Diastereo- and Enantioselective Synthesis of Vicinal Diamines via Aza-Michael Addition to Nitroalkenes

Dieter Enders,* Jürgen Wiedemann

Institut für Organische Chemie, Rheinisch-Westfälische Technische Hochschule, Professor-Pirlet-Straße 1, D-52074 Aachen, Germany

Fax +49(241)8888127; E-mail: Enders@RWTH-Aachen.de

Received 18 July 1996

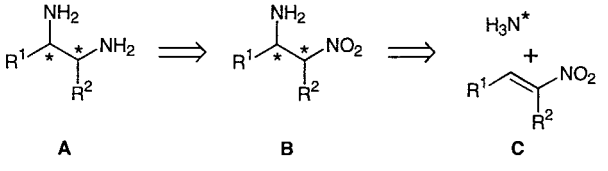
The asymmetric synthesis of protected 1,2-diamines **4** by aza-analogous Michael addition of (−)-(2*S*,3*R*,4*R*,5*S*)-1-amino-3,4-dimethoxy-2,5-bis(methoxymethyl)pyrrolidine (ADMP) to nitroalkenes **1** in good overall yields and high enantiomeric excesses (ee = 93–96%) is described. The auxiliary constitutes a novel chiral equivalent of ammonia and is removed under reductive N–N bond cleavage with Raney nickel, which also reduces the nitro group. The absolute configuration was determined by NMR-spectroscopic methods and polarimetry.

In the last few years vicinal diamines have developed into a class of compounds of extraordinary importance. Molecules with the 1,2-diamino structural unit are not only building blocks for natural products and medicinal chemistry,[1] but there is also a steadily increasing interest in these compounds because of their important role as chiral ligands in transition metal complexes and Lewis acids as well as auxiliaries in asymmetric synthesis. For example, they are frequently used for enantioselective Diels–Alder, Michael and Aldol reactions, the asymmetric dihydroxylation of alkenes, the enantioselective reduction of ketones or the 1,2-addition of organometallics to aldehydes.[2–6] In addition, a new method for the determination of the enantiomeric excesses of chiral alcohols, thiols and amines is based on the application of vicinal diamines.[7] Furthermore, they are effective chiral reagents for the determination of the optical purity of chiral carboxylic acids by NMR spectroscopy.[8] In contrast to their importance, relatively few general methods are known for their diastereo- and enantioselective synthesis from readily available starting materials.[9] Most of these methods are based on the transformation of chiral alcohols via the corresponding azides[10] or the transition-metal-mediated reductive coupling of imines.[11] The latter is generally limited to the synthesis of symmetrical 1,2-diamines.[12] Some interesting new strategies are; the addition of aminomethyl carbanion equivalents to imines,[13] the diastereoselective α-alkylation of *N,N*-dibenzylaminoacetaldehyde SAMP-hydrazones,[14] or the diastereoselective addition of organometallics to enantiopure hydrazones.[15]

Although the conjugate addition of *N*-nucleophiles to electron-deficient C–C double bonds is an efficient method for the stereoselective introduction of the amino moiety,[16] surprisingly only a few efforts have been made to develop a method for the synthesis of vicinal diamines using Michael addition of *N*-nucleophiles to nitroalkenes as the key step.[17]

We now wish to report the first auxiliary-controlled diastereo- and enantioselective synthesis of unsymmetrical and symmetrical vicinal diamines via the aza-analogous Michael addition using (−)-(2*S*,3*R*,4*R*,5*S*)-1-amino-3,4-dimethoxy-2,5-bis(methoxymethyl)pyrrolidine (ADMP) as a chiral equivalent of ammonia.

The priniciple of the synthetic strategy is shown in the retrosynthetic analysis of Scheme 1. Through highly enantioface-selective conjugate addition of the chiral ammonia equivalent **D** to nitroalkenes **C** the β-aminonitroalkanes **B** are formed. These are transformed to the corresponding vicinal diamines **A** by reduction of the nitro group and removal of the auxiliary by N–N bond cleavage.



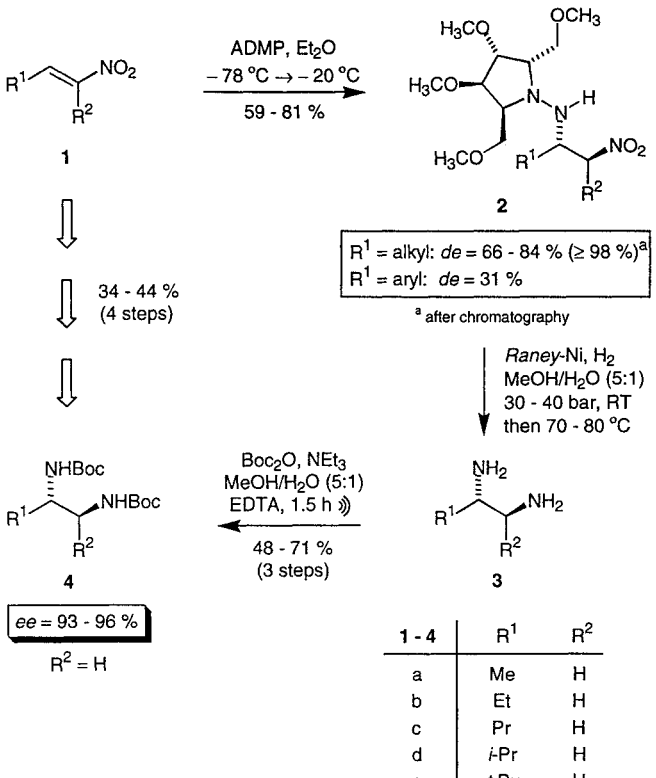
Scheme 1

The chiral ammonia equivalent used in such a synthesis must fulfill a basic requirement; it should be easily removable, liberating the free amino function. With regard to this restriction, various chiral amino group equivalents were examined. It was found that the highest diastereoselectivities were obtained using ADMP as nitrogen nucleophile in diethyl ether. In general, the asymmetric induction increased with decreasing polarity of the solvent system and lower temperature. Nevertheless, temperatures below −20 °C turned out not to be practicable because of rapidly decreasing reaction rates.

As shown in Scheme 2, the pre-cooled nitrogen nucleophile ADMP dissolved in diethyl ether was added dropwise to a solution of the nitroalkenes **1** in diethyl ether at −78 °C. The reaction mixture was warmed to −20 °C and kept at this temperature until the reaction was complete. The reaction could easily be monitored by TLC, because even trace amounts of ADMP or the product hydrazines **2** react with phosphomolybdic acid without heating while the nitroalkenes can easily be detected by aqueous $KMnO_4$ solution. The crude products were purified by column chromatography on deactivated silica gel. In nearly all cases (except **2e**) it was possible to separate the major diastereomers in this way (silica gel, petroleum ether/Et_2O, 5:1–9:1 + 1 Vol% NEt_3) leading

to de ≥98%. It is very important to use deactivated silica gel, because the products show a strong tendency to undergo a retro-Michael reaction leading to the isolation of the starting materials. Afterwards the eluate was concentrated to one third of its initial volume and neutralized by washing with aqueous pH 7 buffer solution to remove the triethylamine, which decomposes the products at higher concentrations. However, during the whole workup procedure it is very important to avoid acidic conditions. Otherwise, rapid epimerization occurs during storage of the products. The nitrohydrazines **2** were obtained as slightly yellow oils in 59–81% yield with diastereomeric excesses ranging from 66–84% and can be stored under an argon atmosphere at −20°C for several months without epimerization. Only the de value of the aryl-substituted nitrohydrazine **2f** was low (31%). The spectroscopic data of the nitrohydrazines **2** are summarized in Table 3.

