

APPENDIX 5

*Spectra Relevant to Chapter 3: An Enantioselective Spirocyclization of
Pd-Enolates and Isocyanates*

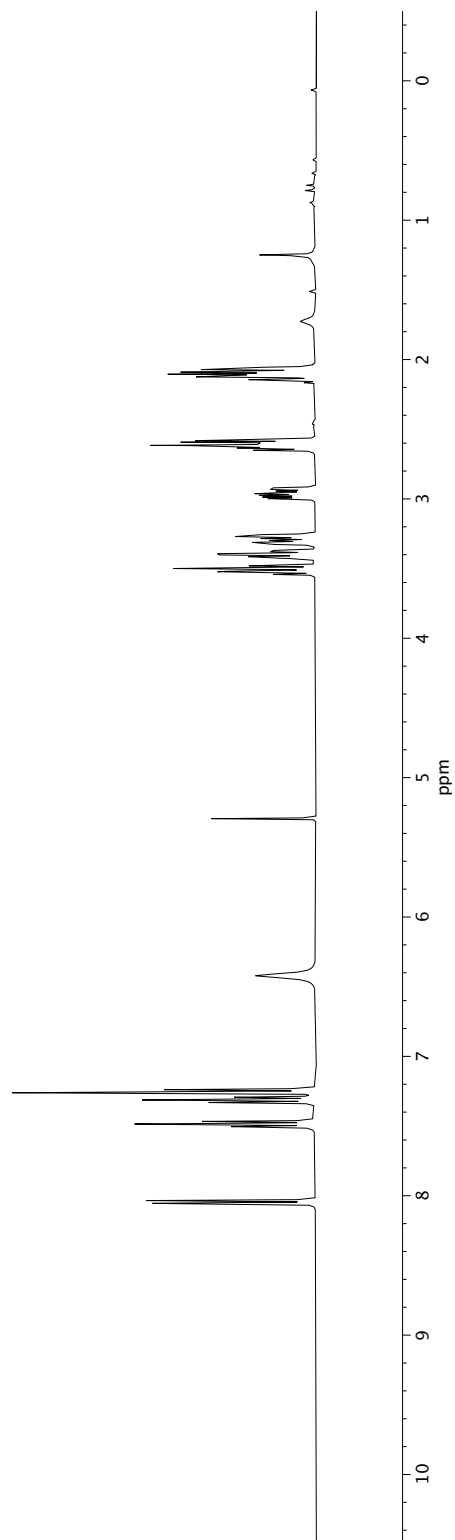
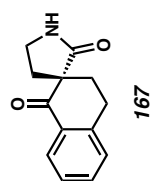


Figure A5.1 ¹H NMR (400 MHz, CDCl₃) of compound **167**.

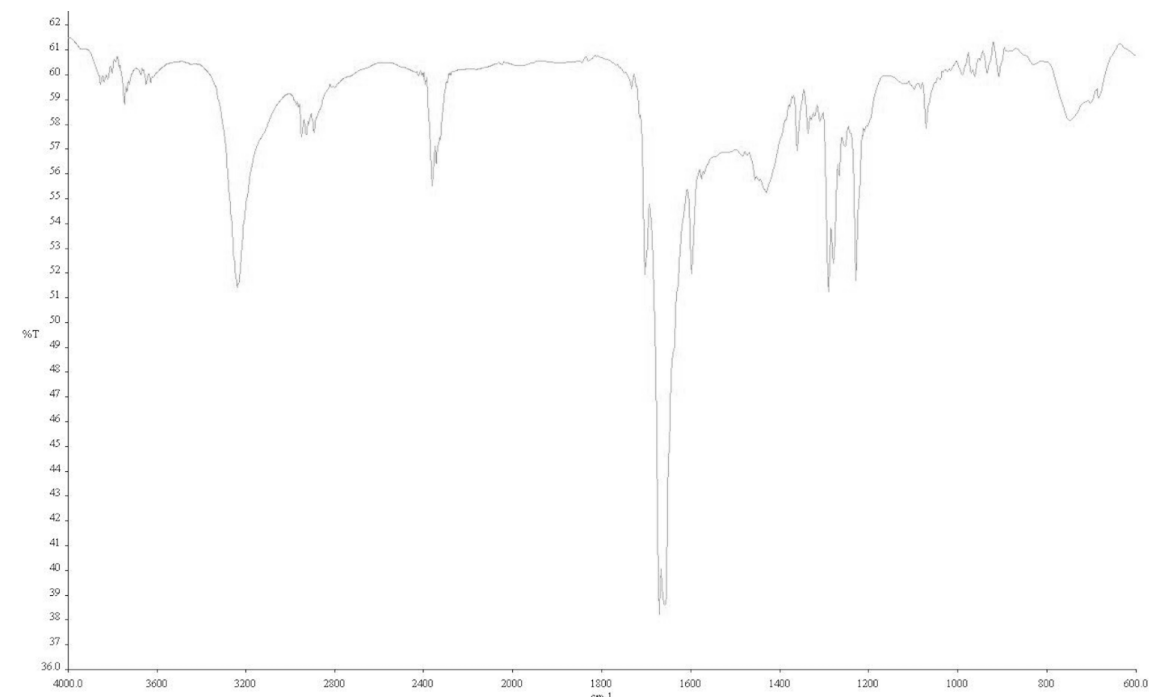


Figure A5.2 Infrared spectrum (Thin Film, NaCl) of compound **167**.

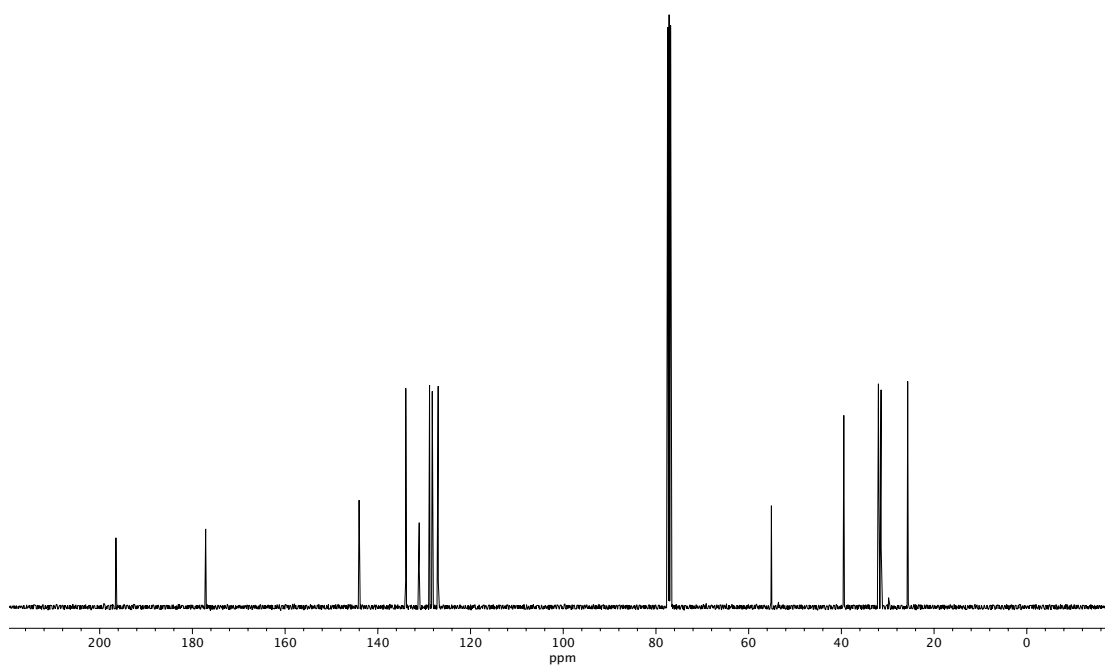


Figure A5.3 ¹³C NMR (100 MHz, CDCl₃) of compound **167**.

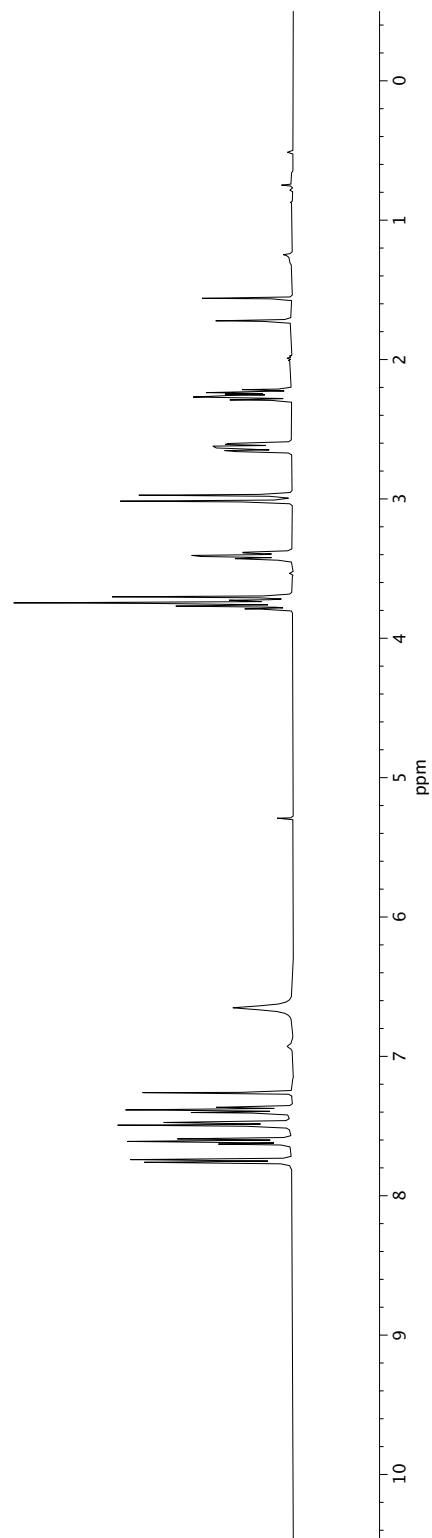
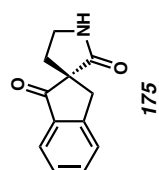


Figure A5.4 ^1H NMR (400 MHz, CDCl_3) of compound **175**.

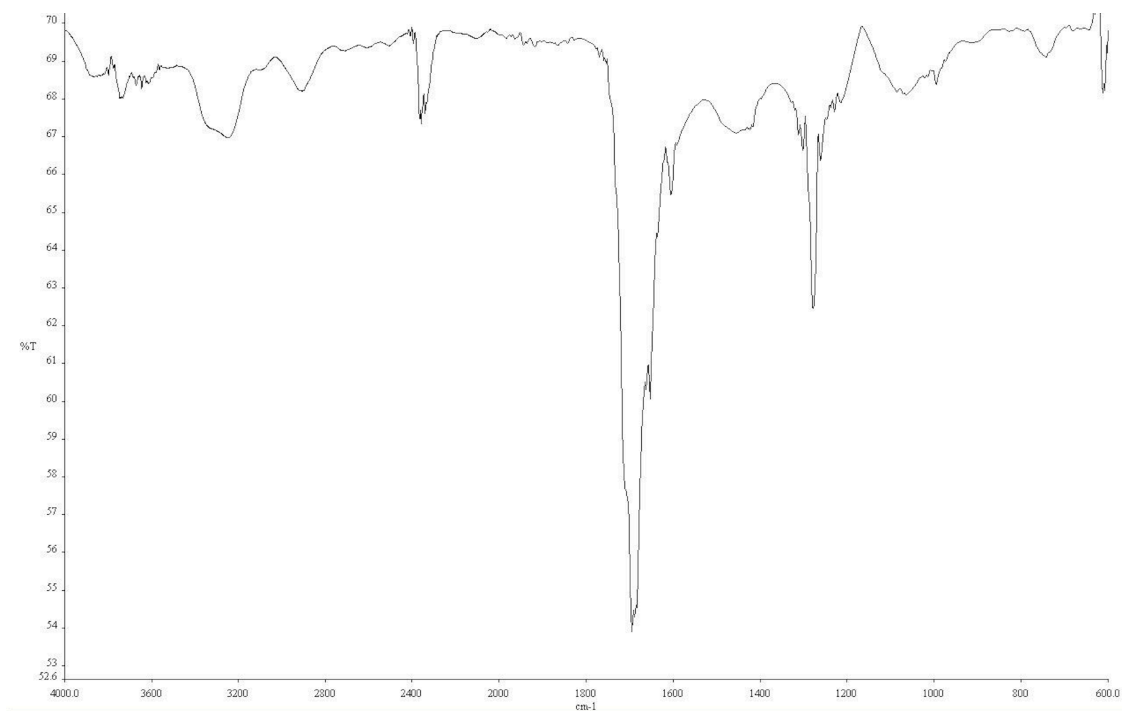


Figure A5.5 Infrared spectrum (Thin Film, NaCl) of compound **175**.

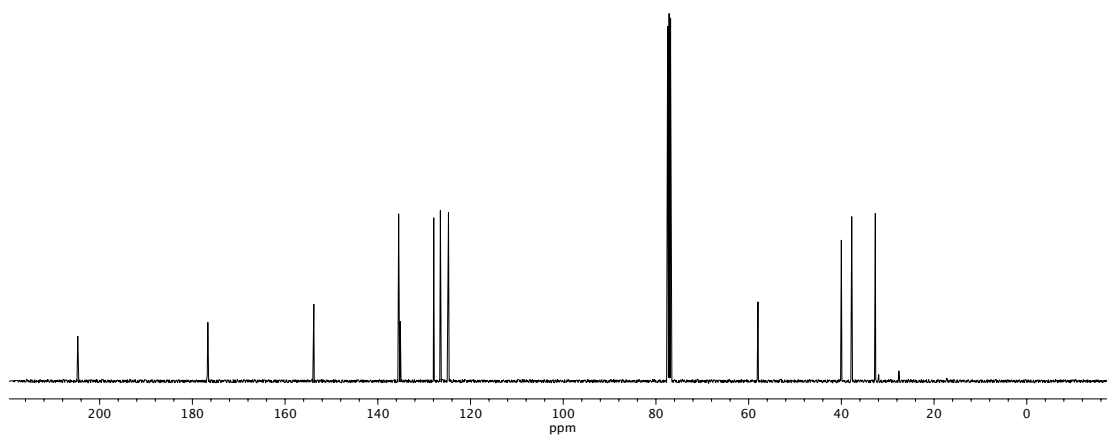


Figure A5.6 ¹³C NMR (100 MHz, CDCl₃) of compound **175**.

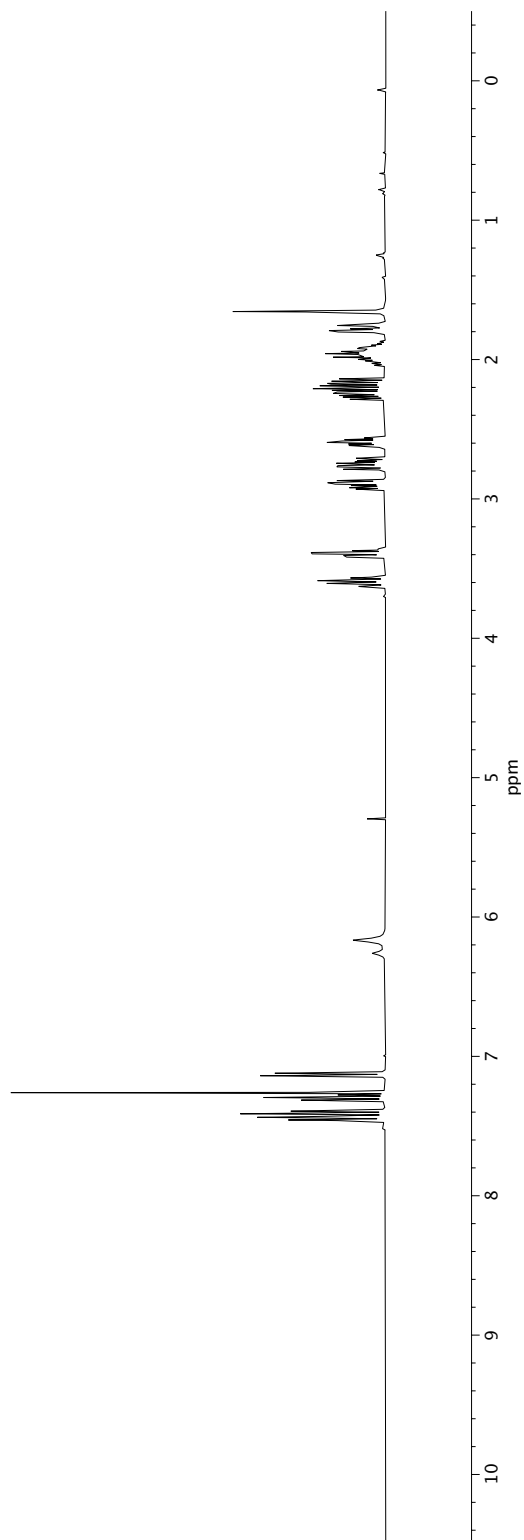
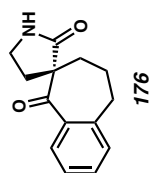


Figure A5.7 ¹H NMR (400 MHz, CDCl₃) of compound **176**.

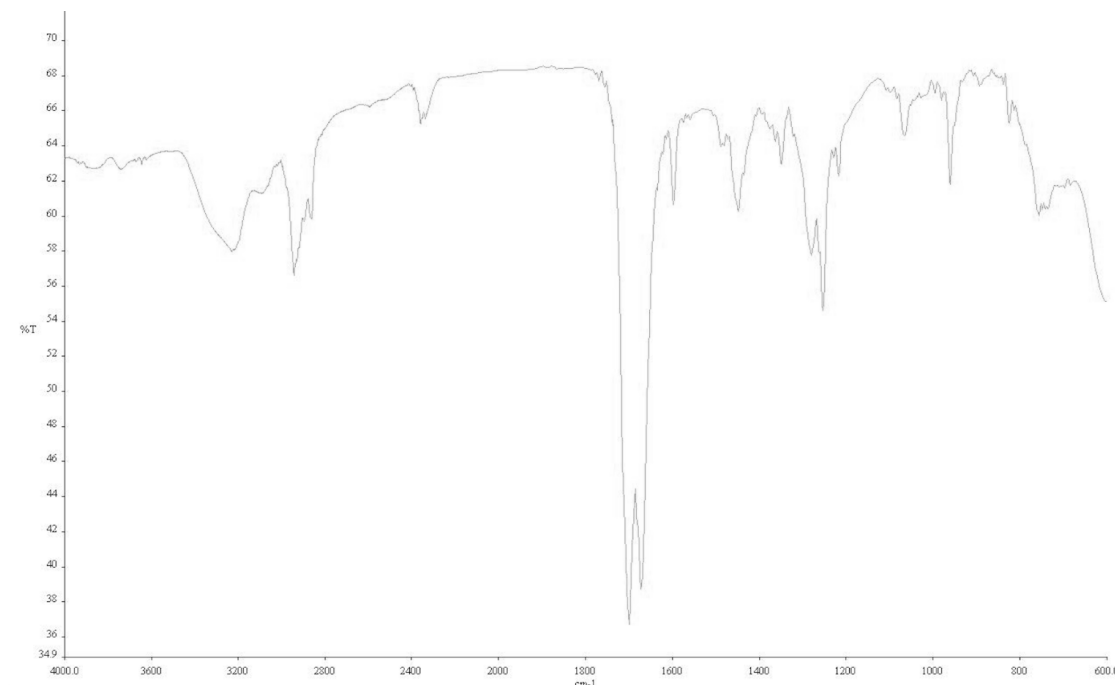


Figure A5.8 Infrared spectrum (Thin Film, NaCl) of compound **176**.

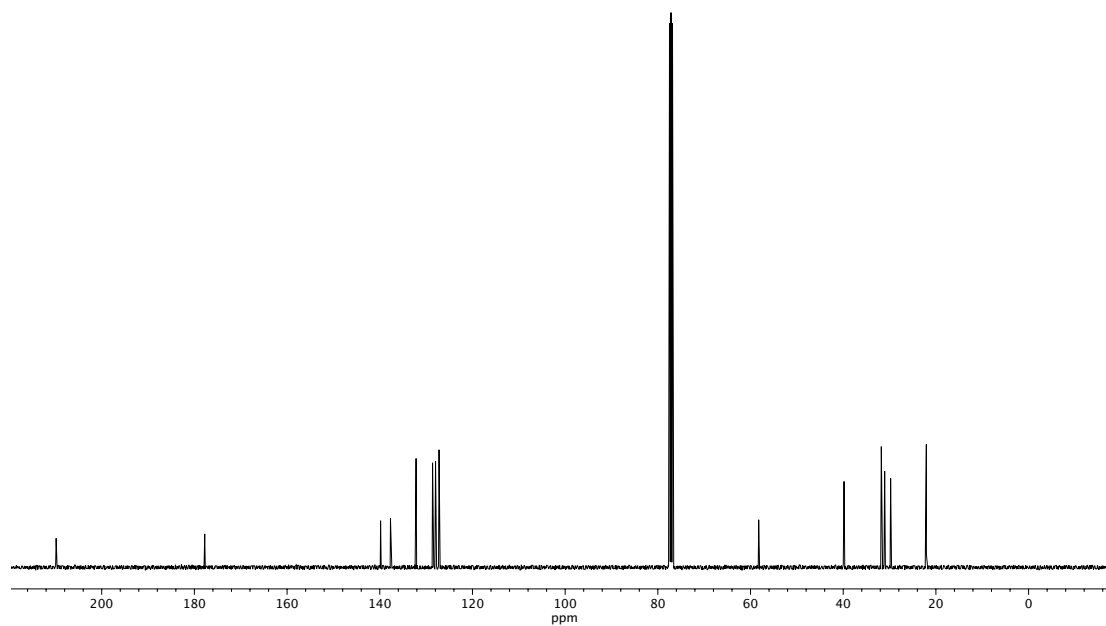


Figure A5.9 ¹³C NMR (100 MHz, CDCl₃) of compound **176**.

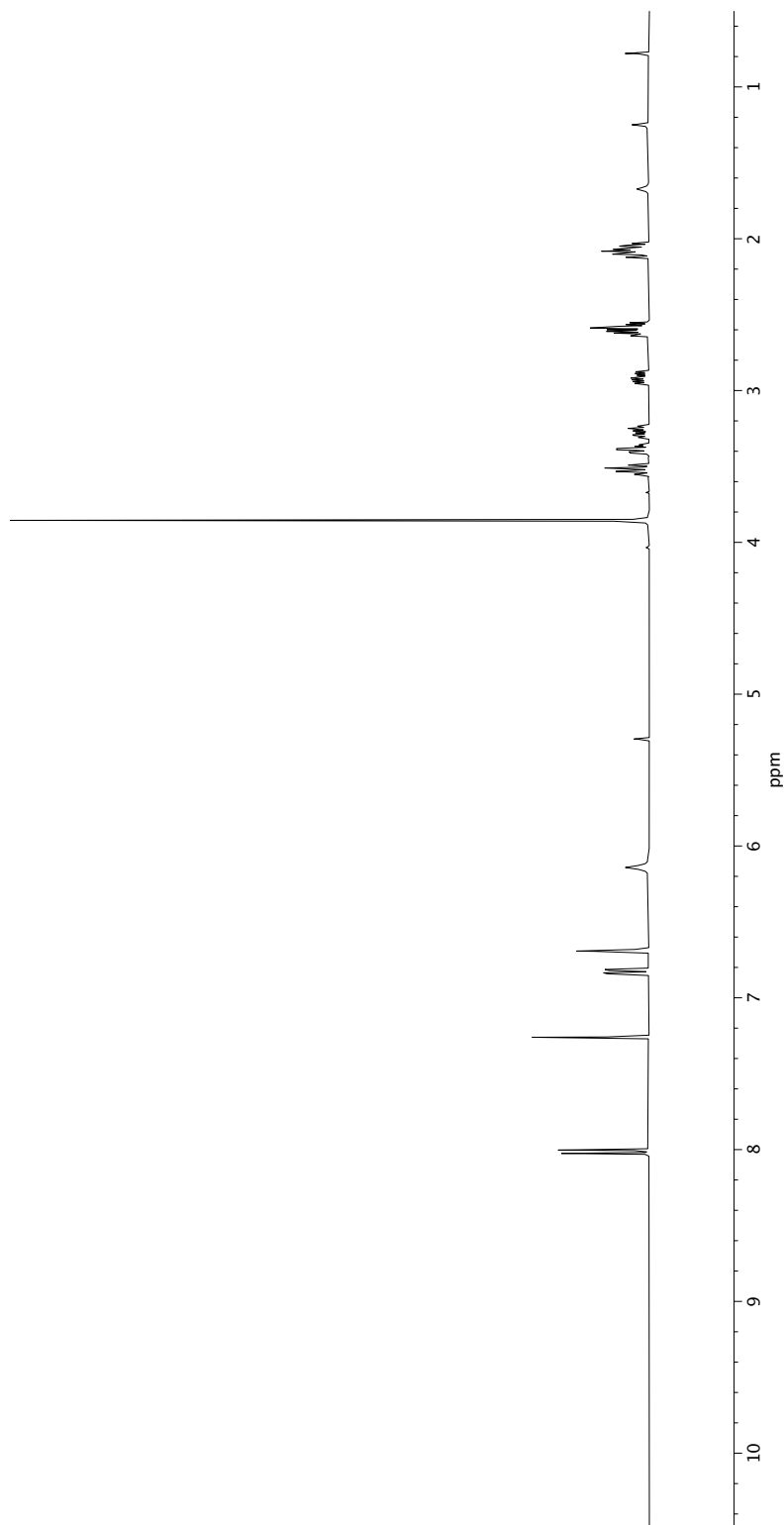
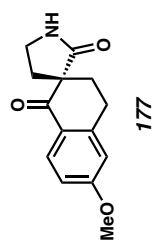


Figure A5.10 ¹H NMR (400 MHz, CDCl₃) of compound **177**.

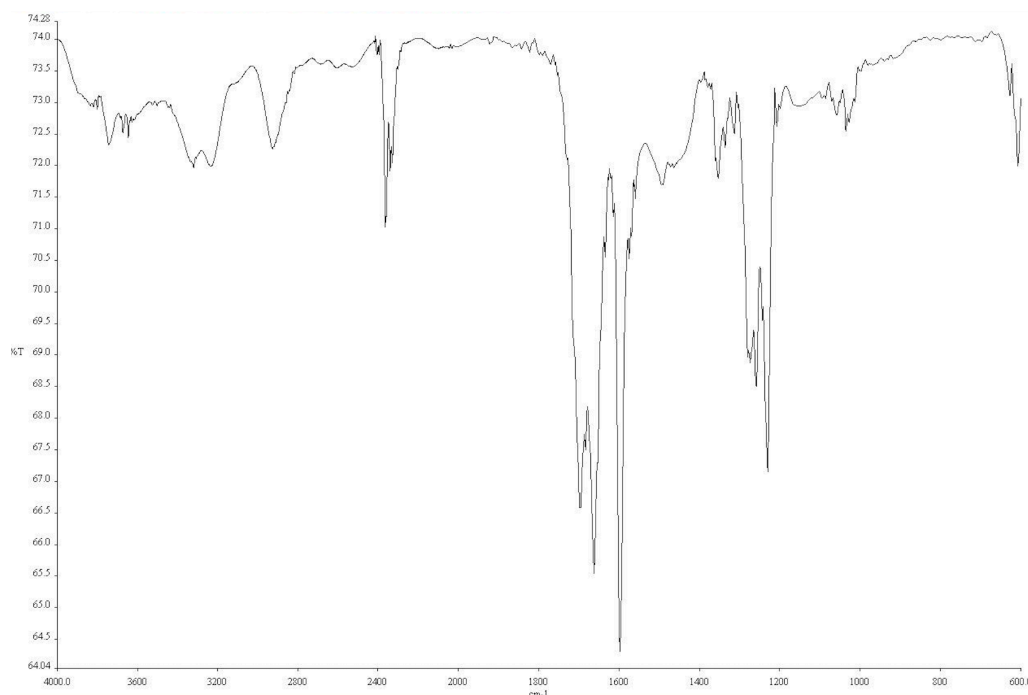


Figure A5.11 Infrared spectrum (Thin Film, NaCl) of compound **177**.

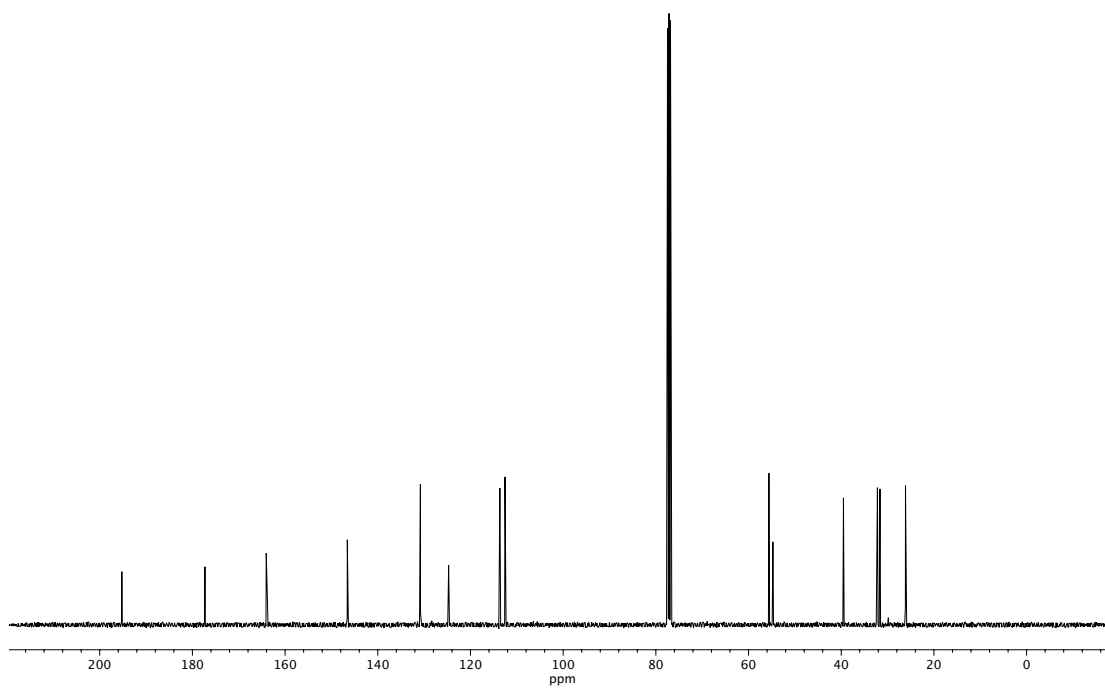


Figure A5.12 ¹³C NMR (100 MHz, CDCl₃) of compound **177**.

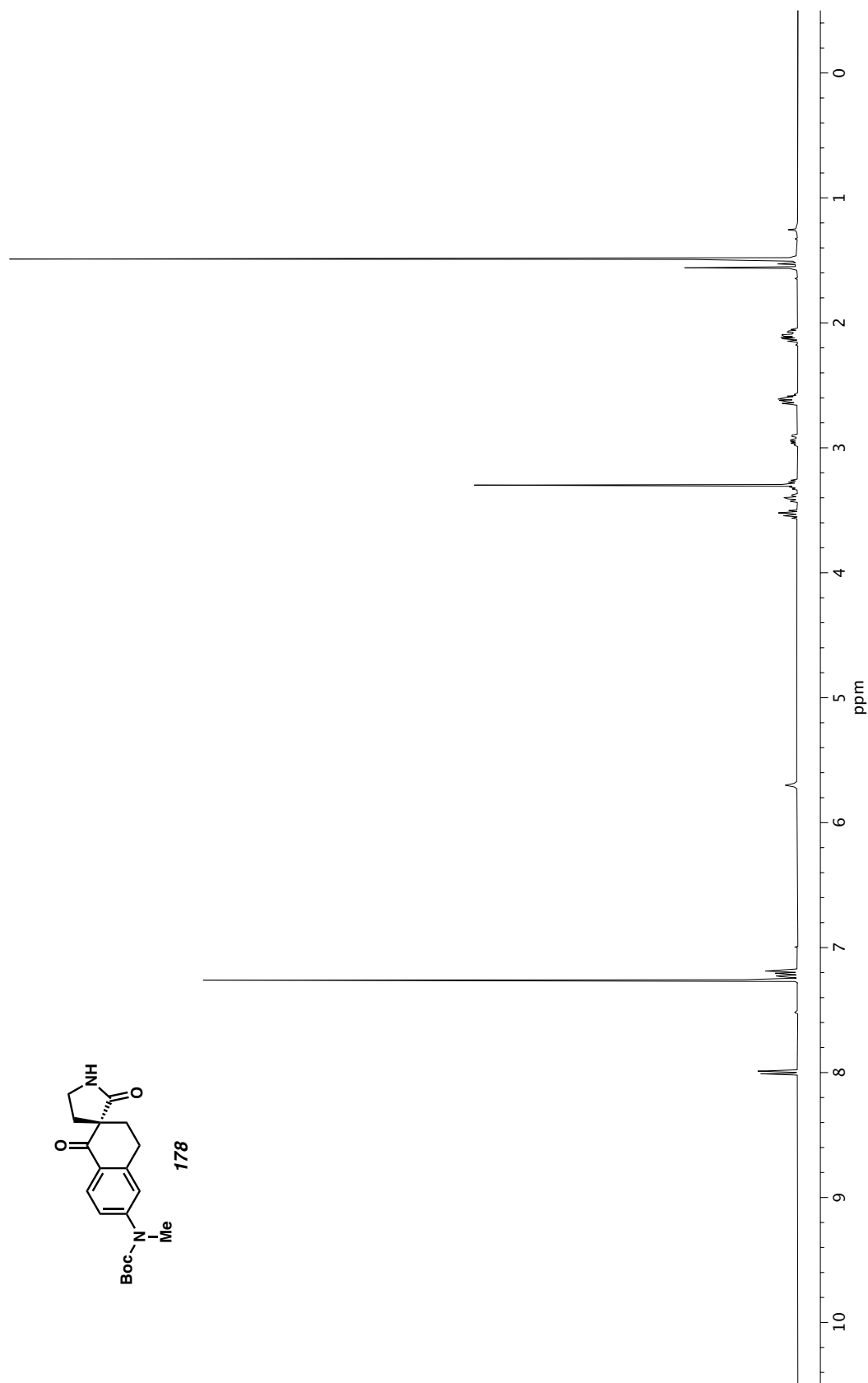


Figure A5.13 ^1H NMR (400 MHz, CDCl_3) of compound **178**.

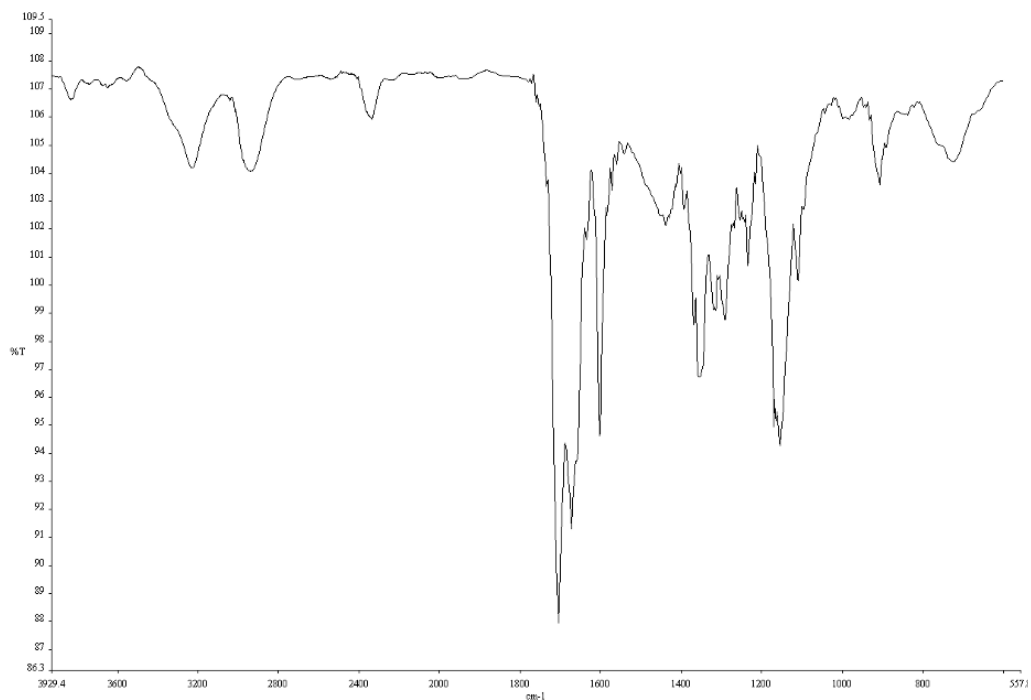


Figure A5.14 Infrared spectrum (Thin Film, NaCl) of compound **178**.

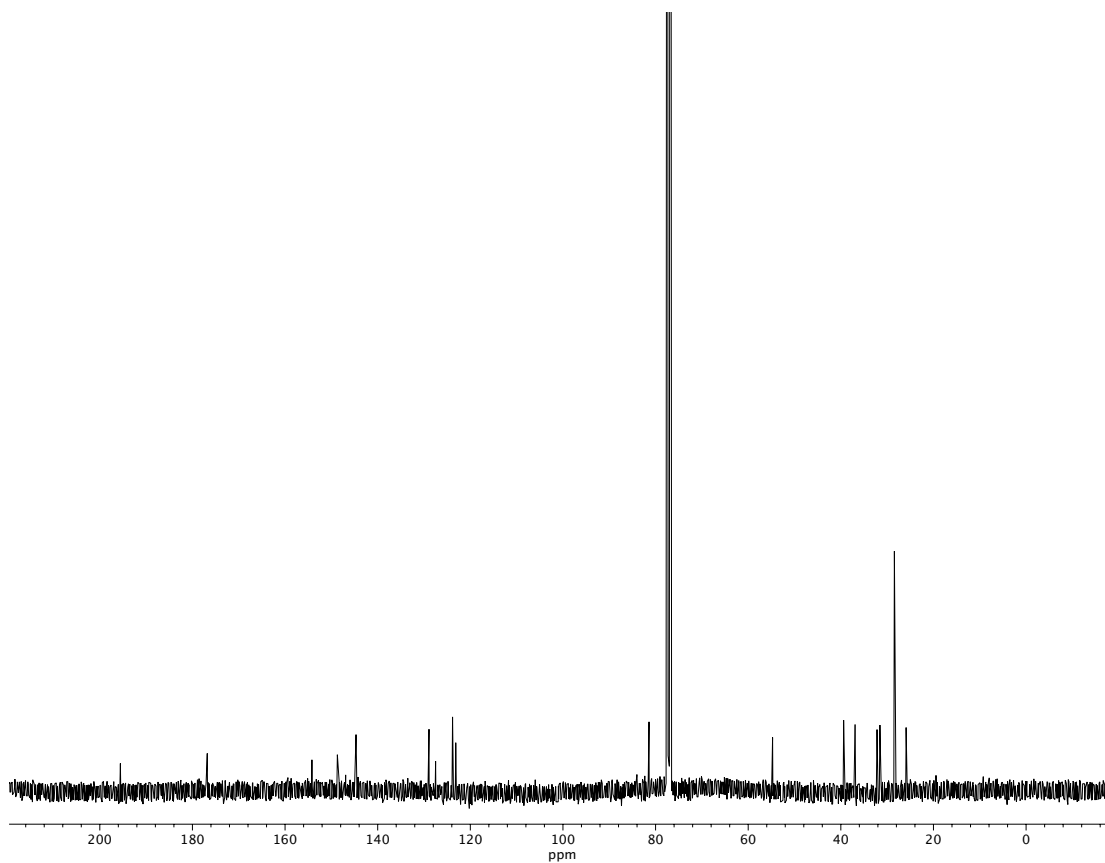


Figure A5.15 ¹³C NMR (100 MHz, CDCl₃) of compound **178**.

