H-Bond Donor-Directed Switch of Diastereoselectivity in the Michael Addition of α-Azido Ketones to Nitroolefins

Pei-Gang Ding, Feng Zhou, Xin Wang, Qiu-Hua Zhao, Jin-Sheng Yu and Jian Zhou

*a Shanghai Engineering Research Center of Molecular Therapeutics and New Drug Development; and Shanghai Key Laboratory of Green Chemistry and Chemical Processes, School of Chemistry and Molecular Engineering, East China Normal University, 3663N Zhongshan Road, Shanghai 200062, China.

b College of Chemistry, Sichuan University, Chengdu, Sichuan 610064, China.

c Key Laboratory of Tropical Medicinal Resource Chemistry of Ministry of Education, Hainan Normal University, Haikou 571158, China.

d State Key Laboratory of Organometallic Chemistry, Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences, Shanghai 200032, China.

Email: X. Wang: wangxin@scu.edu.cn; J. Zhou: jzhou@chem.ecnu.edu.cn

Supporting information

(Part II)

Contents                                      Page

1H, 13C, 19F and 31P NMR spectra               2-150

HPLC spectra                                  151-200

1H, 13C, 19F NMR and 31P NMR spectra were obtained using a Bruker DPX-400 and DPX-300 spectrometer. Chemical shifts are reported in ppm from CDCl3 or (CD3)2SO with the solvent resonance as the internal standard. The following abbreviations were used to designate chemical shift multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, h = heptet, m = multiplet, br = broad.
DPG-DE-13 P 161.7 MHz
DPG-DA-87-2 P 121 MHz
DPG-DF-61-2-A P

18
dpg-dl-146 P 202 MHz
DPG-DL-57 F 376 MHz
DPG-DD-61-6 125 MHz

137 136 135 134 133 132 131 130 129 128 127 126 125 124

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

syn-5f

NO₂
DPG-DD-61-1-4 C 100 MHz

![Chemical Structure and NMR Spectrum](Image)
DPG-DD-53-4 F 282 MHz
DPG-DD-53-3-2 F 376 MHz

syn-5k

10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
ft (ppm)
DPG-DE-49-2-3 C 100 MHz

f1 (ppm)
DPG-DE-49-4-3 H 300 MHz

-7.77 to -7.49 ppm
7.13 ppm
3.41 ppm
6.70 to 6.60 ppm
5.70 ppm
4.84 ppm
3.69 ppm

7.85 to 7.75 ppm
5.70 ppm
4.84 ppm
3.69 ppm

8.50 to 8.00 ppm
6.10 ppm
5.00 ppm
4.00 ppm
3.00 ppm
2.00 ppm
1.00 ppm
0.00 ppm
-0.50 ppm

syn-5n

Ph

NO2

Cl

N3
DPG-DF-80-B H 400 MHz

f1 (ppm)

anti-5q
DPG-DK-121 C 125 MHz

anti-5s

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 ppm

128
DPG-DN-16-2 C 100 MHz

anti-St
Analysis Report

5a

Analysis Report

(S,R)-5a

<Chromatogram>

Detector A Channel 2 230nm

<Peak Table>

Detector A Channel 2 230nm

Peak No. R. T. Area Height Conc.  
1. 58.84 1945.17 96306 22.61  
2. 29.53 2531.45 25555 21.32  
3. 29.94 113946.4 41927 22.53  
4. 33.49 230062.2 44718 27.53  
Total 8005211 218498

Detector A Channel 2 230nm

<Peak Table>

Detector A Channel 2 230nm

Peak No. R. T. Area Height Conc.  
1. 19.01 1960533 27178 2.13  
2. 26.10 497020 11969 6.93  
3. 29.65 6156496 110954 80.97  
4. 33.68 3685253 85727 5.14  
Total 71473088 13750938

D:\Data\dupg\DE\dupg-de-52-1-rec-C2H4=CH=CH-1.0-230.ico
D:\Data\dupg\DE\dupg-de-52-1-ASY-C2H4=CH=CH-1.0-230.ico
Analysis Report

5c

![Chromatogram]

<Peak Table>

| Peak | Ret. Time | Area  | Height | Conc. |
|------|-----------|-------|--------|-------|
| 1    | 9.360     | 1956479 | 114931 | 19.115 |
| 2    | 15.336    | 2701447 | 31529 | 31.486 |
| 3    | 17.424    | 2391130 | 73201  | 31.487 |
| 4    | 20.227    | 1276253 | 44531  | 16.289 |
| Total|           | 2613362 |        |       |

Analysis Report

syn-5c

![Chromatogram]

<Peak Table>

| Peak | Ret. Time | Area  | Height | Conc. |
|------|-----------|-------|--------|-------|
| 1    | 9.561     | 1364907 | 31541  | 86.458 |
| 2    | 15.453    | 942950  | 10883  | 5.455  |
| 3    | 17.568    | 222951  | 6715   | 3.940  |
| 4    | 20.446    | 101734  | 4399   | 2.536  |
| Total|           | 6206577 |        |       |
Analysis Report