The nitrohydrazines **2** were reduced to the corresponding aminohydrazines using Raney nickel/H_2. A multitude of other methods or catalysts were not successful due to epimerization or unselective reaction. Without their isolation the auxiliary was removed by reductive N–N bond cleavage in a one-pot procedure leading to the vicinal diamines **3**, which were immediately transformed to the bis-Boc protected derivatives **4** due to their enhanced stability and easier purification. In the presence of Raney nickel it was essential to sonicate the reaction mixture during the protection step. Otherwise, only 30% of the



1 - 4	R^1	R^2
a	Me	H
b	Et	H
c	Pr	H
d	*i*-Pr	H
e	*t*-Bu	H
f	Ph	H
g	-$(CH_2)_4$-	
h	*c*-Hex	H

Scheme 2

Table 1. β-Hydrazinonitroalkanes **2** Prepared

2	R^1	R^2	Time (d)	Yield (%)	$[\alpha]_D^{r.t.}$ (*c*, C_6H_6)	*de*[a,b] (%)	Config[c]
a	Me	H	6	75	−10.8 (0.98)	66 [≥98]	(*S*)
b	Et	H	7	75	−17.8 (0.74)	72 [≥98]	(*S*)
c	Pr	H	7	81	−22.5 (0.94)	73 [≥98]	(*S*)
d	*i*-Pr	H	9	78	−5.6 (1.06)	84 [≥98]	(*S*)
e	*t*-Bu	H	25	73	−11.3 (0.94)	83	(*S*)
f	Ph	H	14	65	+0.7 (0.86)	31	(*S*)
g	-$(CH_2)_4$-		10	81	+40.5 (1.26)	82 [≥98][d]	(*S,S*)
h	*c*-Hex	H	9	59	−5.4 (0.95)	82	(*S*)

[a] In brackets *de* after chromatographic enrichment.
[b] Determined by ^1H and ^{13}C NMR spectroscopy.
[c] Absolute configuration of the new formed stereocenter.
[d] *trans/cis* 8 : 1 [10 : 1] (determined by ^1H NMR spectroscopy).

Table 2. Protected Vicinal Diamines **4** Prepared

4	R^1	R^2	Time[a] (d/d)	Yield (%)	$[\alpha]_D^{r.t.}$ (*c*, $CHCl_3$)	*ee*[b] (%)	Config[c]
a	Me	H	2/0	70	−22.8 (0.94)	96	(*S*)
b	Et	H	3/1	71	−29.5 (0.98)	93	(*S*)
c	Pr	H	3/2	52	−27.8 (1.06)	96	(*S*)
d	*i*-Pr	H	3/4	48	−28.7 (1.32)	95	(*S*)
g	-$(CH_2)_4$-		3/3	51	−34.5 (1.05)	96[c,d]	(*S,S*)

[a] Reaction times during N–N cleavage (70°C/80°C).
[b] Determined by GC-CSP analysis.
[c] Determined by ^1H and ^{13}C NMR spectroscopy.
[d] *trans/cis* 4 : 1 (determined by GC analysis).

diamine could be converted. After column chromatography the desired protected vicinal diamines **4** were obtained in 48–71% yield over three steps with regard to the nitrohydrazines **2** with only a little loss of enantiomeric purity. The spectroscopic data of the protected diamines **4** are summarized in Table 4.

The diastereomeric excesses of the crude β-nitrohydrazines **2** were determined by ^1H and ^{13}C NMR spectroscopy ranging from de = 66–84% for aliphatic groups R^1, whereas with an aromatic substituent (R^1 = phenyl) the asymmetric induction was rather low (de = 31%).

The enantiomeric excesses of the protected vicinal diamines **4a–d** were determined by GC–CSP analysis (column: 10% heptakis(2,3,6-tri-*O*-methyl)-β-cyclodextrine). Due to the small peak separation of the enantiomers of **4g**, they were transformed into the corresponding diastereomeric bis(*O*-methylmandelic acid amides) [MPA-amides (**5g**)]. For this the biscarbamate **4g** was hydrolyzed with trifluoroacetic acid and the resulting colorless salt was transformed into the corresponding bisamide **5g** by treating it with MPA-Cl in the presence of triethylamine. Then the enantiomeric excess was determined by ^1H and ^{13}C NMR spectroscopy of **5g**.

The absolute configuration of the diamines **4** was determined by a new NMR spectroscopic method, which was independently developed by Trost[18] and Riguera.[19] The method is based on the preferential conformation of *O*-methylmandelic acid amides and the anisotropic magnetic shielding due to the phenyl ring of the MPA moiety. Therefore a racemic and an enantiomerically enriched sample of the biscarbamate **4a** were transformed into the bisamides **5a**.

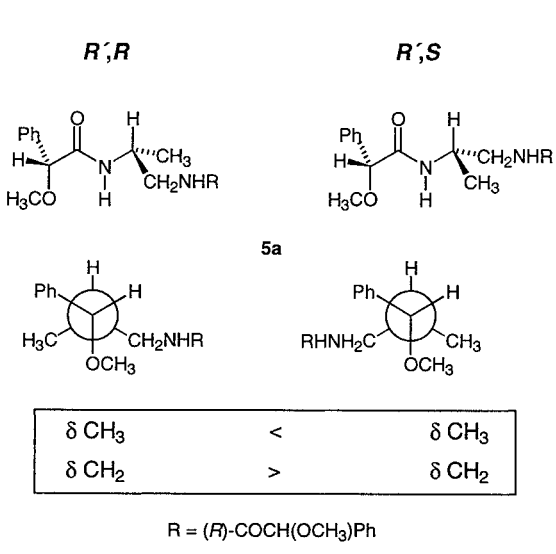
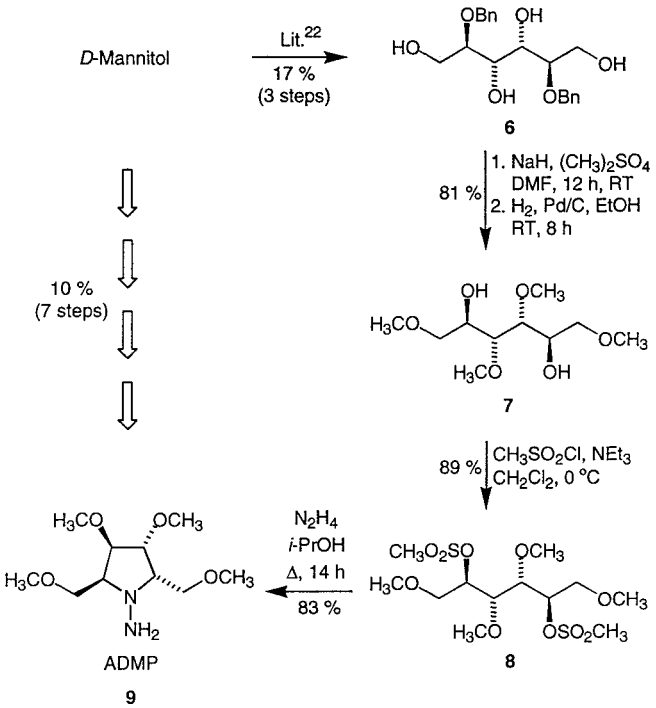


Figure Preferred configurations of the bisamide **5a**

As shown in the extended Newman projection in the Figure, using (*R*)-MPA a significant upfield shift should be expected for the methyl signal of the amino portion of the molecule in case of the *R* configuration relative to the *S* configuration. Due to the observed chemical shifts (δ = 1.10 and 1.19) the absolute configuration *S* could be assigned to the newly formed stereocenter.

