.; López, M.; Ortiz, J. *J. Org. Chem.* **2004**, *69*, 5307–5313. Alternately, diols **1** can be obtained by stereoselective addition of alk-1-yn-3-ols to aldehydes (see Ref. 2b).
4. For an recent review on Pd catalysts, see: Tsuji, J. *Palladium Reagents and Catalysts*; John Wiley and Sons Ltd: Chichester, England, 2004.
5. (a) Oh, C. H.; Jung, H. H.; Kim, K. S.; Kim, N. *Angew. Chem., Int. Ed.* **2003**, *42*, 805–808; For a review on palladium-catalysed cross-coupling reactions of organoboron compounds, see: (b) Miyaura, N.; Suzuki, A. *Chem. Rev.* **1995**, *95*, 2457–2483.
6. *Typical experimental procedure*: Acetic acid (43 μL, 0.75 mmol) was added to a solution of (*S*,*S*)-**1c** (1.707 g, 7.54 mmol), phenylboronic acid (1.103 g, 9.05 mmol), and $Pd(PPh_3)_4$ (174 mg, 0.15 mmol) in dioxane (20 mL) at 0 °C under Ar. The mixture was heated to 60–65 °C until the TLC (hexane/AcOEt 7:3) revealed the disappearance of the starting diol (12 h) and then was quenched by the addition of water (15 mL). The mixture was extracted with $Et_2O$ (3 × 30 mL). The combined organic layers were washed with water (15 mL), dried ($MgSO_4$), and concentrated. The crude was purified by flash

chromatography (hexane/AcOEt 7:3) to afford **6c** (1.790 g, 78%). Colorless oil; $R_f$ ($CH_2Cl_2$): 0.48; $[\alpha]_D^{20}$ +32.0 (*c* 1.0 in $CHCl_3$); $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 0.84 (t, *J* = 6.8 Hz, 3H, $CH_3$), 0.90 (t, *J* = 7.0 Hz, 3H, $CH_3$), 1.22–1.37(m, 10H, $CH_2$), 1.38–1.45 (m, 2H, $CH_2$), 1.51–1.59 (m, 2H, $CH_2$), 1.62–1.69 (m, 2H, $CH_2$), 2.36 (br s, 2H, OH), 4.70 (dt, *J* = 8.8, 6.8 Hz, 1H, =CH–C*H*–OH), 4.74 (dd, *J* = 8.0, 5.2 Hz, 1H, =CPh–C*H*–OH), 5.58 (d, *J* = 8.8 Hz, 1H, CH=), 7.28–7.35 (m, 5H, Ar); $^{13}$C NMR ($CDCl_3$, 101 MHz): d 13.9 and 14.0 ($CH_3$), 22.5, 22.6, 25.3, 25.8, 31.6, 31.8, 36.6, and 37.8 ($CH_2$), 67.6 (=CHCH–OH), 72.8 (CPh*C*H–OH), 127.3, 127.8, 127.8, 128.1 and 128.1 (Ar), 134.2 (CH=), 141.4 (Ar), 146.0 (CPh=); IR (film): $\nu_{max}$ 3388, 2956, 2931, 2860, 1493, 1459, 1028.

7. A series of experiments performed with **3a** showed even worse regio- and stereoselectivities.
8. For a recent review on molybdenum-catalyzed asymmetric allylic alkylations, see: Belda, O.; Moberg, C. *Acc. Chem. Res.* **2004**, *37*, 159–167.
9. For a very recent review on iridium-catalyzed asymmetric allylic substitutions, see: (a) Helmchen, G. In *Iridium Complexes in Organic Synthesis*; Oro, L. A., Claver, C., Eds.; Wiley-Interscience: Weinheim, 2009; pp 211–250; (b) Takeuchi, R.; Kashio, M. *J. Am. Chem. Soc.* **1998**, *120*, 8647–8655; (c) Takeuchi, R.; Ue, N.; Tanabe, K.; Yamashita, K.; Shiga, N. *J. Am. Chem. Soc.* **2001**, *123*, 9525–9534; For examples of Ir-catalysed intramolecular N-alkylations, see: (d) Miyabe, H.; Yoshida, K.; Kobayashi, Y.; Matsumura, A.; Takemoto, Y. *Synlett* **2003**, 1031–1033; (e) Welter, C.; Dahnz, A.; Brunner, B.; Streiff, S.; Dübon, P.; Helmchen, G. *Org. Lett.* **2005**, *7*, 1239–1242.