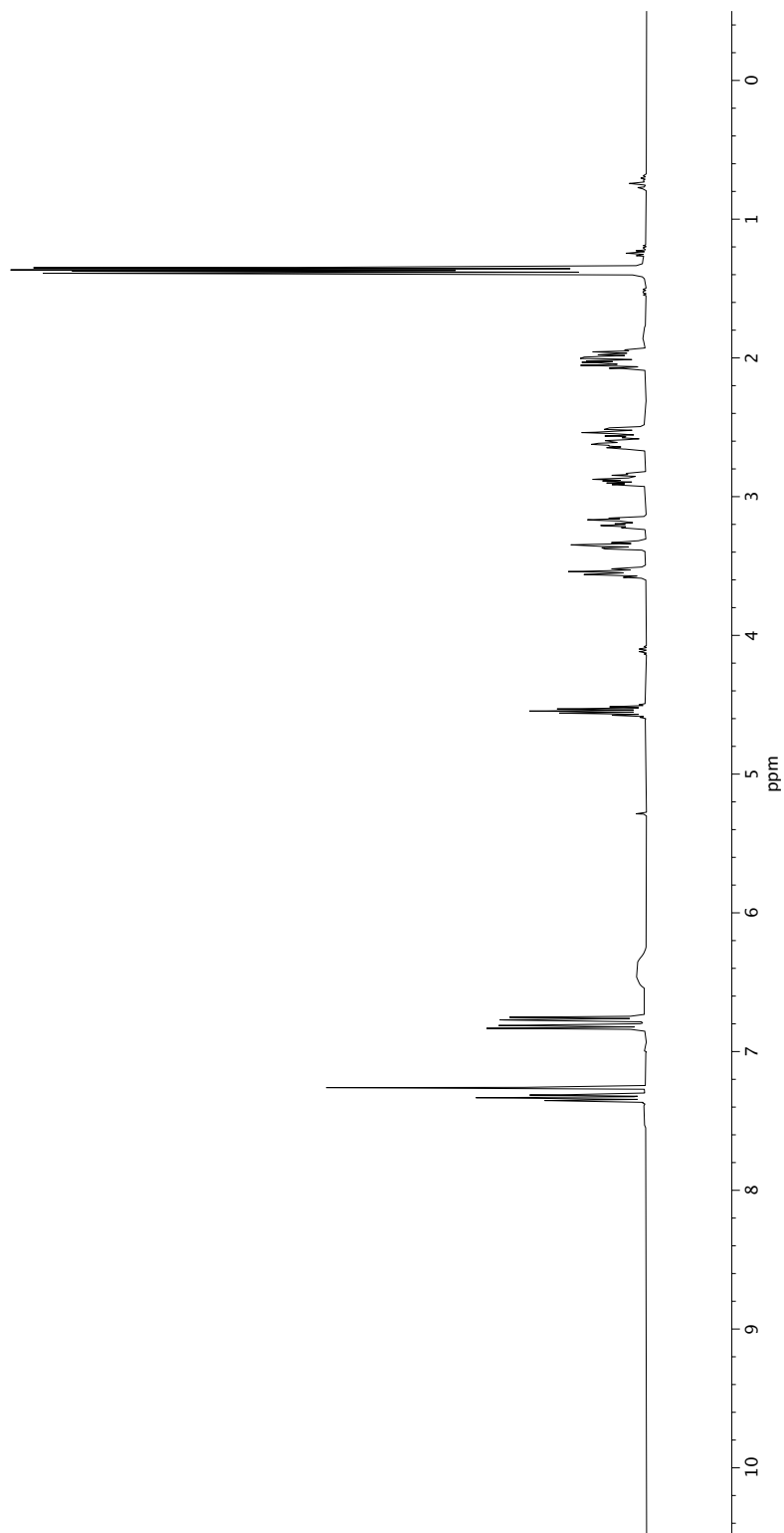
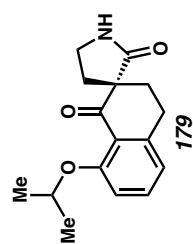


Figure A5.16 ¹H NMR (400 MHz, CDCl₃) of compound **179**.

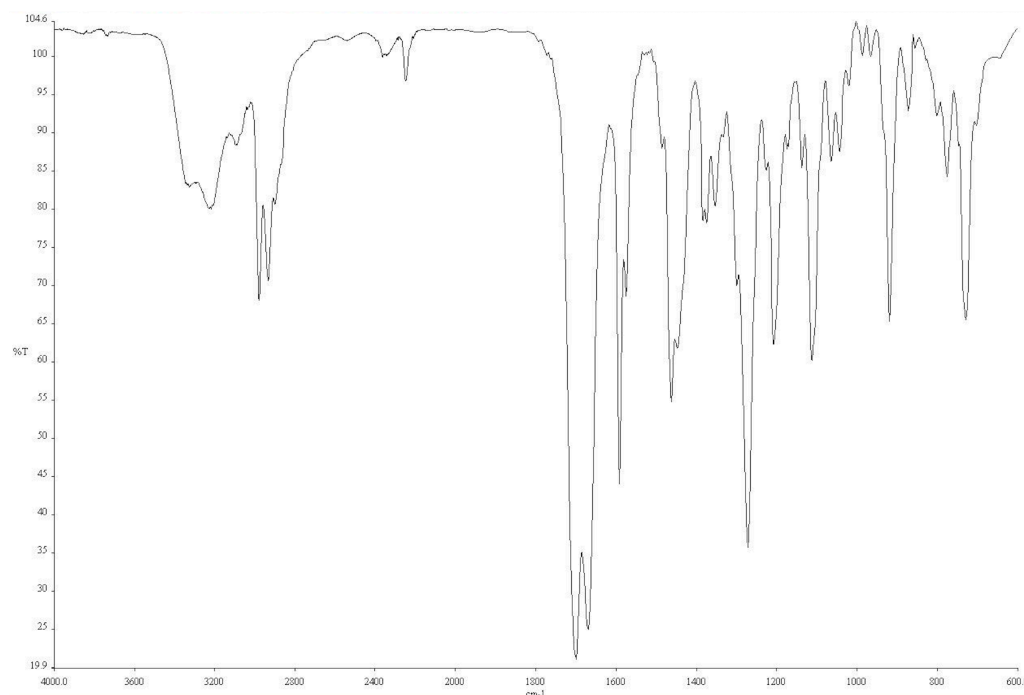


Figure A5.17 Infrared spectrum (Thin Film, NaCl) of compound **179**.

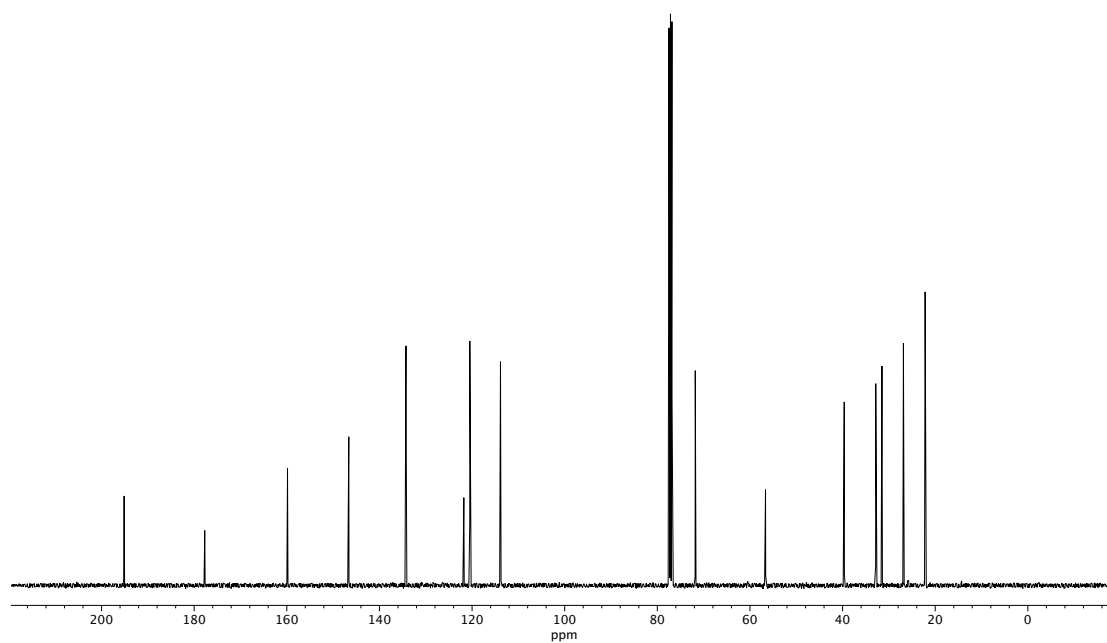


Figure A5.18 ¹³C NMR (100 MHz, CDCl₃) of compound **179**.

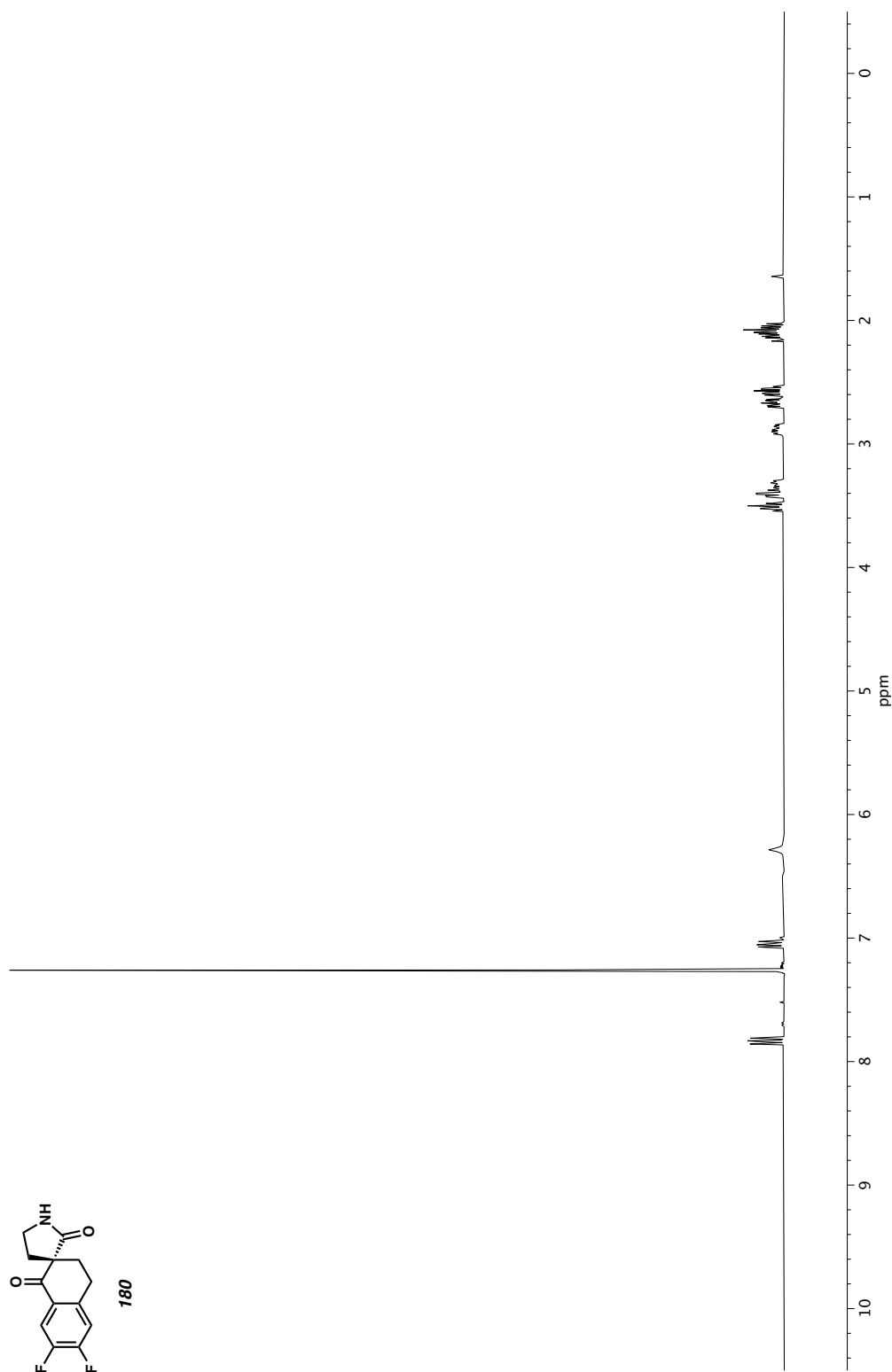


Figure A5.19 ^1H NMR (400 MHz, CDCl_3) of compound **180**.

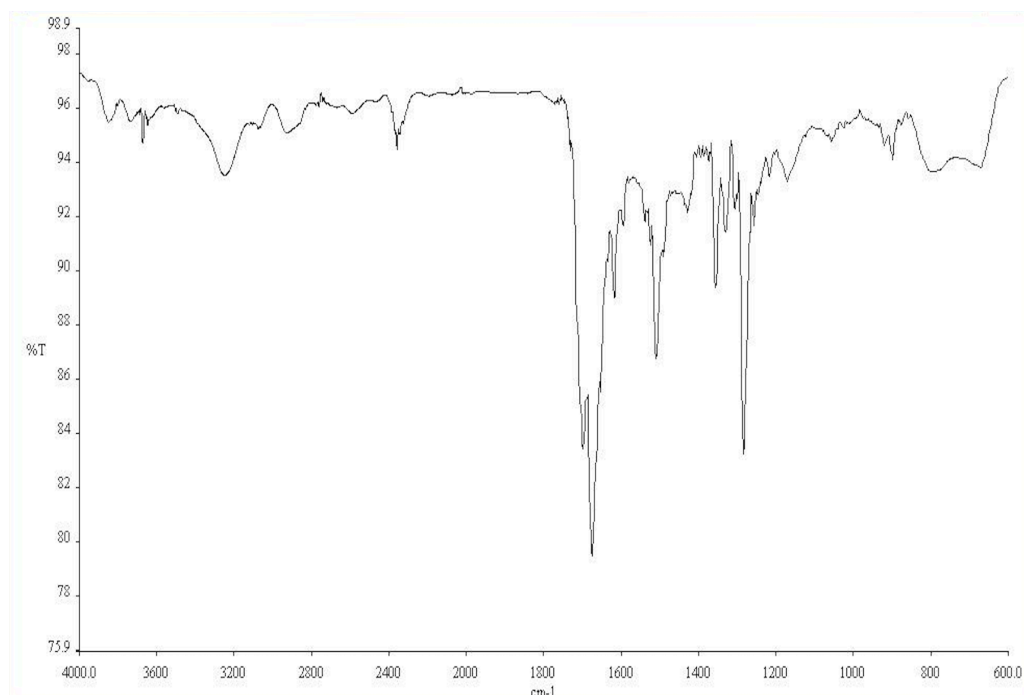


Figure A5.20 Infrared spectrum (Thin Film, NaCl) of compound **180**.

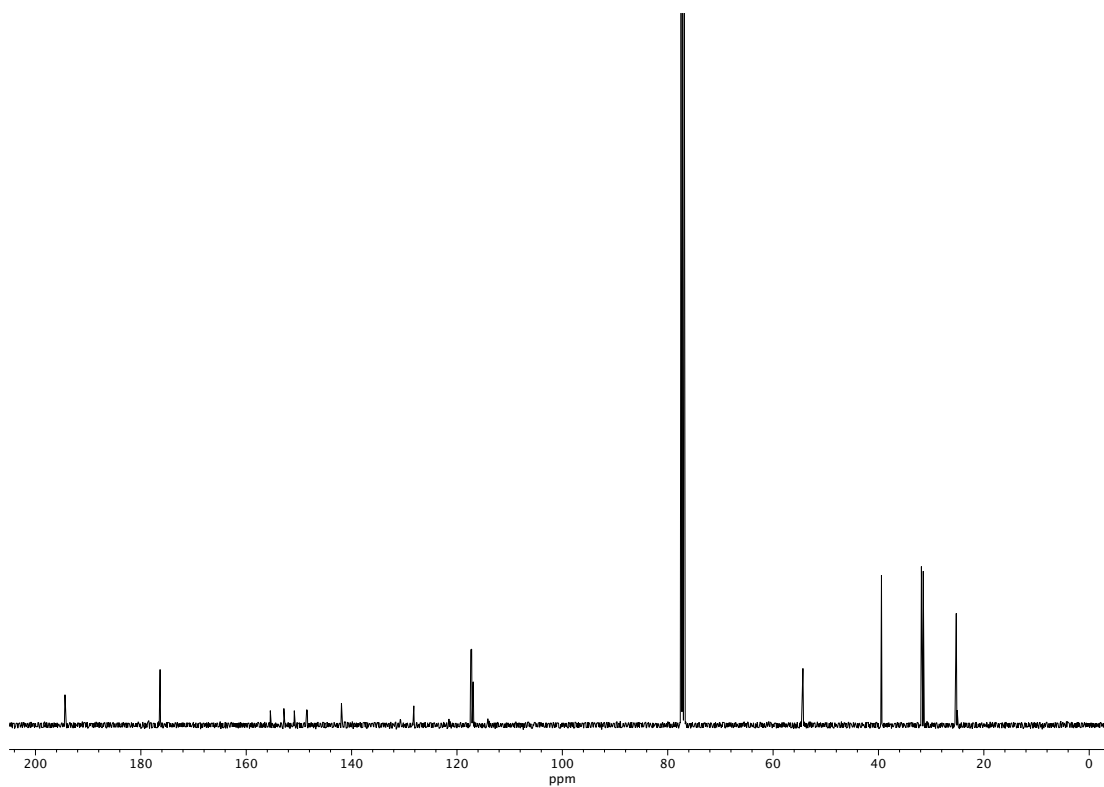


Figure A5.21 ¹³C NMR (100 MHz, CDCl₃) of compound **180**.

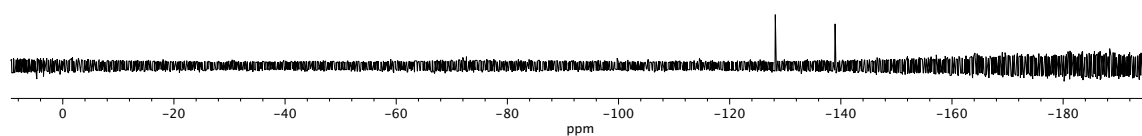


Figure A5.22 ^{19}F NMR (282 MHz, CDCl_3) of compound **180**.

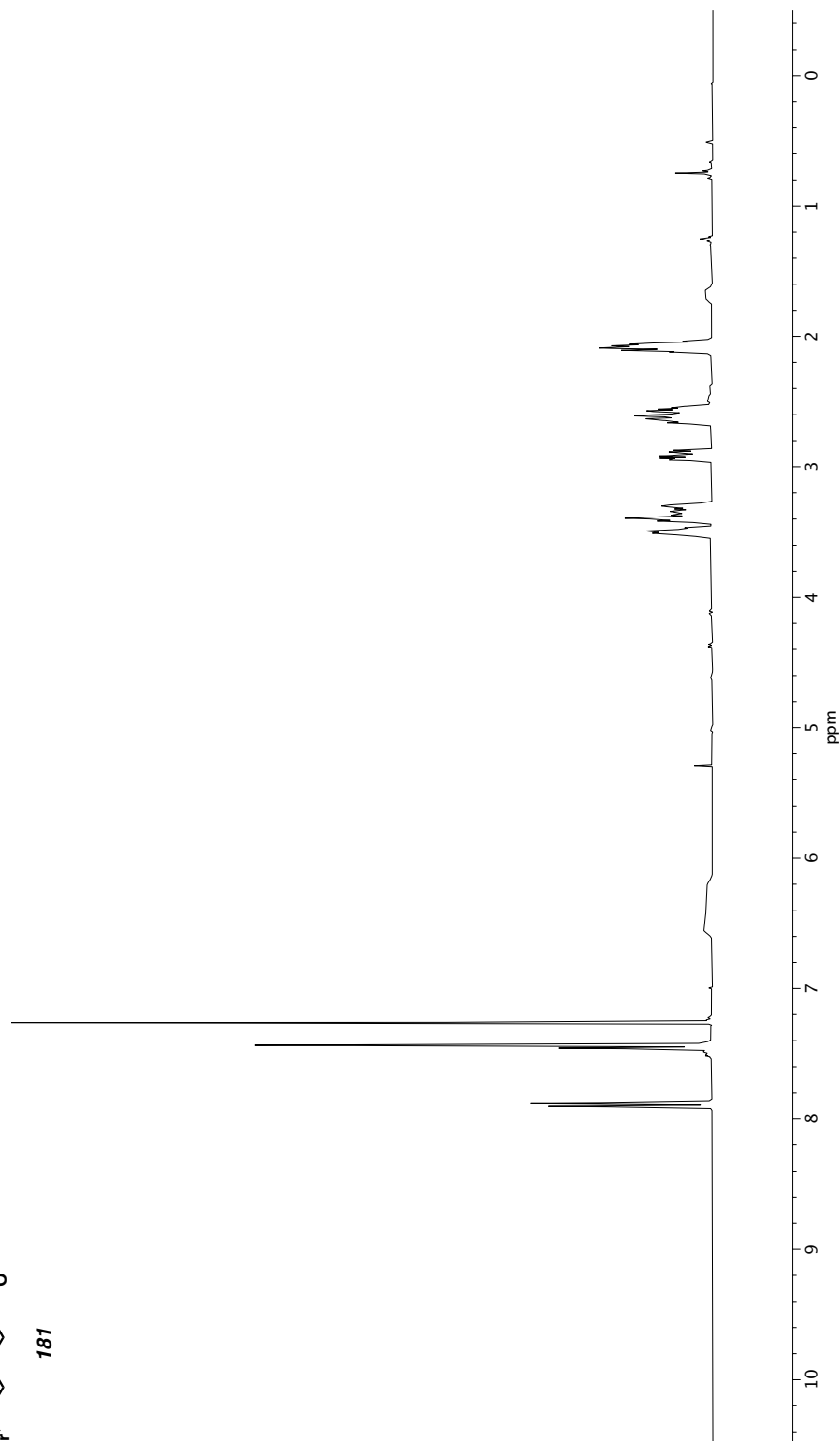
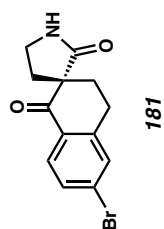


Figure A5.23 ¹H NMR (400 MHz, CDCl₃) of compound **181**.

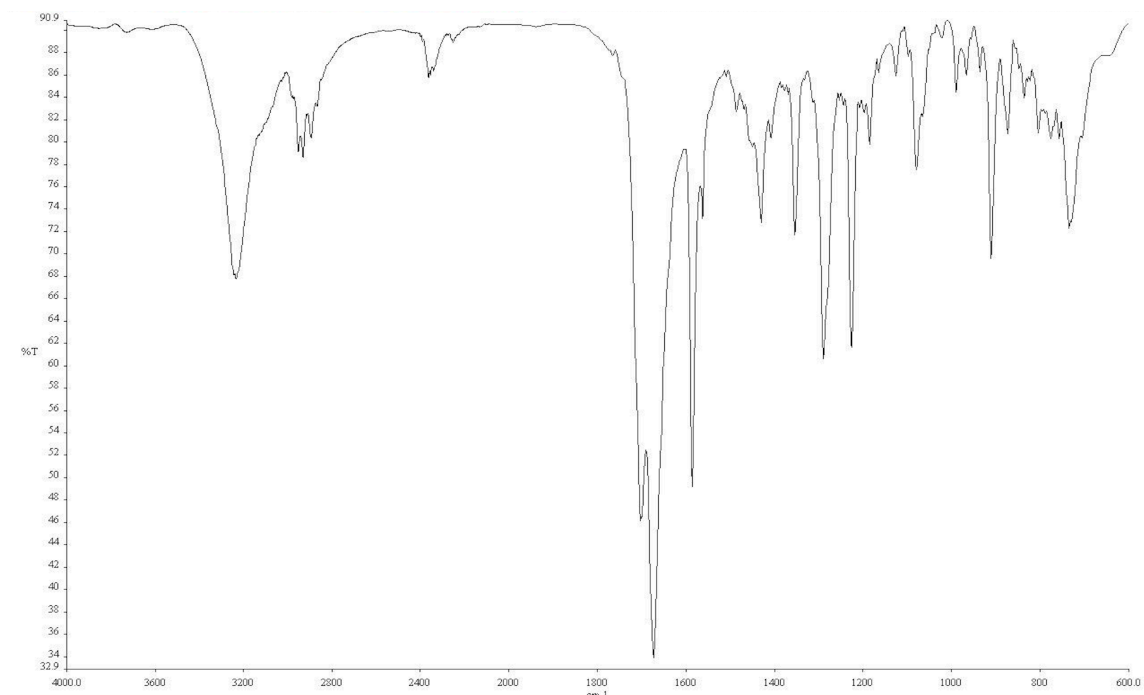


Figure A5.24 Infrared spectrum (CDCl_3 solution) of compound **181**.

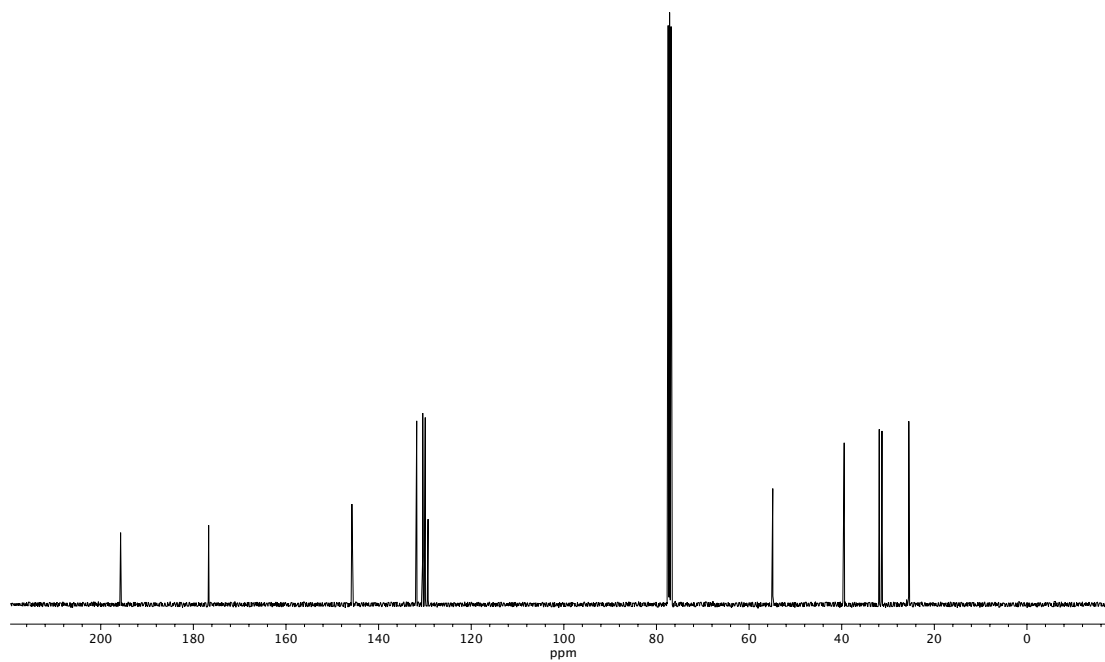


Figure A5.25 ¹³C NMR (100 MHz, CDCl_3) of compound **181**.

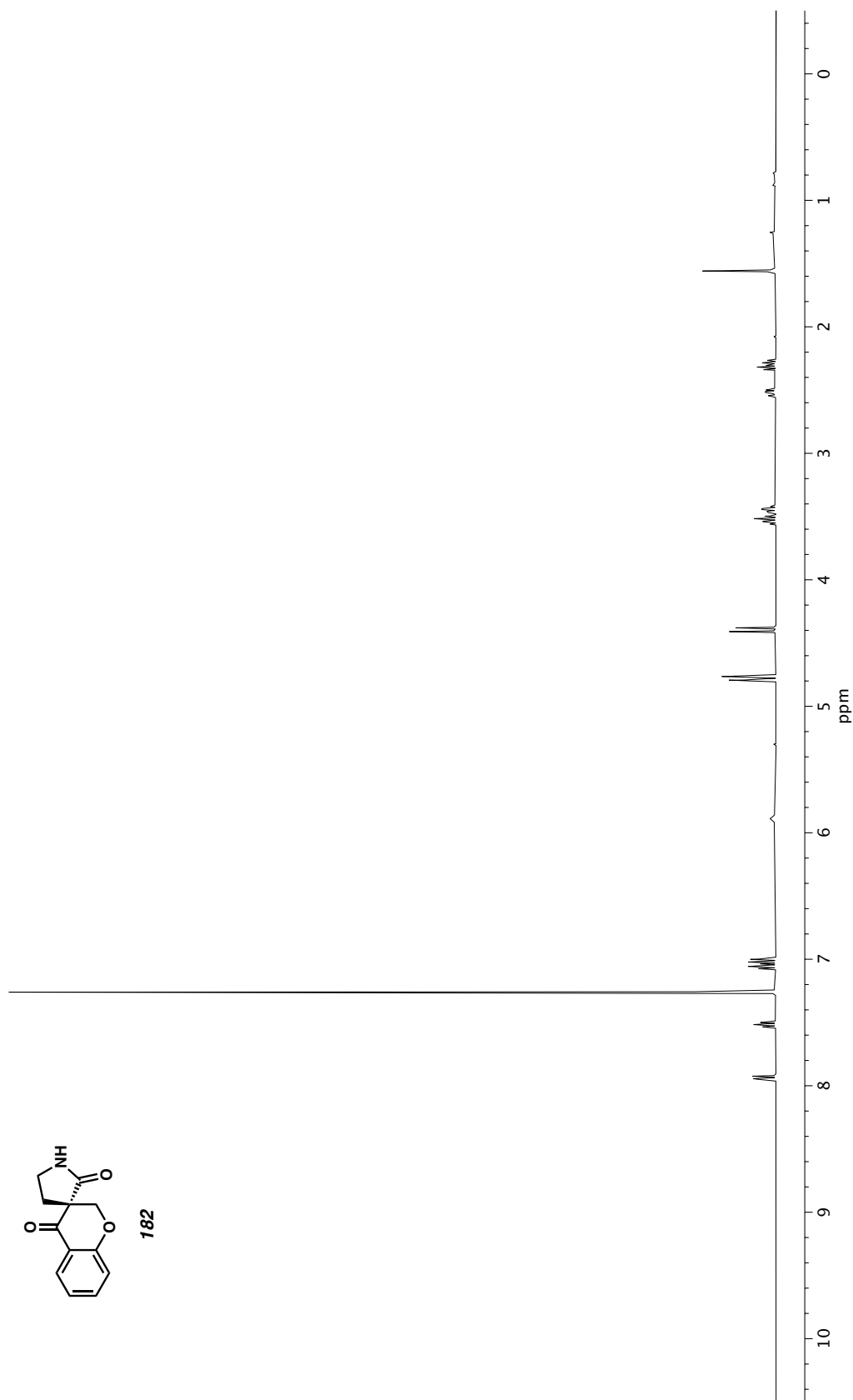


Figure A5.26 ^1H NMR (400 MHz, CDCl_3) of compound **182**.

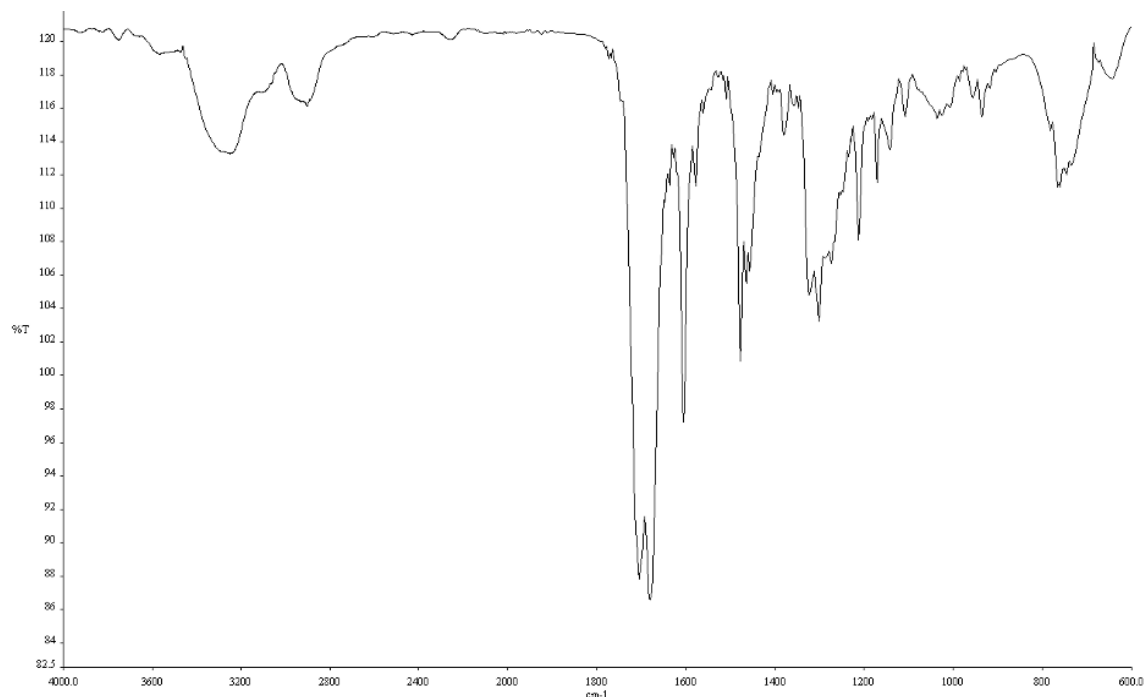


Figure A5.27 Infrared spectrum (CDCl_3 solution) of compound **182**.

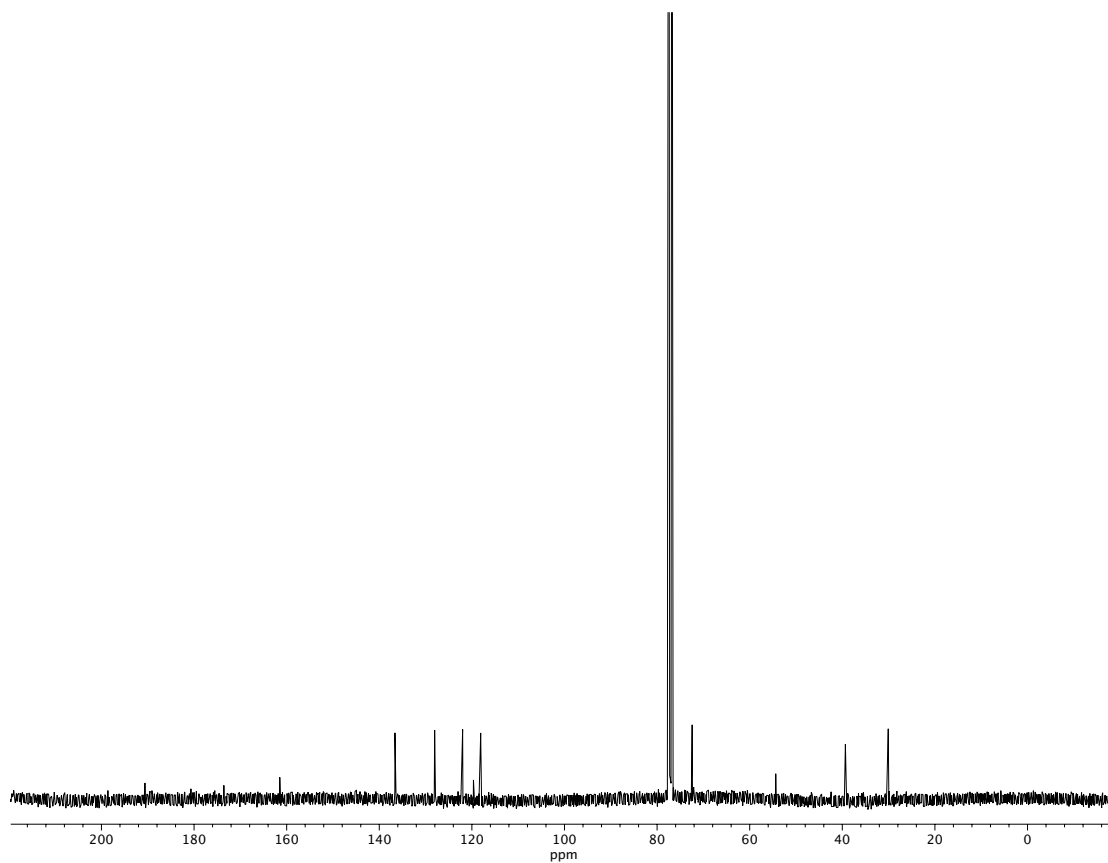


Figure A5.28 ¹³C NMR (100 MHz, CDCl_3) of compound **182**.

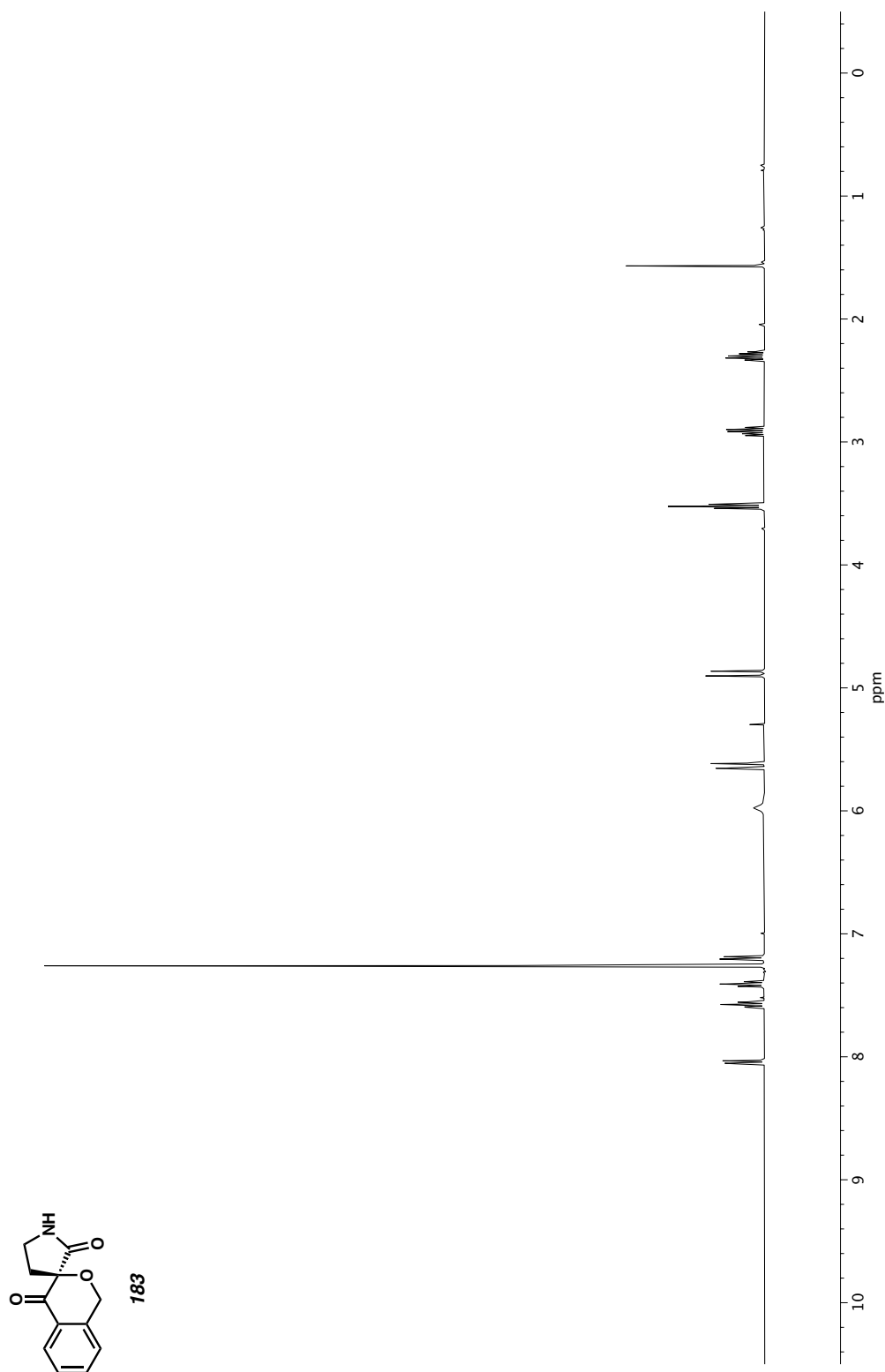


Figure A5.29 ¹H NMR (400 MHz, CDCl₃) of compound **183**.

