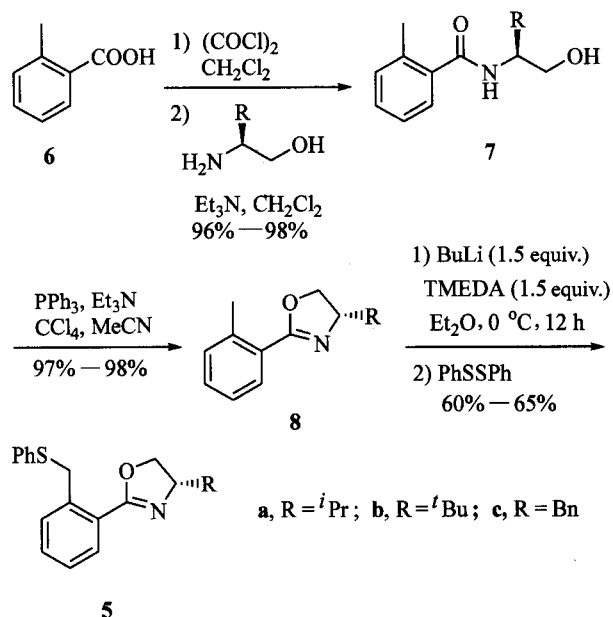


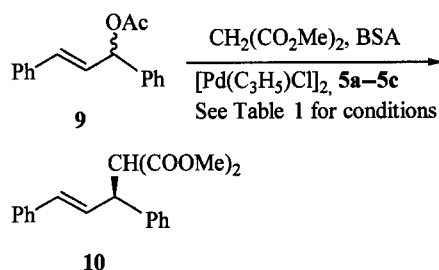
followed by amino alcohols afforded chiral amides **7**. Subsequent reaction of **7** with triphenylphosphine provided oxazolinytoluene **8**. Direct benzylic-lithiation of **8** with BuLi and an equimolar amount of TMEDA followed by quenching with PhSSPh gave rise to the expected products **5a–5c** (Scheme 1). All products were purified by flash chromatography and gave satisfactory analysis results.

Scheme 1



Then asymmetric palladium catalyzed allylic substitution reaction was chosen as test reaction.⁴ Thus treatment of 1,3-diphenylprop-2-enyl-1-acetate (**9**) with the anion of dimethylmalonate in the presence of catalytic amount of palladium complex and ligands **5a–5c** afforded the substitution product **10** (Scheme 2).

Scheme 2



Firstly, the effect of different salts and solvents on the yields and enantioselectivities of the reaction by using ligand **5a** and the reaction conditions which achieved ex-

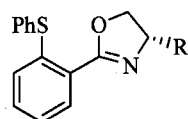
cellent results in our previous work (Table 1) were investigated.^{3a,3d} It was found that all reactions gave excellent yields whether the salt was added or not, but the reaction time was longer if there was no salt (Entry 4). Also, the reaction provided the highest *ee* when it proceeded in CH₂Cl₂ and KOAc as additive (Entry 2).

Table 1 Asymmetric palladium catalyzed allylic substitution with different salts and solvents^a

Entry	Solvent	Additive	Time (h)	Yield (%)	<i>ee</i> (%) ^b
1	MeCN	KOAc	5	99	84 (<i>S</i>)
2	CH ₂ Cl ₂	KOAc	4	99	89 (<i>S</i>)
3	CH ₂ Cl ₂	LiOAc	3	98	82 (<i>S</i>)
4	CH ₂ Cl ₂	None	15	98	75 (<i>S</i>)

^a Reaction conditions: 2.5 mol% [Pd(η^3 -C₃H₅)Cl]₂, 5 mol% ligand **5a**, 3 mol% salt, 300 mol% CH₂(CO₂Me)₂, 300 mol% BSA. ^b The enantiomeric excess was determined by HPLC, and the absolute configuration of the product was determined by comparison of the optical rotation with literature values.⁵

In view of the reaction time, yield and *ee* value, the dichloromethane and the potassium acetate were used in examination of efficiency of ligands **5** and the results were showed in Table 2. Compared with the palladium complexes of chiral thioethers of phenyloxazoline ligands **11** reported by Williams,^{1d} the palladium complexes with chiral benzylthioethers of our's are more efficient. Under similar conditions, the enantioselectivity close to that Williams obtained (88% in Entry 1 vs. 90% in Entry 11, 93% in Entry 2 vs. 96% in Entry 10), but the reactions proceeded much faster (0.6 h in Entry 1 vs. 36 h in Entry 11, 0.75 h in Entry 2 vs. 96 h in Entry 10). When the amount of ligand was varied from 10 mol% to 5 mol%, there was little change in *ee* values (88% in Entry 1 vs. 89% in Entry 4, 93% in Entry 2 vs. 92% in Entry 5) as the amount of ligand down to 5 mol% with little longer reaction time. Even the amount of ligands was down to 1 mol%, high *ee* was also provided and ligand **5c** gave almost quantitative yield and good enantioselectivity (Entry 8).