10. (a) Yamamoto, T.; Ishizu, J.; Yamamoto, A. *J. Am. Chem. Soc.* **1981**, *103*, 6863–6869; (b) Cuvigny, T.; Julia, M. *J. Organomet. Chem.* **1986**, *317*, 383–408. and references therein; (c) Cuvigny, T.; Julia, M. *J. Organomet. Chem.* **1983**, *250*, C21–C24.
11. In contrast to the situation with Pd, allylic alkylation takes place mostly at the more substituted carbon atom when unsymmetrical substrates are used. See, for instance: Co, T. T.; Paek, S. W.; Shim, S. C.; Cho, C. S.; Kim, T.-J.; Choi, D. W.; Kang, S. O.; Jeong, J. H. *Organometallics* **2003**, *22*, 1475–1482; For a review on structure–reactivity relationship in allyl complexes of group 10 metals, see: Kurosawa, H.; Ogoshi, S. *Bull. Chem. Soc. Jpn.* **1988**, *71*, 973–984.
12. The use of $[Mo(CO)_4(bpy)]$ showed similar trends. This dipyridyl-ligated molybdenum complex was prepared by the simple ligand exchange between 2,2′-bipyridyl (bpy) and $Mo(CO)_6$: Stiddardt, M. H. B. *J. Chem. Soc.* **1962**, 4712–4715.
13. In THF no reaction was observed.
14. (a) Moberg, C. *Tetrahedron Lett.* **1980**, *21*, 4539–4542; (b) Bricout, H.; Carpentier, J.-F.; Mortreux, A. *J. Chem. Soc., Chem. Commun.* **1995**, 1863–1864; (c) Bricout, H.; Carpentier, J.-F.; Mortreux, A. *Tetrahedron* **1998**, *54*, 1073–1084; (d) Berkowitz, D. B.; Bose, M.; Choi, S. *Angew. Chem., Int. Ed.* **2002**, *41*, 1603–1607; (e) Berkowitz, D. B.; Maiti, G. *Org. Lett.* **2004**, *6*, 2661–2664.
15. A series of experiments were performed in which we changed the amount of catalyst (0.1–0.4 mol % of $[Ni(COD)_2]$), in the presence or absence of base (LiHMDS), ligands ($PPh_3$, BINAP), and temperatures (rt to MW heating to 120 °C) gave poor and/or erratic results.
16. Relative configurations of cyclic carbamates **4** were readily determined by $^1$H NMR NOE experiments.
17. For very recent reviews on microwave synthesis, see: (a) Caddick, S.; Fitzmaurice, R. *Tetrahedron* **2009**, *65*, 3325–3355; (b) Polshettiwar, V.; Varma, R. S. *Acc. Chem. Res.* **2008**, *41*, 629–639; (c) Kappe, C. O. *Chem. Soc. Rev.* **2008**, *37*, 1127–1139; (d) Dallinger, D.; Kappe, C. O. *Chem. Rev.* **2007**, *107*, 2563–2591.