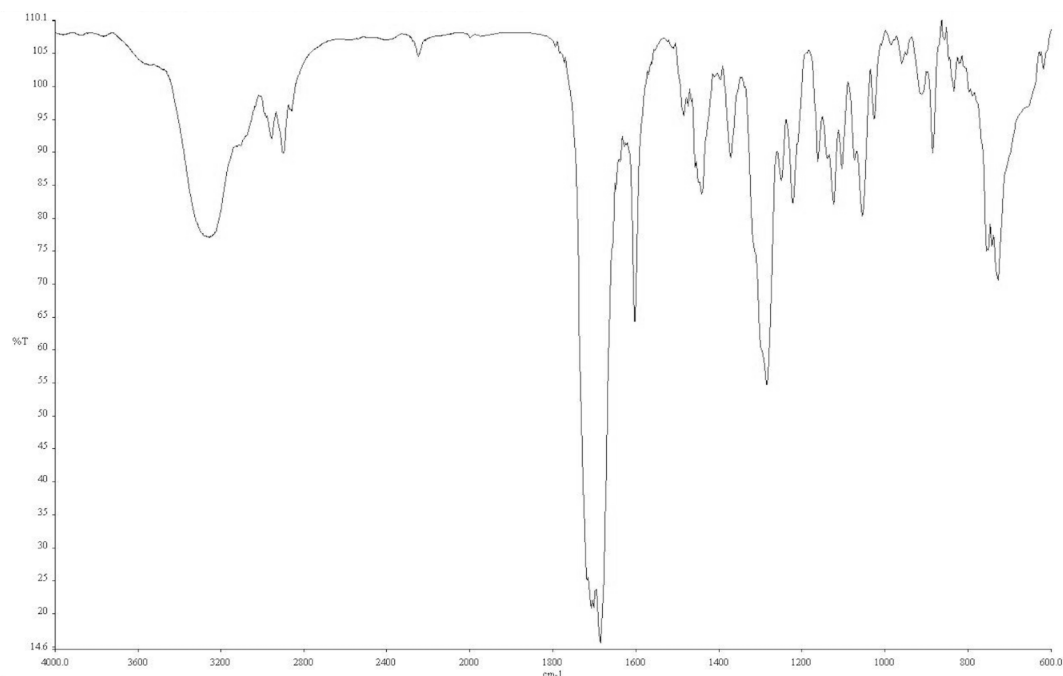


Figure A5.30 Infrared spectrum (Thin Film, NaCl) of compound **183**.

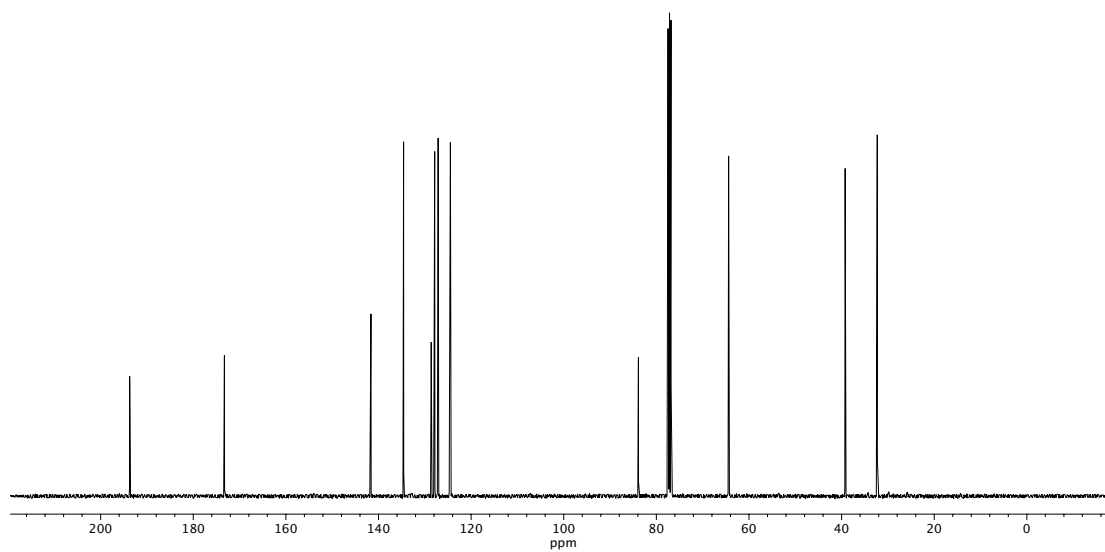


Figure A5.31 ¹³C NMR (100 MHz, CDCl₃) of compound **183**.

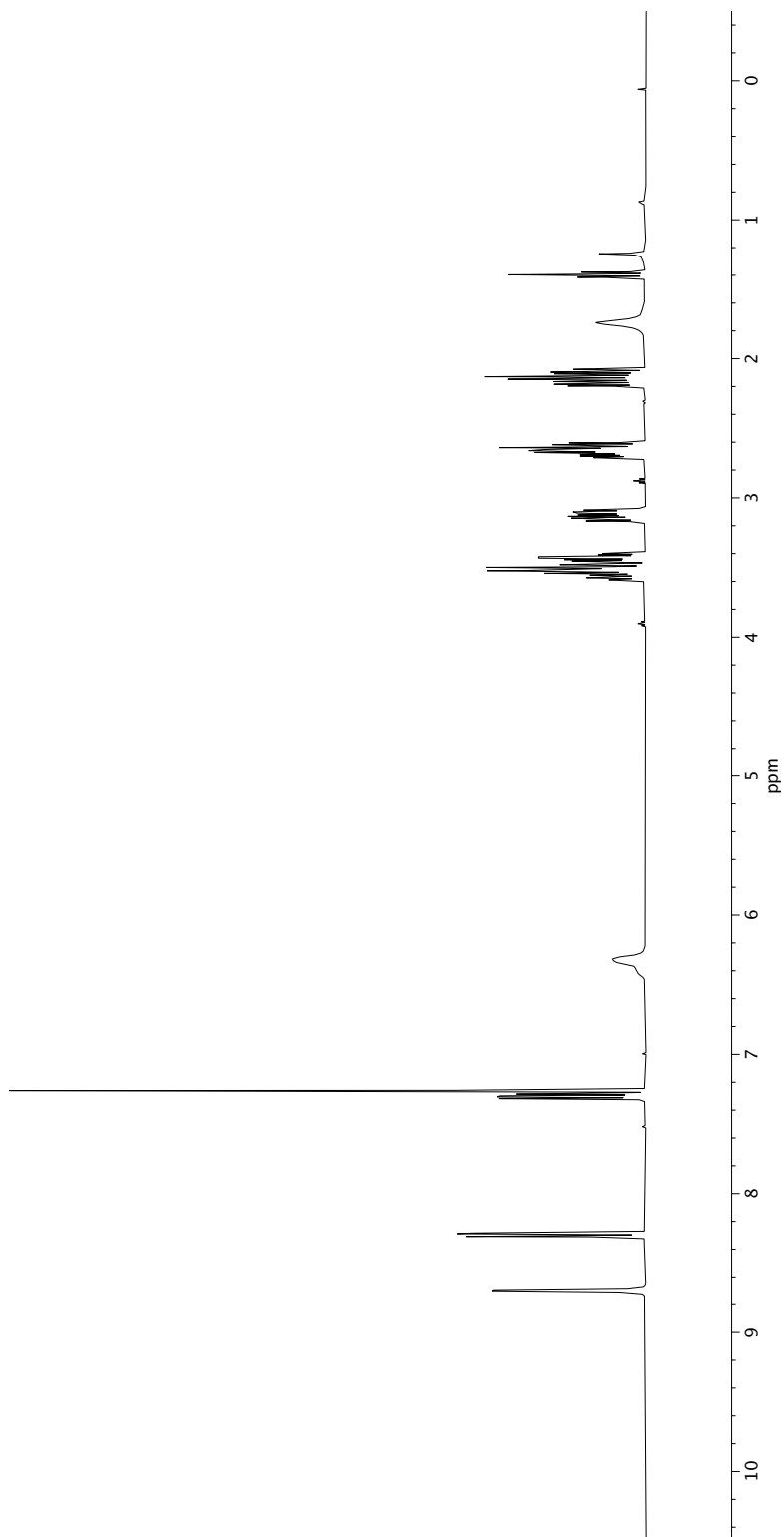
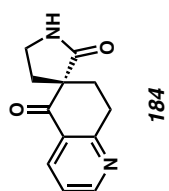


Figure A5.32 ¹H NMR (400 MHz, CDCl₃) of compound **184**.

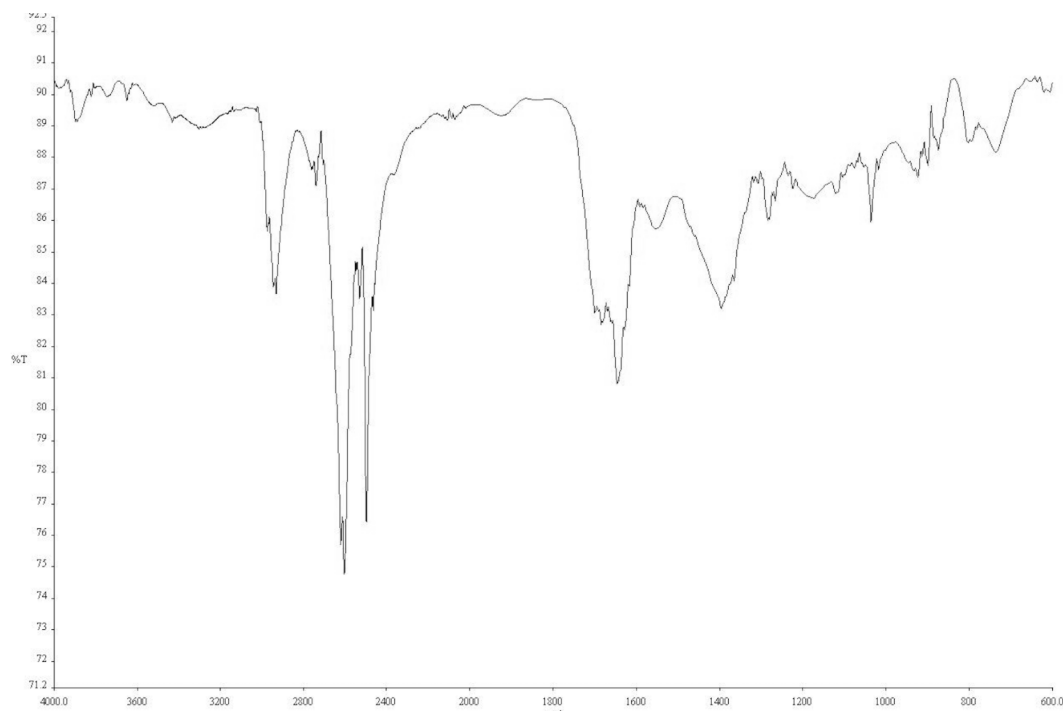


Figure A5.33 Infrared spectrum (Thin Film, NaCl) of compound **184**.

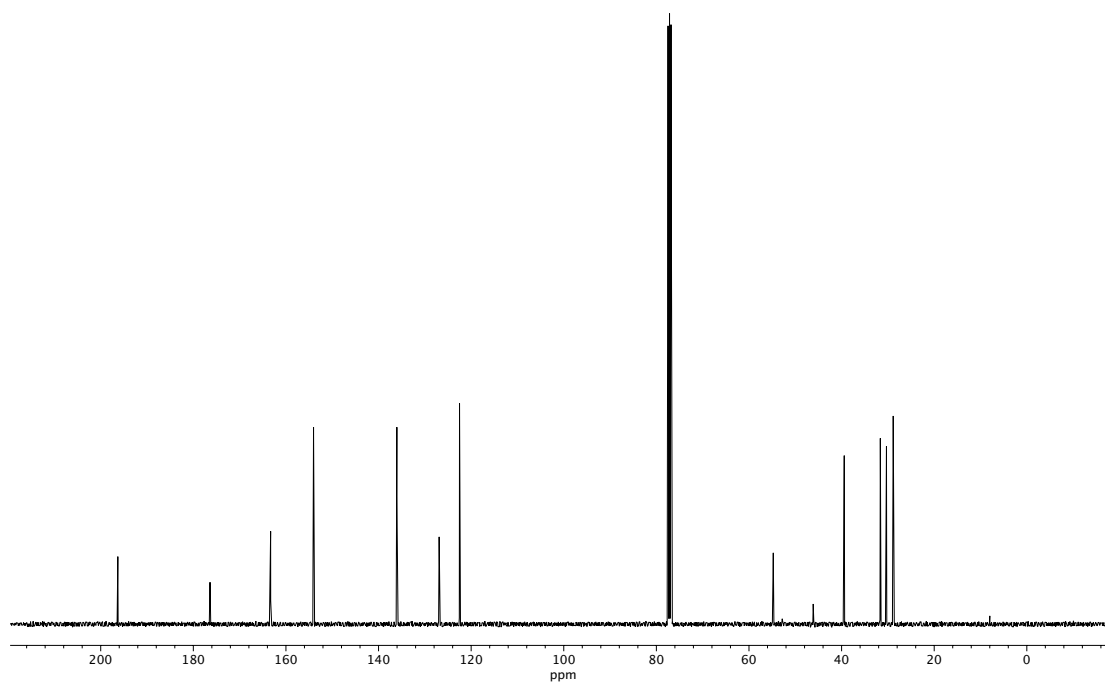


Figure A5.34 ¹³C NMR (100 MHz, CDCl₃) of compound **184**.

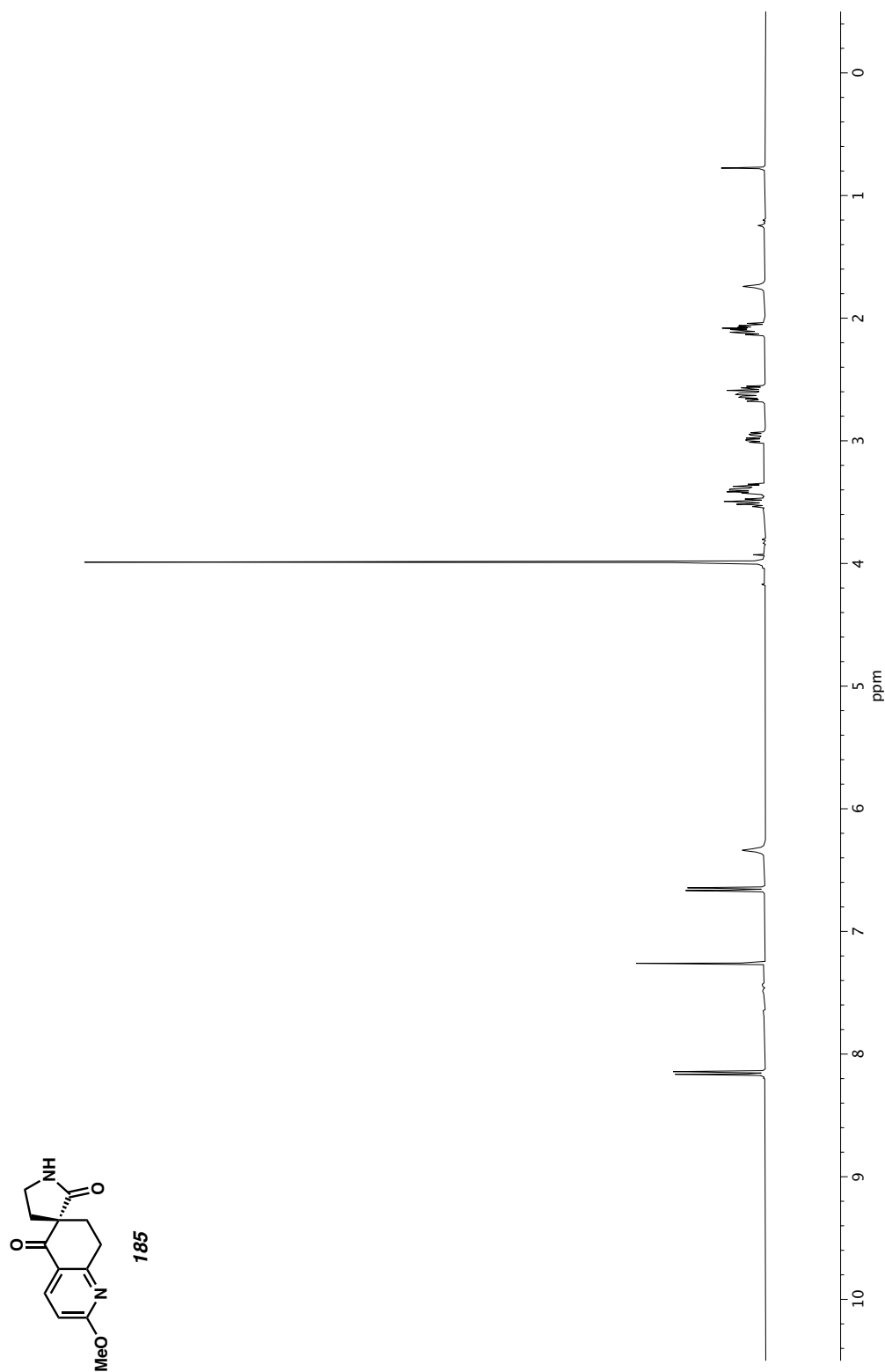


Figure A5.35 ^1H NMR (400 MHz, CDCl_3) of compound **185**.

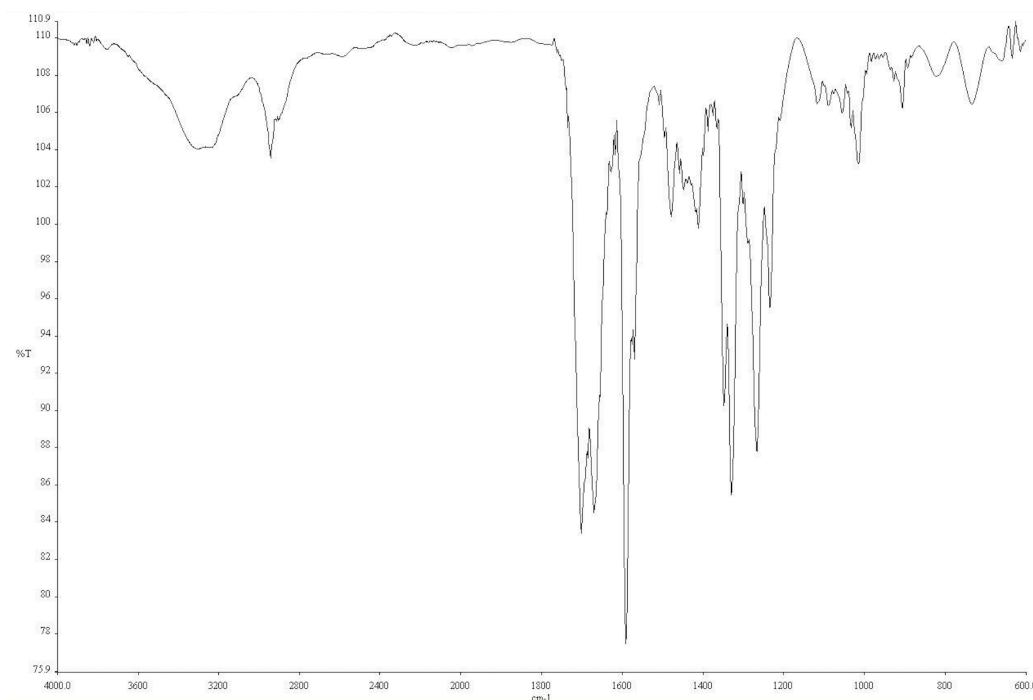


Figure A5.36 Infrared spectrum (Thin Film, NaCl) of compound **185**.

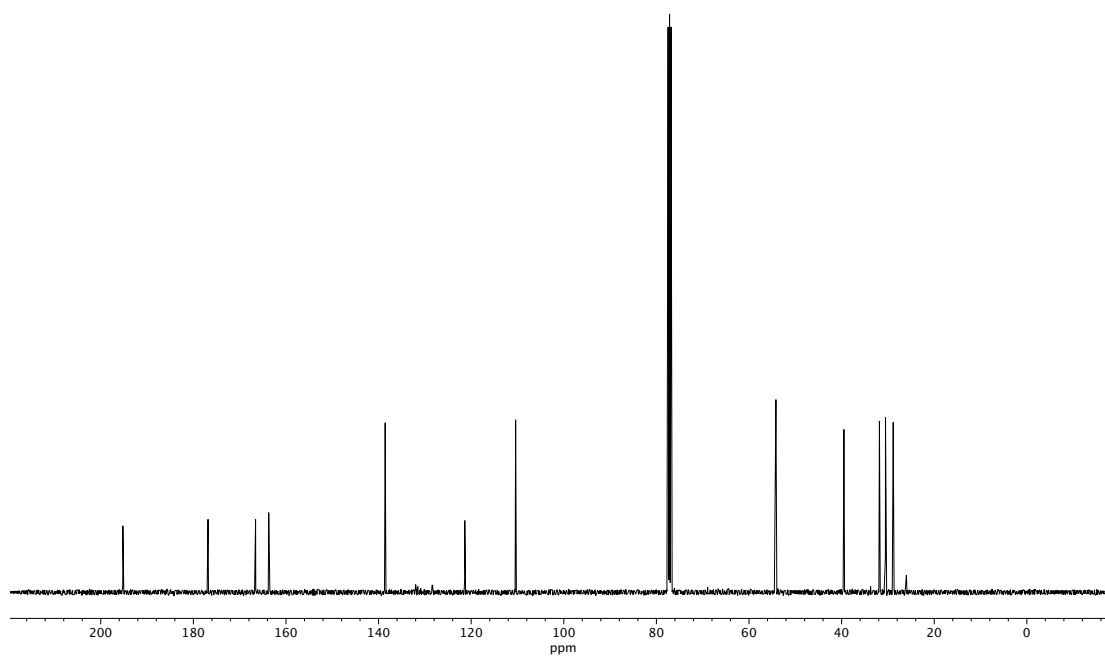


Figure A5.37 ¹³C NMR (100 MHz, CDCl₃) of compound **185**.

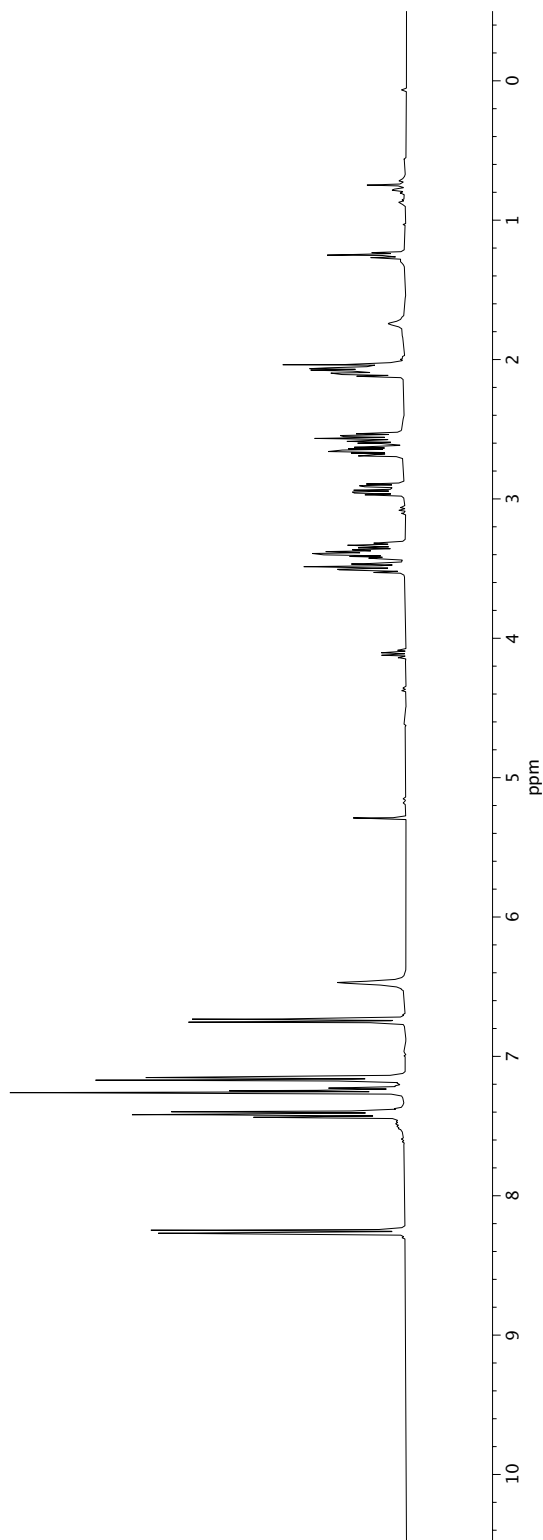
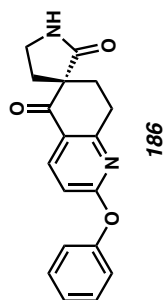


Figure A5.38 ¹H NMR (400 MHz, CDCl₃) of compound **186**.

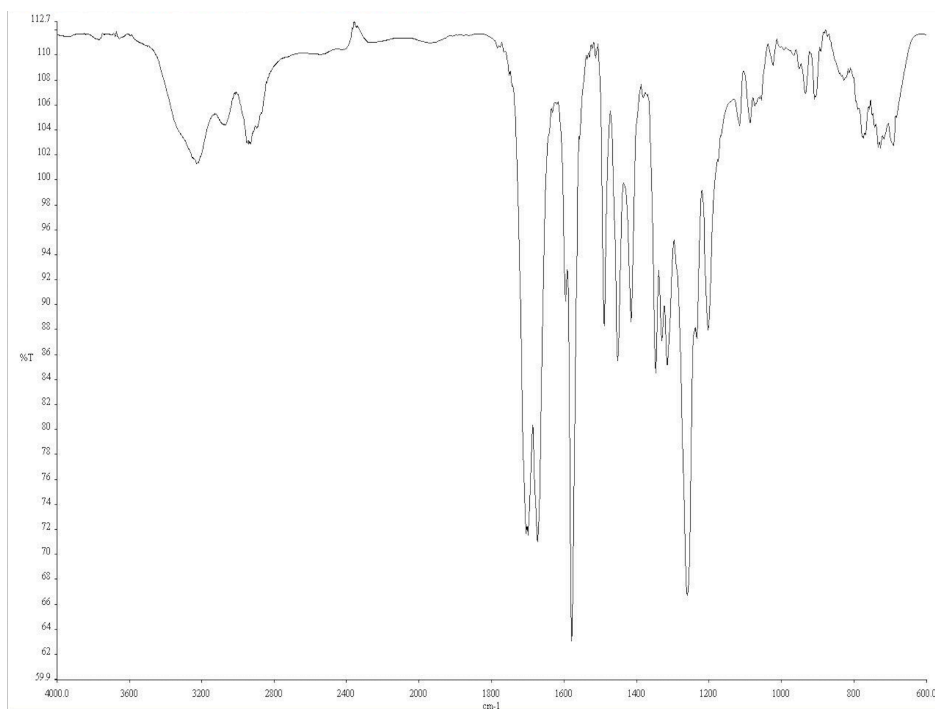


Figure A5.39 Infrared spectrum (Thin Film, NaCl) of compound **186**.

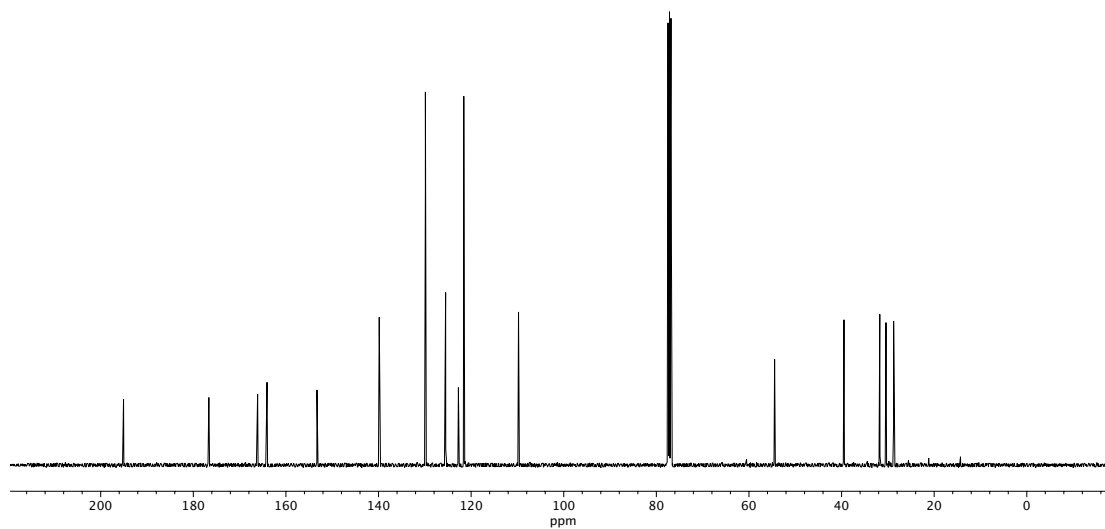


Figure A5.40 ¹³C NMR (100 MHz, CDCl₃) of compound **186**.

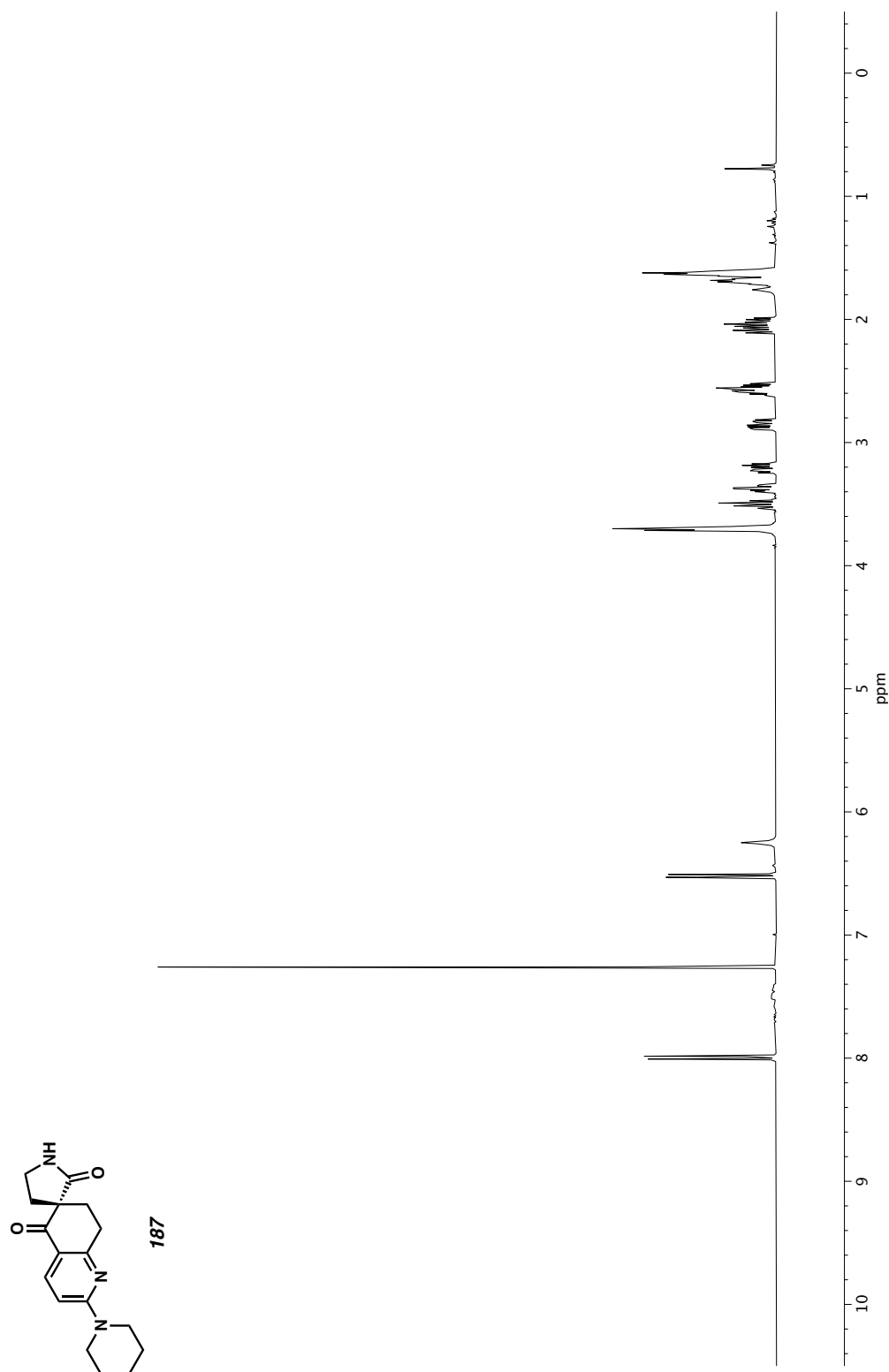


Figure A5.41 ^1H NMR (400 MHz, CDCl_3) of compound **187**.

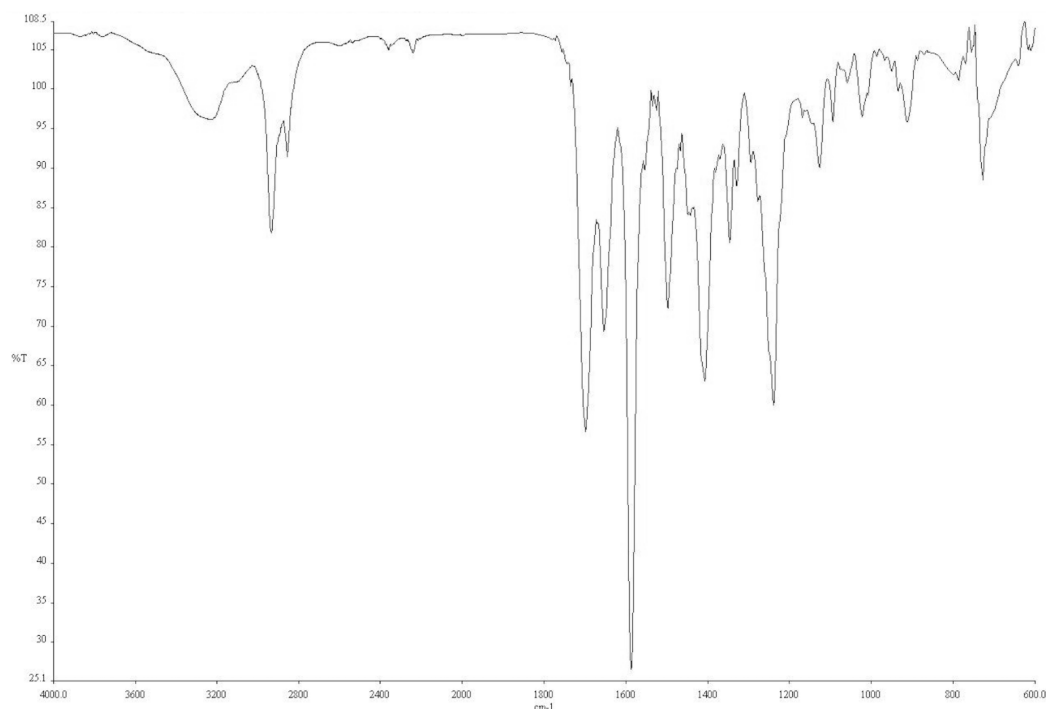


Figure A5.42 Infrared spectrum (Thin Film, NaCl) of compound **187**.

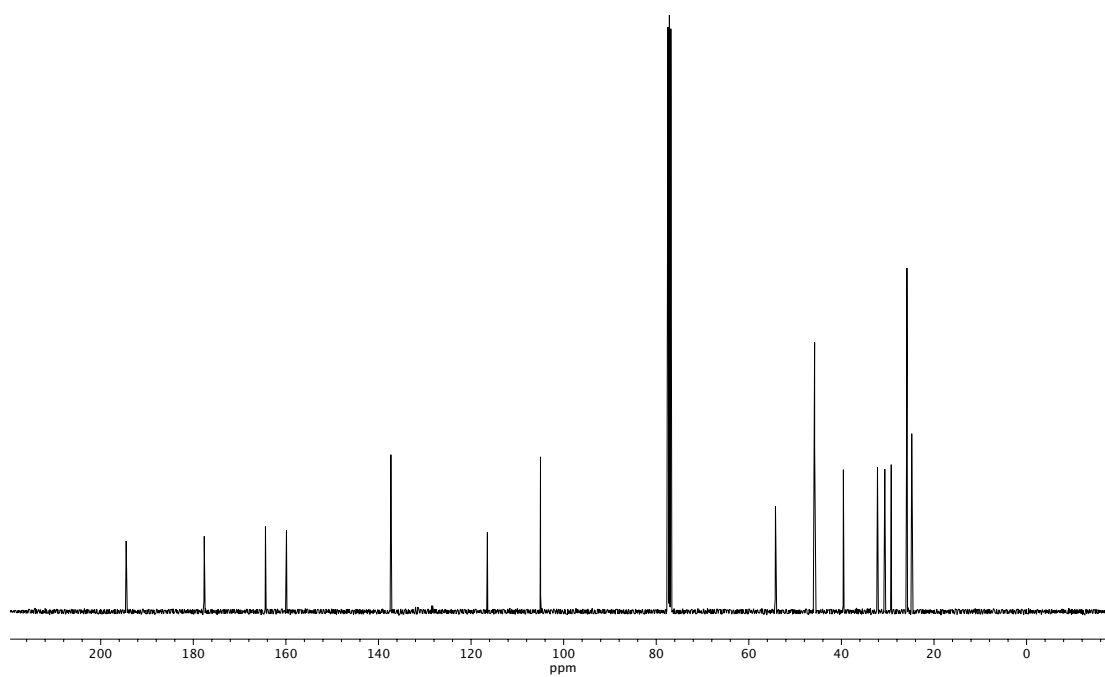


Figure A5.43 ¹³C NMR (100 MHz, CDCl₃) of compound **187**.

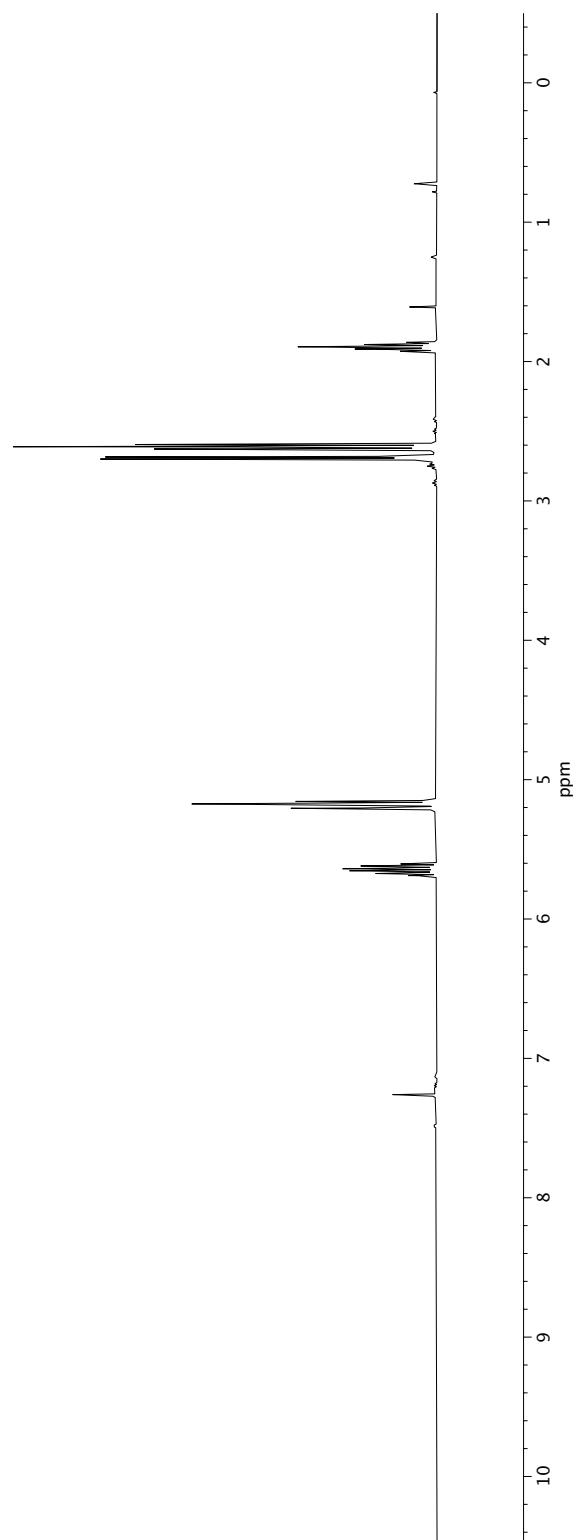
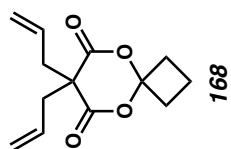


Figure A5.44 ¹H NMR (400 MHz, CDCl₃) of compound **168**.

