

## Diastereoselective Asymmetric Allylation of Chiral $\alpha$ -Keto-amides with Allyltrimethylsilane. Preparation of Protected Homoallylic Alcohols

Kenso Soai\* and Miyuki Ishizaki

*Department of Applied Chemistry, Faculty of Science, Science University of Tokyo, Kagurazaka, Shinjuku-ku, Tokyo 162, Japan*

*In the presence of Lewis acids, protected homoallylic alcohols of high diastereoisomeric excesses (up to 89%) were obtained by the addition of allyltrimethylsilane to chiral  $\alpha$ -keto-amides derived from (S)-proline esters.*

Lewis acid-promoted allylation of carbonyl compounds with allyltrimethylsilane (Sakurai reaction) has served as a versatile tool for the preparation of homoallylic alcohols.<sup>1</sup> Asymmetric reactions for carbon-carbon bond formation are of current interest,<sup>2</sup> but only moderate asymmetric induction [23–56% diastereoisomeric excess (d.e.)] is reported in such a reaction

using a chiral  $\alpha$ -keto-ester derived from (–)-menthol.<sup>3</sup> We recently reported the use of the chiral  $\alpha$ -keto-amide (**1a,b**) derived from methyl (S)-prolinate in the diastereoselective reduction with sodium borohydride.<sup>4</sup>

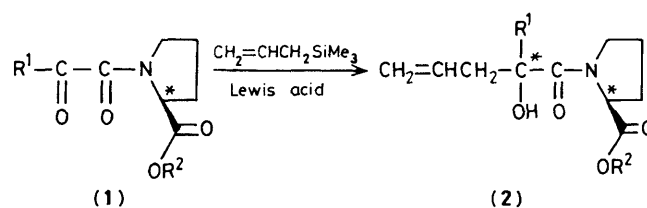
When (**1a**) was treated with allyltrimethylsilane in the presence of tin tetrabromide in CH<sub>2</sub>Cl<sub>2</sub> at 0 °C, (**2a**) in 87%

**Table 1.** Asymmetric addition of allyltrimethylsilane to (1) in the presence of a Lewis acid.<sup>a</sup>

(1)	Lewis acid	Temp. (°C)	Time (h)	Yield <sup>b</sup> (%)	(2a-c) (% d.e.) <sup>c</sup>
a	SnCl <sub>4</sub>	-40	3	40	80
a	SnCl <sub>4</sub>	-78	4	32	87
a	SnBr <sub>4</sub>	-40→Room temp.	44	53	81
a	SnBr <sub>4</sub>	0	24	50	87
a	SnBr <sub>4</sub> <sup>d</sup>	0→Room temp.	46	17	84
a	TiCl <sub>4</sub>	0	1	80	7
a	TiCl <sub>4</sub>	-40	3	65	18
a	TiCl <sub>4</sub> <sup>d</sup>	-40	3	65	75
a	TiCl <sub>4</sub>	-78	6	52	47
a	TiCl <sub>4</sub> <sup>d</sup>	-78	6	17	70
a	AlCl <sub>3</sub>	-40	3	66	41
b	TiCl <sub>4</sub>	-78	3	47	56
b	SnCl <sub>4</sub>	-78	3	67	45
c	TiCl <sub>4</sub>	-78	5	58	75
c	SnCl <sub>4</sub>	-78	4.5	46	89

<sup>a</sup> Unless otherwise noted, CH<sub>2</sub>Cl<sub>2</sub> was used as solvent. <sup>b</sup> Isolated yield. <sup>c</sup> D.e. = diastereoisomeric excess, determined by g.l.c. analysis. (2a); Silicone SE-30, 25 m capillary column, column temp. 170 °C, flame ionisation detector; retention time 37.6 min for the major diastereoisomer and 45.6 min for the minor isomer. (2b); Poly(ethylene glycol) (PEG)-20M, 25 m capillary column, column temp. 180 °C, flame ionisation detector; retention time 14.1 min for the minor isomer and 15.1 min for the major isomer. Compound (2c) was converted into (2a) by titanate-mediated transesterification (D. Seebach, E. Hungerbühler, R. Naef, P. Schnurrenberger, B. Weidmann, and M. Zuger, *Synthesis*, 1982, 138), and then characterized as described for (2a). <sup>d</sup> Mixed solvent was used [CH<sub>2</sub>Cl<sub>2</sub>: n-hexane 2:1 (v/v)].

d.e. (g.l.c.) was obtained, see Table 1. It should be noted that the enhancement of % d.e. of (2a) by recrystallisation was promising. One recrystallisation of (2a) in 81% d.e. from n-hexane afforded (2a) in 98% d.e. When titanium tetra-



a; R<sup>1</sup> = Ph, R<sup>2</sup> = Me  
 b; R<sup>1</sup> = Me, R<sup>2</sup> = Me  
 c; R<sup>1</sup> = Ph, R<sup>2</sup> = PhCH<sub>2</sub>

chloride was used as the Lewis acid, a heterogeneous reaction mixture (mixed solvent of n-hexane and CH<sub>2</sub>Cl<sub>2</sub>) was found to achieve higher stereoselectivity than a homogeneous reaction mixture (solvent, CH<sub>2</sub>Cl<sub>2</sub> only). Compounds (1b) and (1c) were also converted into (2b) and (2c) respectively in good to high diastereoisomeric excesses (56–89% d.e.). Chelation of the Lewis acid with oxygen atom(s) of the ester group of (1), which does not occur in the conventional method,<sup>3</sup> may reduce the number of possible conformations of (1), and hence be one of the reasons for the high diastereoselectivity.

As noted previously,<sup>5</sup> (2) is the synthetic equivalent of the product from a crossed-aldol reaction. The present observations compete with the recently reported diastereoselective ene reaction of chiral α-keto-esters.<sup>5</sup>

Received, 26th March 1984; Com. 406

## References

- 1 A. Hosomi and H. Sakurai, *Tetrahedron Lett.*, 1976, 1295.
- 2 For a review, see J. W. ApSimon and R. P. Seguin, *Tetrahedron*, 1979, **35**, 2797.
- 3 I. Ojima, Y. Miyazawa, and M. Kumagai, *J. Chem. Soc., Chem. Commun.*, 1976, 927.
- 4 K. Soai, K. Komiya, Y. Shigemitsu, H. Hasegawa, and A. Ookawa, *J. Chem. Soc., Chem. Commun.*, 1982, 1282.
- 5 J. K. Whitesell, D. Deyo, and A. Bhattacharya, *J. Chem. Soc., Chem. Commun.*, 1983, 802.