11a, R = *i*Pr
11b, R = *t*Bu

Table 2 Conversion of **9** into **10** with palladium catalyst and enantiomerically pure ligands^a

Entry	Ligand (L)	Catalyst (Pd) (mol%)	ligand (mol%)	Time (h)	Yield (%)	ee (%) ^b
1	5a	5	10	0.6	98	88(S)
2	5b	5	10	0.75	98	93(S)
3	5c	5	10	0.5	99	83(S)
4	5a	2.5	5	3.5	98	89(S)
5	5b	2.5	5	4	99	92(S)
6	5c	2.5	5	2	99	84(S)
7	5a	0.5	1	120	60	82(S)
8	5b	0.5	1	120	55	90(S)
9	5c	0.5	1	68	98	84(S)
10	11b^a	5	10	96	92	96(S)
11	11a^a	5	10	36	96	90(S)

^aReaction conditions: the amount of $[Pd(\eta^3-C_3H_5)Cl]_2$ and ligands as indicated, 3 mol% salt, 300 mol% $CH_2(CO_2Me)_2$, 300 mol% BSA, 20 °C. ^bThe enantiomeric excess was determined by HPLC, and the absolute configuration of the product was determined by comparison of the optical rotation with literature values.⁵

These results and our previous studies^{3e} clearly show that the ligands with the two coordinating atoms at benzylic and benzene ring-positions are more effective than that with both the coordinating atoms at benzene ring-positions in catalytic efficiency. This is presumably due to the increased tether length between the donor atoms that coordinate closer to the allyl species during the reaction.⁶

In summary, several novel oxazolinyl toluene ligands containing thiophenyl at benzylic position, which are more effective than that with two substituents at benzene ring, have been prepared. Further studies regarding the synthesis of ligands **2** with other kind of coordination atoms and their applications in asymmetric catalysis, the reason why the ligands **5** give high catalytic efficiency are under further investigation.

References and notes

- (a) Dawson, G. J.; Frost, C. G.; Williams, J. M. J.; Coate, S. W. *Tetrahedron Lett.* **1993**, *34*, 3149.
(b) Sprinz, J.; Helmchen, G. *Tetrahedron Lett.* **1993**, *34*, 1769.
(c) Sprinz, J.; Kiefer, M.; Helmchen, G.; Reggelin, M.; Huttner, G.; Walter, O.; Zsolnai, L. *Tetrahedron Lett.* **1994**, *35*, 1523.
(d) Allen, J. V.; Coote, S. J.; Dawson, G. J.; Frost, C. G.; Martin, C. J.; Williams, J. M. J. *J. Chem. Soc., Perkin Trans. 1* **1994**, *15*, 2065.
(e) Barbaro, P.; Currao, A.; Herrmann, J.; Nesper, R.; Pregosin, P. S.; Salzmann, R. *Organometallics* **1996**, *15*, 1879.
(f) Loiseleur, O.; Meier, P.; Pfaltz, A. *Angew. Chem., Int. Ed. Engl.* **1996**, *35*, 200.
(g) Helmchen, G.; Pfaltz, A. *Acc. Chem. Res.* **2000**, *33*, 336.
- Boog-Wick, K.; Pregosin, P. S.; Trabesinger, G. *Organometallics* **1998**, *17*, 3254.
- (a) You, S. L.; Zhou, Y. G.; Hou, X. L.; Dai, L. X. *Chem. Commun.* **1998**, 2765.
(b) Du, X. D.; Dai, L. X.; Hou, X. L.; Xia, L. J.; Tang, M. H. *Chin. J. Chem.* **1998**, *16*, 90.
(c) Deng, W. P.; Hou, X. L.; Dai, L. X.; Yu, Y. H.; Xia, W. *Chem. Commun.* **2000**, 1483.
(d) You, S. L.; Hou, X. L.; Dai, L. X.; Cao, B. X.; Sun, J. *Chem. Commun.* **2000**, 1933.
(e) Hou, X. L.; Wu, X. W.; Dai, L. X.; Cao, B. X.; Sun, J. *Chem. Commun.* **2000**, 1195.
(f) Deng, W. P.; You, S. L.; Hou, X. L.; Dai, L. X.; Yu, Y. H.; Xia, W.; Sun, J. *J. Am. Chem. Soc.* **2001**, *123*, 6508.
(g) You, S. L.; Zhu, X. Z.; Luo, Y. M.; Hou, X. L.; Dai, L. X. *J. Am. Chem. Soc.* **2001**, *123*, 7471.
- Jacobsen, E. N.; Pfaltz, A.; Yamamoto, H. *Comprehensive Asymmetric Catalysis*, Vol. 2, Springer, Berlin, **1999**.
- Leutenegger, U.; Umbrich, G.; Fahmi, C.; von Matt, P.; Pfaltz, A. *Tetrahedron* **1992**, *48*, 2143.
- Trost, B. M.; Van Vranken, D. L. *Angew. Chem., Int. Ed. Engl.* **1992**, *31*, 228.