**Chromatogram**

Detector A Channel 2 230nm

| Peak | Retention Time (min) | Area | Height | Conc. |
|------|----------------------|------|--------|-------|
| 1    | 12.777               | 1632474 | 80.112 | 27.25L |
| 2    | 15.367               | 1104776 | 41.492 | 22.394 |
| 3    | 21.949               | 1405120 | 30357  | 28.065 |
| 4    | 24.393               | 1159476 | 20798  | 22.394 |
| Total|                      | 5220296 | 161159 |

**Peak Table**

Detector A Channel 2 230nm

| Peak | Retention Time (min) | Area | Height | Conc. |
|------|----------------------|------|--------|-------|
| 1    | 13.564               | 4890782 | 213779 | 96.799 |
| 2    | 15.044               | 111273 | 3950   | 1.326 |
| 3    | 21.691               | 1208451 | 7110   | 5.706 |
| 4    | 24.158               | 123420 | 2301   | 2.234 |
| Total|                      | 5167595 | 228083 |

D:\Data\DPS\E\dps-cw-49-4-RAC-029H-90-15-1.0-230.tcd

D:\Data\DPS\E\dps-cw-49-4-ASY-029H-90-15-1.0-230.tcd
Analysis Report

**5u**

![Chemical Structure](attachment:image1.png)

**<Chromatogram>**

Detector A Channel 2 250nm

**<Peak Table>**

| Peak | Ret. Time | Height | Area | Area% |
|------|-----------|--------|------|-------|
| 1    | 22.150    | 12700  | M    | 19.545|
| 2    | 29.989    | 5216   | M    | 18.801|
| 3    | 41.102    | 4149   | M    | 31.070|
| 4    | 50.336    | 6452   | M    | 30.585|
| Total| 45530     | 100.000|

Analysis Report

**syn-5u**

![Chemical Structure](attachment:image2.png)

**<Chromatogram>**

Detector A Channel 2 250nm

**<Peak Table>**

| Peak | Ret. Time | Height | Area | Area% |
|------|-----------|--------|------|-------|
| 1    | 21.650    | 15156  | M    | 15.856|
| 2    | 29.305    | 6022   | M    | 10.722|
| 3    | 39.692    | 36213  | M    | 10.631|
| 4    | 49.025    | 71333  | M    | 12.741|
| Total| 71334     | 100.000|
Analysis Report

5a

<Chromatogram>

Detector A Channel 2 220 nm

| Peak # | Ret. Time | Area | Height | Conc. |
|--------|-----------|------|--------|-------|
| 1      | 39.15     | 4136447 | 563922 | 22.953 |
| 2      | 26.531    | 4917736 | 1271933| 27.243 |
| 3      | 30.695    | 413754  | 63715  | 22.522 |
| 4      | 38.017    | 5333486 | 886021 | 27.066 |

Total 18825445 433364

Analysis Report

(R,R)-5a

<Chromatogram>

Detector A Channel 2 220 nm

| Peak # | Ret. Time | Area | Height | Conc. |
|--------|-----------|------|--------|-------|
| 1      | 19.196    | 56045 | 2577   | 0.681 |
| 2      | 25.450    | 310579 | 5244   | 2.307 |
| 3      | 30.600    | 288394 | 8244   | 3.276 |
| 4      | 34.665    | 850597 | 140517 | 80.536 |

Total 9144906 150742

D:\Data\dpkg\data-52-3-rec-O2H+H5-5-1.0-230.iod  D:\Data\dpkg\data-52-3-ASY-O2H+H5-5-1.0-230.iod
Analysis Report

5b

<Chromatogram>

Detector A Channel 2 230 nm

| Peak | Ret. Time | Area   | Height | Conc. |
|------|-----------|--------|--------|-------|
| 1    | 22.85     | 74000  | 2187   | 19.573|
| 2    | 22.516    | 1139023| 204953 | 29.843|
| 3    | 35.497    | 7901493| 1340953| 20.747|
| 4    | 41.144    | 11284475| 158798 | 29.738|

Total: 30050095 | 717994

Analysis Report

anti-5b

<Chromatogram>

Detector A Channel 2 230 nm

| Peak | Ret. Time | Area   | Height | Conc. |
|------|-----------|--------|--------|-------|
| 1    | 22.452    | 771192 | 29316  | 2.5932|
| 2    | 32.701    | 974257 | 172097 | 50.174|
| 3    | 35.523    | 107096 | 80531  | 1.866|
| 4    | 41.574    | 249822 | 30399  | 2.309|

Total: 10422757 | 1374611
Analysis Report

\[ \text{NO}_2 \]
\[ \text{5d} \]

| Peak | Ret. Time | Area  | Height | Conc. |
|------|-----------|-------|--------|-------|
| 1    | 36.8      | 187146| 709947 | 19.59%|
| 2    | 22.2      | 643232 | 77376  | 36.98%|
| 3    | 24.210    | 1387974| 44012  | 19.80%|
| 4    | 27.717    | 24316999| 57920  | 35.50%|