This result was confirmed by determining the absolute configuration of **4g** to be (*S,S*) in the same way. In addition, this was verified by comparison of the optical rotation value of **4g** with those of carbamates prepared from commercially available 1,2-diaminocyclohexane of known configuration [$[\alpha]_D^{r.t.}$ + 33.4 (*c* = 1.23, $CHCl_3$) (*R,R*)/ – 32.3 (*c* = 0.91, $CHCl_3$) (*S,S*)].

The enantiopure C_2-symmetrical nitrogen nucleophile ADMP **(9)** was synthesized according to a procedure developed in our group.[20] As shown in Scheme 3, the hydrazine **9** was obtained starting from commercially available D-mannitol in seven steps in large scale quantities. After the literature known conversion of D-mannitol into 2,5-di-*O*-benzyl-D-mannitol **(6)**,[21] the latter was transformed in two steps into the diol **7**, which could easily be mesylated affording **8**. Finally, the bismesylate **8** was cyclized leading to the enantiopure hydrazine **9**.



Scheme 3

In summary, an efficient, diastereo- and enantioselective synthesis of unsymmetrical, as well as symmetrical, protected vicinal diamines has been developed using, to the best of our knowledge, the first auxiliary controlled diastereoselective conjugate addition of a chiral ammonia equivalent to nitroalkenes as the key step. An extension of this C–N connective methodology with regard to alternative transformations of the nitro group is currently being investigated in our laboratories.

Solvents were dried and purified according to known procedures. All reagents were distilled prior to use or were of commercial quality from freshly opened containers. Analytical TLC plates (silica gel 60 F_{254}) and silica gel (100–200 mesh) were purchased from Merck,

Table 3. Spectroscopic Data of β-Hydrazinonitroalkanes **2**[a,b]

2	IR ($CHCl_3$) $\tilde{\nu}$ (cm^{-1})	^1H NMR (C_6D_6/TMS) δ, J (Hz)	^{13}C NMR (C_6D_6/TMS) δ	MS (70 eV) m/z (%)
a	3283, 2980, 2927, 2896, 2827, 1550, 1456, 1382, 1270, 1201, 1105, 993, 953, 876, 795, 736, 611	0.83 (d, 3H, J = 6.32, CH_3CHN), 3.16, 3.17 (2s, 12H, CH_3O), 3.32–3.40 (m, 2H, CHN), 3.46 (dd, 2H, J = 9.61/5.22, CHHO), 3.57–3.70 (m, 1H, CHNH), 3.66 (dd, 2H, J = 9.61/4.95, CHHO), 3.70–3.76 (m, 2H, CHO), 3.91 (dd, 1H, J = 11.54/5.77, $CHHNO_2$), 4.27 (dd, 1H, J = 11.54/5.50, $CHHNO_2$)	16.72 (CH_3CHN), 53.04 (CHNH), 58.08, 58.69, (CH_3O), 66.60 (br, CHN), 70.70 (br, CH_2O), 80.13 (CH_2NO_2), 84.57 (CHO)	321 (24, $M^{+\bullet}$), 277 (13), 276 (100), 233 (14), 140 (12), 101 (50), 75 (12), 71 (31), 57 (11), 55 (13), 45 (79), 44 (12), 43 (31), 41 (42)
b	3286, 2974, 2927, 2894, 2828, 1551, 1461, 1382, 1201, 1107, 975, 953, 755	0.75 (t, 3H, J = 7.41, CH_3), 1.24–1.36 (m, 2H, CH_2CH_3), 3.17, 3.18 (2s, 12H, CH_3O), 3.34–3.43 (m, 2H, CHN), 3.44–3.55 (m, 3H, CHNH/CHHO), 3.67 (dd, 2H, J = 9.61/4.95, CHHO), 3.70–3.77 (m, 2H, CHO), 4.08 (dd, 1H, J = 11.82/5.50, $CHHNO_2$), 4.27 (dd, 1H, J = 11.82/5.77, $CHHNO_2$)	9.79 (CH_3CH_2), 23.98 (CH_2CHN), 58.10, 58.68, 59.06 (CH_3O/CHNH), 66.80 (br, CHN), 70.60 (br, CH_2O), 78.38 (CH_2NO_2), 84.59 (CHO)	335 (26, $M^{+\bullet}$), 291 (13), 290 (100), 233 (12), 101 (21), 71 (12), 55 (8), 45 (23), 41 (8)
c	3285, 2958, 2929, 2828, 1551, 1462, 1382, 1242, 1200, 1108, 976, 952, 888, 756	0.75 (t, 3H, J = 6.87, CH_3), 1.12–1.29 (m, 4H, CH_2CH_2), 3.17 (brs, 12H, CH_3O), 3.36–3.42 (m, 2H, CHN), 3.48 (dd, 2H, J = 9.61/5.22, CHHO), 3.57–3.65 (m, 1H, CHNH), 3.68 (dd, 2H, J = 9.61/4.95, CHHO), 3.72–3.76 (m, 2H, CHO), 4.08 (dd, 1H, J = 11.81/5.49, $CHHNO_2$), 4.30 (dd, 1H, J = 11.81/5.49, $CHHNO_2$)	14.24 (CH_3CH_2), 18.98 (CH_3CH_2), 33.35 (CH_2CHNH), 57.73, 58.09, 58.70 (CH_3O/CHNH), 67.10 (br, CHN), 70.80 (br, CH_2O), 78.57 (CHO), 78.85 (CH_2NO_2), 84.57 (CHO)	349 (25, $M^{+\bullet}$), 305 (14), 304 (100), 233 (16), 101 (32), 71 (16), 69 (11), 45 (31), 43 (11), 41 (18)
d	3312, 2960, 2929, 2895, 2828, 1553, 1465, 1426, 1383, 1371, 1200, 1106, 976, 953, 757, 667	0.75 (d, 3H, J = 7.02, CH_3), 0.77 (d, 3H, J = 7.02, CH_3), 1.73–1.80 (m, 1H, $CH(CH_3)_2$), 3.18 (brs, 12H, CH_3O), 3.37–3.42 (m, 2H, CHN), 3.35 (brs, 1H, NH), 3.48 (dd, 2H, J = 9.76/5.19, CHHO), 3.55–3.59 (m, 1H, CHNH), 3.66 (dd, 2H, J = 9.76/5.19, CHHO), 3.71–3.75 (m, 2H, CHO), 4.02 (dd, 1H, J = 11.91/4.58, $CHHNO_2$), 4.24 (dd, 1H, J = 11.91/7.02, $CHHNO_2$)	17.61, 18.12 ($CH_3)_2CH_2$), 28.57 (CH_3CHNH), 58.12, 58.68 (CH_3O), 62.52 (CHNH), 66.50 (br, CHN), 70.50 (br, CH_2O), 77.00 (CH_2NO_2), 84.50 (CHO)	349 (30, $M^{+\bullet}$), 305 (16), 304 (100), 233 (16), 101 (30), 71 (18), 69 (10), 45 (36), 43 (12), 41 (19)
e	3314, 2927, 2828, 1554, 1471, 1424, 1398, 1381, 1369, 1196, 1105, 992, 974, 953, 706	0.78 (s, 9H, $C(CH_3)_3$), 3.16, 3.18 (2s, 12H, CH_3O), 3.36–3.44 (m, 2H, CHN), 3.52 (dd, 2H, J = 9.61/5.49, CHHO), 3.68–3.79 (m, 5H, CHNH/CHO/CHHO), 4.04 (dd, 1H, J = 12.91/3.57, $CHHNO_2$), 4.34 (dd, 1H, J = 12.91/6.32, $CHHNO_2$)	26.37 ($CH_3)_3C$), 32.89 (($CH_3)_2CH$), 57.99, 58.64 (CH_3O), 66.50 (CHNH), 68.10 (br, CHN), 70.80 (br, CH_2O), 77.76 (CH_2NO_2), 84.50 (CHO)	363 (35, $M^{+\bullet}$), 319 (17), 318 (100), 260 (24), 257 (15), 233 (24), 215 (24), 140 (11), 101 (41), 83 (14), 75 (13), 71 (31), 57 (19), 55 (19), 45 (65), 43 (25), 41 (35)
f[c]	3264, 3031, 2982, 2927, 2895, 2827, 1551, 1494, 1456, 1378, 1344, 1310, 1200, 1106, 1030, 974, 952, 761, 702	3.07, 3.19 (2s, 12H, CH_3O), 3.16–3.27 (m, 2H, CHN), 3.30–3.42 (m, 2H, CHHO), 3.51–3.63 (brs, 1H, NH), 3.53 (dd, 2H, J = 9.61/5.77, CHHO), 3.64–3.72 (m, 1H, CHO), 4.17 (dd, 1H, J = 11.81/6.87, $CHHNO_2$), 4.81 (dd, 1H, H, J = 11.81/6.32, $CHHNO_2$), 4.94–4.99 (m, 1H, CHNH), 7.03–7.13 (m, 3H, *p*/*m*-H-Ar), 7.20–7.29 (m, 2H, *o*-H-Ar)	57.94, 58.74 (CH_3O), 62.31 (CHNH), 65.50 (br, CHN), 70.10 (br, CH_2O), 80.19 (CH_2NO_2), 84.70 (CHO), 128.03, 128.11, 128.87 (CH_{arom}), 139.23 (C_{arom})	383 (7, $M^{+\bullet}$), 338 (10), 234 (12), 233 (100), 201 (13), 201 (13), 101 (13), 71 (12), 45 (27)
g[c]	3281, 2930, 2827, 1550, 1453, 1374, 1292, 1241, 1200, 1107, 1029, 992, 976, 956, 899, 756, 735	0.75–1.08 (m, 4H, CH_2CH_2), 1.30–1.42 (m, 2H, CH_2CHNH), 1.58–1-73 (m, 1H, CHHCHNO), 1.73–1.85 (m, 1H, CHHCJMP$_2$), 3.20, 3.23 (2s, 12H, CH_3O), 3.30–3.39 (m, 1H, CHNH), 3.42–3.48 (m, 2H, CHN), 3.54 (dd, 2H, J = 4.39/9.61, CHHO), 3.61 (brs, 1H, NH), 3.68 (dd, 2H, J = 9.61/4.94, CHHO), 3.74–3.79 (m, 2H, CHO), 4.19 (ddd, J = 11.27/9.35/4.39, $CHNO_2$)	23.59, 24.12 ($CH_2CH_2CH_2CH_2$), 29.81 (CH_2CHNH), 30.75 (CH_2CHNO_2), 58.25, (CHNH), 58.67, 58.87 (CH_3O), 64.60 (br, CH_2N), 70.30 (br, CH_2O), 84.66 (CHO), 90.35 ($CHNO_2$)	361 (22, $M^{+\bullet}$), 317 (16), 316 (100), 233 (10), 140 (10), 128 (11), 110 (10), 101 (40), 81 (12), 75 (10), 71 (23), 55 (11), 45 (46), 43 (16), 41 (21)