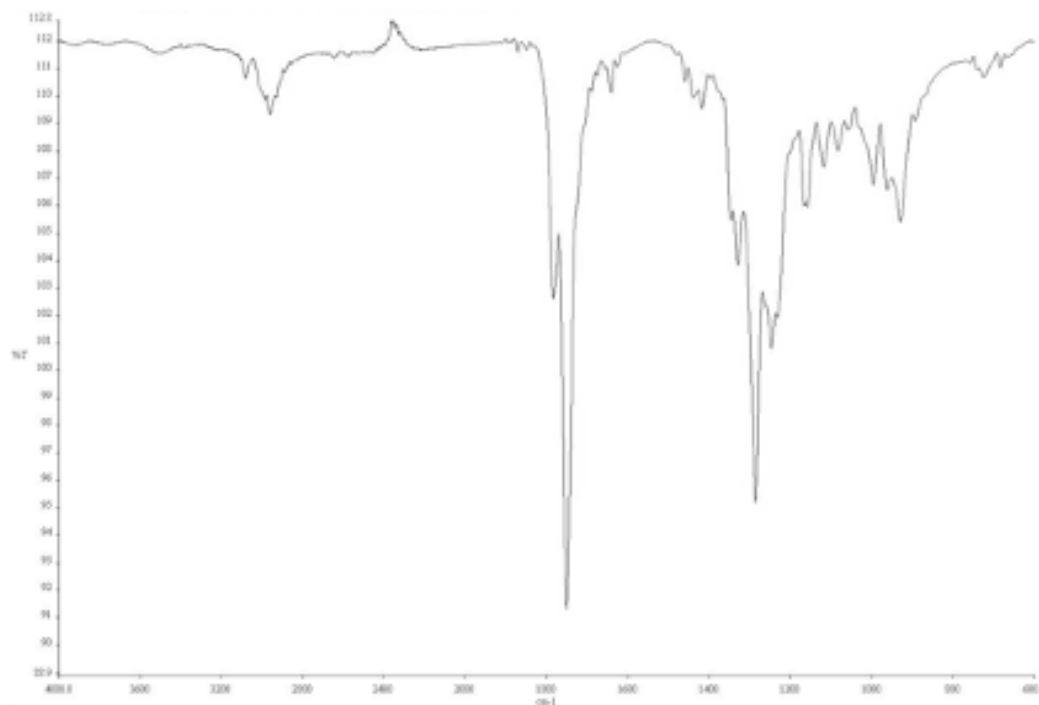


Figure A5.45 Infrared spectrum (Thin Film, NaCl) of compound **168**.

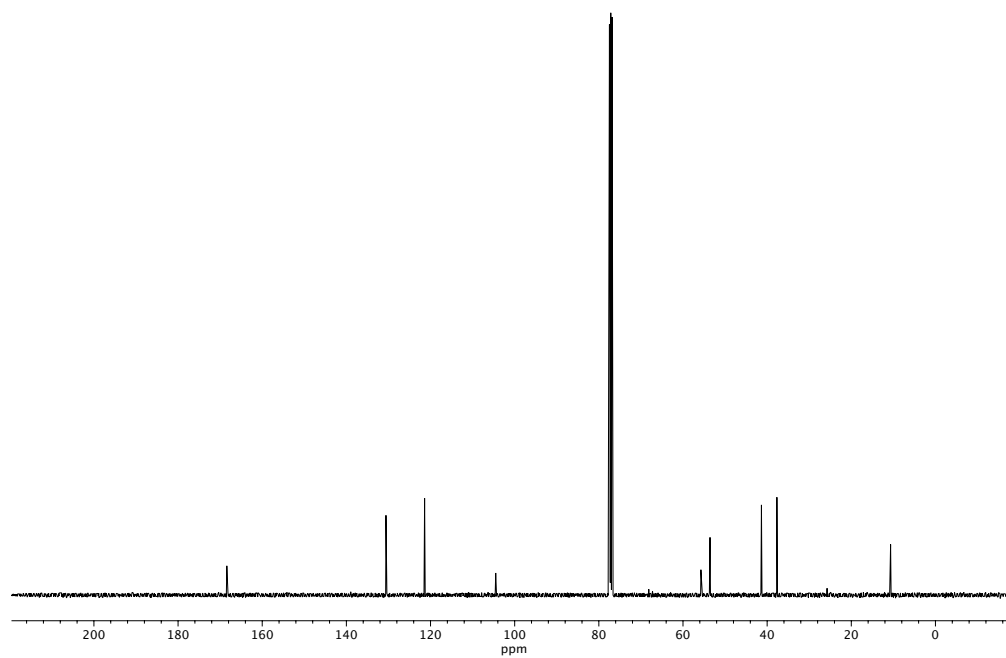


Figure A5.46 ¹³C NMR (100 MHz, CDCl₃) of compound **168**.

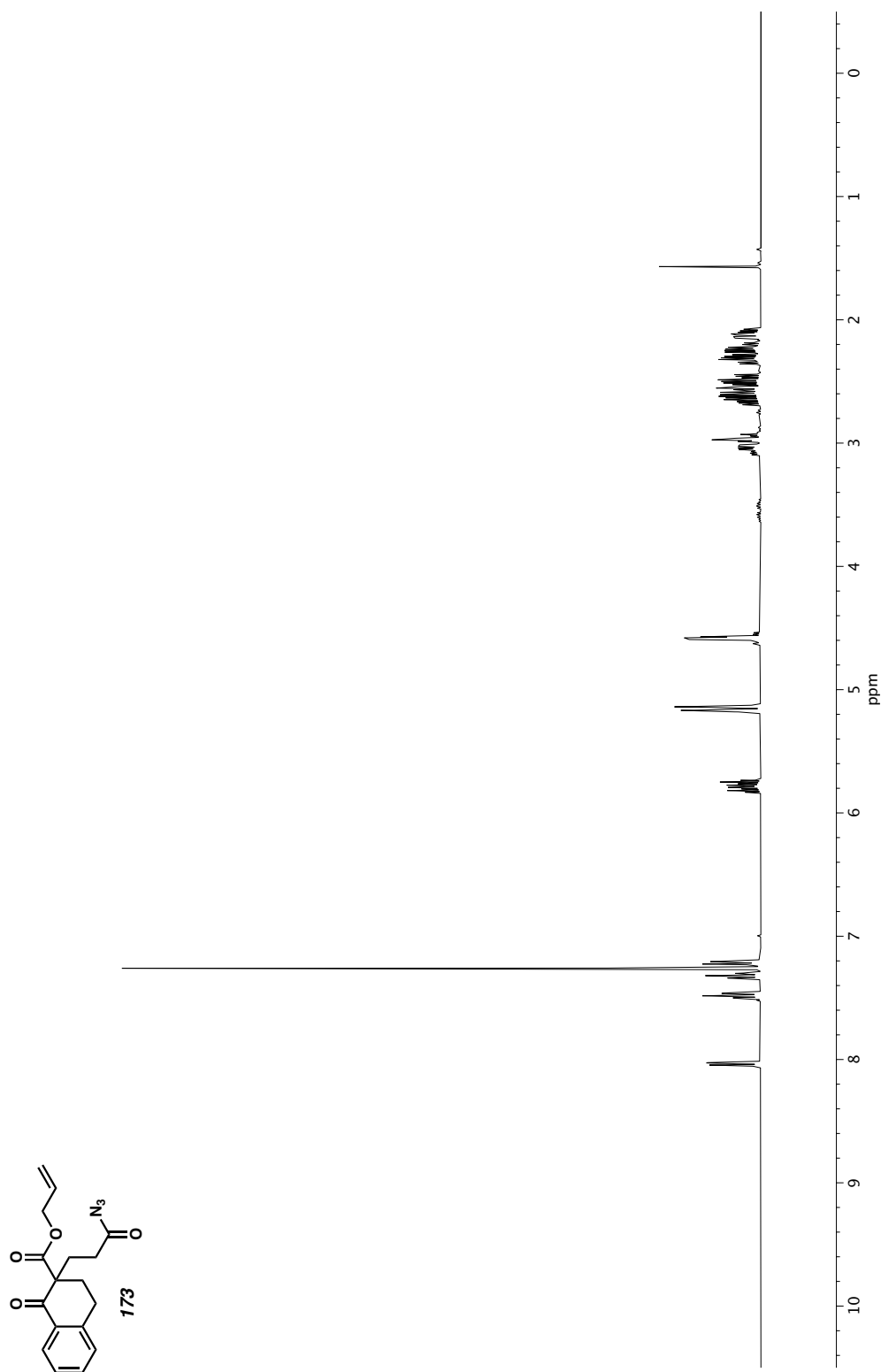


Figure A5.47 ^1H NMR (400 MHz, CDCl_3) of compound **173**.

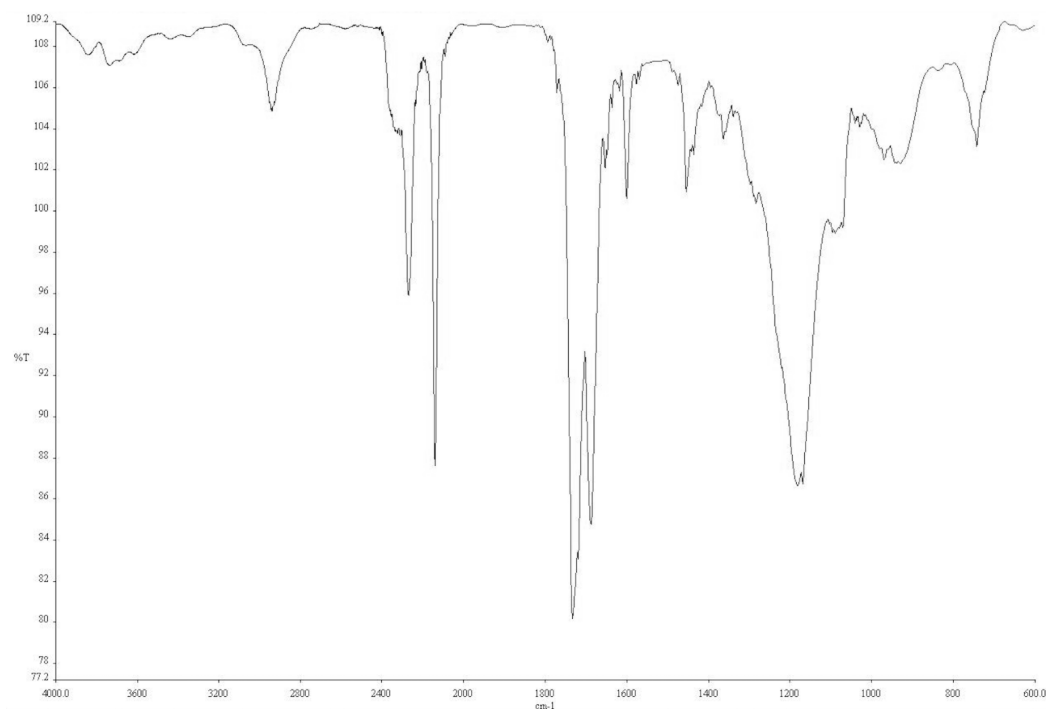


Figure A5.48 Infrared spectrum (Thin Film, NaCl) of compound **173**.

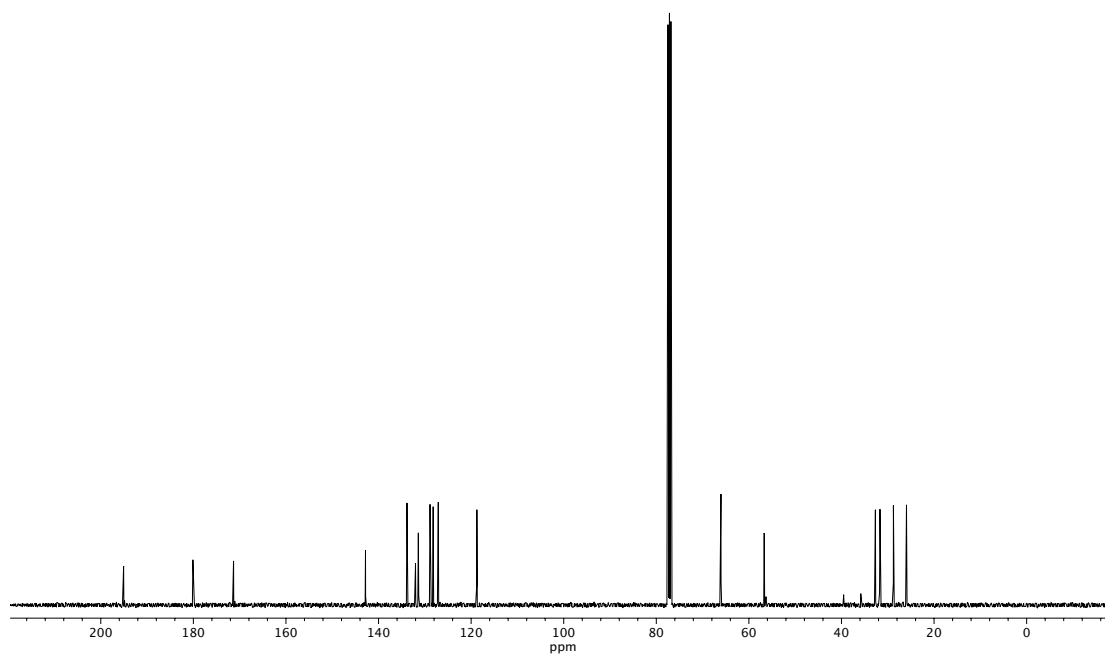


Figure A5.49 ¹³C NMR (100 MHz, CDCl₃) of compound **173**.

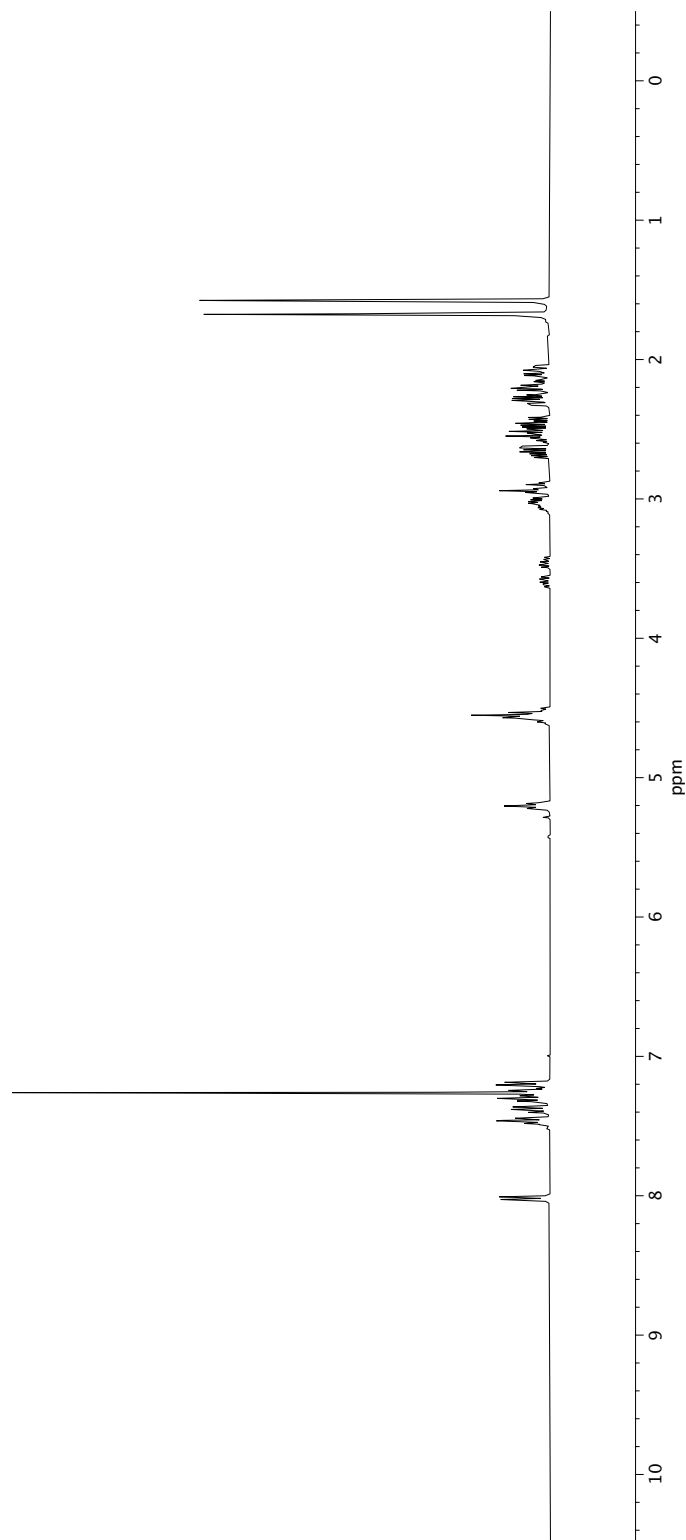
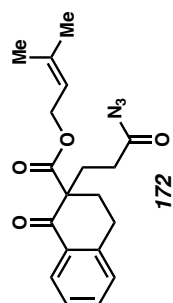


Figure A5.50 ^1H NMR (400 MHz, CDCl_3) of compound **172**.

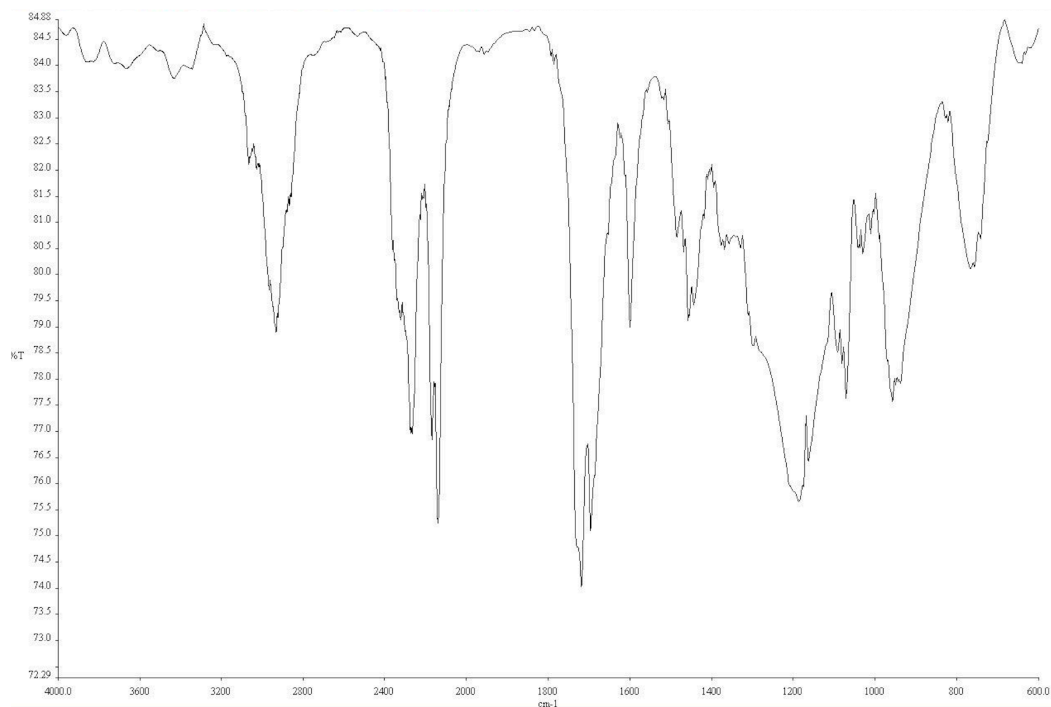


Figure A5.51 Infrared spectrum (Thin Film, NaCl) of compound **172**.

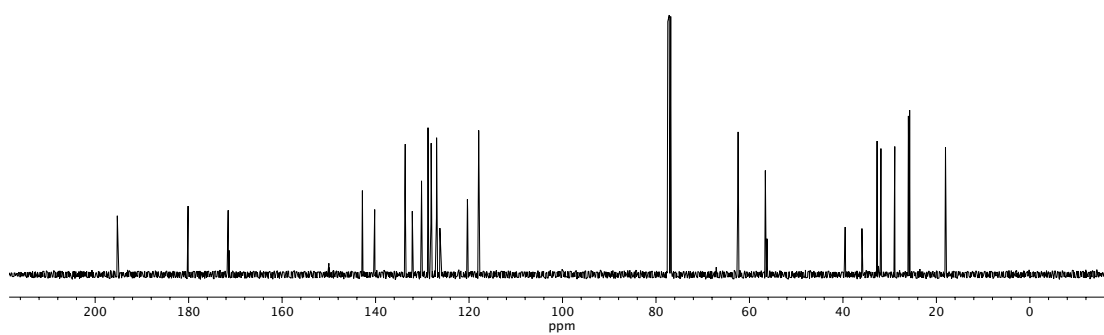


Figure A5.52 ¹³C NMR (100 MHz, CDCl₃) of compound **172**.

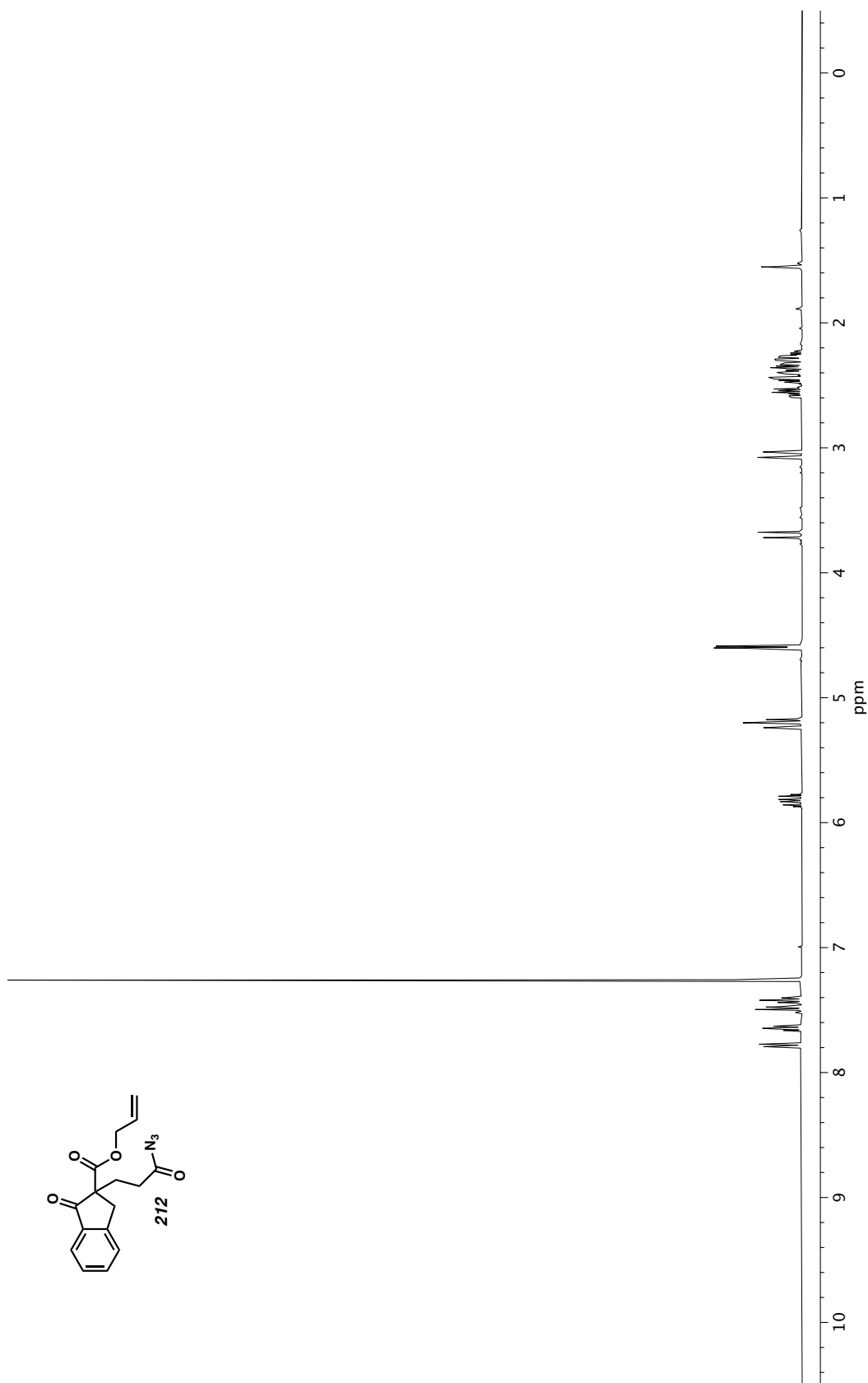


Figure A5.53 ^1H NMR (400 MHz, CDCl_3) of compound **212**.

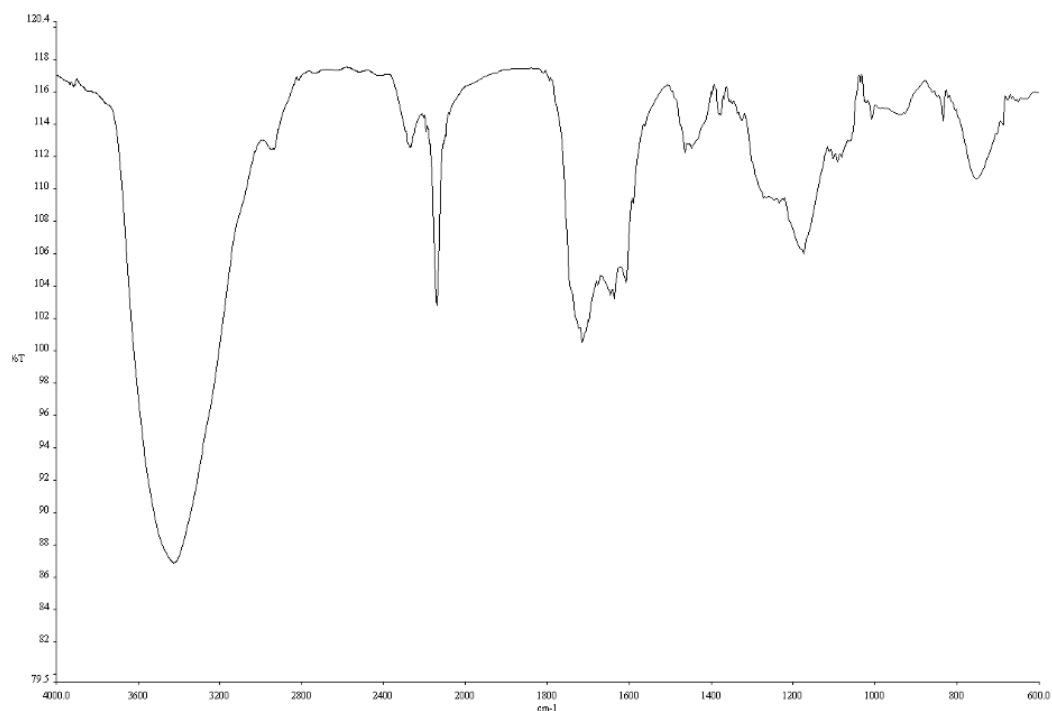


Figure A5.54 Infrared spectrum (Thin Film, NaCl) of compound **212**.

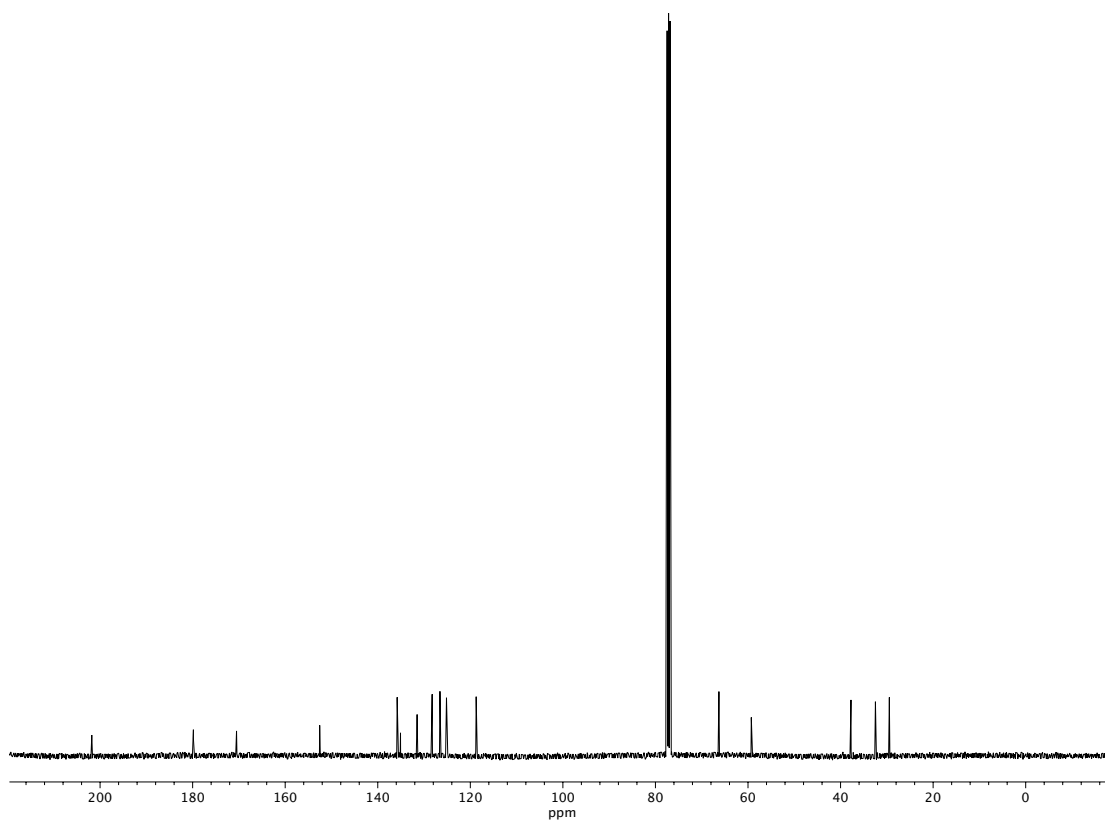


Figure A5.55 ¹³C NMR (100 MHz, CDCl₃) of compound **212**.

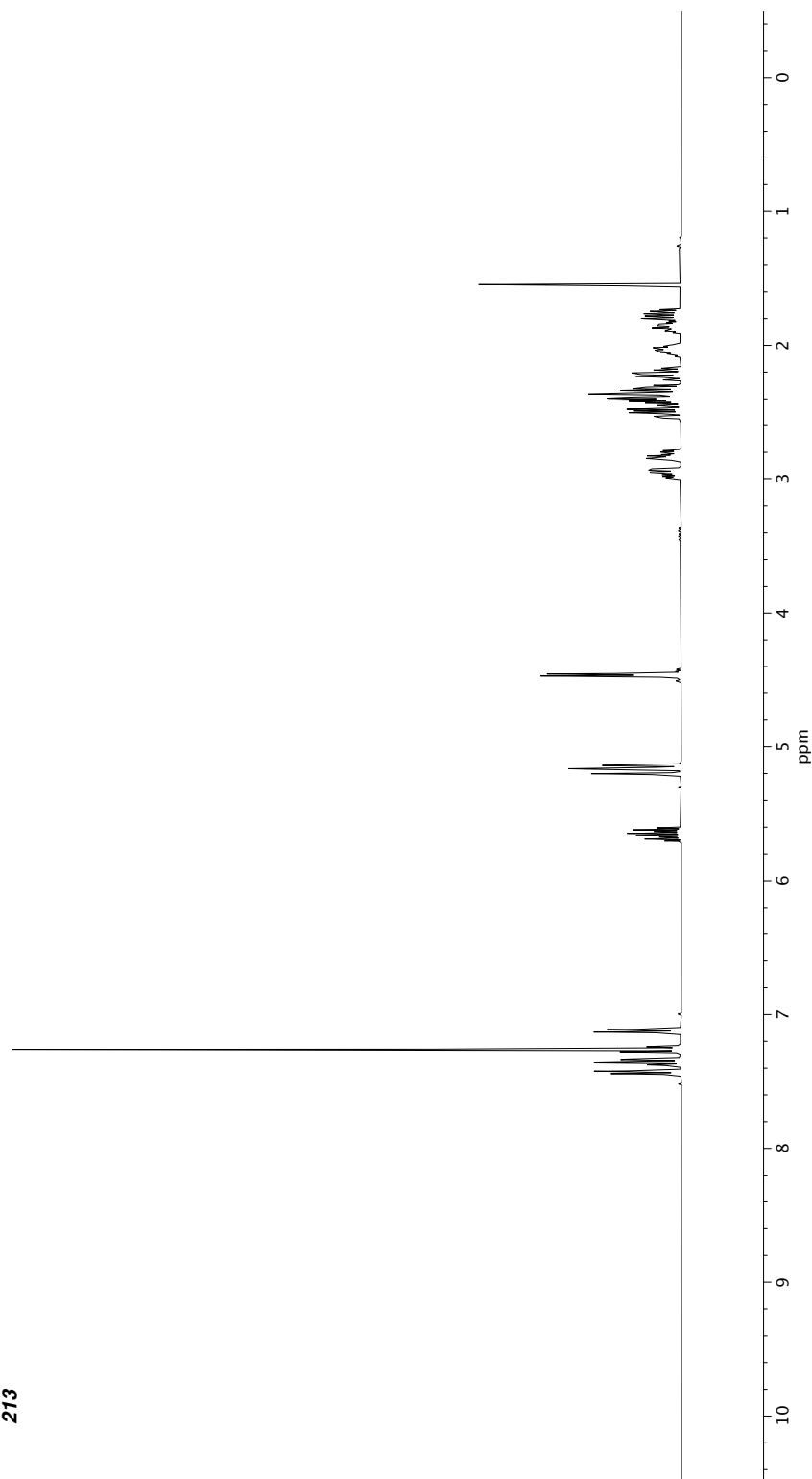
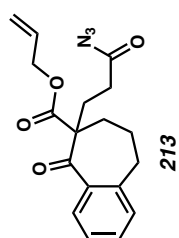


Figure A5.56 ¹H NMR (400 MHz, CDCl₃) of compound **213**.

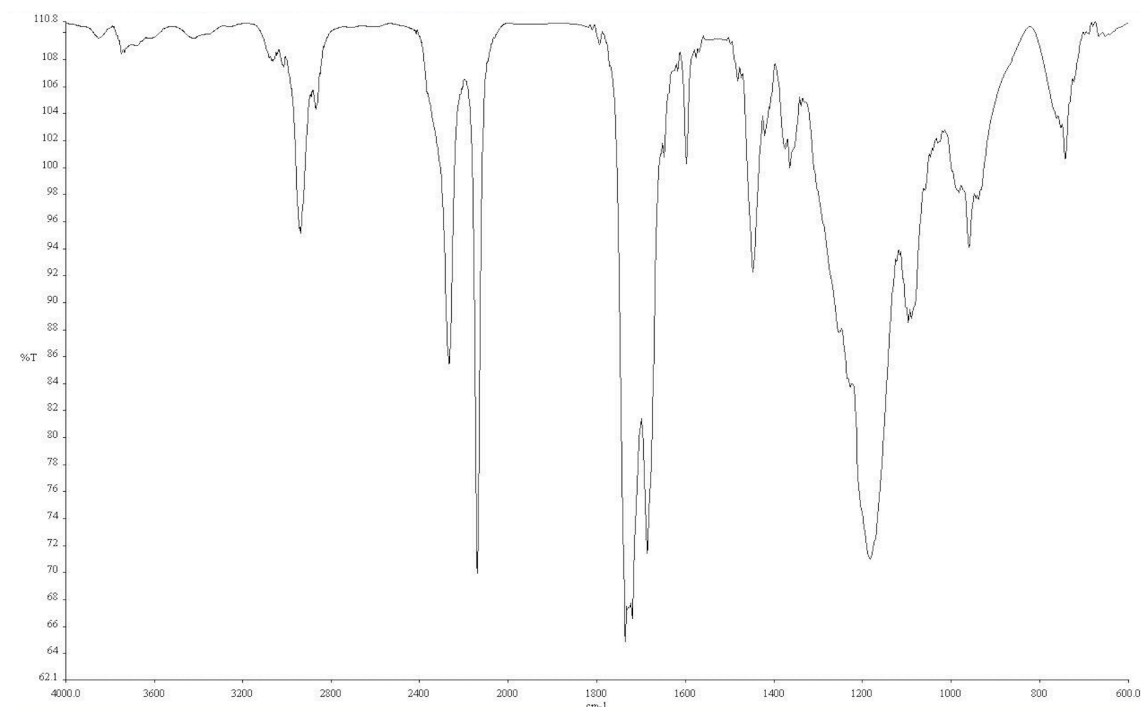


Figure A5.57 Infrared spectrum (Thin Film, NaCl) of compound **213**.

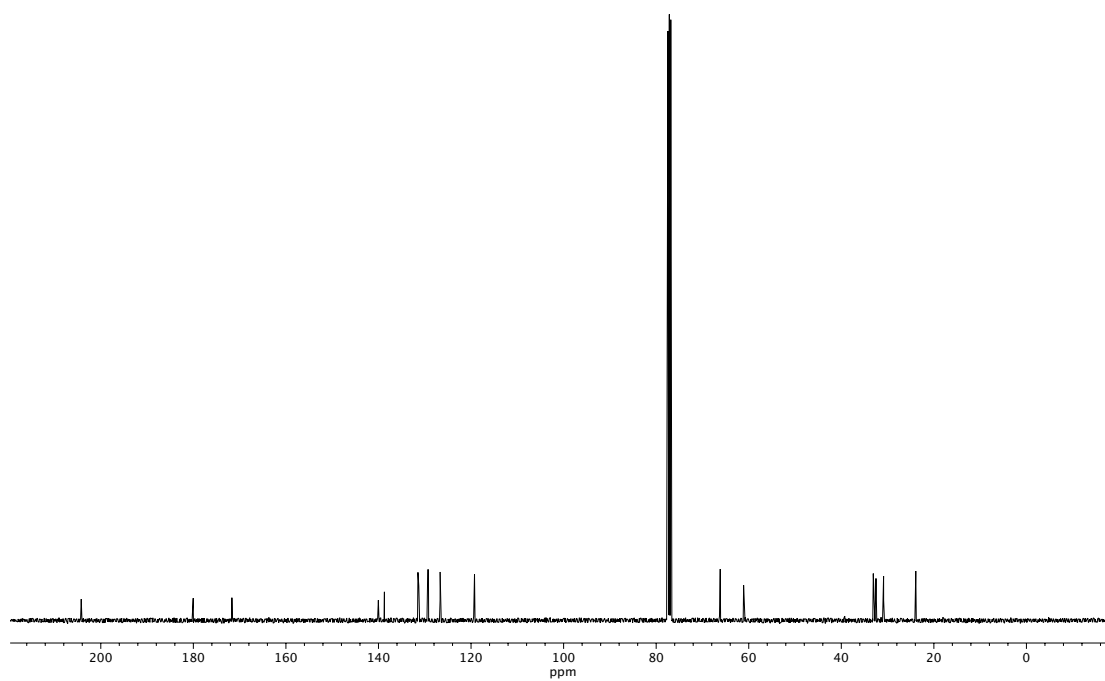


Figure A5.58 ¹³C NMR (100 MHz, CDCl₃) of compound **213**.

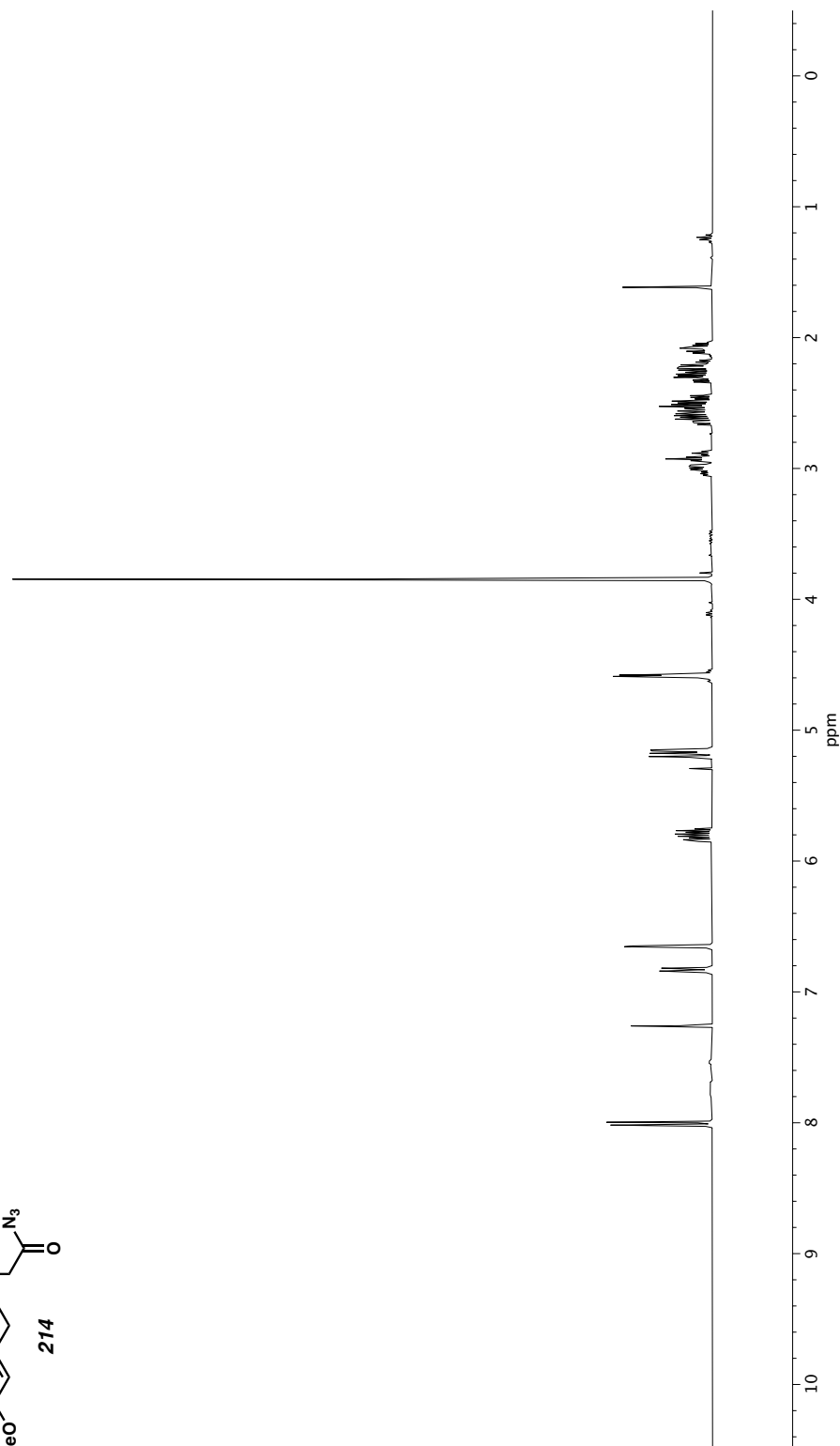
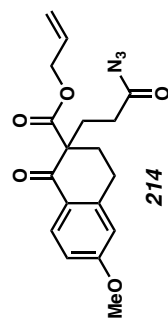


Figure A5.59 ¹H NMR (400 MHz, CDCl₃) of compound **214**.