18. *Typical procedure*: To a solution of $[NiCl_2(PPh_3)_2]$ (19 mg, 28.6 μmol) in dry THF (0.6 mL) was added *i*-PrMgCl (29 μL, 57.2 μmol, 2.0 M solution in $Et_2O$) at 0 °C under Ar. After 10 min the color of the solution changed from green to brown. Then the mixture was transferred via cannula to a flask containing a solution of dicarbamate (*S*,*S*)-**3c** (100 mg, 0.143 mmol) in THF (0.6 mL) under Ar and the mixture was heated in a microwave oven for 2 h to 120 °C (inside pressure was 5–6 bars). Then, the solvent was removed and the crude was filtered through a short pad of Celite (AcOEt). The solvent was removed and the residue was purified by flash chromatography (hexane/AcOEt 8:2) to afford a 92:8 mixture of **4c**/**4′c** (40 mg, 0.083 mmol, 58%). (b) Compound **4c**: white solid, mp 84–85 °C; $R_f$ (hexane/AcOEt 7:3): 0.47; $[\alpha]_D^{20}$ −47.0 (*c* 0.6 in $CHCl_3$); $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 0.80 (t, *J* = 6.8 Hz, 3H, $CH_3$), 0.92 (t, *J* = 7.2 Hz, 3H, $CH_3$), 1.15–1.20 (m, 6H, $CH_2$), 1.33–1.40 (m, 6H, $CH_2$), 1.49–1.54 (m, 2H, $CH_2$), 2.25–2.31 (m, 2H, $CH_2$), 2.42 (s, 3H, $CH_3$–Ar), 4.44 (dd, *J* = 10.0, 2.8 Hz, 1H, C*H*–O), 5.92 (dt, *J* = 15.6, 1.4 Hz, 1H, C*H*=CHCH$_2$), 6.18 (dt, *J* = 15.6, 6.8 Hz, 1H, CH=C*H*–$CH_2$), 7.23 (d, *J* = 8.4 Hz, 2H, Ar), 7.39–7.49 (m, 5H, Ar), 7.63 (d, *J* = 8.4 Hz, 2H, Ar). $^{13}$C NMR ($CDCl_3$, 101 MHz): d 13.8 ($CH_3$), 14.0 ($CH_3$), 21.6 ($CH_3$-Ar), 22.2, 22.4, 25.5, 28.5, 28.9, 31.3, 31.4 and 32.7 ($CH_2$), 74.1 (CPh–NTs), 87.9 (CH–O), 123.5 (TsNCPh–CH=), 127.6, 128.5, 129.0, 129.1, 129.2 and 135.8 (Ar), 137.1 ($CH_2$*C*H=), 138.9 (C(Ar)), 145.0 (C(Ar)–$SO_2$)), 152.5 (C=O).; IR (KBr): $\nu_{max}$ 2929–2860, 1781, 1175, 1090.
19. Experiments performed with **3c** and DBU in the presence of 20 mol % of $Sc(OTf)_2$ (THF, rt or 60 °C) caused the degradation of starting material. The use of $PtCl_2$ led to the recovery of starting dicarbamate. In THF no reaction was observed.
20. Lei, A.; Liu, G.; Lu, X. *J. Org. Chem.* **2002**, *67*, 974–980.
21. (a) Albert, J.; Granell, J.; Luque, A.; Minguez, J.; Moragas, R.; Font-Bardia, M.; Solans, X. *J. Organomet. Chem.* **1996**, *522*, 87–95; (b) Albert, J.; Granell, J.; Zafrilla, J.; Font-Bardia, M.; Solans, X. *J. Organomet. Chem.* **2005**, *690*, 422–429; (c) Albert, J.; D'Andrea, L.; Granell, J.; Tavera, R.; Font-Bardia, M.; Solans, X. *J. Organomet. Chem.* **2007**, *692*, 3070–3080.
22. For a very recent review on palladacycles, see Dupont, J.; Consorti, C. S.; Spencer, J. *Chem. Rev.* **2005**, *105*, 2527–2572.
23. Dalcanale, E.; Montanari, F. *J. Org. Chem.* **1986**, *51*, 567–569.
24. Carlsen, H. J.; Katsuki, T.; Martin, V. S.; Sharpless, K. B. *J. Org. Chem.* **1981**, *46*, 3936–3938.
25. For very recent reviews on stereoselective construction of α,α-disubstituted α-amino acids, see: (a) Ohfune, Y.; Shinada, T. *Eur. J. Org. Chem.* **2005**, 5127–5143; (b) Byun, H.-S.; Lu, X.; Bittman, R. *Synthesis* **2006**, 2447–2474.