Table 3. (continued)

2	IR ($CHCl_3$) $\tilde{\nu}$ (cm^{-1})	^1H NMR (C_6D_6/TMS) δ, J (Hz)	^{13}C NMR (C_6D_6/TMS) δ	MS (70 eV) m/z (%)
h	3308, 2980, 2926, 2856, 2828, 1552, 1451, 1383, 1307, 1268, 1201, 1106, 1031, 976, 953, 892, 875, 746	0.65–1.73 (m, 11 H, CH_3CH), 3.16, 3.18 (2 s, 12 H, CH_3O), 3.36 (brs, 1 H, NH), 3.39–3.47 (m, 2 H, CHN/CHNH), 3.52 (dd, 2 H, J = 9.34/5.22, $CHHO$), 3.54–3.63 (m, 1 H, CHN), 3.69 (dd, 2 H, J = 9.34/4.95, $CHHO$), 3.72–3.78 (m, 2 H, CHO), 4.05 (dd, 1 H, J = 12.08/4.67, $CHHNO_2$), 4.27 (dd, 1 H, J = 12.08/6.87, $CHHNO_2$)	26.66, 26.70, 26.79, 28.64, 29.11 (CH_2 c-Hex), 39.09 (CHCHNH), 58.13, 58.73, (CH_3O), 62.43, 66.80 (br, CHN), 70.70 (br, CH_2O), 77.33 (CH_2NO_2), 84.53 (CHO)	389 (74, $M^{+\cdot}$), 346 (11), 345 (70), 344 (100), 329 (19), 283 (37), 253 (13), 234 (13), 233 (85), 215 (17), 189 (22), 140 (12), 125 (13), 115 (13), 110 (16), 101 (50), 95 (12), 85 (12), 81 (14), 71 (46), 67 (20), 55 (30), 45 (49)

[a] Satisfactory microanalyses obtained: C ± 0.49, H ± 0.12, N ± 0.37.
[b] Data given are those of the major diastereomer.
[c] IR (neat).

Table 4. Spectroscopic Data of the Boc-Protected Vicinal Diamines **4**[a]