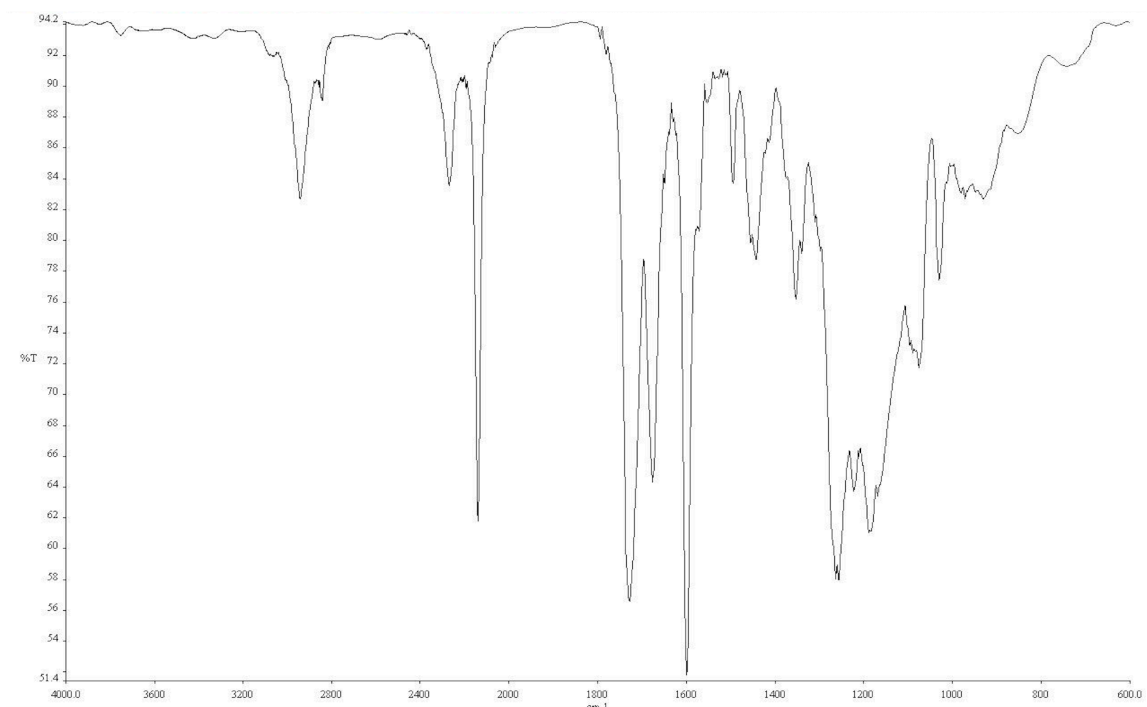


Figure A5.60 Infrared spectrum (Thin Film, NaCl) of compound **214**.

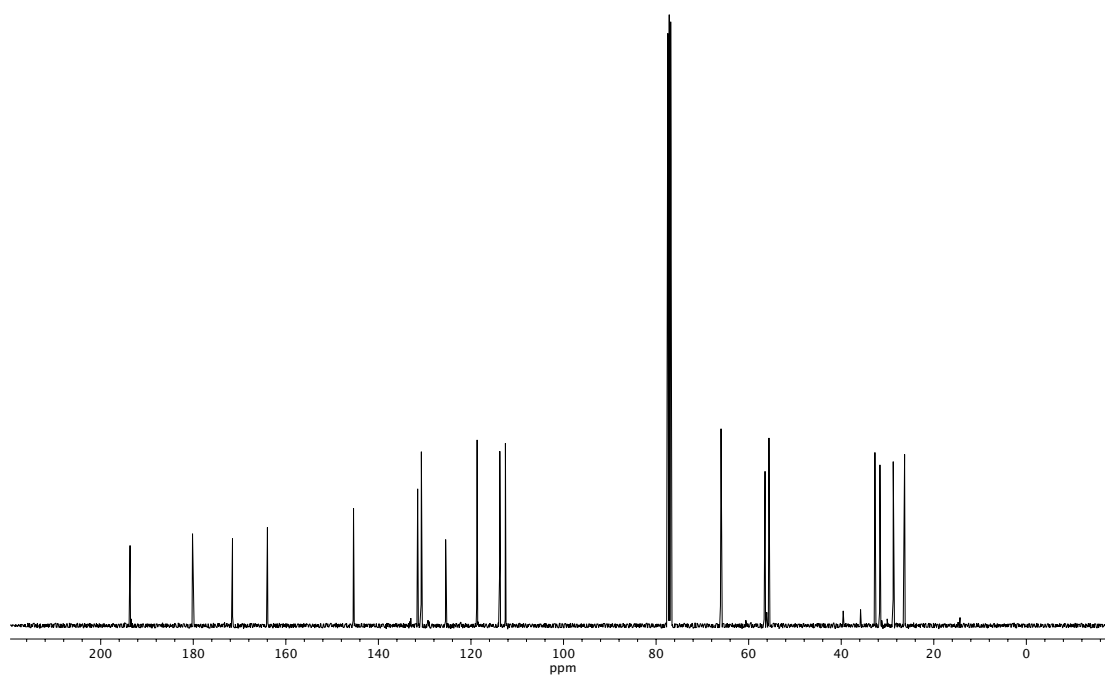


Figure A5.61 ¹³C NMR (100 MHz, CDCl₃) of compound **214**.

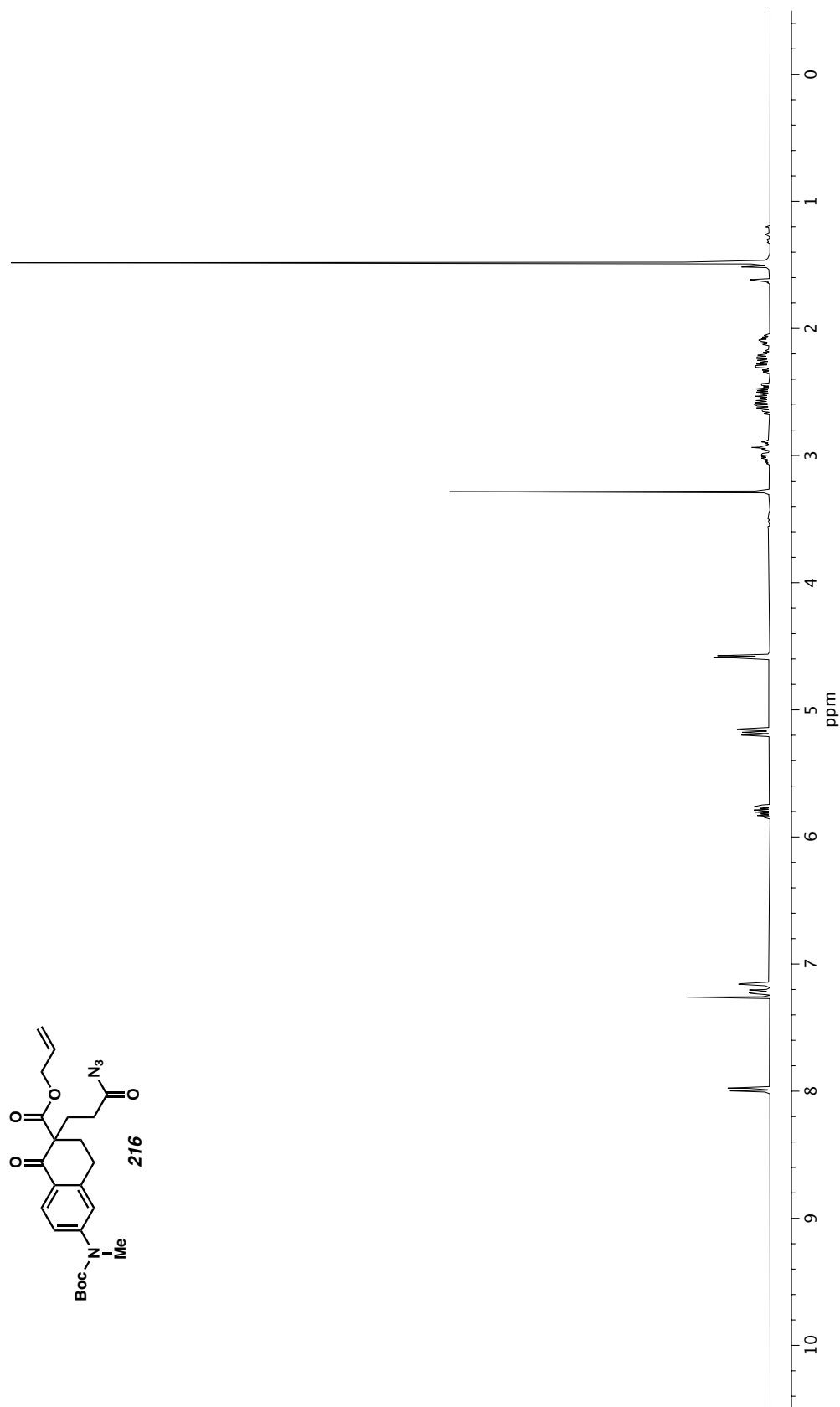


Figure A5.62 ^1H NMR (400 MHz, CDCl_3) of compound **216**.

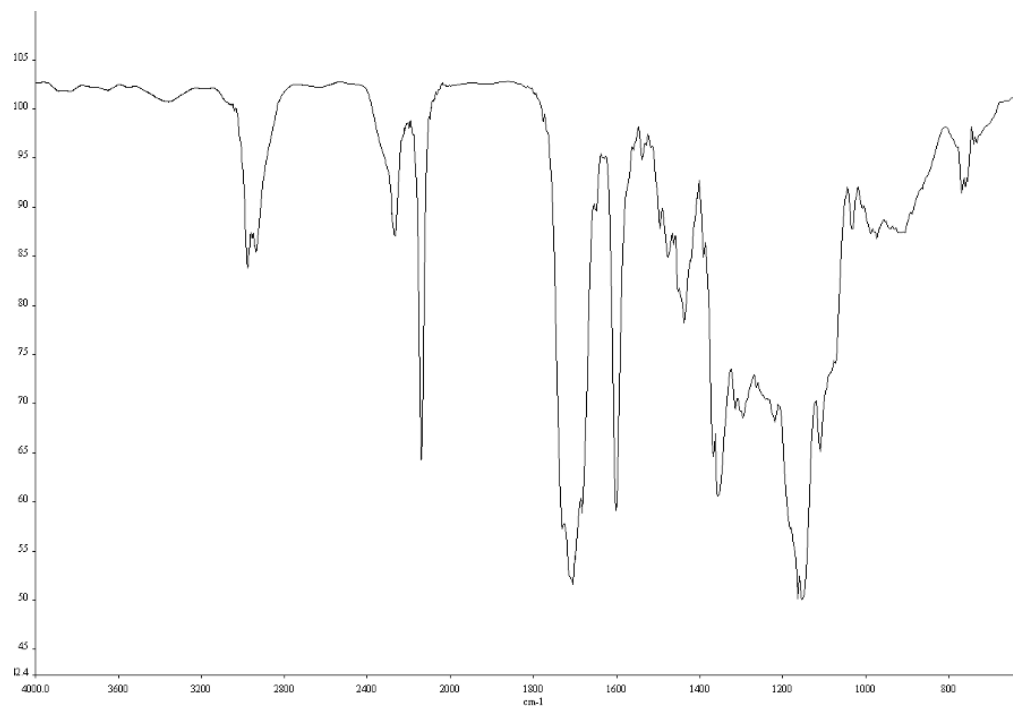


Figure A5.63 Infrared spectrum (Thin Film, NaCl) of compound **216**.

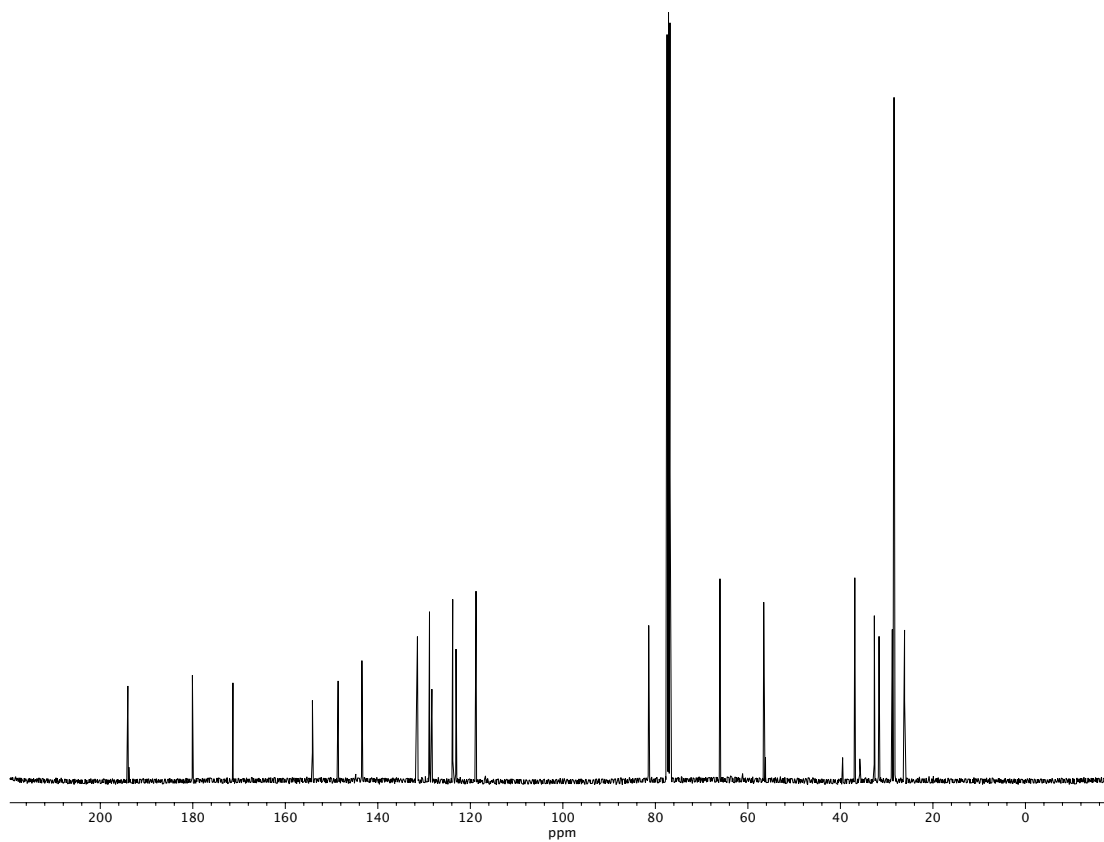


Figure A5.64 ¹³C NMR (100 MHz, CDCl₃) of compound **216**.

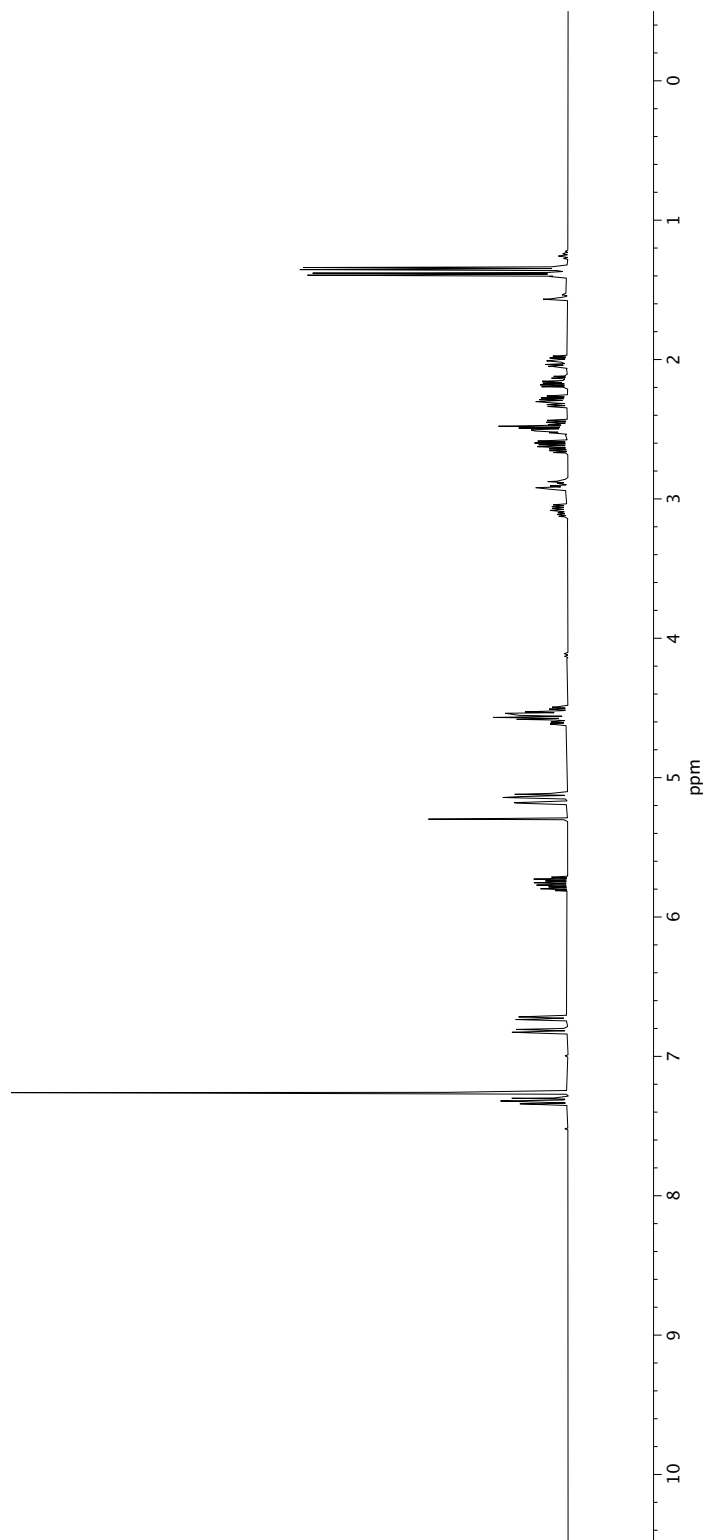
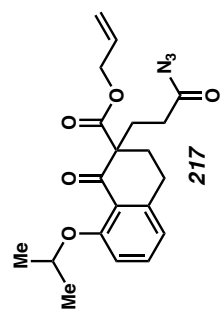


Figure A5.65 ¹H NMR (400 MHz, CDCl₃) of compound **217**.

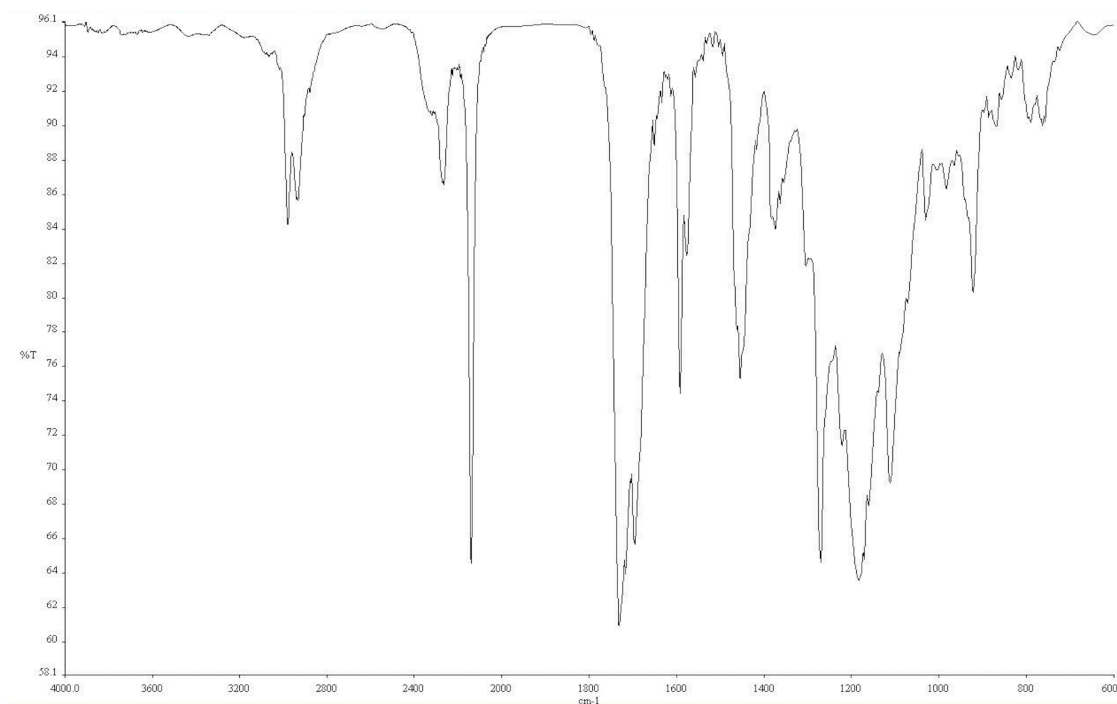


Figure A5.66 Infrared spectrum (Thin Film, NaCl) of compound **217**.

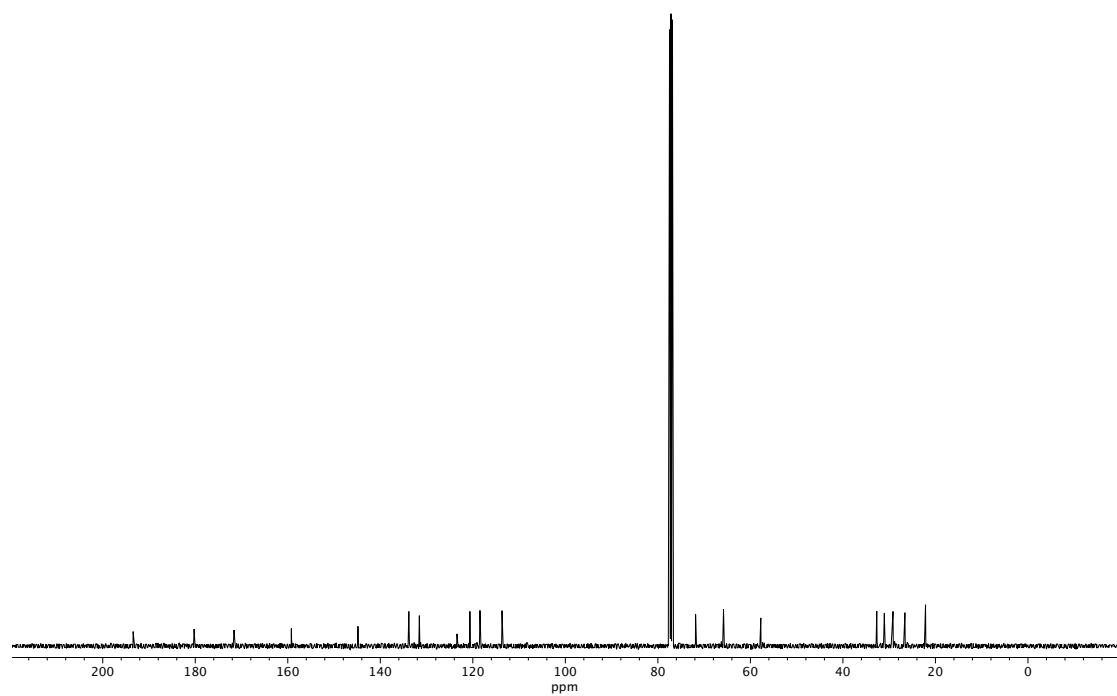


Figure A5.67 ¹³C NMR (100 MHz, CDCl₃) of compound **217**.

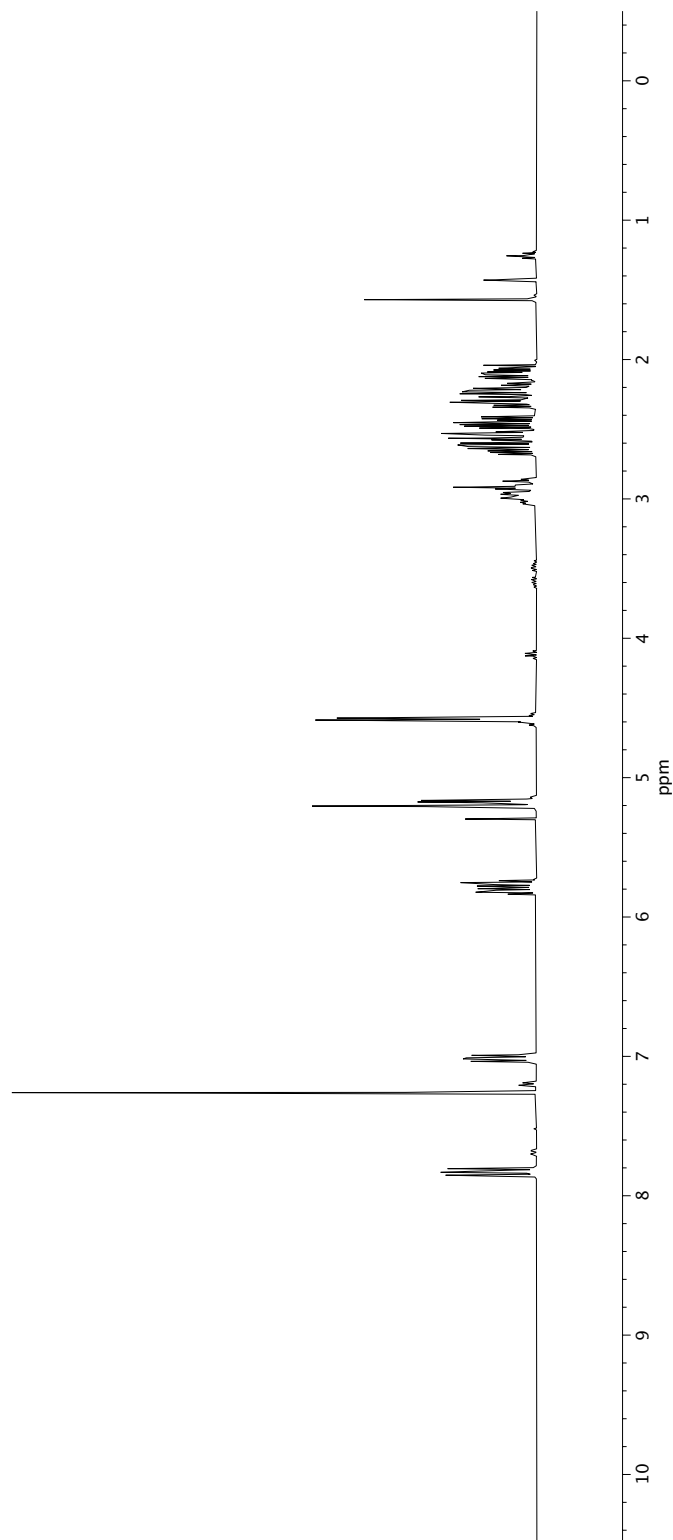
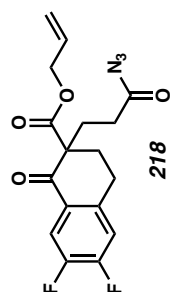


Figure A5.68 ¹H NMR (400 MHz, CDCl₃) of compound **218**.

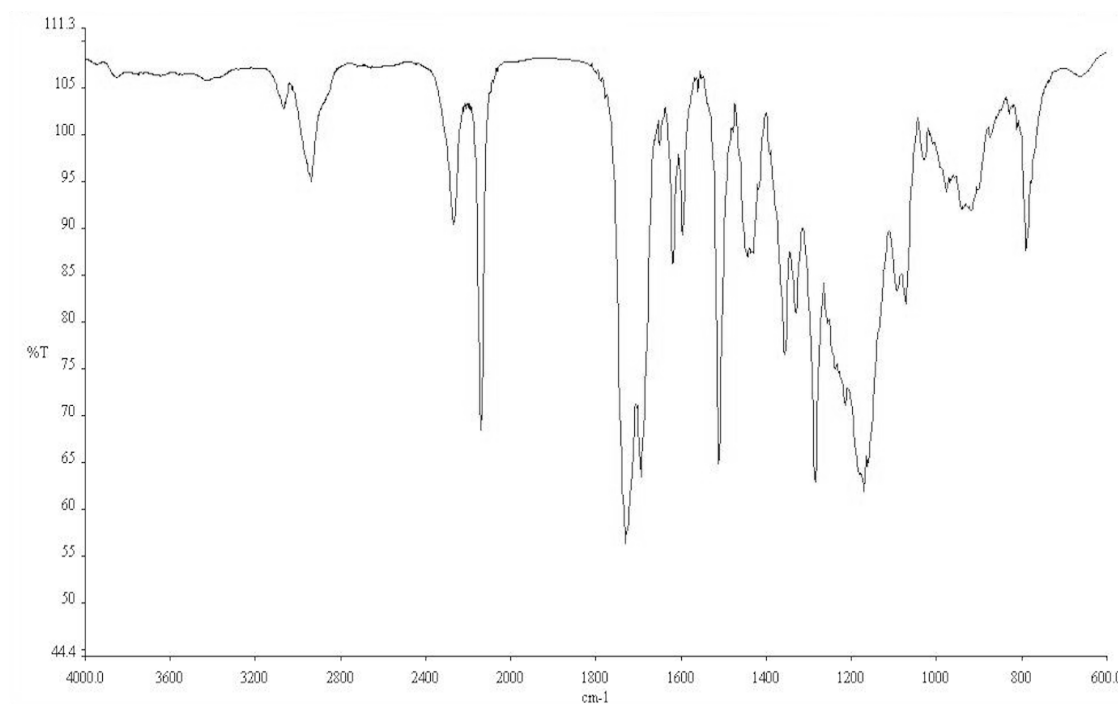


Figure A5.69 Infrared spectrum (Thin Film, NaCl) of compound **218**.

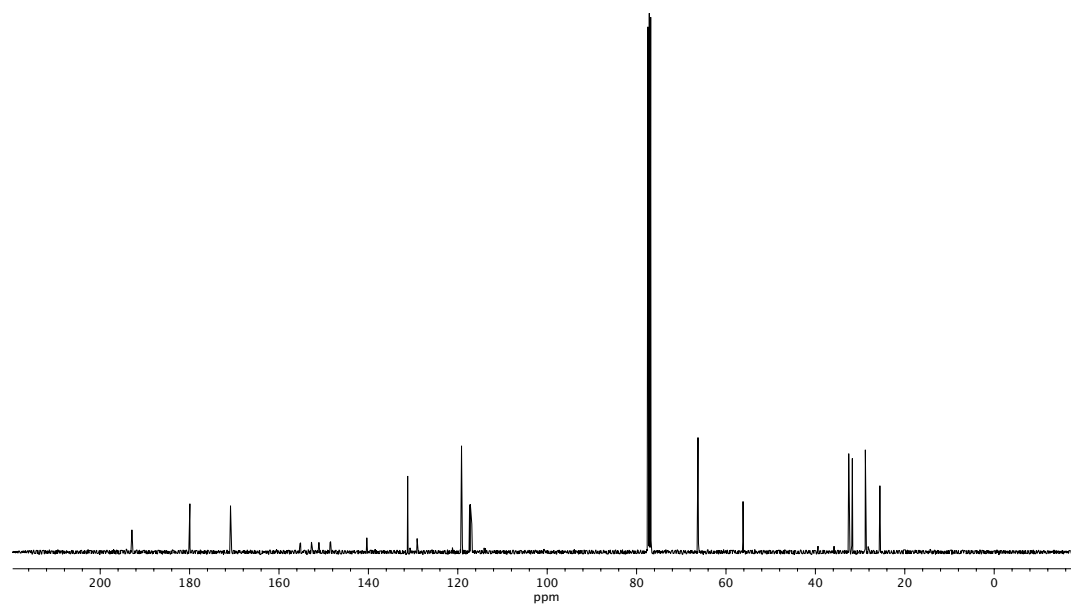


Figure A5.70 ¹³C NMR (100 MHz, CDCl₃) of compound **218**.

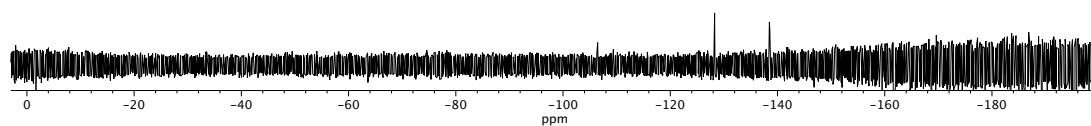


Figure A5.71 ^{19}F NMR (282 MHz, CDCl_3) of compound **218**.

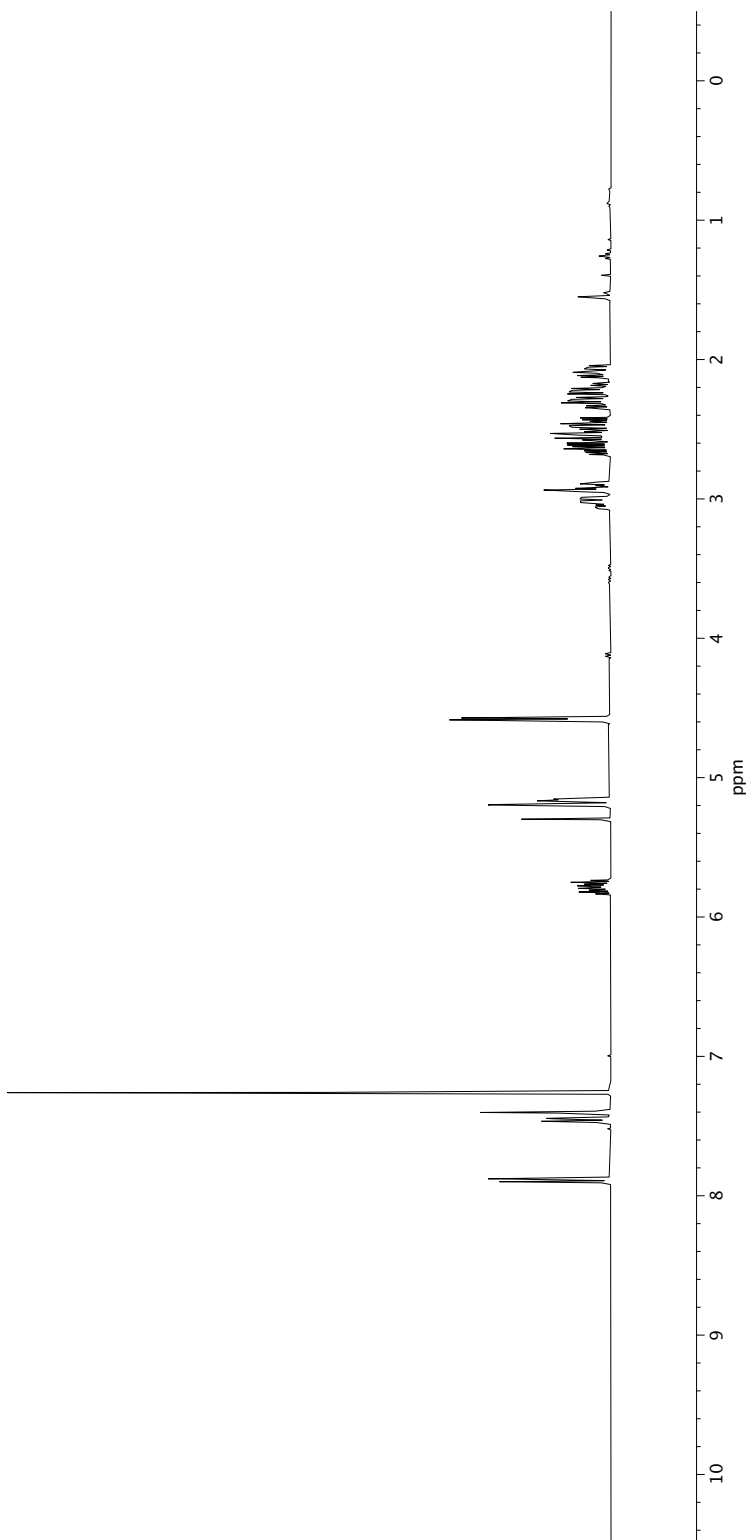
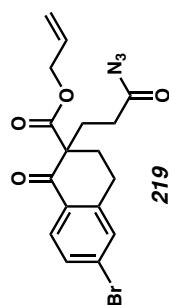


Figure A5.72 ¹H NMR (400 MHz, CDCl₃) of compound **219**.

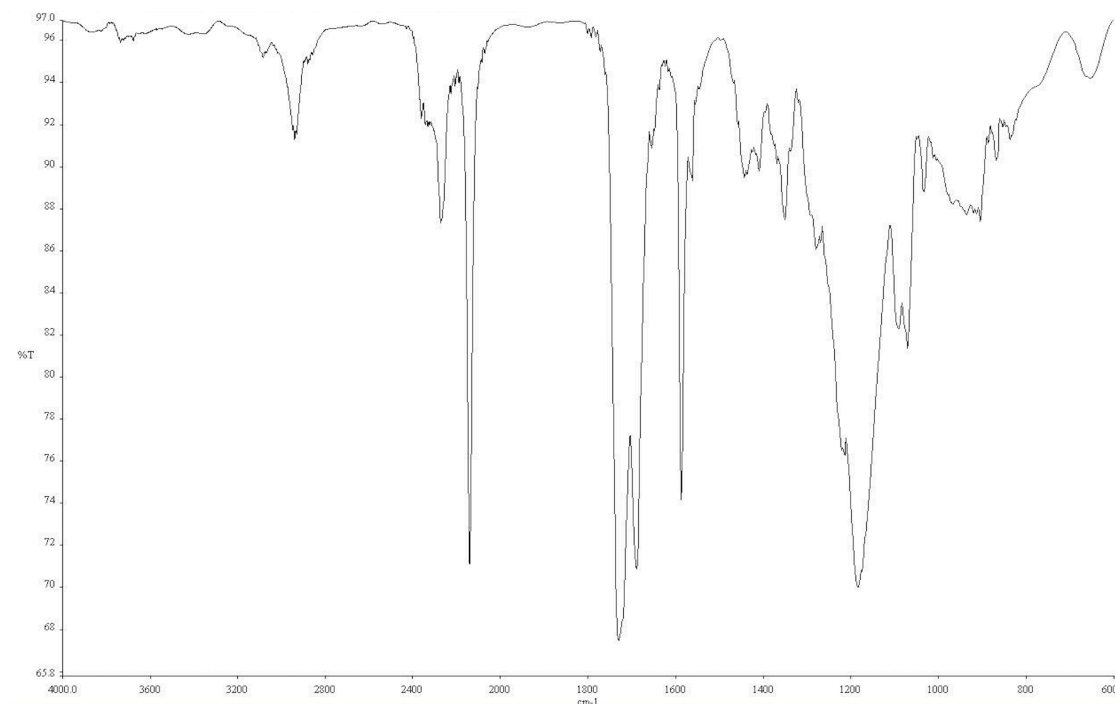


Figure A5.73 Infrared spectrum (Thin Film, NaCl) of compound **219**.

