APPENDIX 1

Spectra Relevant to Chapter 1:

Expanding Insight into the Asymmetric Palladium-Catalyzed
Allylic Alkylation of N-Heterocyclic Molecules and Cyclic Ketones
Figure A1.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 17.
Figure A1.1.2. Infrared spectrum (thin film/NaCl) of compound 17.

Figure A1.1.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 17.
Figure A1.2.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 16a.
Figure A1.2.2. Infrared spectrum (thin film/NaCl) of compound 16a.

Figure A1.2.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 16a.
Figure A1.3.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 16b.
Figure A1.3.2. Infrared spectrum (thin film/NaCl) of compound 16b.

Figure A1.3.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 16b.
Figure A1.4.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 16c.
Figure A1.4.2. Infrared spectrum (thin film/NaCl) of compound 16c.

Figure A1.4.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 16c.
Figure A1.5.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 18.
Figure A1.5.2. Infrared spectrum (thin film/NaCl) of compound 18.

Figure A1.5.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 18.
Figure A1.6.1. 1H NMR (500 MHz, CDCl₃) of compound 16f.
Figure A1.6.2. Infrared spectrum (thin film/NaCl) of compound 16f.

Figure A1.6.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 16f.
Figure A1.7.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 16g.
Figure A1.7.2. Infrared spectrum (thin film/NaCl) of compound \textit{16g}.

Figure A1.7.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound \textit{16g}.
Figure A1.8.1. 1H NMR (500 MHz, CDCl₃) of compound 20.
Figure A1.8.2. Infrared spectrum (thin film/NaCl) of compound 20.

Figure A1.8.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 20.
Figure A1.9.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 16h.
Figure A1.9.2. Infrared spectrum (thin film/NaCl) of compound 16h.

Figure A1.9.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 16h.
Figure A1.10.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 16d.
Figure A1.10.2. Infrared spectrum (thin film/NaCl) of compound 16d.

Figure A1.10.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 16d.
Figure A11.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 16i.
Figure A1.11.2. Infrared spectrum (thin film/NaCl) of compound 16i.

Figure A1.11.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 16i.
Figure A1.1.2.i. $^1$H NMR (500 MHz, CDCl$_3$) of compound 16e.
Figure A1.12.2. Infrared spectrum (thin film/NaCl) of compound 16e.

Figure A1.12.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 16e.
Figure A1.1.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 16j.
Figure A1.13.2. Infrared spectrum (thin film/NaCl) of compound 16j.

Figure A1.13.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 16j.
Figure A1.14.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 23a.
Figure A1.14.2. Infrared spectrum (thin film/NaCl) of compound 23a.

Figure A1.14.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 23a.
Figure A1.15.1: $^1$H NMR (500 MHz, CDCl$_3$) of compound 23b.
Figure A1.15.2. Infrared spectrum (thin film/NaCl) of compound 23b.

Figure A1.15.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 23b.
Figure A1.16.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 23d.
Figure A1.16.2. Infrared spectrum (thin film/NaCl) of compound 23d.

Figure A1.16.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 23d.
Figure A1.17.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 23e.
Figure A1.17.2. Infrared spectrum (thin film/NaCl) of compound 23e.

Figure A1.17.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 23e.
Figure A1.18.1. $^1H$ NMR (500 MHz, CDCl$_3$) of compound 23f.
Figure A1.18.2. Infrared spectrum (thin film/NaCl) of compound 23f.

Figure A1.18.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 23f.
Figure A1.19.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 23g.
Figure A1.19.2. Infrared spectrum (thin film/NaCl) of compound 23g.

Figure A1.19.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 23g.
Figure A1.20.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 29a.
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Figure A1.20.2. Infrared spectrum (thin film/NaCl) of compound 29a.

Figure A1.20.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 29a.
Figure A1.21.1. 1H NMR (500 MHz, CDCl$_3$) of compound 48b.
Figure A1.21.2. Infrared spectrum (thin film/NaCl) of compound 48b.

Figure A1.21.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 48b.
Figure A1.22.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 29b.
Figure A1.22.2. Infrared spectrum (thin film/NaCl) of compound 29b.

Figure A1.22.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 29b.
Figure A1.2.3.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 48c.
Figure A1.23.2. Infrared spectrum (thin film/NaCl) of compound 48c.

Figure A1.23.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 48c.
Figure A.1.2.4.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 29c.
Figure A1.24.2. Infrared spectrum (thin film/NaCl) of compound 29c.

Figure A1.24.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 29c.
Figure A1.25.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 48d.
Figure A1.25.2. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 48d.
Figure A1.26.1. 1H NMR (500 MHz, CDCl3) of compound 29d.
Figure A1.26.2. Infrared spectrum (thin film/NaCl) of compound 29d.