4	IR (KBr) $\tilde{\nu}$ (cm^{-1})	^1H NMR (C_6D_6/TMS) δ, J (Hz)	^{13}C NMR (C_6D_6/TMS) δ	MS (70 eV) m/z (%)
a	3568, 3356, 2979, 2931, 1685, 1532, 1458, 1390, 1346, 1317, 1277, 1256, 1238, 1177, 1065, 998, 914, 655	1.12 (d, 3 H, J = 6.72, CH_3CHNH), 1.44 (s, 18 H, $C(CH_3)_3$), 3.10–3.20 (brm, 2 H, CH_2NH), 3.66–3.80 (brm, 1 H, CHNH), 4.75 (brd, 1 H, J = 7.06, CHNH), 4.90–5.03 (brm, 1 H, CH_2NH)	18.65 (CH_3CHNH), 28.39, 28.40 ($C(CH_3)_3$), 46.13 (CH_2NH), 47.27 (br, CHNH), 79.33 (br, $C(CH_3)_3$), 155.90, 156.6 (br, CO_2N)	274 (0.58, $M^{+\cdot}$), 229 (8), 173 (38), 129 (16), 113 (15), 57 (100), 41 (16)
b	3356, 2977, 2932, 1687, 1538, 1454, 1390, 1367, 1328, 1291, 1271, 1249, 1229, 1176, 1147, 1074, 1039, 1019, 999, 976, 881, 778, 754, 643	0.94 (t, 3 H, J = 7.42, CH_3), 1.41–1.50 (m, 2 H, CH_3CH_2), 1.44 (brs, 18 H, $C(CH_3)_3$), 3.12–3.23 (brm, 2 H, CH_2N), 3.46–3.61 (brm, 1 H, CHN), 4.70–4.86 (brm, 1 H, CHNH), 5.00–5.10 (brm, 1 H, CH_2NH)	10.33 (CH_3CH_2), 25.91, (CH_3CH_2), 28.27, 28.40 ($C(CH_3)_3$), 44.51 (CH_2NH), 52.76 (br, CHNH), 79.19, (br, $C(CH_3)_3$), 156.35, 156.6 (br, CO_2N)	288 (0.07, $M^{+\cdot}$), 171 (8), 159 (8), 159 (7), 158 (19), 115 (15), 102 (43), 76 (9), 75 (8), 59 (11), 58 (98), 57 (100), 41 (22)
c	3354, 2964, 2930, 2873, 1686, 1530, 1458, 1392, 1367, 1327, 1295, 1270, 1253, 1171, 1080, 1051, 1023, 1023, 980, 879, 781, 651	0.88–0.96 (m, 3 H, CH_3), 1.18–1.41 (m, 4 H, $CH_3CH_2CH_2$CHNH), 1.65 (brs, 18 H, $C(CH_3)_3$), 3.10–3.26 (brm, 2 H, CH_2N), 3.54–3.71 (brm, 1 H, CHN), 4.64 (brd, 1 H, J = 8.24, CHNH), 4.85–5.20 (brm, 1 H, CH_2NH)	13.96 (CH_3CH_2), 19.11, (CH_3CH_2), 28.40 ($C(CH_3)_3$), 35.18 (CH_2CHNH), 44.98 (CH_2NH), 52.76 (br, CHNH), 79.26 (br, $C(CH_3)_3$), 156.3, 156.6 (br, CO_2N)	185 (4), 172 (13), 129 (13), 116 (50), 76 (6), 75 (7), 72 (88), 59 (7), 57 (100), 41 (19)
d	3361, 3339, 2980, 2963, 2932, 2876, 1686, 1655, 1637, 1543, 1458, 1391, 1368, 1338, 1312, 1300, 1277, 1267, 1254, 1229, 1175, 1093, 1022, 973, 875, 784, 754, 656	0.92 (d, 3 H, J = 6.87, CH_3), 0.94 (d, 3 H, J = 6.87, CH_3), 1.44 (brs, 18 H, $C(CH_3)_3$), 1.64–1.81 (m, 1 H, $CH(CH_3)_2$), 3.10–3.26 (brm, 2 H, CH_2N), 3.41–3.56 (brm, 1 H, CHN), 4.59–4.72 (brm, 1 H, CHNH), 4.78–4.94 (brm, 1 H, CH_2NH)	18.03, 19.25 ($(CH_3)_2$CH), 28.40 ($(CH_3)_3$C), 30.68 ($(CH_3)_2$CH), 42.85 (CH_2NH), 56.25 (CHNH), 79.26, ($(CH_3)_3$C), 156.68 (br, CO_2N)	185 (5), 173 (9), 172 (23), 129 (19), 116 (63), 85 (6), 72 (86), 59 (13), 58 (6), 57 (100), 56 (9), 55 (7)
g[b]	3371, 3013, 2989, 2974, 2930, 2859, 1683, 1637, 1518, 1446, 1392, 1367, 1321, 1283, 1248, 1234, 1173, 1059, 1044, 1023, 1029, 1008, 956, 925, 865, 853, 780, 757	1.04–1.33 (m, 4 H, CH_2), 1.42 (brs, 18 H, $C(CH_3)_3$), 1.67–1.81 (m, 2 H, CH_2), 1.97–2.07 (m, 2 H, CH_2), 3.20–3.36 (m, 2 H, CHN), 4.89–4.99 (brm, 2 H, CH_2NH)	24.89 (CH_2CH_2CH), 28.40 ($(CH_3)_3$C), 33.01 (CH_2CH_2CH), 55.09 (CH_2NH), 79.12 ($(CH_3)_3C$), 156.52 (CO_2N)	197 (19), 185 (6), 157 (6), 142 (6), 141 (67), 114 (6), 97 (75), 96 (25), 81 (5), 70 (15), 59 (7), 58 (5), 57 (100), 56 (30)

[a] Satisfactory microanalyses obtained: C ± 0.49, H ± 0.11, N ± 0.42; mp **4a** 110 °C, **4b** 102 °C, **4c** 80–81 °C, **4d** 68–70 °C, **4e** 160–161 °C.
[b] Data given are those of the major diastereomer.

Darmstadt. All melting points (Büchi apparatus, system Dr. Tottoli) are uncorrected. Optical rotation values were measured using a Perkin-Elmer P241 polarimeter. Microanalyses were obtained with a Heraeus CHN-O-RAPID element analyser. IR spectra were recorded on a Perkin-Elmer FT/IR 1750 spectrophotometer. ^1H and ^{13}C NMR spectra were measured on a Varian VXR 300 (300 and 75 MHz), Varian Gemini 300 (300 and 75 MHz) or Varian Unity (500 and 125 MHz). MS were recorded on a Varian MAT 212 spectrometer (EI 70 eV, 1 mA) with DEI ionization (relative intensities in parentheses).

The nitroalkenes were synthesized according to literature procedures.[22] 1-Nitrocyclohex-1-ene and (*R*)- and (*S*)-*O*-methylmandelic acid were purchased from Aldrich Chem. Co. Ni/Al alloy was a donation from Degussa AG. D-Mannitol was purchased from Fluka. Abs hydrazine was prepared according to a literature procedure.[23]

Synthesis of β-Nitrohydrazines 2; General Procedure:
A pre-cooled solution of ADMP (515 mg, 2.2 mmol) in abs Et_2O (4 mL) was added dropwise to the nitroalkene **1** (2 mmol) dissolved

Table 5. Spectroscopic Data of the Diamides **5**[a]