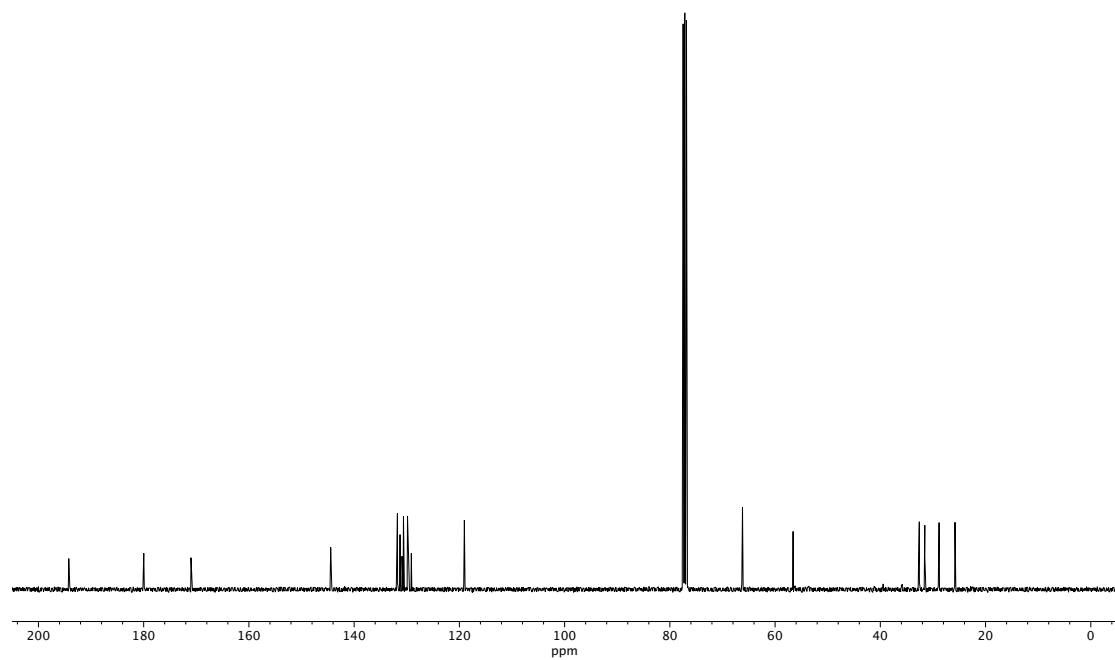


Figure A5.74 ¹³C NMR (100 MHz, CDCl₃) of compound **219**.

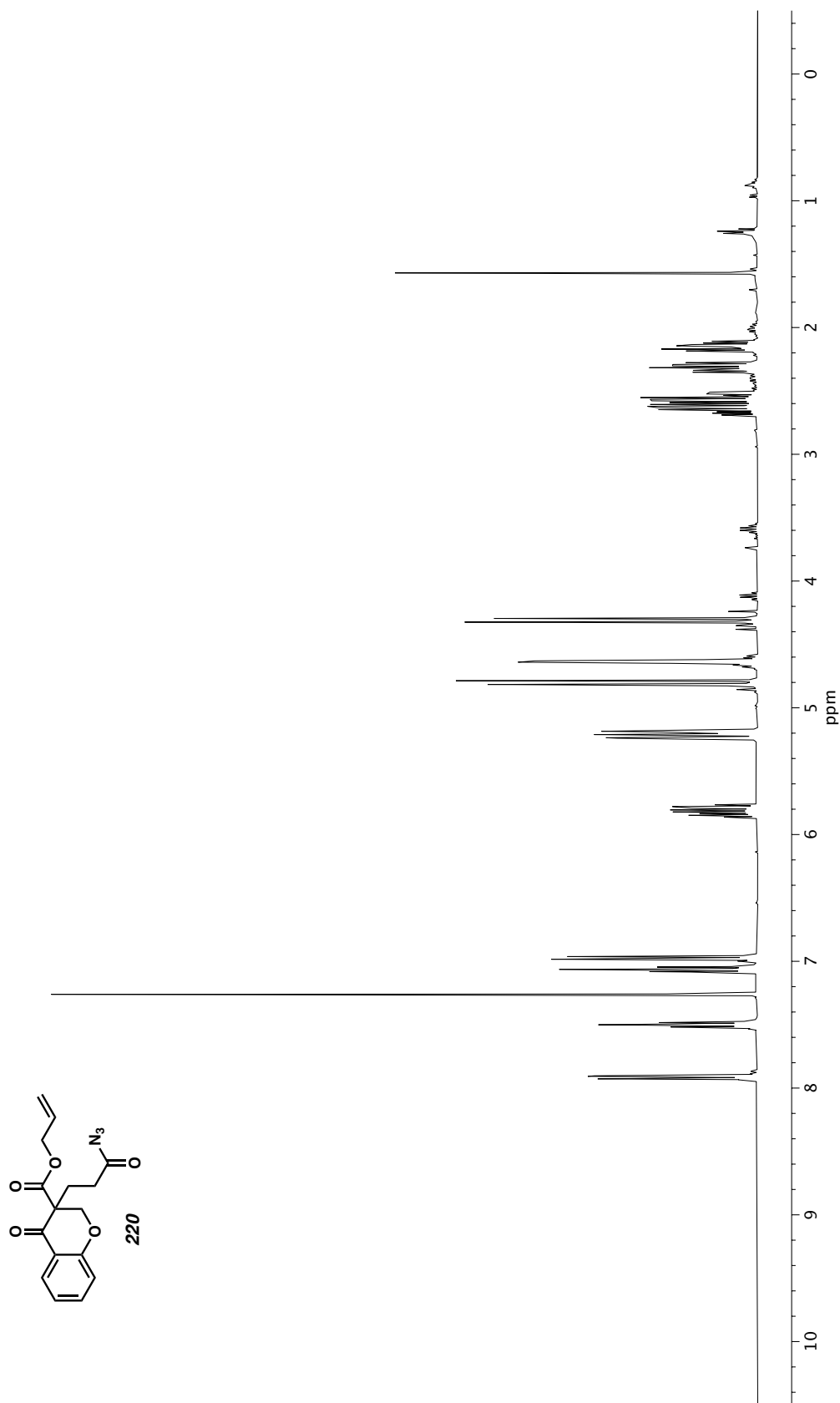


Figure A5.75 ¹H NMR (400 MHz, CDCl₃) of compound **220**.

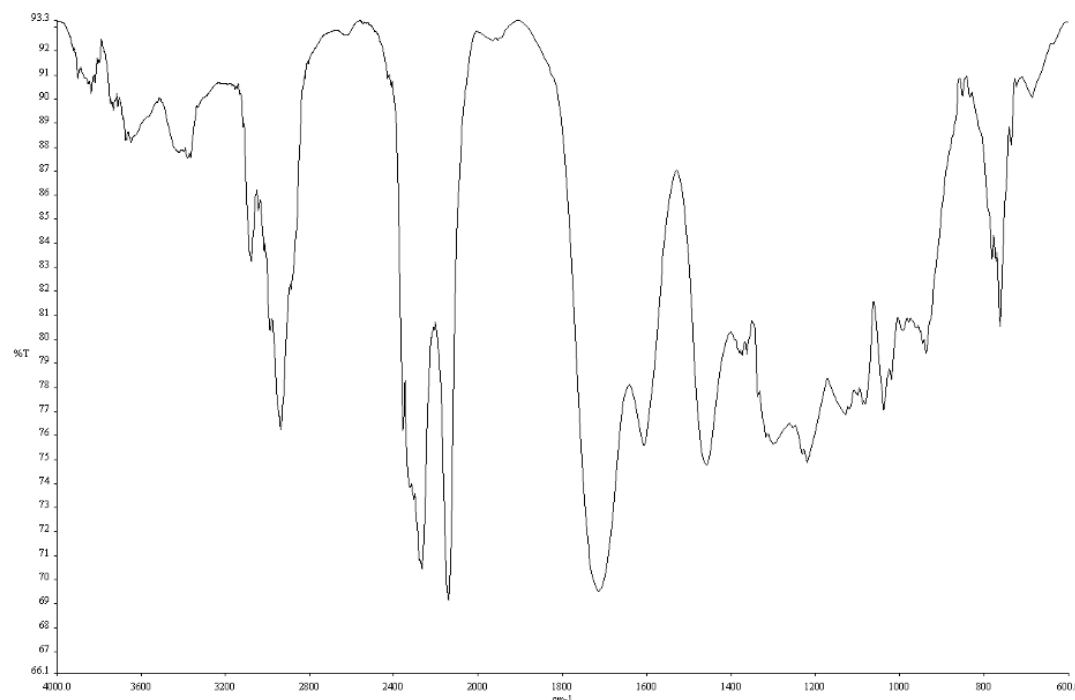


Figure A5.76 Infrared spectrum (Thin Film, NaCl) of compound **220**.

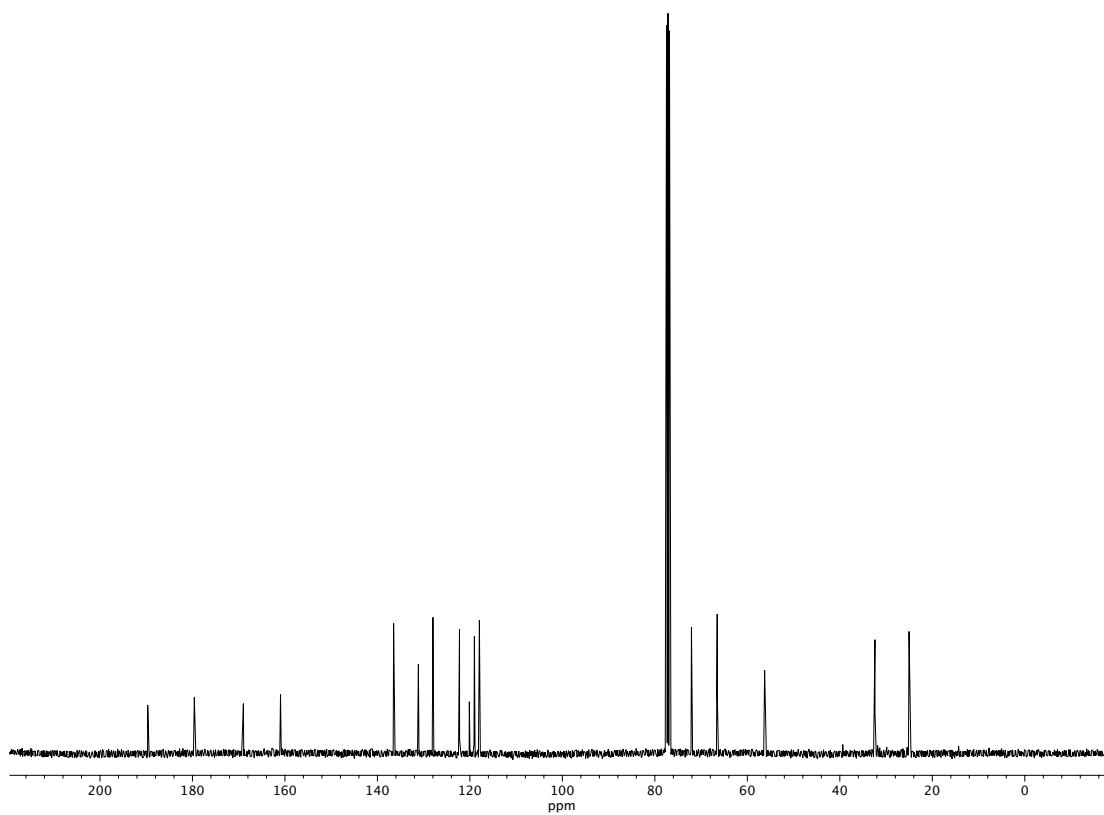


Figure A5.77 ¹³C NMR (100 MHz, CDCl₃) of compound **220**.

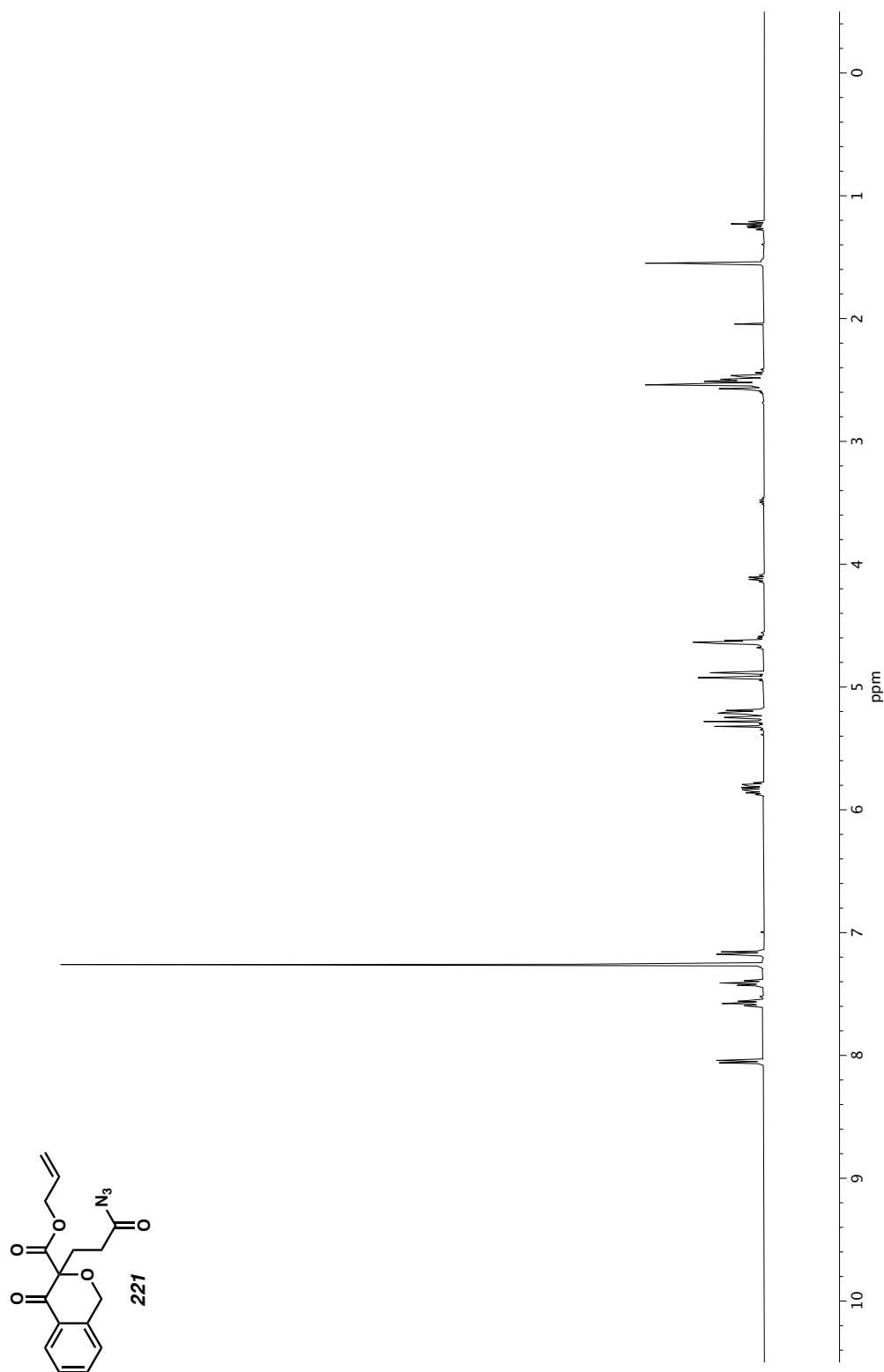


Figure A5.78 ¹H NMR (400 MHz, CDCl₃) of compound **221**.

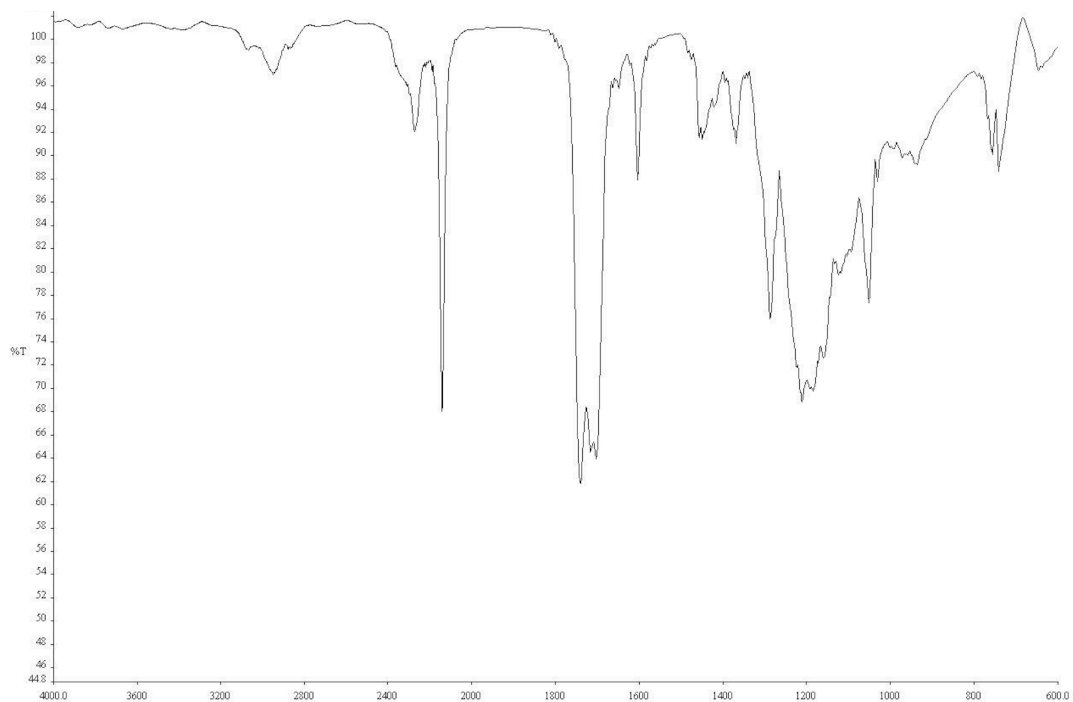


Figure A5.79 Infrared spectrum (Thin Film, NaCl) of compound **221**.

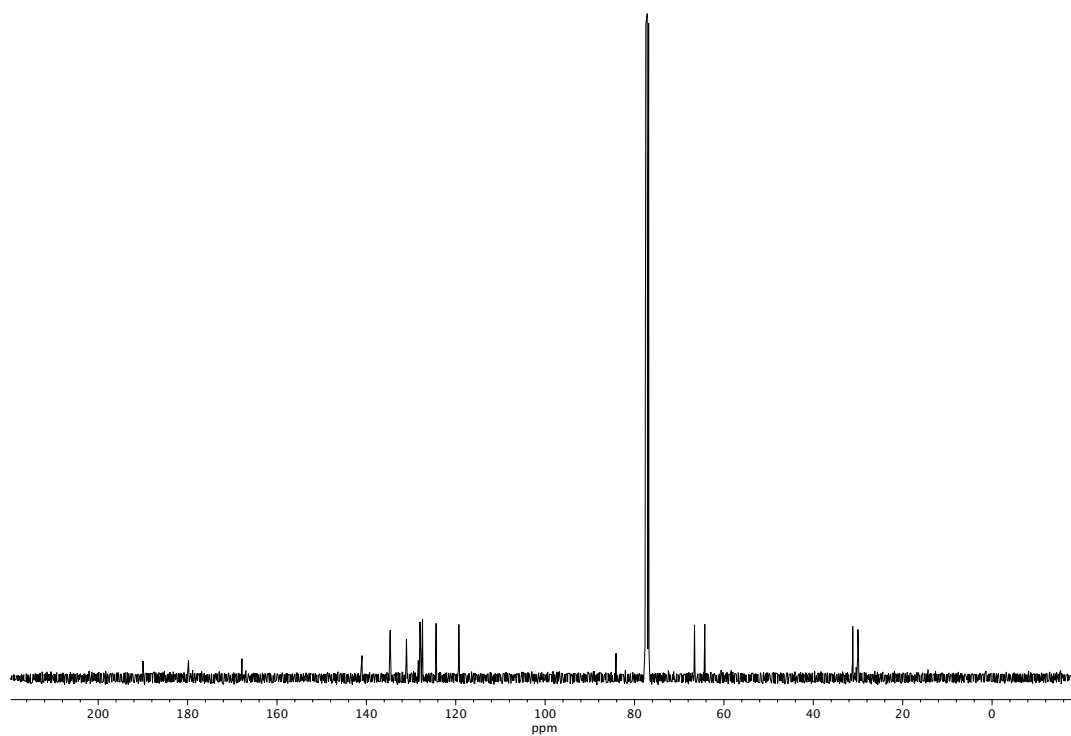


Figure A5.80 ¹³C NMR (100 MHz, CDCl₃) of compound **221**.

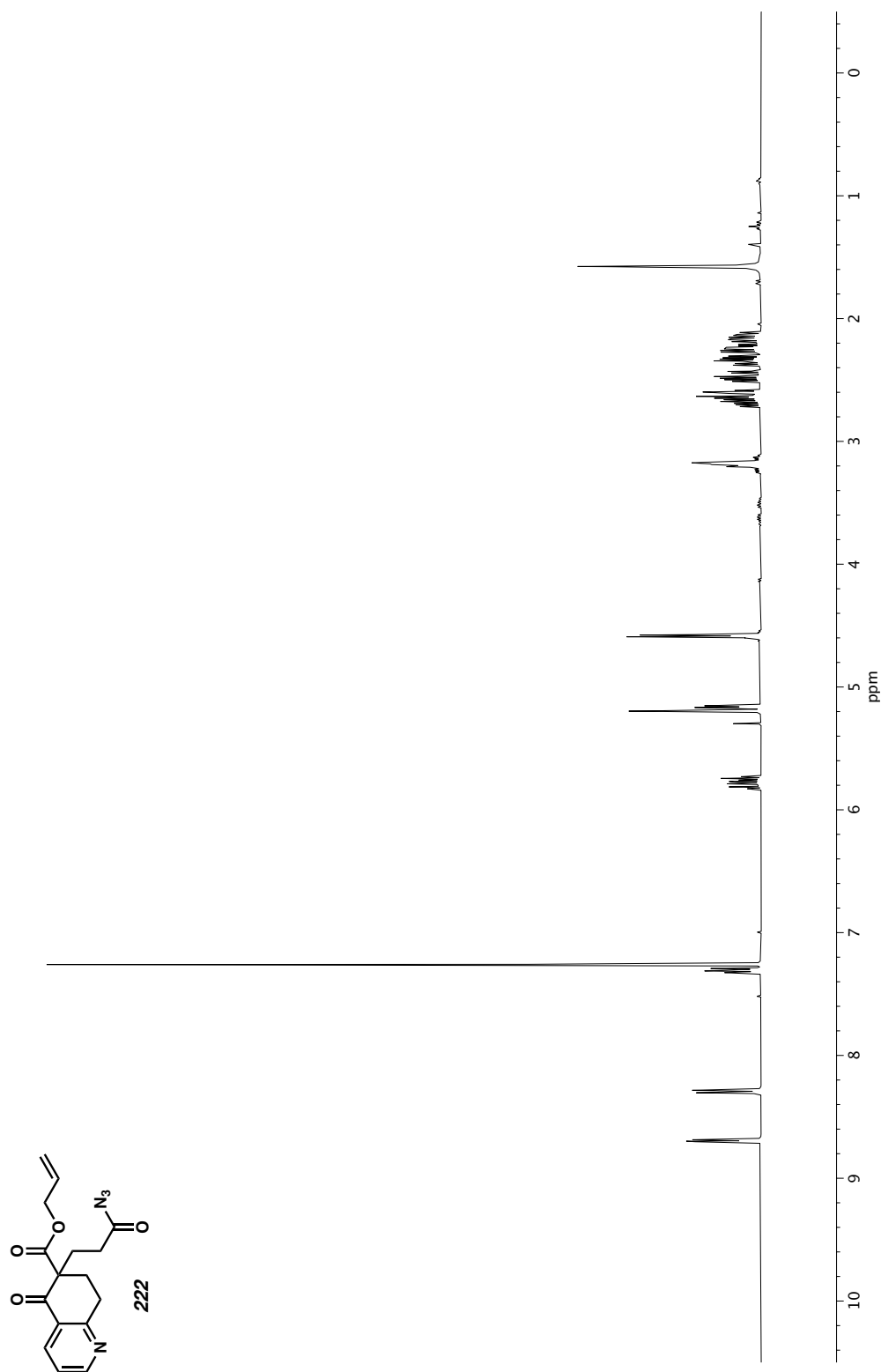


Figure A5.81 ¹H NMR (400 MHz, CDCl₃) of compound 222.

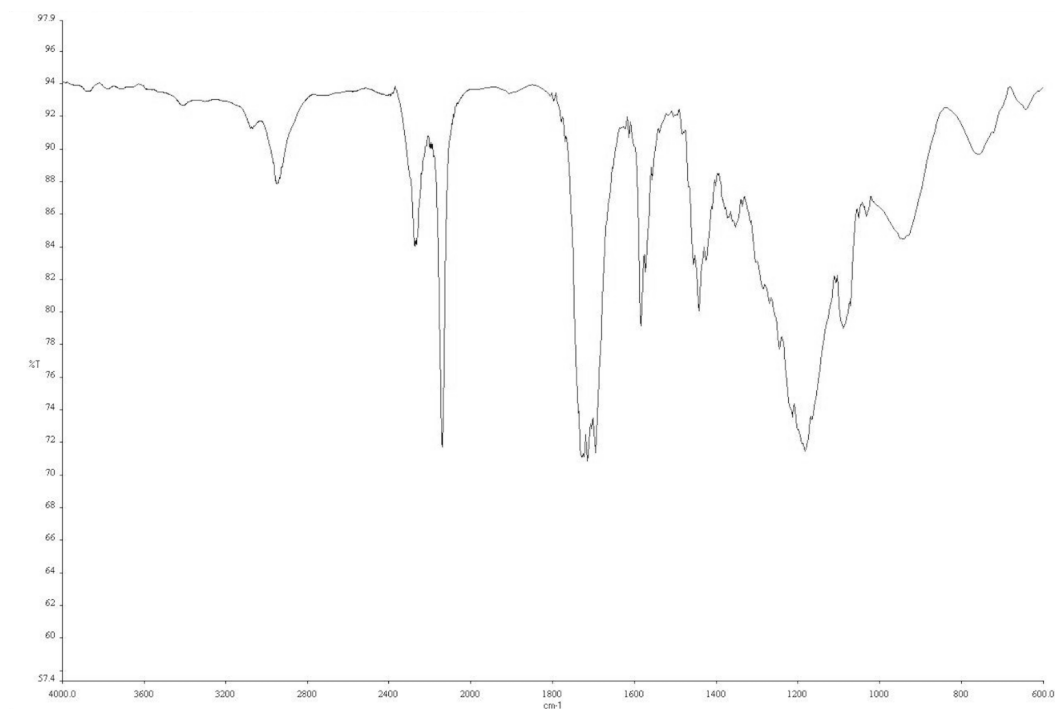


Figure A5.82 Infrared spectrum (Thin Film, NaCl) of compound **222**.

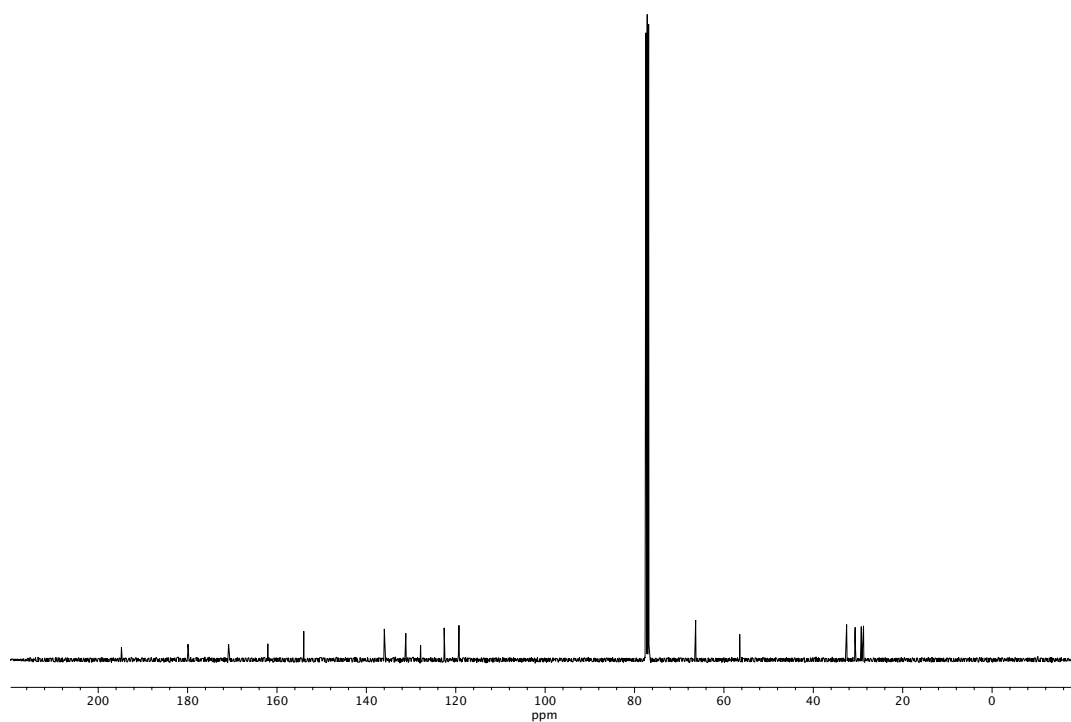


Figure A5.83 ¹³C NMR (100 MHz, CDCl₃) of compound **222**.

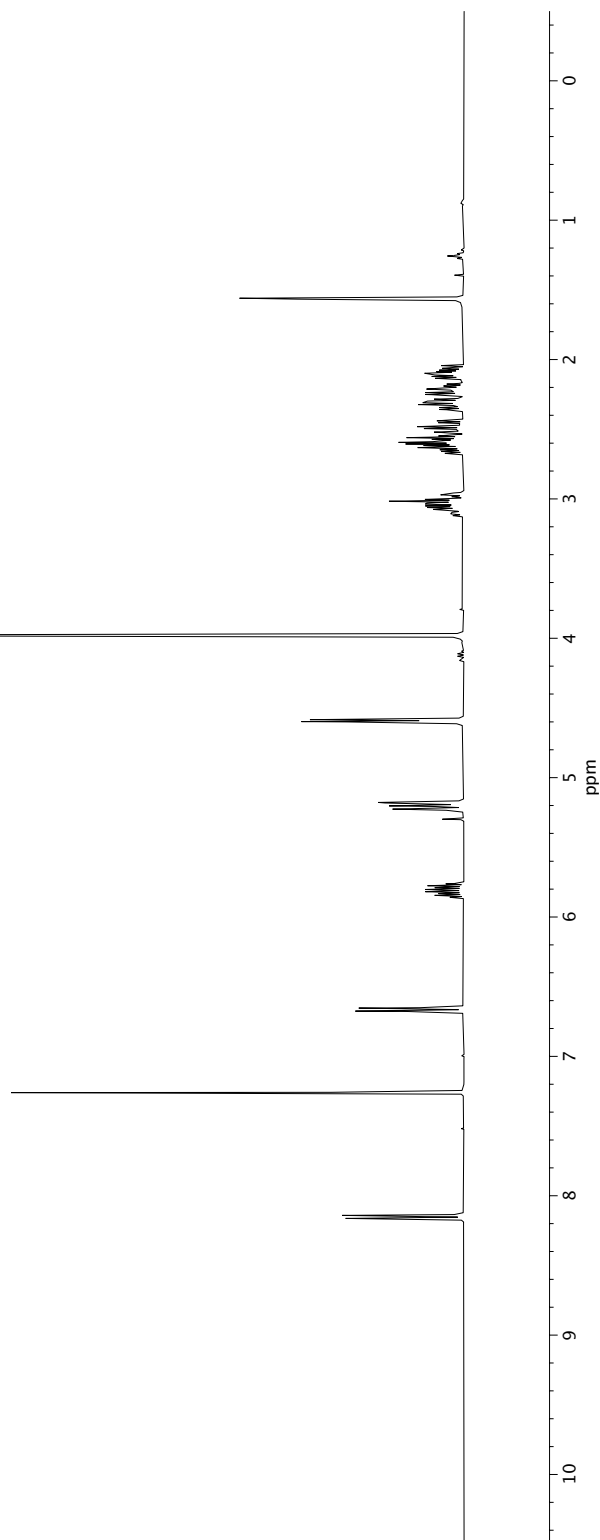
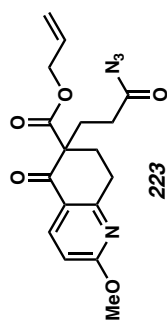


Figure A5.84 ¹H NMR (400 MHz, CDCl₃) of compound **223**.

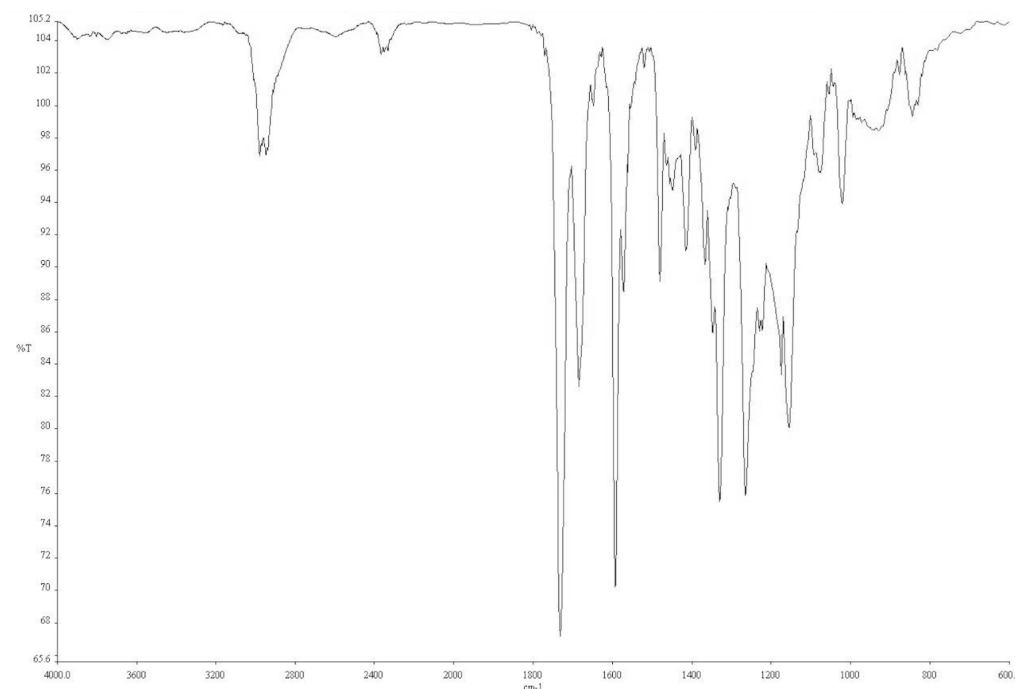


Figure A5.85 Infrared spectrum (Thin Film, NaCl) of compound **223**.

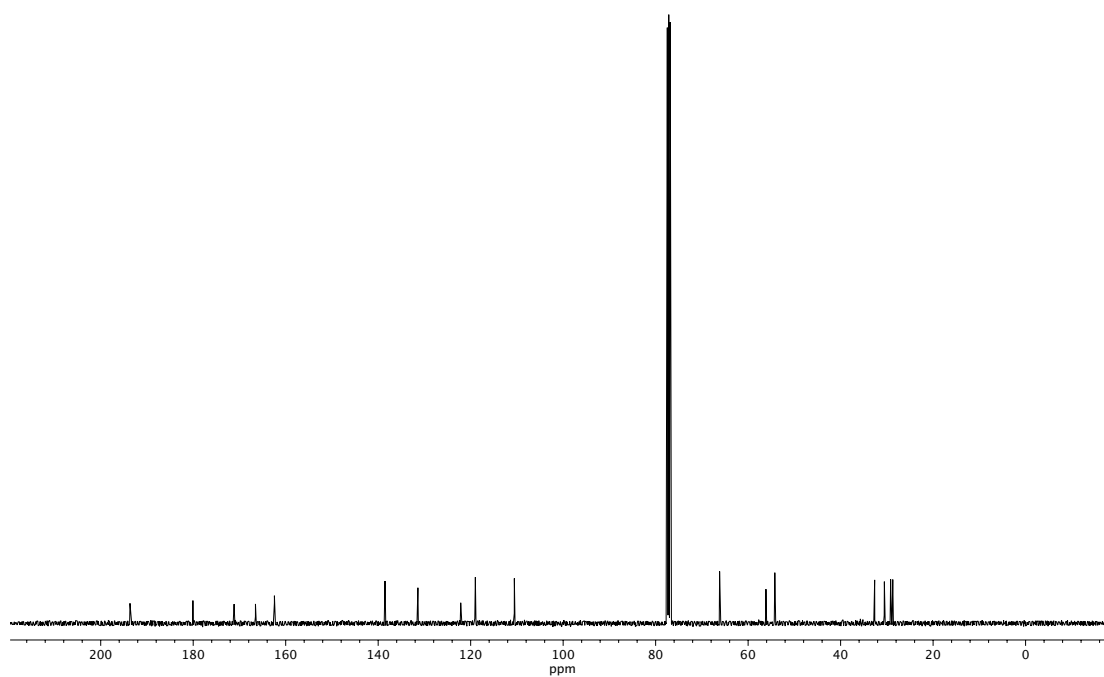


Figure A5.86 ¹³C NMR (100 MHz, CDCl₃) of compound **223**.

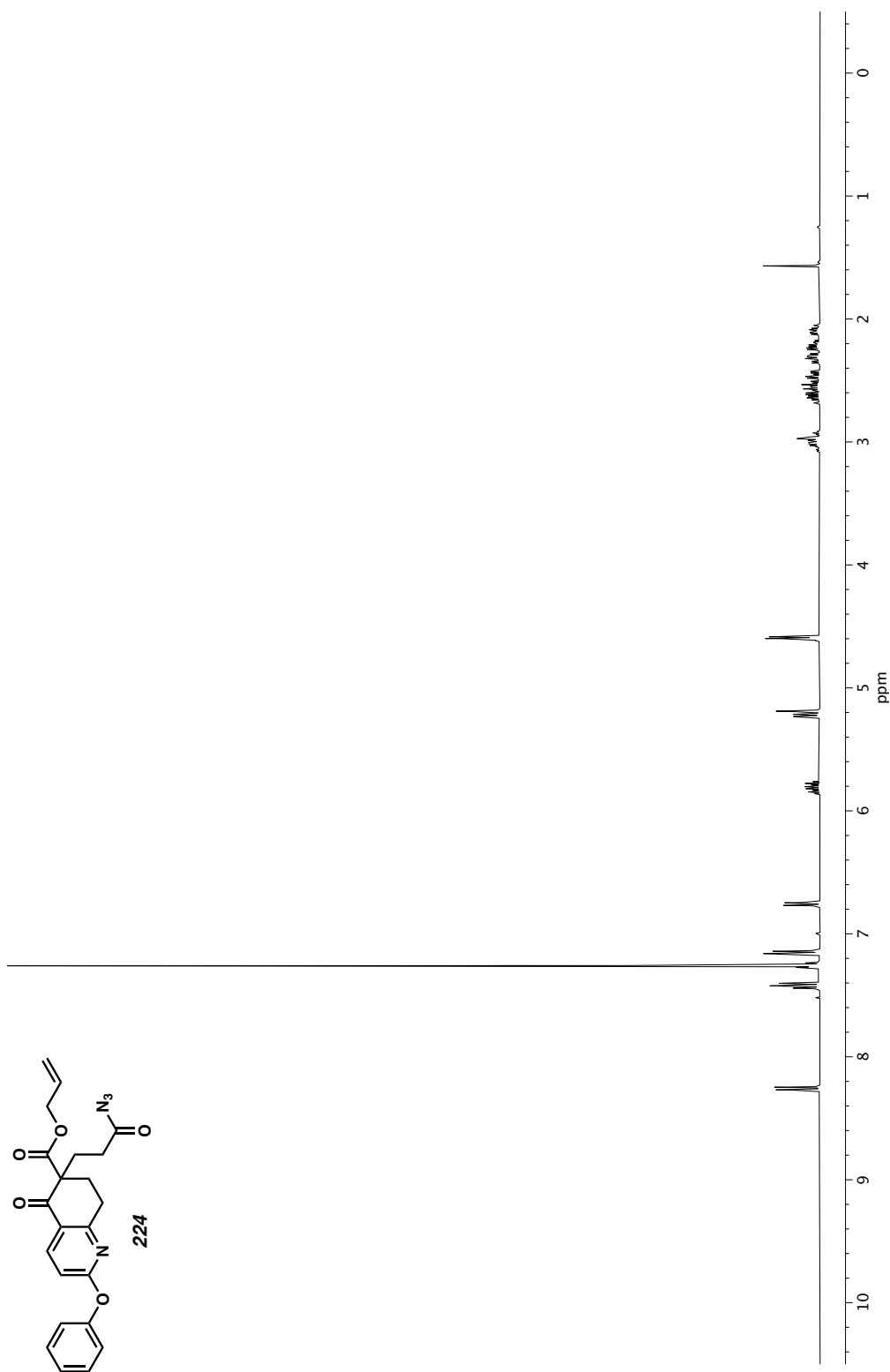


Figure A5.87 ^1H NMR (400 MHz, CDCl_3) of compound 224.