Figure A1.26.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 29d.
Figure A1.27.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 30a.
Figure A1.27.2. Infrared spectrum (thin film/NaCl) of compound 30a.

Figure A1.27.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 30a.
Figure A1.28.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 30b.
Figure A1.28.2. Infrared spectrum (thin film/NaCl) of compound 30b.

Figure A1.28.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 30b.
Figure A1.29.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 30c.
Figure A1.29.2. Infrared spectrum (thin film/NaCl) of compound 30c.

Figure A1.29.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 30c.
Figure A1.30.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 30d.
Figure A1.30.2. Infrared spectrum (thin film/NaCl) of compound 30d.

Figure A1.30.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 30d.
Figure A13.1.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 4i.
Figure A1.31.2. Infrared spectrum (thin film/NaCl) of compound 4i.

Figure A1.31.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 4i.
Figure A1.32.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 4j.
Figure A1.32.2. Infrared spectrum (thin film/NaCl) of compound 4j.

Figure A1.32.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 4j.
Figure A1.3.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 5i.
Figure A1.33.2. Infrared spectrum (thin film/NaCl) of compound 5i.

Figure A1.33.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 5i.
Figure A1.34.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 5j.
Figure A1.34.2. Infrared spectrum (thin film/NaCl) of compound 5j.

Figure A1.34.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 5j.
Figure A1.35.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 6c.
**Figure A1.35.2.** Infrared spectrum (thin film/NaCl) of compound 6c.

**Figure A1.35.3.** $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 6c.
Figure A1.36.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 50.
Figure A1.36.2. Infrared spectrum (thin film/NaCl) of compound 50.

Figure A1.36.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 50.
Figure A1.37.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound $6d$. 
Figure A1.37.2. Infrared spectrum (thin film/NaCl) of compound 6d.

Figure A1.37.3. ¹³C NMR (125 MHz, CDCl₃) of compound 6d.
Figure A1.38.1. $^1H$ NMR (500 MHz, CDCl$_3$) of compound 6e.
Figure A1.38.2. Infrared spectrum (thin film/NaCl) of compound 6e.

Figure A1.38.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 6e.
Figure A1.39.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 7c.
Figure A1.39.2. Infrared spectrum (thin film/NaCl) of compound 7c.

Figure A1.39.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 7c.
Figure A1.40.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 7d.
Figure A1.40.2. Infrared spectrum (thin film/NaCl) of compound 7d.

Figure A1.40.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 7d.
Figure A1.1. 1H NMR (500 MHz, CDCl3) of compound 7e.
Figure A1.41.2. Infrared spectrum (thin film/NaCl) of compound 7e.

Figure A1.41.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 7e.
Figure A1.42.1. 'H NMR (500 MHz, CDCl₃) of compound 44.
Figure A1.42.2. Infrared spectrum (thin film/NaCl) of compound 44.
Figure A1.43.1. 1H NMR (500 MHz, C6D6) of compound 13b.
Figure A1.43.2. Infrared spectrum (thin film/NaCl) of compound 13b.

Figure A1.43.3. $^{13}$C NMR (125 MHz, C$_6$D$_6$) of compound 13b.
Figure A1.44.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 41.
Figure A1.44.2. Infrared spectrum (thin film/NaCl) of compound 41.

Figure A1.44.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 41.
Figure A1.45.1. ¹H NMR (500 MHz, CDCl₃) of compound 13c.
Figure A1.45.2. Infrared spectrum (thin film/NaCl) of compound 13c.

Figure A1.45.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 13c.
Figure A1.46.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 13d.
Figure A1.46.2. Infrared spectrum (thin film/NaCl) of compound 13d.

Figure A1.46.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 13d.
Figure A1.47.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 45a.
Figure A1.47.2. Infrared spectrum (thin film/NaCl) of compound 45a.

Figure A1.47.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 45a.
Figure A1.48.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 45b.
Figure A1.48.2. Infrared spectrum (thin film/NaCl) of compound 45b.

Figure A1.48.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 45b.
Figure A1.49.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 21c.
Figure A1.49.2. Infrared spectrum (thin film/NaCl) of compound 21c.

Figure A1.49.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 21c.
Figure A.1.50.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 21d.
Figure A1.50.2. Infrared spectrum (thin film/NaCl) of compound 21d.

Figure A1.50.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 21d.
Figure A1.5.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 46a.
Figure A1.51.2. Infrared spectrum (thin film/NaCl) of compound 46a.

Figure A1.51.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 46a.
Figure A1.52.1. $^1$H NMR (500 MHz, CDCl$_3$) of compound 46b.
Figure A1.52.2. Infrared spectrum (thin film/NaCl) of compound 46b.

Figure A1.52.3. $^{13}$C NMR (125 MHz, CDCl$_3$) of compound 46b.