5	IR (KBr) $\tilde{\nu}$ (cm^{-1})	^1H NMR ($CDCl_3$/TMS) δ, J (Hz)	^{13}C NMR ($CDCl_3$/TMS) δ	MS (70 eV) m/z (%)
a	3313, 3063, 2981, 2933, 2824, 1661, 1601, 1528, 1496, 1454, 1381, 1362, 1311, 1258, 1196, 1145, 1098, 1030, 986, 913, 788, 736, 698, 607	1.19 (d, 3H, J = 6.59, CH_3CH), 3.11–3.49 (m, 2H, CH_2NH), 3.22 (s, 3H, OCH_3), 3.32 (s, 3H, OCH_3), 3.98–4.15 (m, 1H, $CHNH$), 4.53 (s, 1H, CHO), 4.57 (s, 1H, CHO), 6.91 (brd, 1H, J = 7.69, $CHNH$), 7.05–7.12 (brm, 1H, CH_2NH), 7.29–7.43 (m, 10H, H-Ar)	18.36 (CH_3CHNH), 44.55 (CH_2NH), 45.42 ($CHNH$), 57.07, 57.25 (CH_3O), 83.68, 83.79 (CHI), 126.99, 127.06, 128.34, 128.44, 128.49, 128.60 (C_{arom}), 137.05 (C_{arom}), 170.89, 171.29 ($CONH$)	250 (7), 249 (40), 217 (25), 189 (13), 122 (11), 121 (100), 118 (7), 105 (10), 91 (20), 77 (20)
g	3281, 3062, 3032, 2983, 2930, 2858, 2823, 1646, 1602, 1532, 1497, 1453, 1384, 1340, 1317, 1298, 1298, 1274, 1251, 1194, 1145, 1103, 1091, 995, 725, 698	1.13–1.44 (m, 4H, CH_2), 1.62–1.83 (m, 2H, CHH), 2.09–2.23 (m, 2H, CHH), 3.23 (s, 6H, OCH_3), 3.63–3.73 (m, 2H, $CHNH$), 4.45 (s, 2H, CHO), 6.81–6.91 (m, 2H, NH), 6.91–7.99 (m, 10H, H-Ar)	25.19 (CH_2CH_2CHNH), 32.98 (CH_2CH_2CHNH), 53.23 ($CHNH$), 57.59 (CH_3O), 84.10 (CHO), 128.00, 128.89 129.04 (CH_{arom}), 137.49 (C_{arom}), 171.45 ($CONH$)	290 (10), 289 (54), 257 (40), 229 (23), 139 (17), 122 (12), 121 (100), 106 (10), 105 (10), 91 (24), 77 (19)

[a] Satisfactory microanalyses obtained: C ± 0.35, H ± 0.22, N ± 0.21; mp **5a** 74–75 °C, **5g** 160 °C; yields: **5a** 58 mg (78%), **5g** 67 mg (82%).
[b] Data given are those of the diastereomers (*R',R',S*) **5a**/(*R',R',S,S*) **5g**.

in abs Et_2O (6 mL) at −78 °C under argon. After stirring for 1 h, the reaction mixture was warmed up to −20 °C and kept at this temperature until the reaction was complete (TLC control). Afterwards the solvent was evaporated at r.t. and the crude product was immediately purified by column chromatography (silica gel, petroleum ether/Et_2O, 5:1–9:1 +1 Vol% NEt_3). The eluate was subsequently concentrated to 25% of the initial volume and neutralized by washing with aq pH 7 buffer solution (3 × 20 Vol% of the eluate). After drying ($MgSO_4$) the solvent was evaporated in vacuo and the products **2** were obtained as colorless to slightly yellow oils, which can be stored under argon at −20 °C for several months without racemization.

The nitrohydrazines **2** are very sensitive to racemization in the presence of traces of acids due to retro-Michael reaction. The silica gel was therefore deactivated prior to use by addition of 1 Vol% NEt_3 to the eluent. Caution is recommended concerning the drying agent. Especially Na_2SO_4 turned out to be slightly acidic.

Synthesis of the Protected Vicinal Diamines 4; General Procedure:
The synthesis starting from the nitrohydrazines **2** consists of three steps: reduction of the nitro group leading to the corresponding aminohydrazines, removal of the auxiliary by hydrogenolytic cleavage of the N–N bond and transformation of the resulting vicinal diamines **3** into their Boc-protected derivatives **4**.

The appropriate nitrohydrazine **2** (1 mmol) was added to a suspension of freshly prepared Raney nickel in MeOH/H_2O (5:1, 30 mL) and stirred under a hydrogen pressure of 10 bar for 12 h at r.t. After complete transformation to the aminohydrazine, the reaction mixture was heated to 70 °C/80 °C according to Table 2 until cleavage was completed (TLC control). Afterwards the autoclave was cooled to r.t. and immediately after opening $Na_2EDTA \cdot 2\ H_2O$ (652 mg, 2 mmol), Boc_2O (1.31 g, 6 mmol) and NEt_3 (3 mL) were added prior to sonication for 1.5 h at r.t. After stirring for additionally 12 h the reaction mixture was filtered over Celite and the product eluted with small portions of MeOH. After evaporation of the MeOH in vacuo the residue was dissolved in Et_2O (25 mL) and washed with aq pH 7 buffer solution (3 × 25 mL). The organic layer was dried ($MgSO_4$) and the crude products were purified by column chromatography (silica gel, petroleum ether/Et_2O, 5:1) affording **4** as colorless solids.

Preparation of the Raney Nickel:
Ni/Al alloy (3 g/mmol) was suspended in water (50 mL/mmol) and cautiously treated with NaOH until hydrogen evolution ceased. The suspension was heated to 70 °C for 30 min and the black solid obtained was washed with water (25 × 50 mL/mmol).

Synthesis of the Bis[(*R*/*S*)-(−)-*O*-methylmandelic Acid] Amides 5 (MPA-Amides); General Procedure:
The Boc-protected diamine **4** (0.2 mmol) was suspended in TFA (5 mL) and water (1 mL). This suspension was stirred for 20 h at r.t. and then the reaction mixture was concentrated to dryness in vacuo yielding the trifluorocetate as colorless solid. After addition of abs CH_2Cl_2 (5 mL) and (−)-(*R*)-*O*-methylmandelic acid chloride ((*R*/*S*)-MPA-Cl) (92 mg, 0.5 mmol) NEt_3 (1 mL) was added. After stirring at r.t. for 20 h the reaction mixture was washed with aq pH 7 buffer solution (3 × 20 mL), dried ($MgSO_4$) and the solvent was evaporated in vacuo. The crude product was purified by column chromatography (silica gel, Et_2O/MeOH, 20:1) leading to the analytically pure diamide **5** as a colorless solid.

Synthesis of (−)-(2*S*,3*R*,4*R*,5*S*)-1-Amino-3,4-dimethoxy-2,5-bis-(methoxymethyl)pyrrolidine [ADMP (9)]:
NaH (24.0 g, 1 mol) was suspended in DMF (1 L) under argon. Afterwards 2,5-di-*O*-methyl-D-mannitol **(6)**[21] (45.0 g, 0.124 mol) was slowly added and the suspension stirred for 1 h. After dimethyl sulfate (70.4 g, 0.75 mol) was added dropwise, the reaction mixture was stirred overnight at r.t. MeOH was added until gas evolution ceased and the solvents were evaporated in vacuo. The resulting oil was separated between $CHCl_3$ and water and the organic layer was dried (Na_2SO_4). After filtration over silica gel the solvents were evaporated affording the resulting ether as a colorless oil, which was dissolved in EtOH (600 mL) followed by the addition of Pd/C (1 g). After hydrogenation for 4 h at r.t. and a hydrogen pressure of 4–5 bar, the catalyst was removed by filtration and the solvent was evaporated in vacuo. A small amount of Et_2O was added leading to crystallization of the diol **7** upon cooling to 0 °C (yield: 23.8 g, 81% over two steps). NEt_3 (40.5 g, 0.4 mol) was added to the crude diol **7** (23.8 g, 0.1 mol) dissolved in CH_2Cl_2 (1 L). Afterwards MsCl (40.1 g, 0.35 mol) was slowly added at 0 °C and the solution stirred for another 10 min. After addition of dil HCl (500 mL, 1 M) the organic layer was separated, washed with sat. $NaHCO_3$ and dried (Na_2SO_4). The solvents were evaporated in vacuo and the bismesylate **8** was obtained upon cooling to 0 °C as a colorless solid (yield: 35.1 g, 84%). Bismesylate **8** (35.1 g, 89 mmol) was dissolved in *i*-PrOH (250 mL) and abs hydrazine (61 g, 1.9 mol) was added prior to reflux for 14 h. Then the reaction mixture was concentrated in vacuo and the residue separated between water and CH_2Cl_2. The organic layer was dried (K_2CO_3) and the solvents were evaporated in vacuo. Afterwards the crude product was purified by distillation yielding the hydrazine **9** as a colorless oil; yield: 17.3 g (83%); bp 97–103 °C/0.3 Torr; $[\alpha]_D^{r.t.}$ −37.7 (c = 1.42 $CHCl_3$).