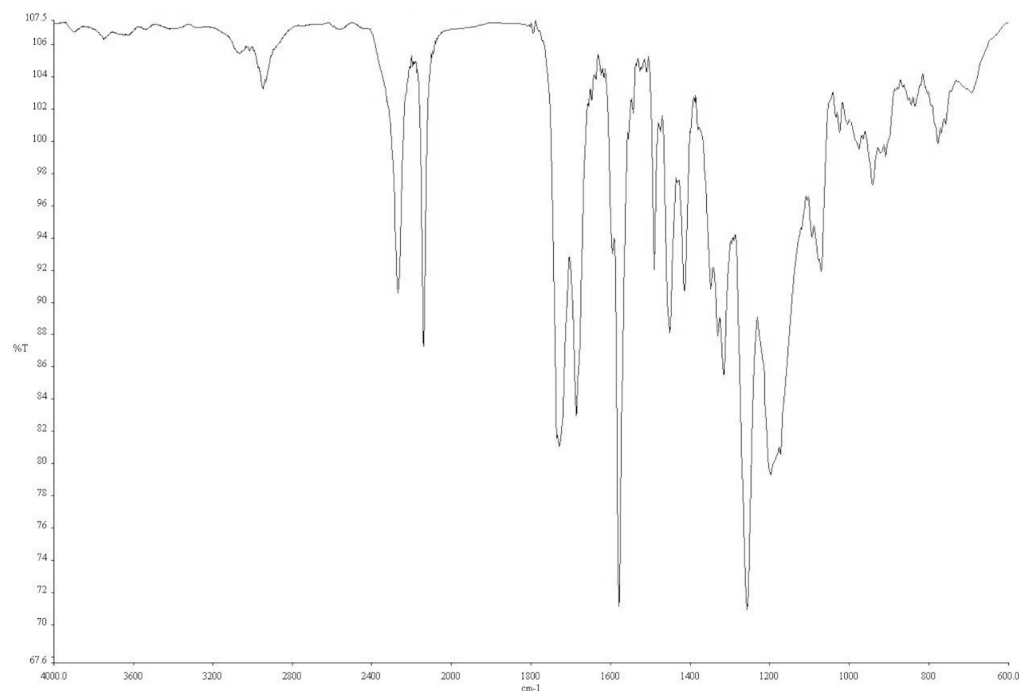


Figure A5.88 Infrared spectrum (Thin Film, NaCl) of compound **224**.

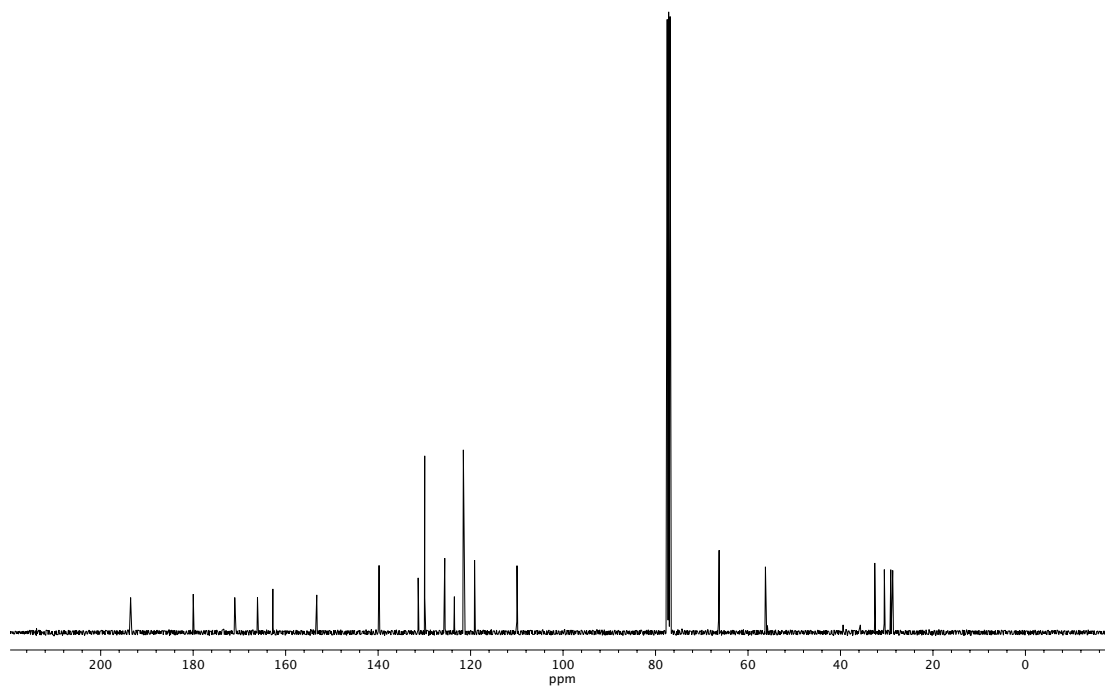


Figure A5.89 ¹³C NMR (100 MHz, CDCl₃) of compound **224**.

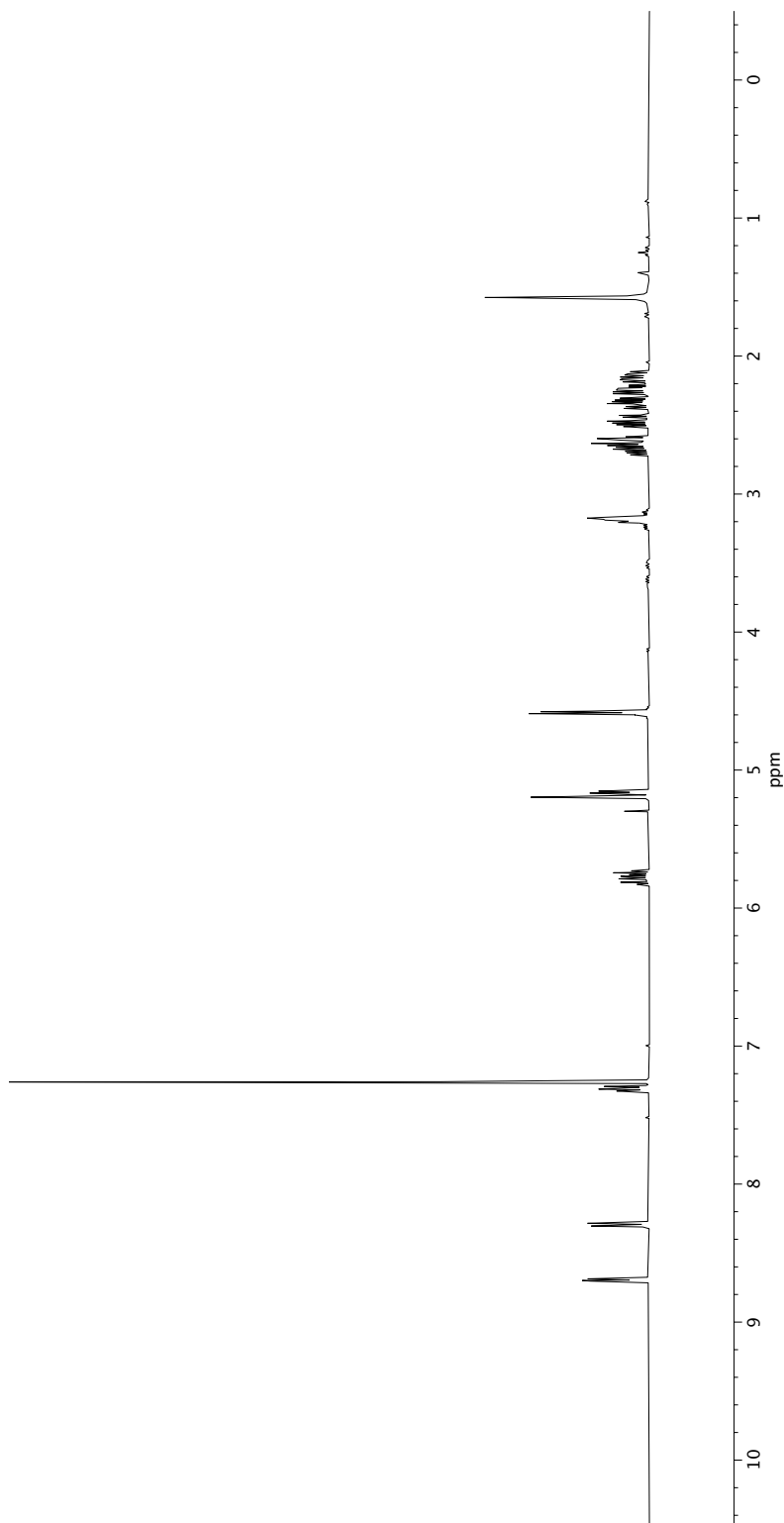
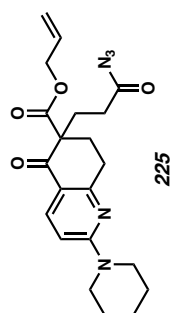


Figure A5.90 ¹H NMR (400 MHz, CDCl₃) of compound 225.

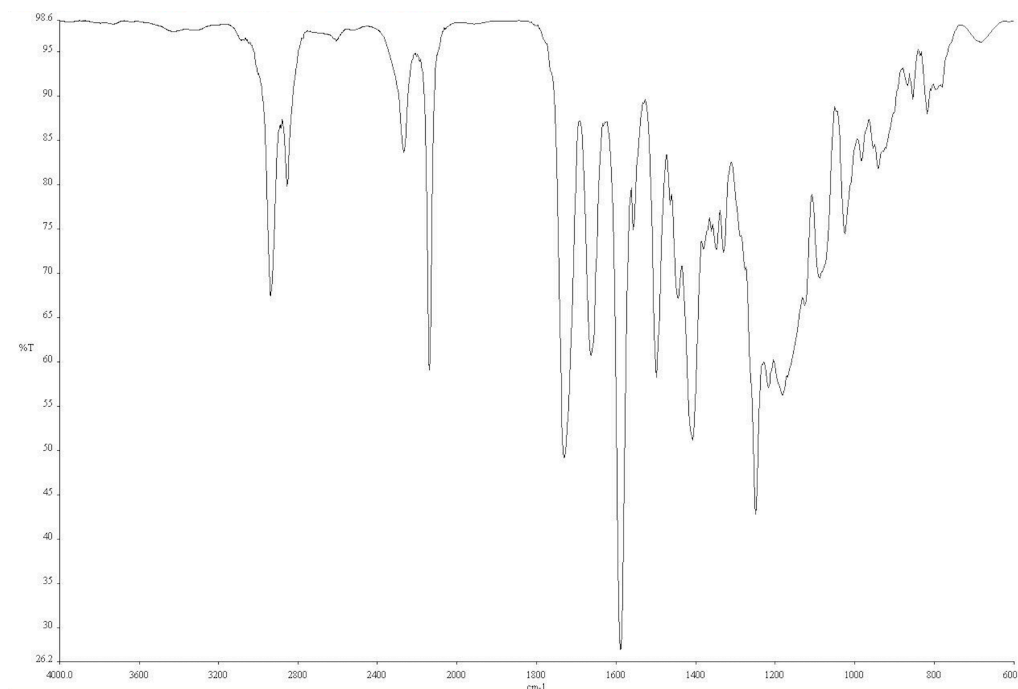


Figure A5.91 Infrared spectrum (Thin Film, NaCl) of compound **225**.

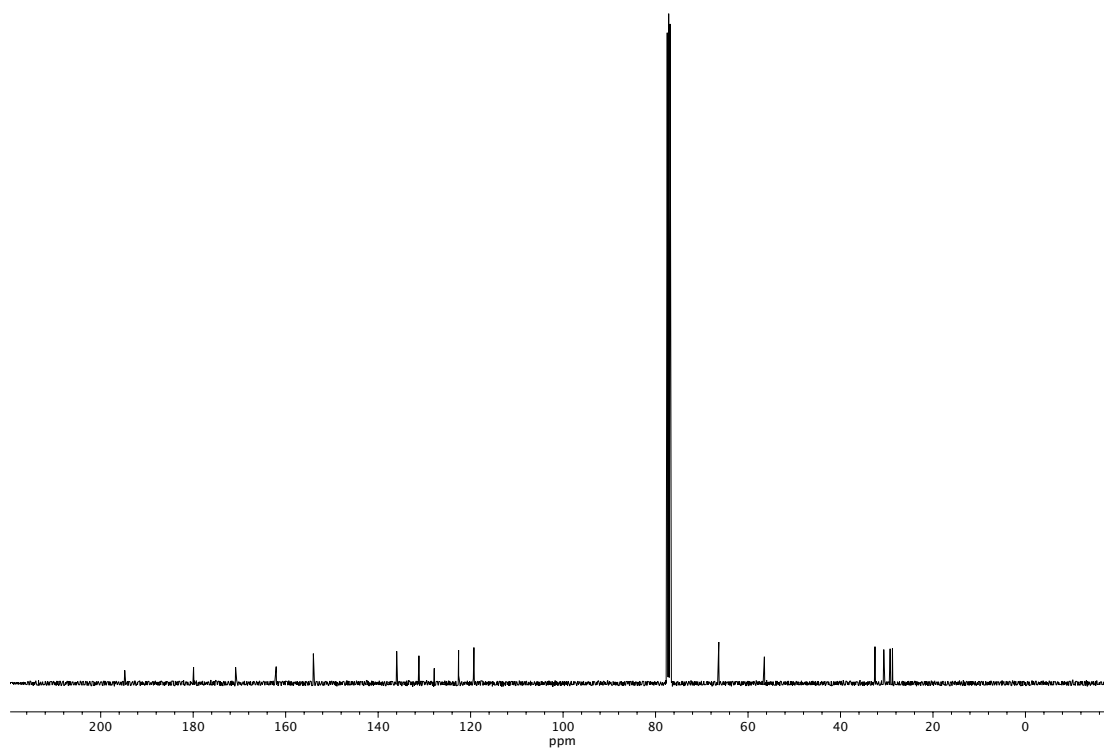


Figure A5.92 ¹³C NMR (100 MHz, CDCl₃) of compound **225**.

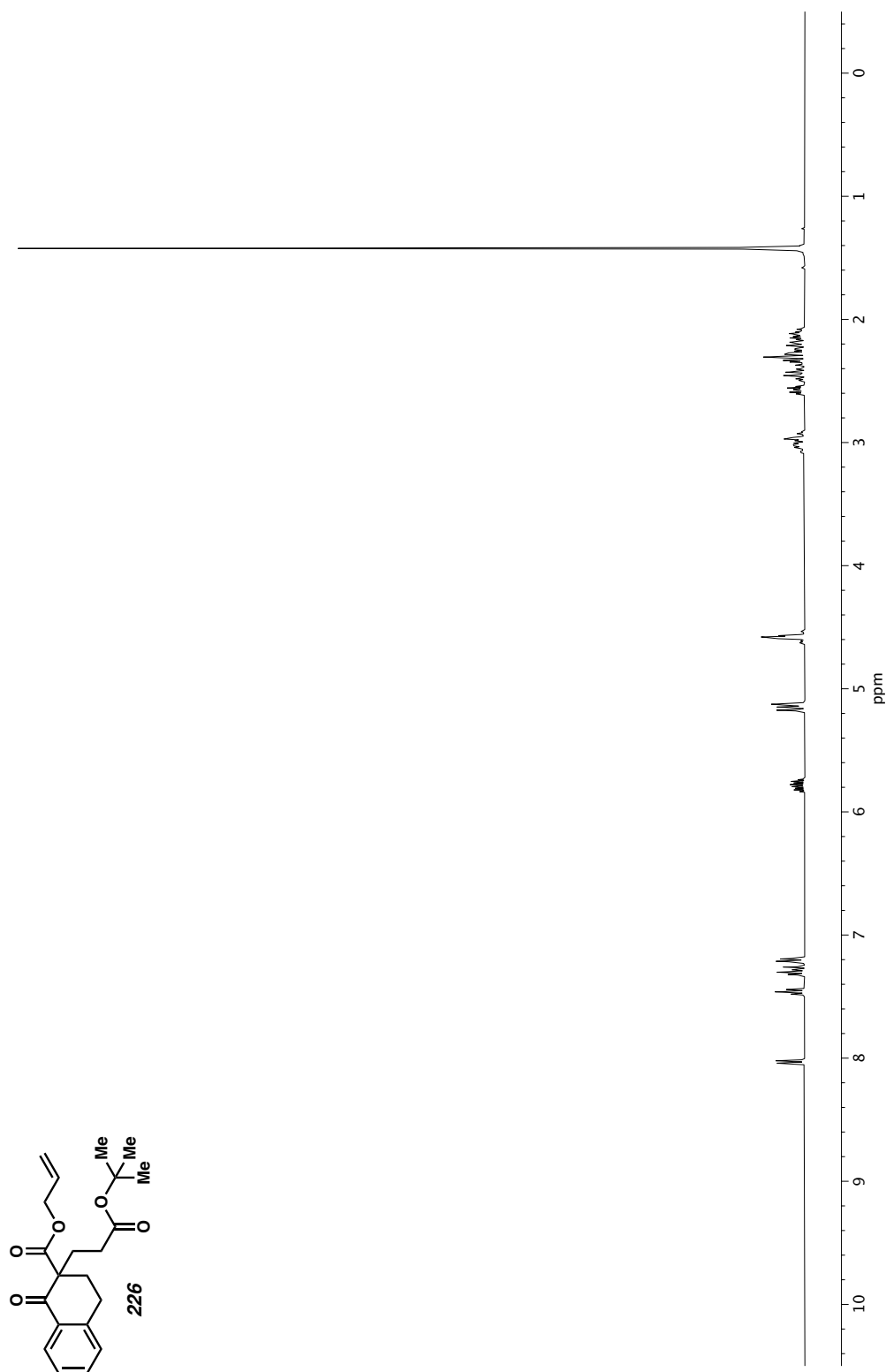


Figure A5.93 ¹H NMR (400 MHz, CDCl₃) of compound 226.

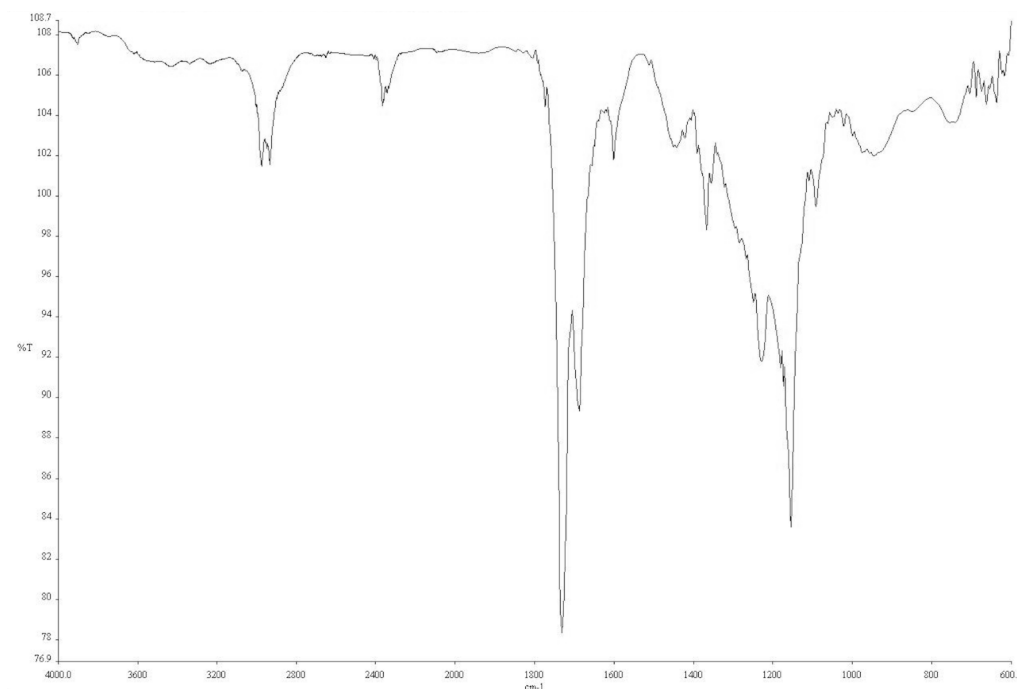


Figure A5.94 Infrared spectrum (Thin Film, NaCl) of compound **226**.

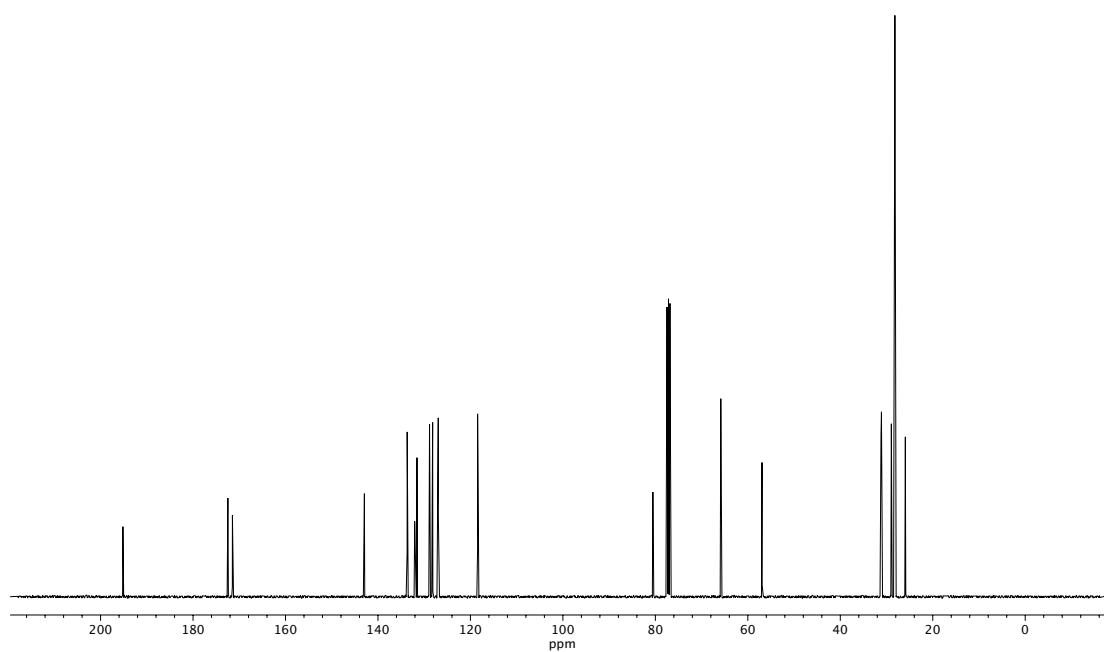


Figure A5.95 ¹³C NMR (100 MHz, CDCl₃) of compound **226**.

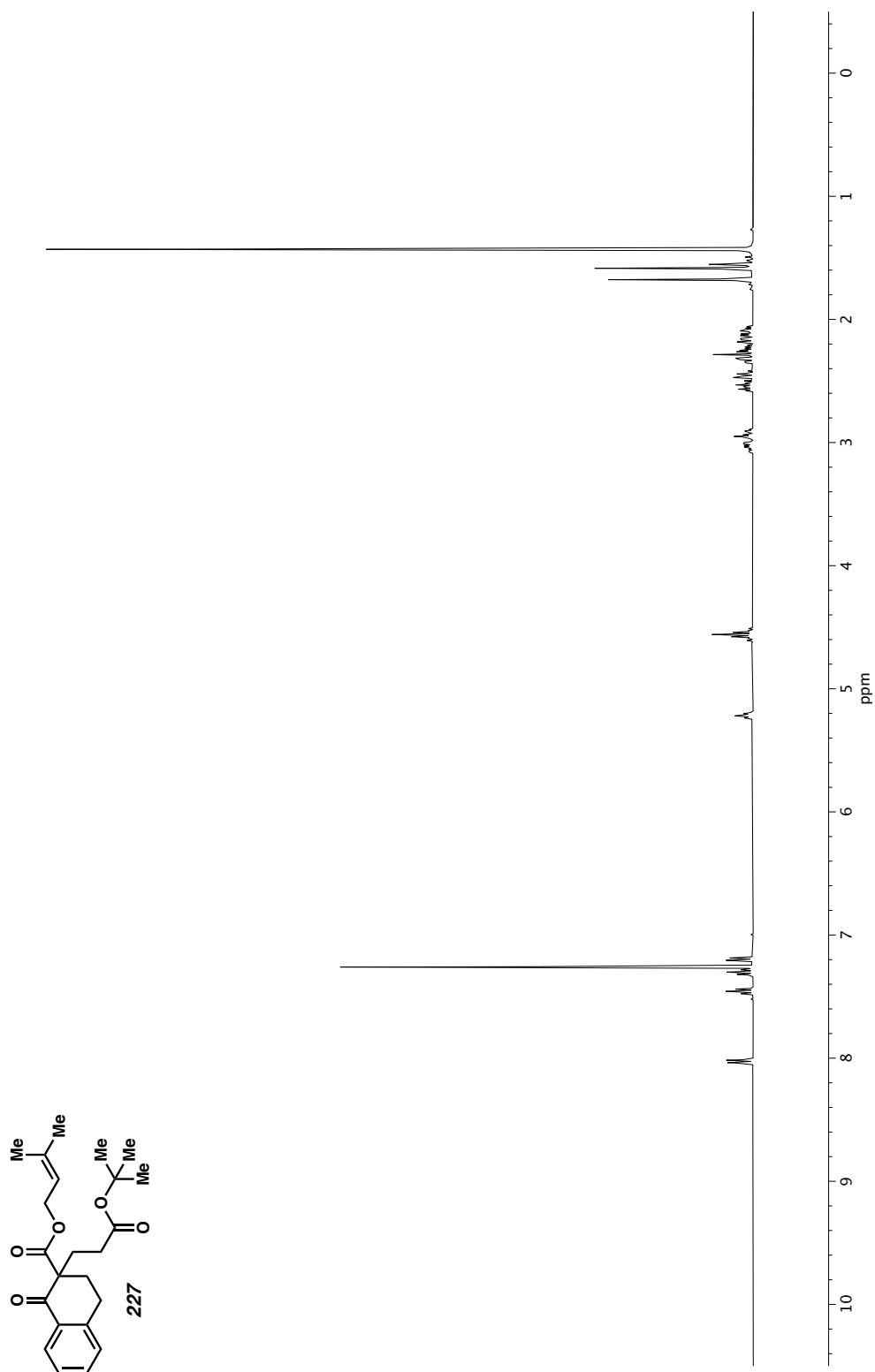


Figure A5.96 ¹H NMR (400 MHz, CDCl₃) of compound 227.

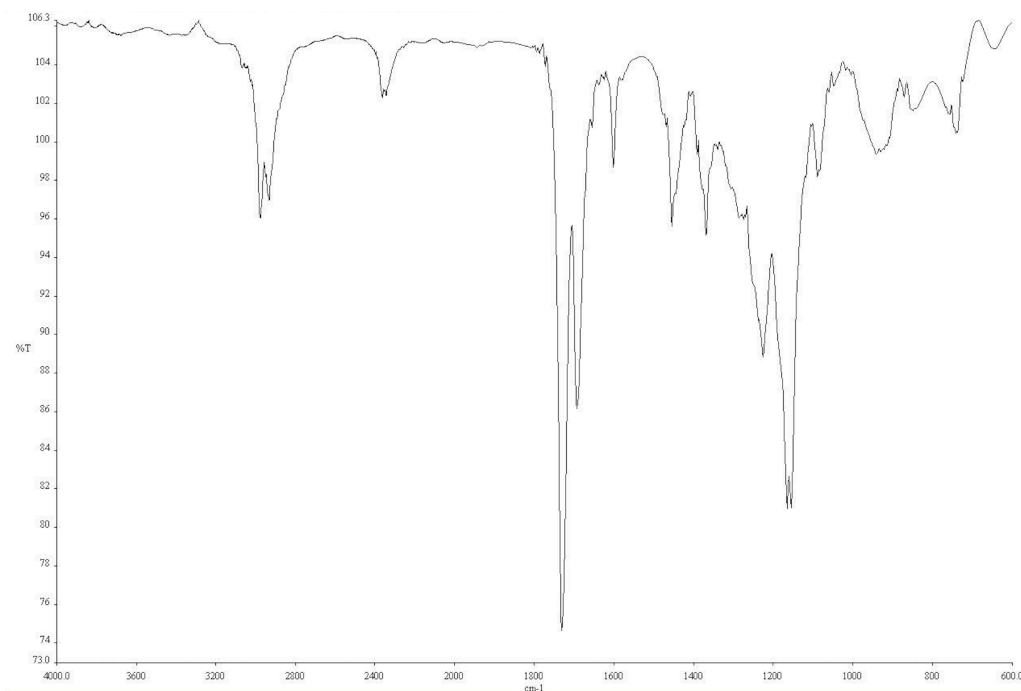


Figure A5.97 Infrared spectrum (Thin Film, NaCl) of compound **227**.

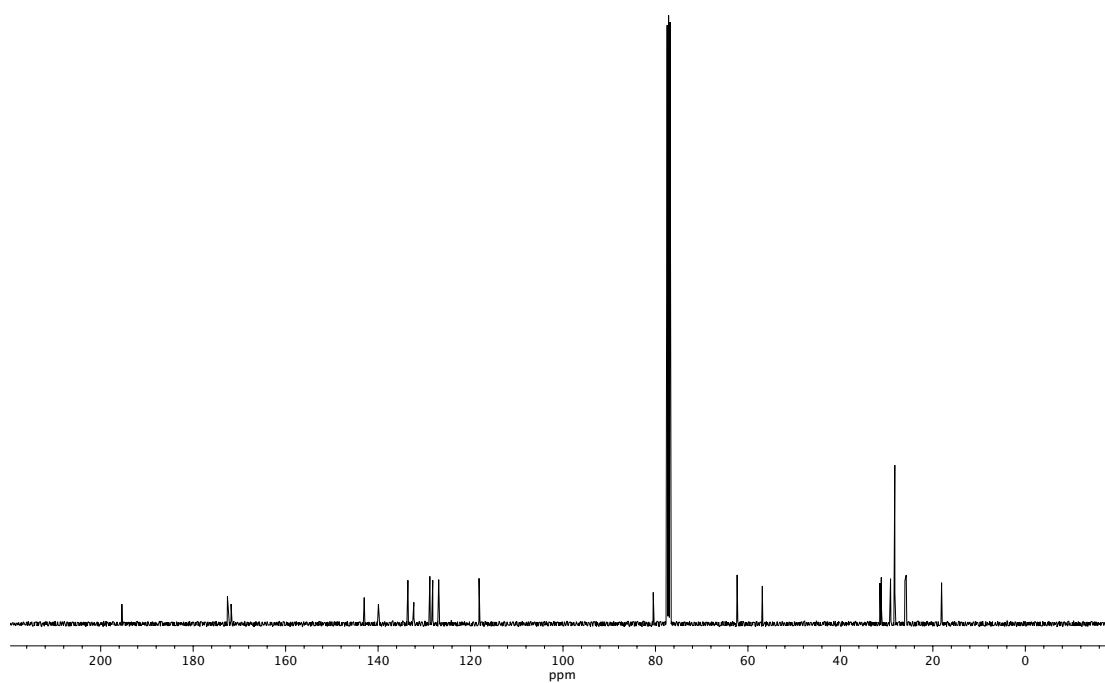


Figure A5.98 ¹³C NMR (100 MHz, CDCl₃) of compound **227**.

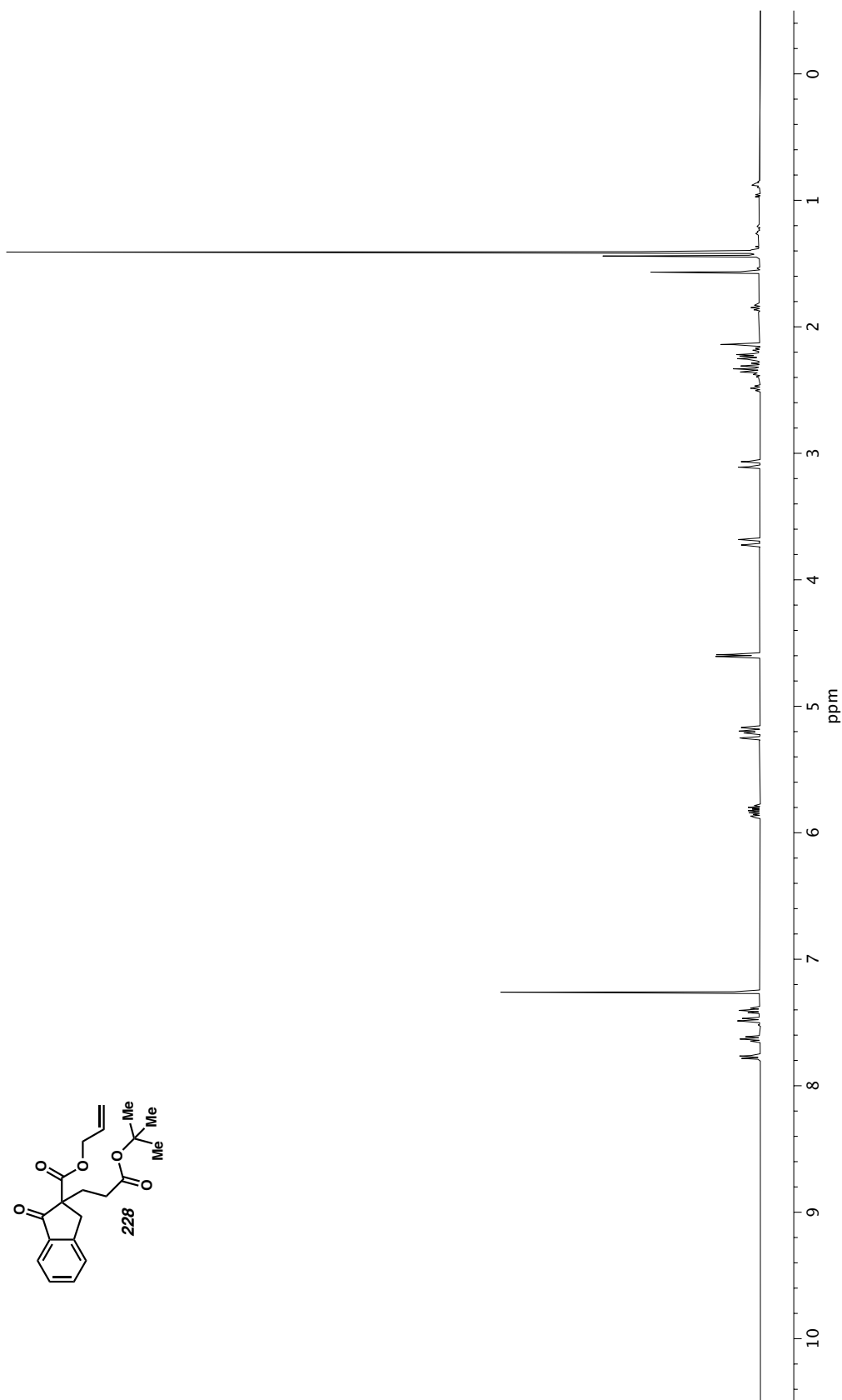


Figure A5.99 ¹H NMR (400 MHz, CDCl₃) of compound **228**.

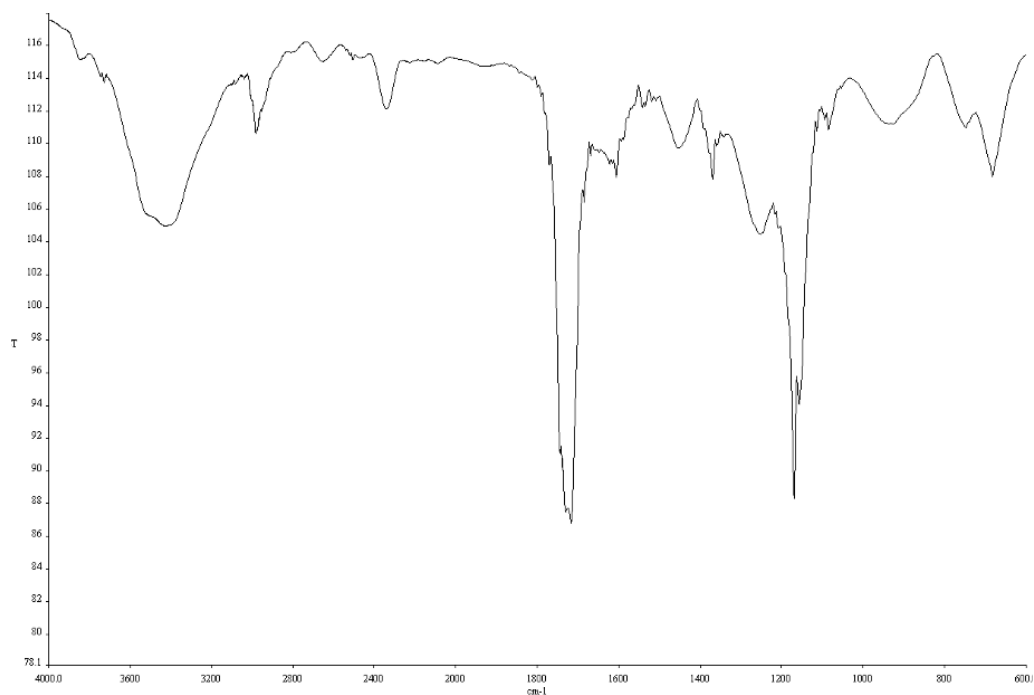


Figure A5.100 Infrared spectrum (Thin Film, NaCl) of compound **228**.

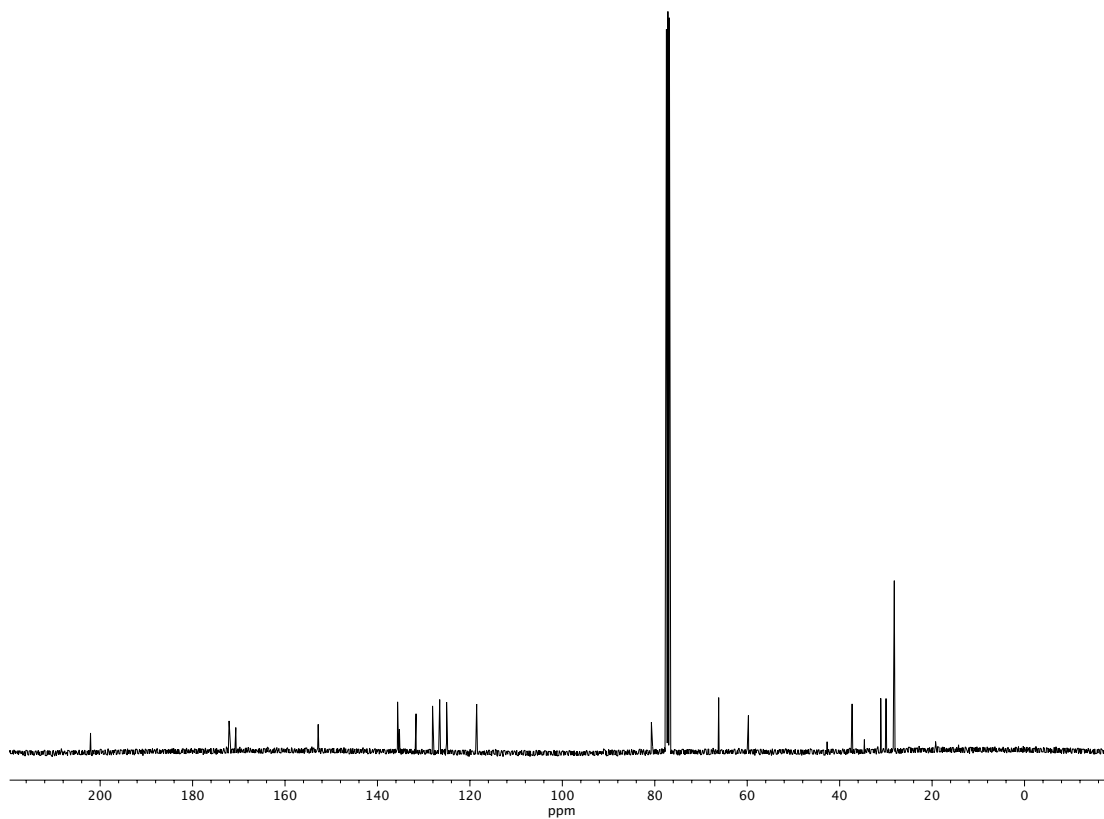


Figure A5.101 ¹³C NMR (100 MHz, CDCl₃) of compound **228**.