Total 8210911 231085

Analysis Report

\[ \text{NO}_2 \]
\[ \text{anti-5d} \]

| Peak | Ret. Time | Area  | Height | Conc. |
|------|-----------|-------|--------|-------|
| 1    | 30.712    | 1052486| 8147   | 1.858%|
| 2    | 22.121    | 6011196| 151862 | 56.137%|
| 3    | 24.305    | 405772 | 1212   | 0.773%|
| 4    | 27.665    | 171352 | 2712   | 2.132%|

Total 5265944 159954
Analysis Report

<Chromatogram>

<Peak Table>

| Peak | Ret. Time | Area   | Height | Conc. |
|------|-----------|--------|--------|-------|
| 1    | 20.887    | 699471 | 195214 | 23.201 |
| 2    | 29.701    | 707788 | 148325 | 26.874 |
| 3    | 26.369    | 795136 | 158242 | 26.743 |
| 4    | 32.446    | 671252 | 122933 | 23.330 |

Total: 28772135 965395

Analysis Report

<Chromatogram>

<Peak Table>

| Peak | Ret. Time | Area   | Height | Conc. |
|------|-----------|--------|--------|-------|
| 1    | 20.710    | 126779 | 271303 | 4.132 |
| 2    | 24.613    | 345477 | 579377 | 96.393 |
| 3    | 25.472    | 529590 | 198950 | 3.457 |
| 4    | 32.170    | 400540 | 70988  | 1.957 |

Total: 2719241 640655
Analysis Report

5y

<Chromatogram>

Detector A Channel 2 220nm

| Peak | Ret. Time | Area | Height | Conc. |
|------|-----------|------|--------|-------|
| 1    | 23.10     | 4331496 | 0.11989 | 21.301 |
| 2    | 33.88     | 3681142 | 0.15025 | 28.744 |
| 3    | 35.79     | 4343941 | 0.08799 | 21.599 |
| 4    | 45.03     | 3619827 | 0.78137 | 28.599 |
| Total|           | 20350296| 304518  |       |

Analysis Report

anti-5y

<Chromatogram>

Detector A Channel 2 220nm

| Peak | Ret. Time | Area | Height | Conc. |
|------|-----------|------|--------|-------|
| 1    | 23.572    | 417952 | 0.15489 | 4.840 |
| 2    | 34.605    | 8650530| 127744  | 52.975 |
| 3    | 35.789    | 660013 | 12833   | 0.709 |
| 4    | 40.171    | 2560050| 357913  | 2.774 |
| Total|           | 9306417| 154074  |       |
Analysis Report

<Chromatogram>

Detector A Channel 2 230nm

| Peak # | Ret. Time | Area   | Height | Conc.  |
|--------|-----------|--------|--------|--------|
| 1      | 9.306     | 33962  | 24.995 |        |
| 2      | 12.520    | 75717  | 15.995 |        |
| 3      | 13.285    | 23068  | 23.995 |        |
| 4      | 13.792    | 25703  | 26.995 |        |
| Total  | 992578    | 283434 |        |        |

<Peak Table>

Detector A Channel 2 230nm

| Peak # | Ret. Time | Area   | Height | Conc.  |
|--------|-----------|--------|--------|--------|
| 1      | 9.690     | 192939 | 6110   | 7.889  |
| 2      | 15.434    | 200270 | 80.975 |        |
| 3      | 15.026    | 8321   | 4571   |        |
| 4      | 10.540    | 1777   | 2.955  |        |
| Total  | 1768484   | 59124  |        |        |

D:\Desktop\DF\dpqg-40-ge-c29h-95-5-1-0-230.iso
d:\Desktop\DF\dpqg-40-ge-c29h-95-5-1-0-230.iso

187
### Analysis Report

**Chemical Structures**

1. **Sze**
   ![Sze structure](image1.png)

2. **anti-Sze**
   ![anti-Sze structure](image2.png)

### Chromatograms

**Detector A Channel 2 (230nm)**

#### Peak Table

| Peak # | Ret. Time | Area  | Conc. |
|--------|-----------|-------|-------|
| 1      | 20.782    | 448847| 8190  |
| 2      | 25.191    | 432973| 8070  |
| 3      | 26.090    | 1169223| 21235| 36.362 |
| 4      | 36.649    | 1150489| 14804| 38.181 |
| Total  |           | 250431| 51508 |

**Detector A Channel 2 (230nm)**

#### Peak Table

| Peak # | Ret. Time | Area  | Conc. |
|--------|-----------|-------|-------|
| 1      | 27.453    | 4400512| 7144  |
| 2      | 39.082    | 81348 | 1064  |
| Total  |           | 404961| 78105 |
Analysis Report

(Rac)-15b

<Chromatogram>

<Peak Table>

Detector A Channel 2 220nm
Peak Ret. Time Area Height Conc.
1 25.306 1990514 40.7462 80.141
2 33.152 18844148 354301 48.893
Total 36300653 702533

<Chromatogram>

<Peak Table>

Detector A Channel 2 220nm
Peak Ret. Time Area Height Conc.
1 30.652 12649952 259850 49.982
2 33.613 487774 7150 2.136
Total 13106402 264112