IR (neat): $\tilde{\nu}$ = 3340, 2980, 2930, 2890, 1610, 1450, 1385, 1370, 1340, 1280, 1195, 1110, 1020, 990, 970, 955, 935, 865, 720 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 3.35 (s, 6H, CH_2OCH_3), 3.25–3.40 (m, 4H, NH_2, NCH), 3.41 (s, 6H, $CHOCH_3$), 3.46 (dd, 2H, J = 7.7/5.0 Hz, $CHHOCH_3$), 3.67 (dd, 2H, J = 7.7/4.4 Hz, $CHHOCH_3$), 3.84 (m, 2H, $CHOCH_3$).

^{13}C NMR (75 MHz, $CDCl_3$): δ = 58.59 (CH_2OCH_3), 59.3 ($CHOCH_3$), 66.25 (NCH), 70.85 (CH_2OCH_3), 84.57 ($CHOCH_3$).

MS: m/z [%] = 234 (19, $M^{+\cdot}$), 233 (14), 189 (39), 174 (13), 140 (20), 125 (12), 115 (18), 110 (14), 105 (11), 101 (43), 98 (14), 96 (21), 85 (13), 84 (11), 75 (40), 71 (26), 55 (15), 45 (100), 44 (11), 42 (11), 41 (24).

$C_{10}H_{22}N_2O_4$ (234.29) calc.: C, 51.26; H, 9.46; N, 11.96; found: C, 51.20; H, 9.42; N, 11.48.

This work was supported by the Fonds der Chemischen Industrie and the Deutsche Forschungsgesellschaft (Leibniz award). We thank BASF AG, Bayer AG, Degussa AG and Hoechst AG for providing us with chemicals.

(1) Bristol, J.A. *Annual Reports in Medicinal Chemistry*; Academic: San Diego, 1994; Vol. 29.
Michalson, E.T.; Szmuszkovicz, J. *Prog. Drug Res.* **1989**, *33*, 135.
For further examples see:
Reedijk, J. *J. Chem. Soc., Chem. Commun.* **1996**, 801.
Albrecht, K.; Belzner, J.; Fürstner, A.; Bienewald, F.; Bolm, C.; Ziegler, T.; Frobel, K.; Krämer, T.; Niewöhner, U.; Schneider, S. *Nachr. Chem. Tech. Lab.* **1996**, *44*, 164.
Falorni, M.; Giacomelli, G. *Synlett* **1996**, 143.
Bruce, M.A.; Laurent, D.R.S.; Poindexter, G.S.; Moncovic, I.; Huang, S.; Balasubramanian, N. *Synth. Commun.* **1995**, *17*, 2673.
Askin, D.; Eng, K.K.; Rossen, K.; Purick, R.M.; Wells, K.M.; Volante, R.P.; Reider, P.J. *Tetrahedron Lett.* **1994**, *35*, 673.
Rogawski, M.A.; Porter, R.J. *Pharm. Rev.* **1990**, *42*, 223.

(2) Katsuki, T. *Coord. Chem. Rev.* **1995**, *140*, 189.
Stingl, K.; Martens, J. *Liebigs Ann. Chem.* **1994**, 243 and literature cited therein.
Jacobsen, E.N. *Catalytic Asymmetric Synthesis*; Ojima, I.; Ed.; VCH: New York, 1993; p 159.
Reetz, M.T.; Jäger, R.; Drewlies, R.; Hübel, M. *Angew. Chem.* **1991**, *103*, 76; *Angew. Chem., Int. Ed. Engl.* **1991**, *30*, 103 and literature cited therein.
For further examples see:
Asami, M. *J. Synth. Org. Chem. Jpn.* **1996**, *54*, 188.
Kobayashi, S.; Horibe, M.; Matsumura, M. *Synlett* **1995**, 675.
Kobayashi, S.; Nishio, K. *Tetrahedron Lett.* **1995**, *36*, 6729.
Nozaki, K.; Tsutumi, T.; Takaya, H. *J. Org. Chem.* **1995**, *60*, 6668.
Uragami, M.; Tomioka, K.; Koga, K. *Tetrahedron: Asymmetry* **1995**, *6*, 701.
Torii, S.; Liu, P.; Tanaka, H. *Chem. Lett.* **1995**, 319.
Togni, A.; Venanzi, L.M. *Angew. Chem.* **1994**, *106*, 517; *Angew. Chem., Int. Ed. Engl.* **1994**, *33*, 497.
Cox, P.J.; Simpkins, N.S. *Tetrahedron: Asymmetry* **1991**, *2*, 1.
Corey, E.J. *Pure Appl. Chem.* **1990**, *62*, 1209.

(3) Recent examples for the application as auxiliaries:
Alexakis, A.; Lensen, N.; Tranchier, J.-P.; Mangeney, P.; Feneau-Dupont, J.; Declercq, J.P. *Synthesis* **1995**, 1038.
Alexakis, A.; Kanger, T.; Mangeney, P.; Rose-Munch, F.; Perrotey, A.; Rose, E. *Tetrahedron: Asymmetry* **1995**, *6*, 47.
Alexakis, A.; Kanger, T.; Mangeney, P.; Rose-Munch, F.; Perrotey, A.; Rose, E. *Tetrahedron: Asymmetry* **1995**, *6*, 2135.
Alexakis, A.; Tranchier, J.-P.; Lensen, N.; Mangeney, P. *J. Am. Chem. Soc.* **1995**, *117*, 10767.
Davies, S.G.; Evans, G.B.; Mortlock, A.A. *Tetrahedron: Asymmetry* **1994**, *5*, 585.

(4) Recent examples for the application as ligands:
Fujii, A.; Hashiguchi, S.; Uematsu, N.; Ikarya, T.; Noyori, R. *J. Am. Chem. Soc.* **1996**, *118*, 2521.
Nisiyabashi, Y.; Arikawa, Y.; Ohe, K.; Uemura, S. *J. Org. Chem.* **1996**, *61*, 1172.
Ohkuma, T.; Ooka, H.; Hashiguchi, S.; Ikarya, T.; Noyori, R. *J. Am. Chem. Soc.* **1995**, *117*, 2675.
Alexakis, A.; Kanger, T.; Mangeney, P.; Rose-Munch, R.; Perrotey, A.; Rose, E. *Tetrahedron: Asymmetry* **1995**, *6*, 2135.
Gamez, P.; Fache, F.; Lemaire, M. *Tetrahedron: Asymmetry* **1995**, *6*, 705.

(5) Recent examples for the application as ligand component:
Gao, J.X.; Ikariya, T.; Noyori, R. *Organometallics* **1996**, *15*, 1087.
Trost, B.M.; Shi, Z. *J. Am. Chem. Soc.* **1996**, *118*, 3037.
Trost, B.M., Bunt, R.C. *Angew. Chem.* **1996**, *108*, 70; *Angew. Chem., Int. Ed. Engl.* **1996**, *35*, 70.
Zhang, X.; Guo, C. *Tetrahedron Lett.* **1995**, *36*, 4947.
Denmark, S.E.; Christenson, B.L.; O'Connor, S.P. *Tetrahedron Lett.* **1995**, *36*, 2219.
Vaupel, A.; Knochel, P. *Tetrahedron Lett.* **1995**, *36*, 231.
Takahashi, H.; Yoshioka, M.; Shibasaki, M.; Ohno, M.; Imai, N.; Kobayashi, S. *Tetrahedron* **1995**, *51*, 12013.

(6) Recent examples for the application in salen complexes:
Belokon, Y.; Ikonnikov, N.; Moscalenko, N.; North, M.; Orlova, S.; Tararov, V.; Yashkina, L. *Tetrahedron: Asymmetry* **1996**, *7*, 851.
De, B.B.; Lohray, B.B.; Sivaram, S.; Dahl, P.K. *Tetrahedron: Asymmetry* **1995**, *6*, 2105.
Brandes, B.D.; Jacobsen, E.N. *Tetrahedron Lett.* **1995**, *36*, 5123.
Mikame, D.; Hamada, T.; Irie, R.; Katsuki, T. *Synlett* **1995**, 827.
Rasmussen, K.G.; Thomsen, D.S.; Joergensen, K.A. *J. Chem. Soc., Perkin Trans. 1* **1995**, 2009.
Nagata, T.; Yorozu, K.; Yamada, T.; Mukaiyama, T. *Angew. Chem.* **1995**, *1017*, 2309; *Angew. Chem., Int. Ed. Engl.* **1995**, *34*, 2145.
Pie-Tikäinen, P. *Tetrahedron Lett.* **1995**, *36*, 319.
Jacobsen, E.N.; Deng, L.; Furukawa, Y.; Martinez, L.E. *Tetrahedron* **1994**, *50*, 4323.

(7) Alexakis, A.; Frutos, J.C.; Mutti, S.; Mangeney, P. *J. Org. Chem.* **1994**, *59*, 3326.

(8) Fulwood, R.; Parker, D. *J. Chem. Soc., Perkin Trans. 2* **1995**, 2376.

(9) Roos, G.H.P.; Balasubramanian, S.; Doyle, M.P.; Raab, C.E. *Synth. Commun.* **1996**, *26*, 2165.
Pansare, S.V.; Malusare, M.G. *Tetrahedron Lett.* **1996**, *37*, 2859.
Corey, E.J.; Lu, D.-H.; Sarshar, S. *Tetrahedron: Asymmetry* **1995**, *6*, 3.
Bambridge, K.; Begley, M.J.; Simpkins, N.S. *Tetrahedron Lett.* **1994**, *35*, 3391 and literature cited therein.
Dondoni, A.; Merchan, F.L.; Merino, P.; Pejero, T.; Bertolasi, V. *J. Chem. Soc., Chem. Comun.* **1994**, 1731.
Gmeiner, P.; Hummel, E. *Synthesis* **1994**, 1026.
Reetz, M.T.; Hübel, M.; Jaeger, R.; Schwickhardi, R.; Goddard, R. *Synthesis* **1994**, 733.
Altman, J.; Ben-Ishai, D.; Beck, W. *Tetrahedron: Asymmetry* **1994**, *5*, 887.
Katritzky, A.R.; Fan, W.-Q.; Fu, C. *J. Org. Chem.* **1990**, *55*, 3209 and literature cited therein.
Jung, S.-H.; Kohn, H. *J. Am. Chem. Soc.* **1985**, *107*, 2931.
Natsugari, H.; Whittle, R.R.; Weinreb, S.M. *J. Am. Chem. Soc.* **1984**, *106*, 7867.

(10) Recent examples:
Kotsuki, H.; Kuzume, H.; Gohda, T.; Fukuhara, M.; Ochi, M.; Oishi, T.; Hirami, M.; Shiro, M. *Tetrahedron: Asymmetry* **1996**, *6*, 2227.
Effenberger, F.; Kremser, A.; Stelzer, U. *Tetrahedron: Asymmetry* **1996**, *7*, 607.
Altman, J.; Beck, W. *Tetrahedron* **1995**, *51*, 13309.

(11) For leading references see:
Baruah, B.; Prajapati, D.; Sandhu, J.S. *Tetrahedron Lett.* **1995**, *36*, 6747.
Kalyanam, N.; Rao, G.V. *Tetrahedron Lett.* **1993**, *34*, 1647.
Imamoto, T.; Nidhimura, S. *Chem. Lett.* **1990**, 1141.
Enholm, E.J.; Forbes, D.C.; Holub, D.P. *Synth. Commun.* **1990**, *20*, 981.
Cuvinot, D.; Mangeney, P.; Alexakis, A.; Normant, J.-F. *J. Org. Chem.* **1989**, *54*, 2420.
Betschart, C.; Schmidt, R.; Seebach, D. *Helv. Chim. Acta* **1988**, *71*, 1999.
(12) Ricardson, P.F.; Nelson, L.T.J.; Sharpless, K.B. *Tetrahedron Lett.* **1995**, *36*, 9241.
(13) Ahlbrecht, H.; Schmitt, C. *Synthesis* **1994**, 719.
Kise, N.; Kashiwagi, K.; Watanabe, M.; Joshida, J.I. *J. Org. Chem.* **1996**, *61*, 428.
(14) Enders, D.; Schiffers, R. *Synthesis* **1996**, 53.
(15) Enders, D.; Meiers, M. *Angew. Chem.* **1996** *108*, 2391.
(16) Schäfer, M.; Drauz, K.; Schwarm, M. In *Houben Weyl*, Vol. E21e, Helmchen, G.; Hoffmann, R.W.; Mulzer, J.; Schaumann, E., Eds., Thieme: Stuttgart, 1995; p 5588 and literature cited therein.
(17) Perekalin, V.V.; Lipina, E.S.; Beretovitskaya, V.M.; Efremov, D.A. *Nitroalkenes*; Wiley: Chichester, 1994 and literature cited therein.
Imagawa, K.; Hata, E.; Yamada, T.; Mukaiyama, T. *Chem. Lett.* **1996**, 291.
Morris, M.L.; Sturgess, M.A. *Tetrahedron Lett.* **1993**, *34*, 43.
(18) Trost, B.M.; Bunt, R.C.; Pulley, S.R. *J. Org. Chem.* **1994**, *59*, 4202.
(19) Latypov, S.K.; Seco, J.M.; Quiñoá, E.; Riguera, R. *J. Org. Chem.* **1995**, *60*, 1538.
(20) Enders, D.; Kempen, H. *Synlett* **1994**, 969.
Kempen, H. *Dissertation*, Technical University of Aachen, 1994.
(21) Bagget, N.; Stribblehill, P. *J. Chem. Soc., Perkin Trans. 1* **1977**, 1123.
(22) Knochel, P.; Seebach, D. *Synthesis* **1982**, 1017.
Fort, G.; McLean, A. *J. Chem. Soc.* **1948**, 1907.
(23) Raschig, F. *Ber. Dtsch. Chem. Ges.* **1910**, *43*, 1927.