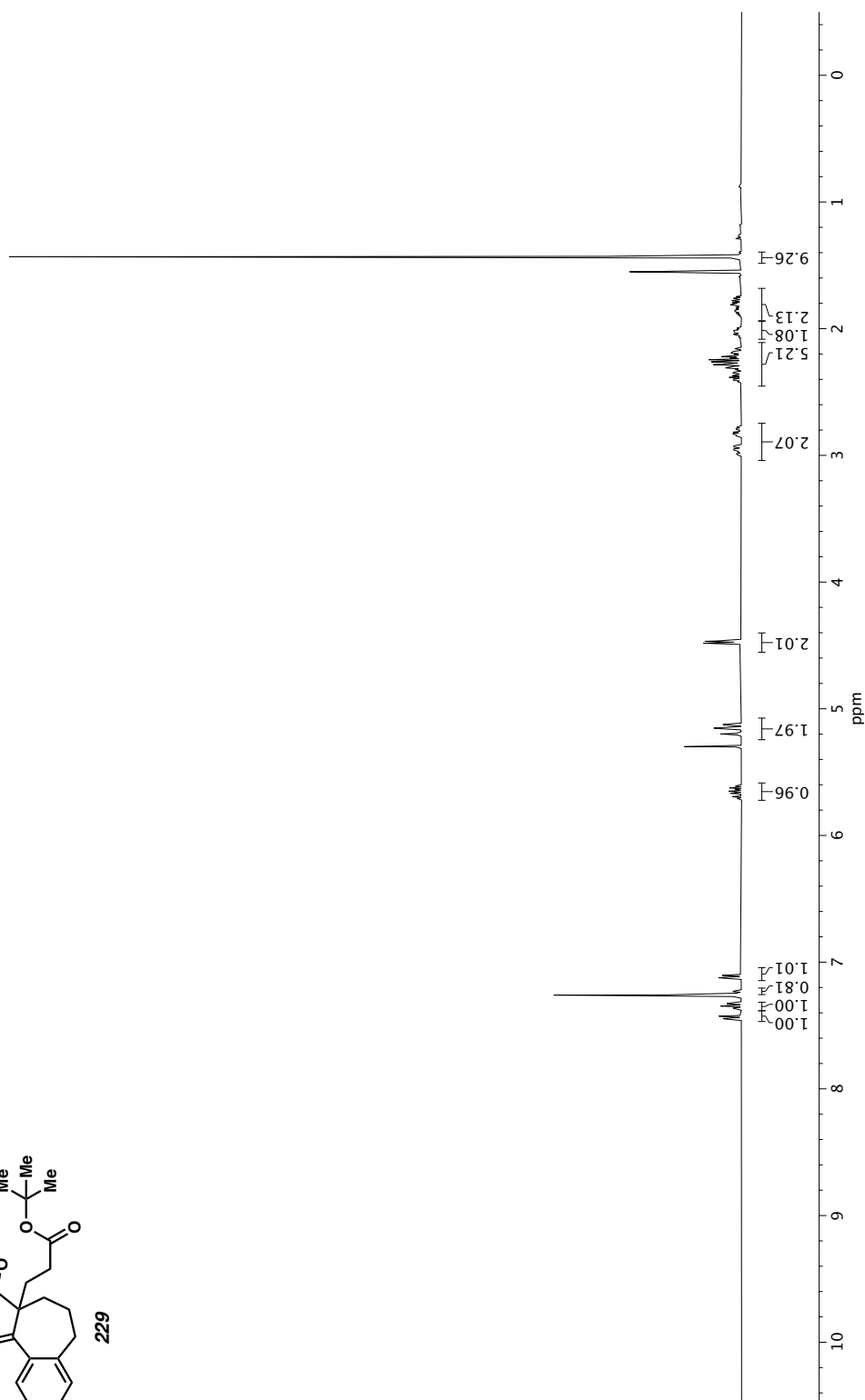
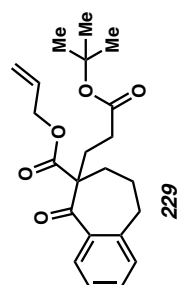


Figure A5.102 ¹H NMR (400 MHz, CDCl₃) of compound 229.

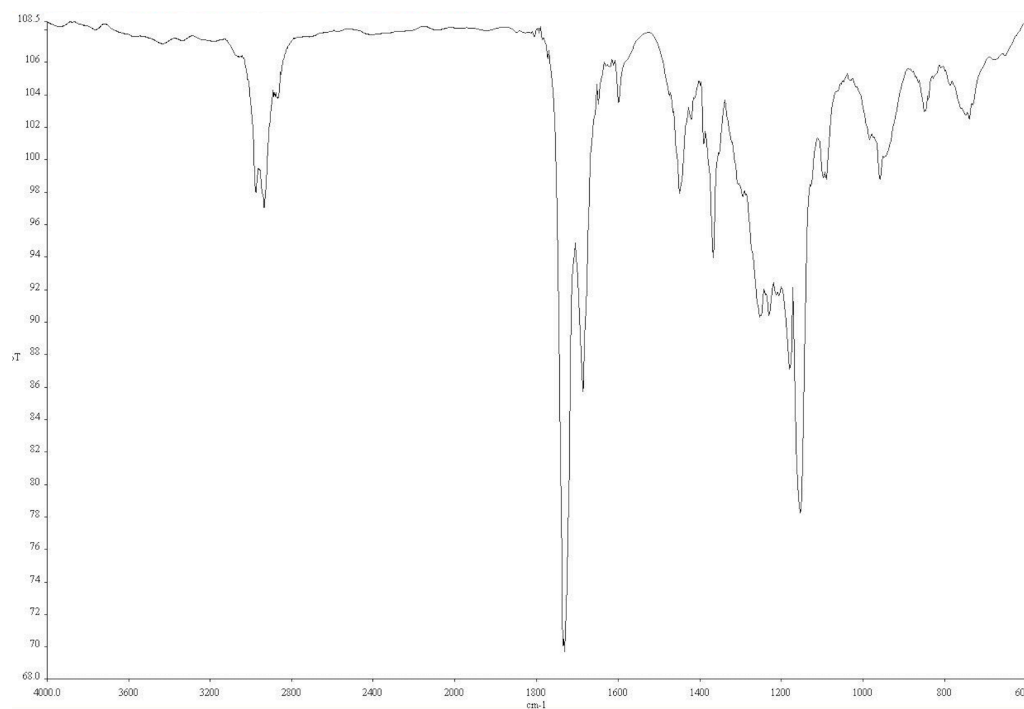


Figure A5.103 Infrared spectrum (Thin Film, NaCl) of compound **229**.

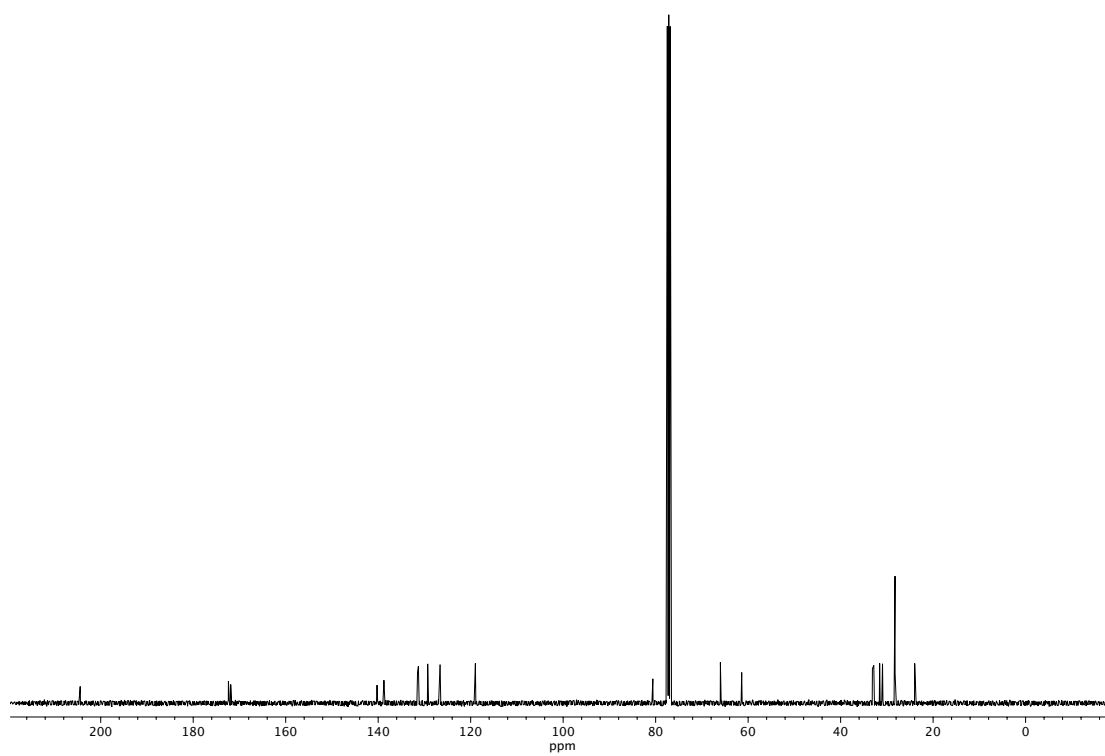


Figure A5.104 ¹³C NMR (100 MHz, CDCl₃) of compound **229**.

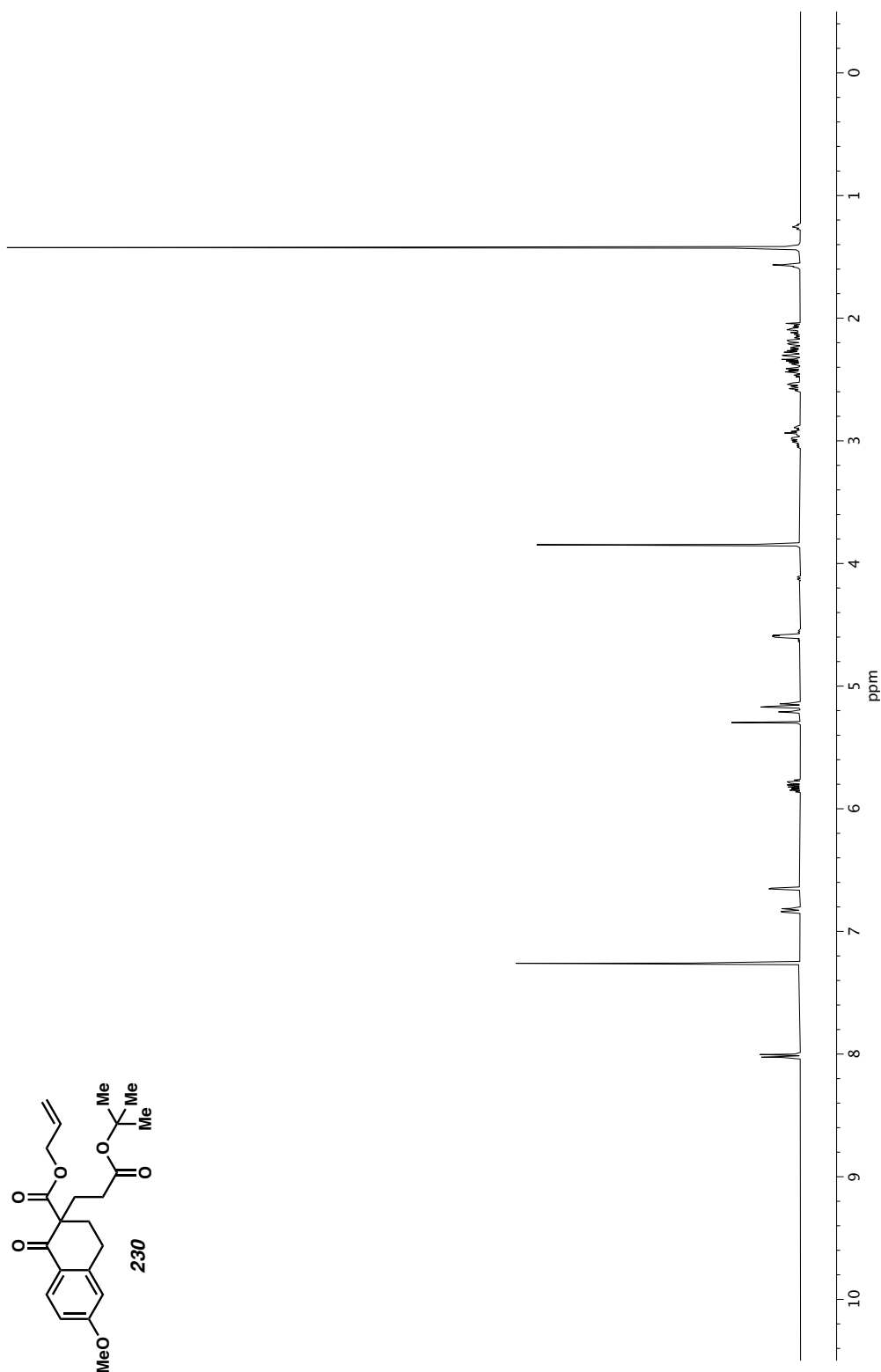


Figure A5.105 ¹H NMR (400 MHz, CDCl₃) of compound 230.

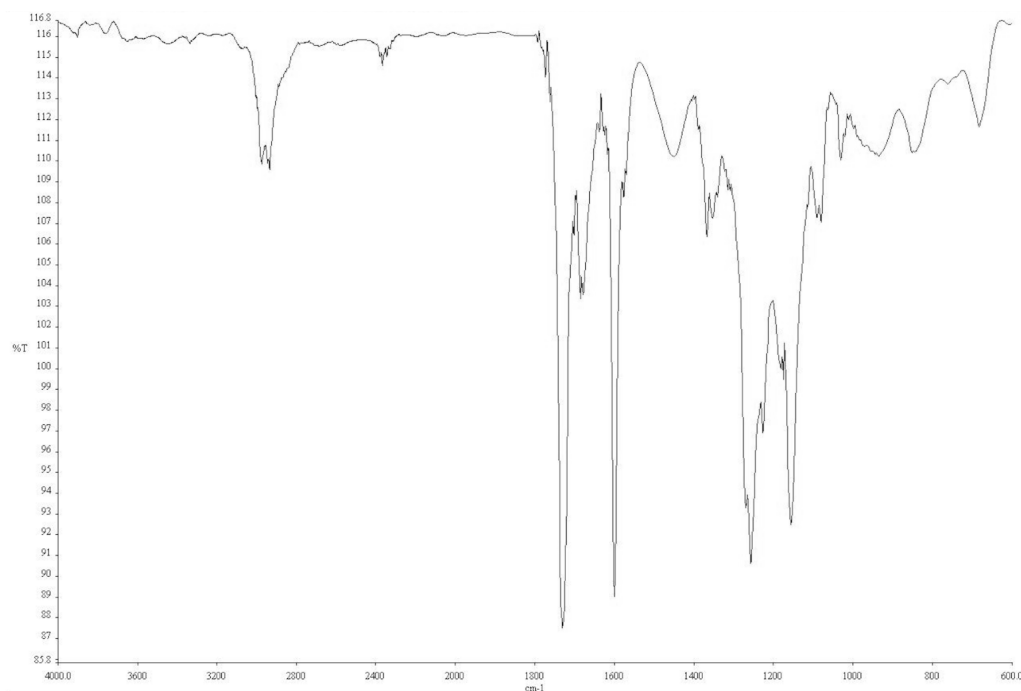


Figure A5.106 Infrared spectrum (Thin Film, NaCl) of compound **230**.

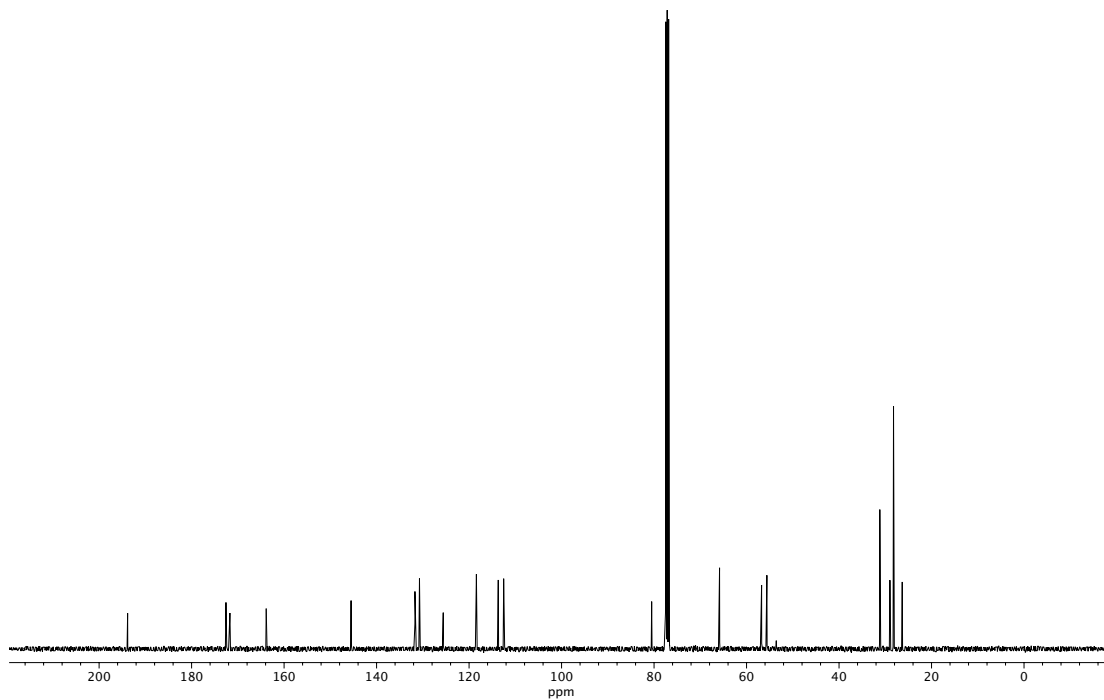


Figure A5.107 ¹³C NMR (100 MHz, CDCl₃) of compound **230**.

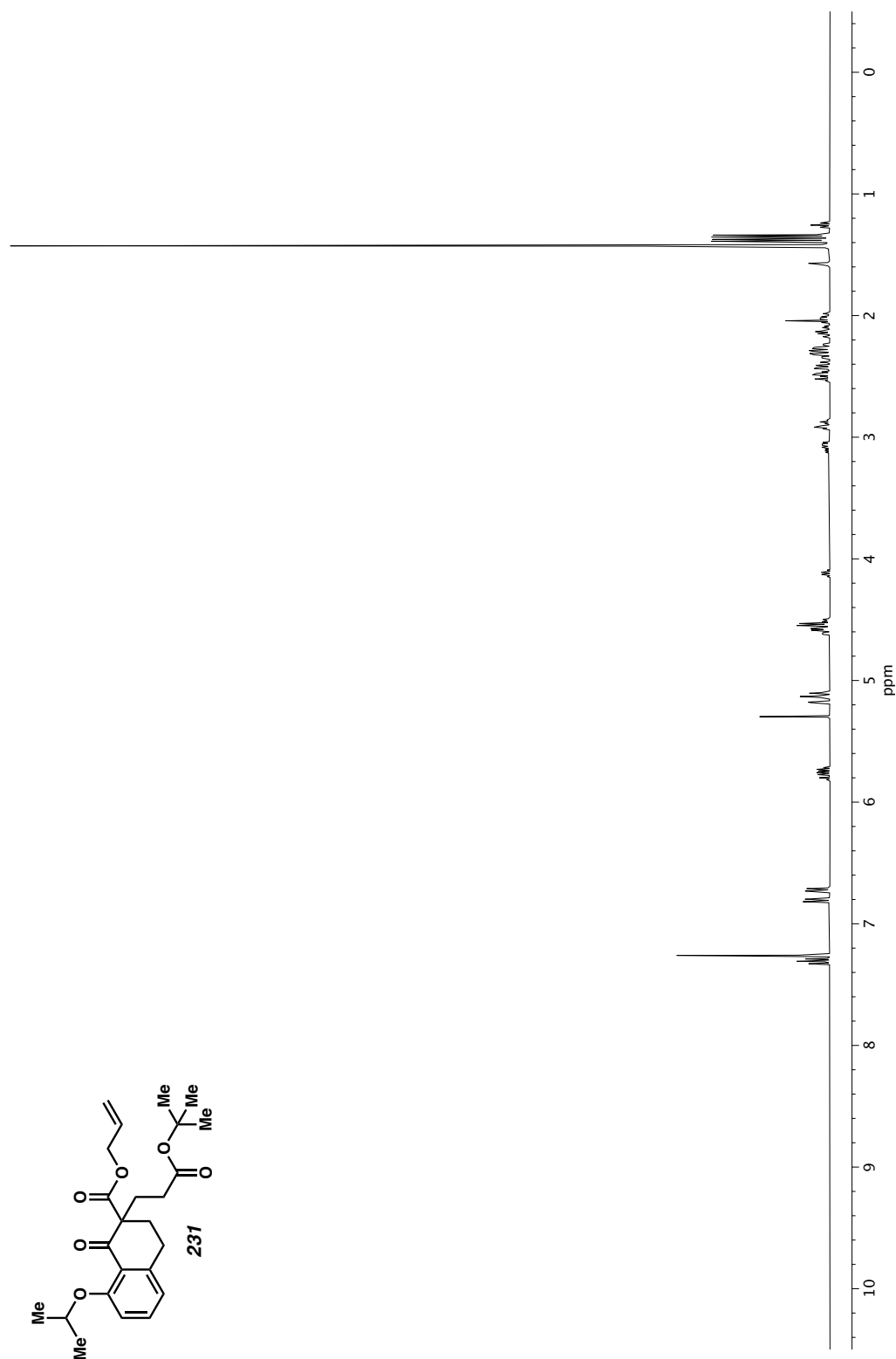


Figure A5.108 ¹H NMR (400 MHz, CDCl₃) of compound 231.

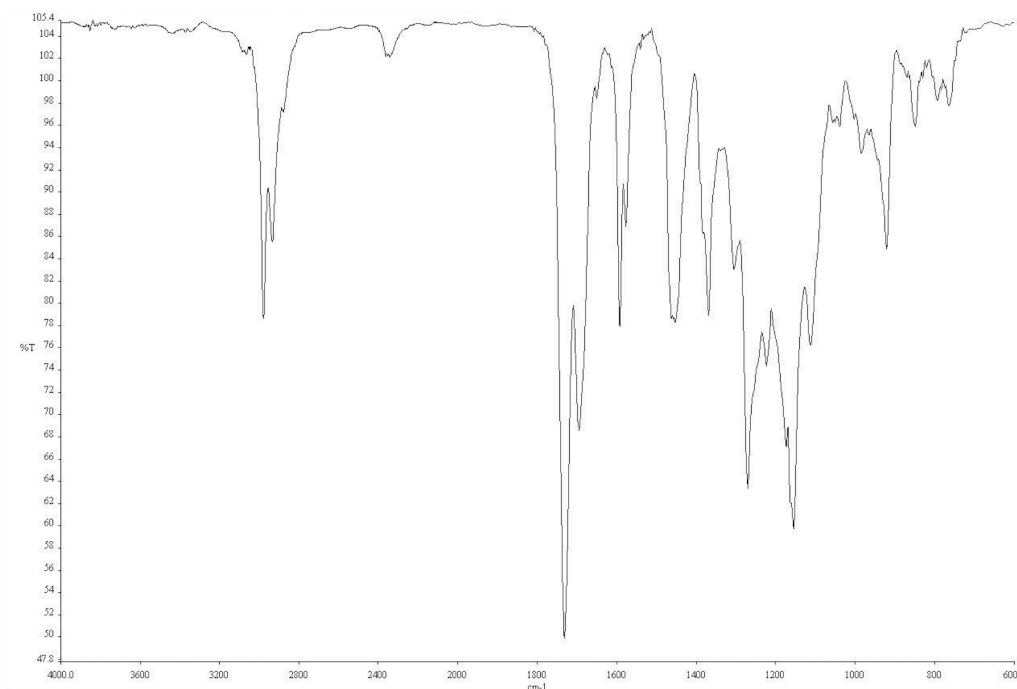


Figure A5.109 Infrared spectrum (Thin Film, NaCl) of compound **231**.

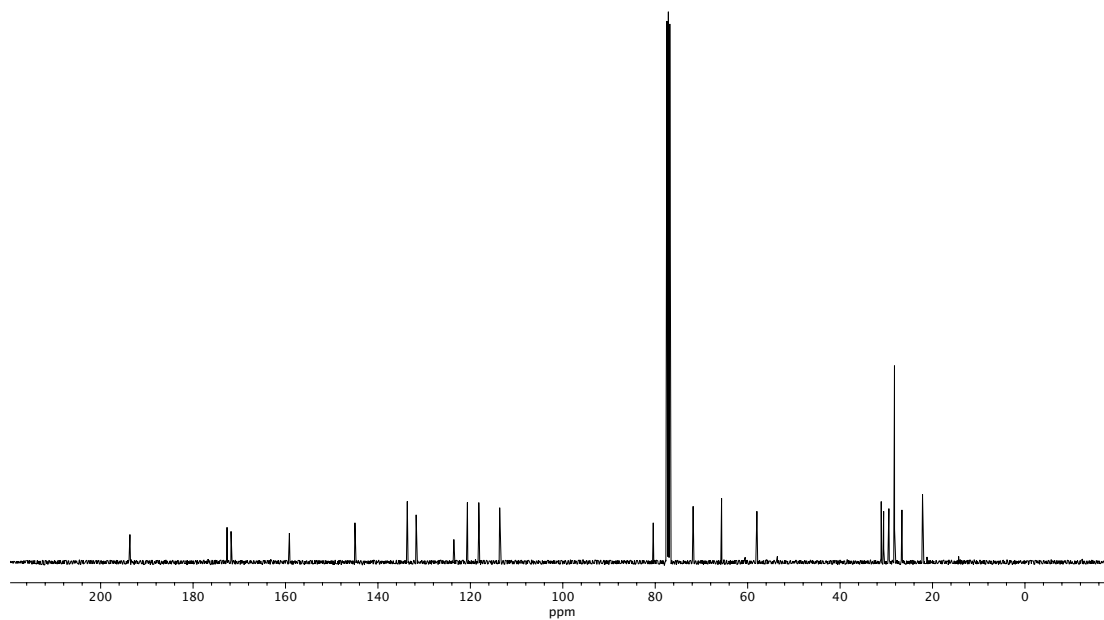


Figure A5.110 ¹³C NMR (100 MHz, CDCl₃) of compound **231**.

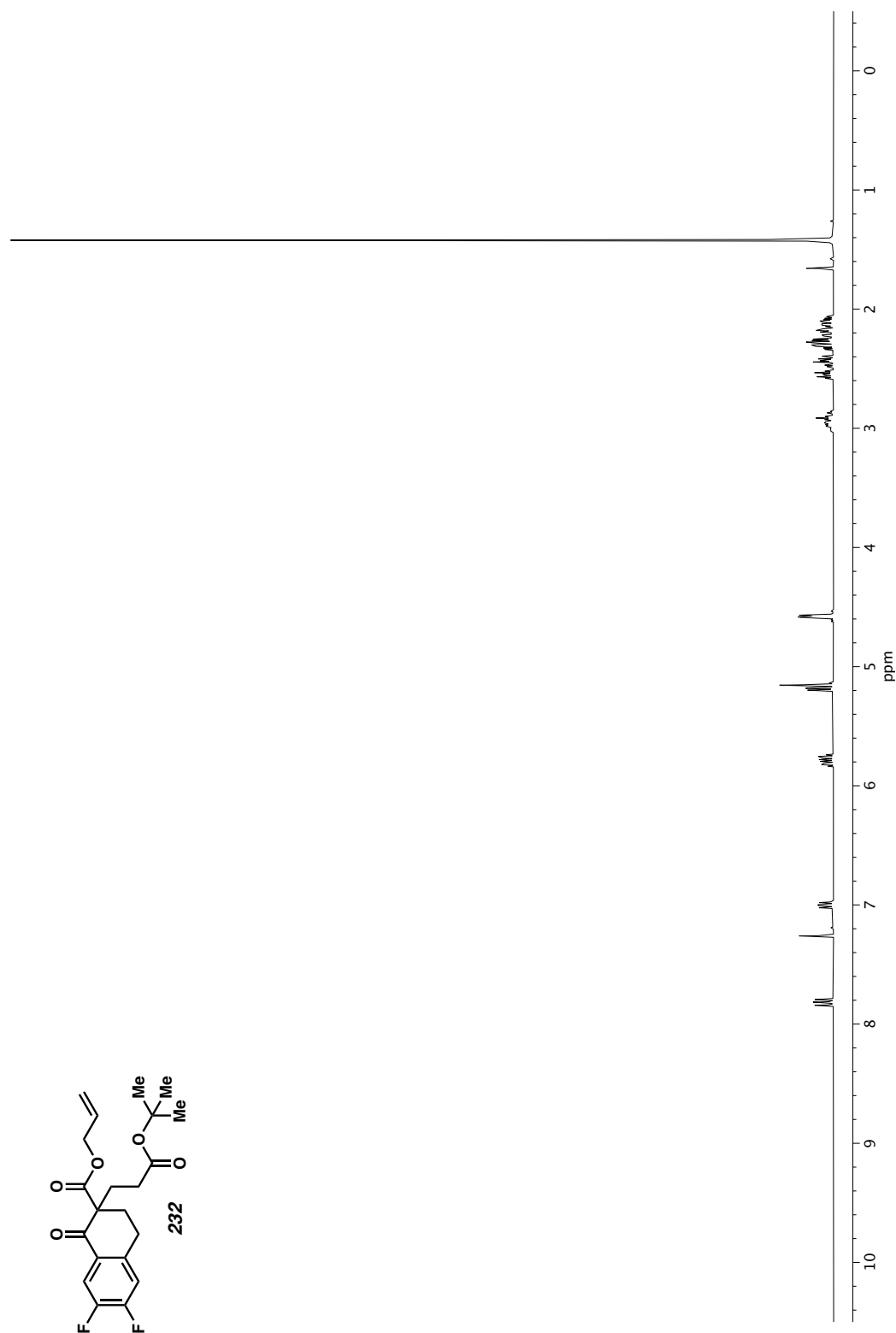


Figure A5.111 ¹H NMR (400 MHz, CDCl₃) of compound 232.

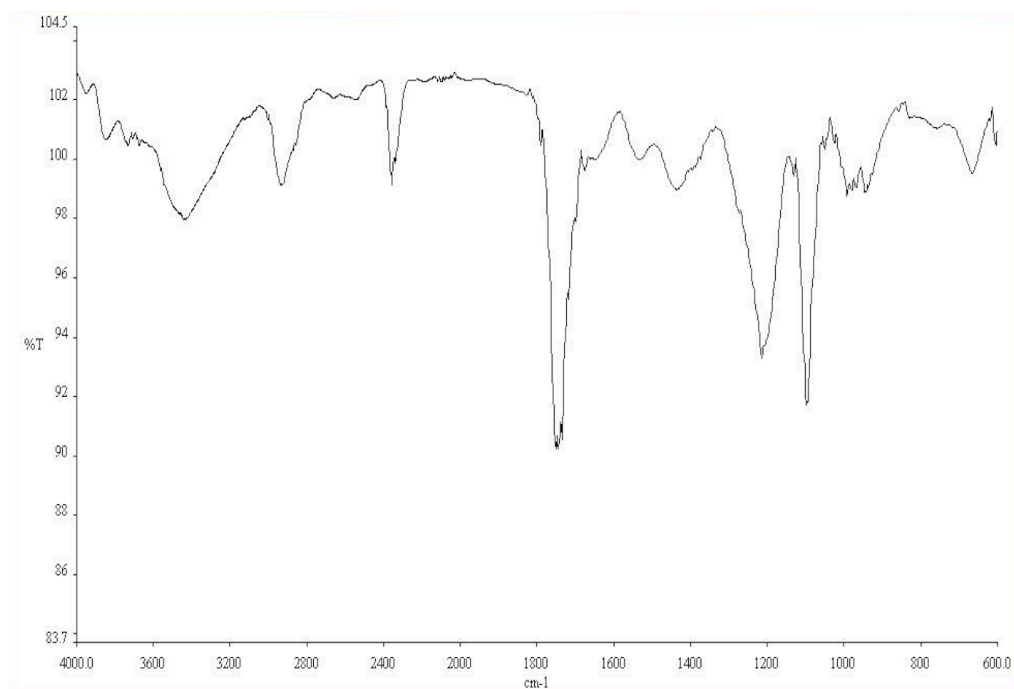


Figure A5.112 Infrared spectrum (Thin Film, NaCl) of compound **232**.

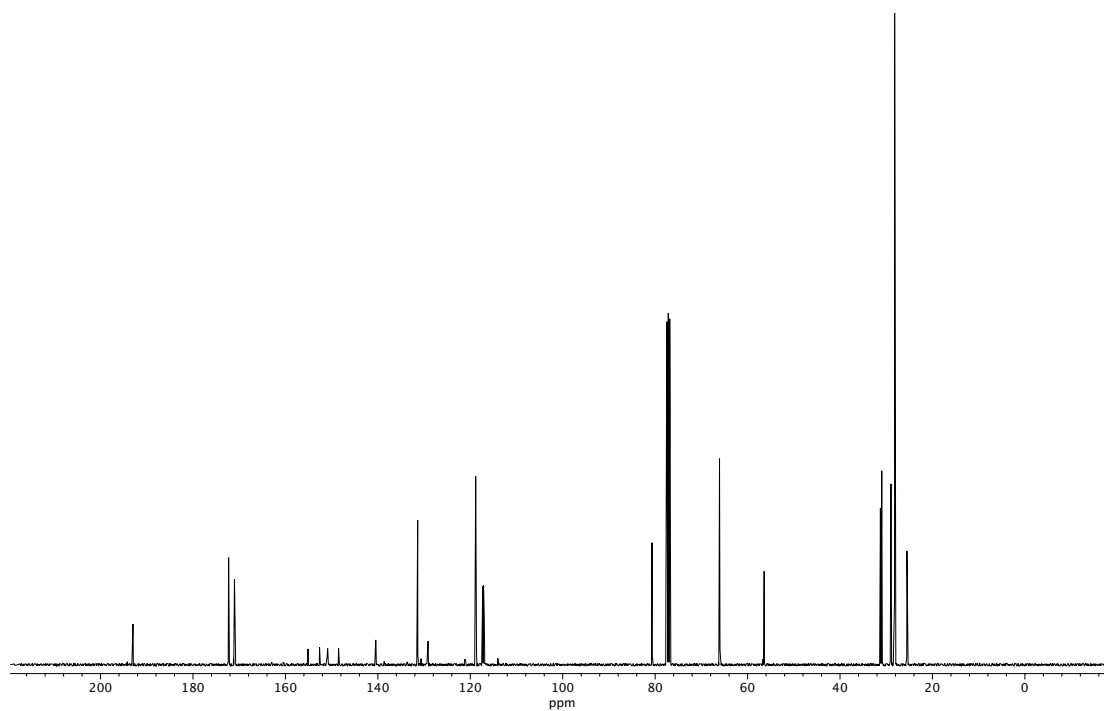


Figure A5.113 ¹³C NMR (100 MHz, CDCl₃) of compound **232**.

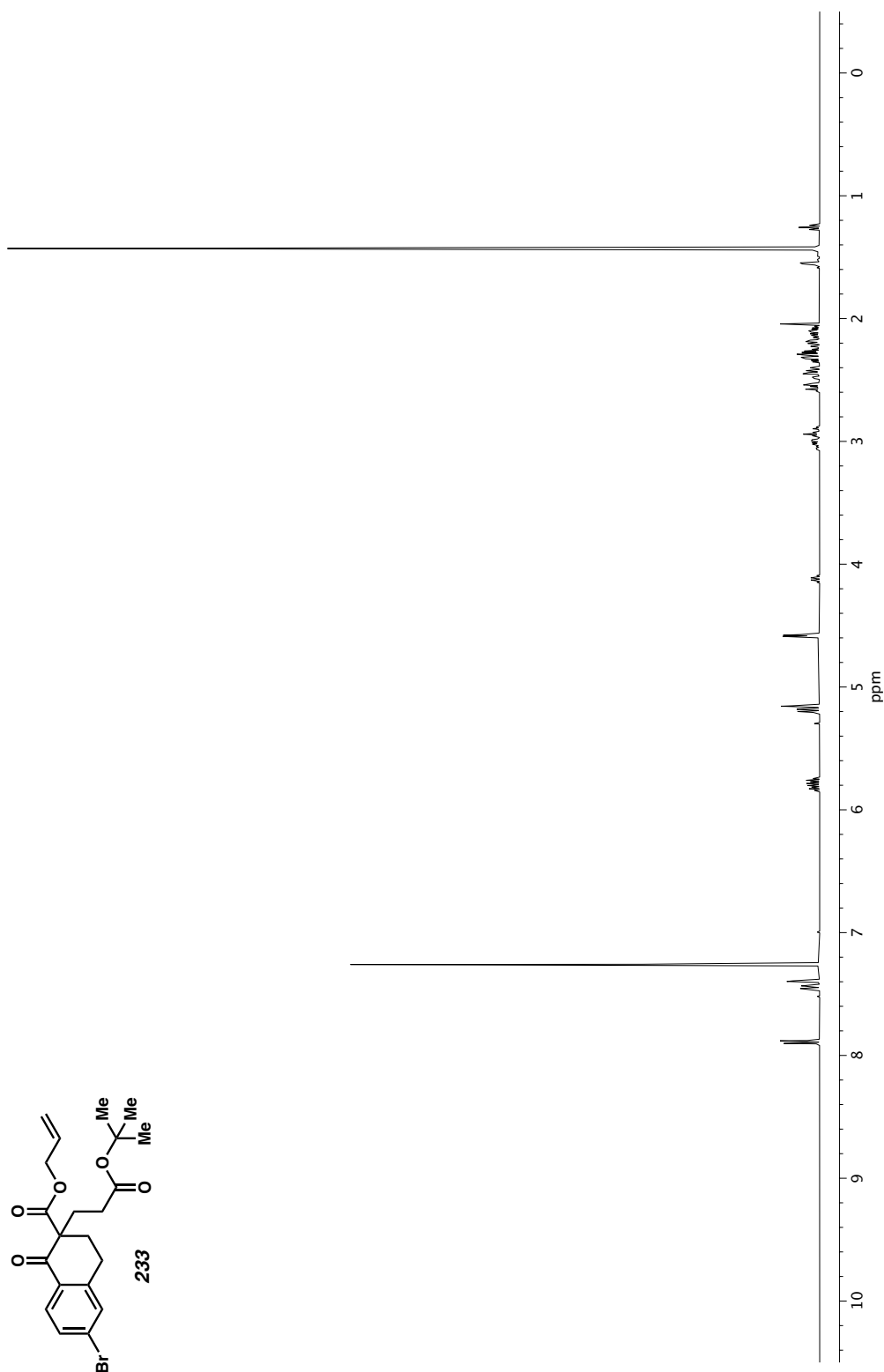


Figure A5.114 ^1H NMR (400 MHz, CDCl_3) of compound **233**.

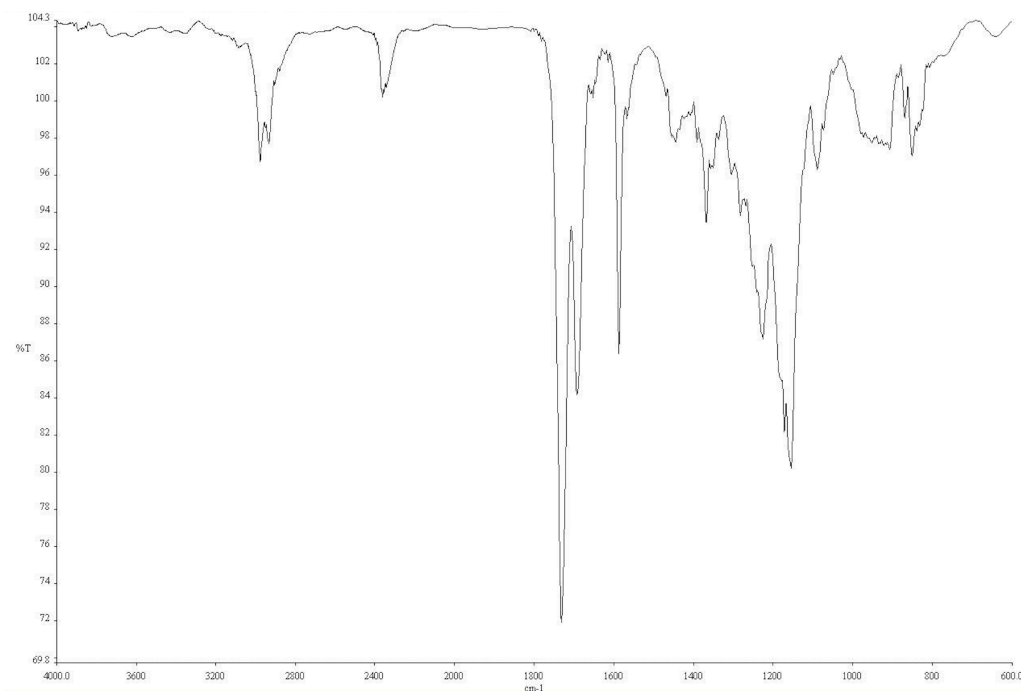


Figure A5.115 Infrared spectrum (Thin Film, NaCl) of compound **233**.

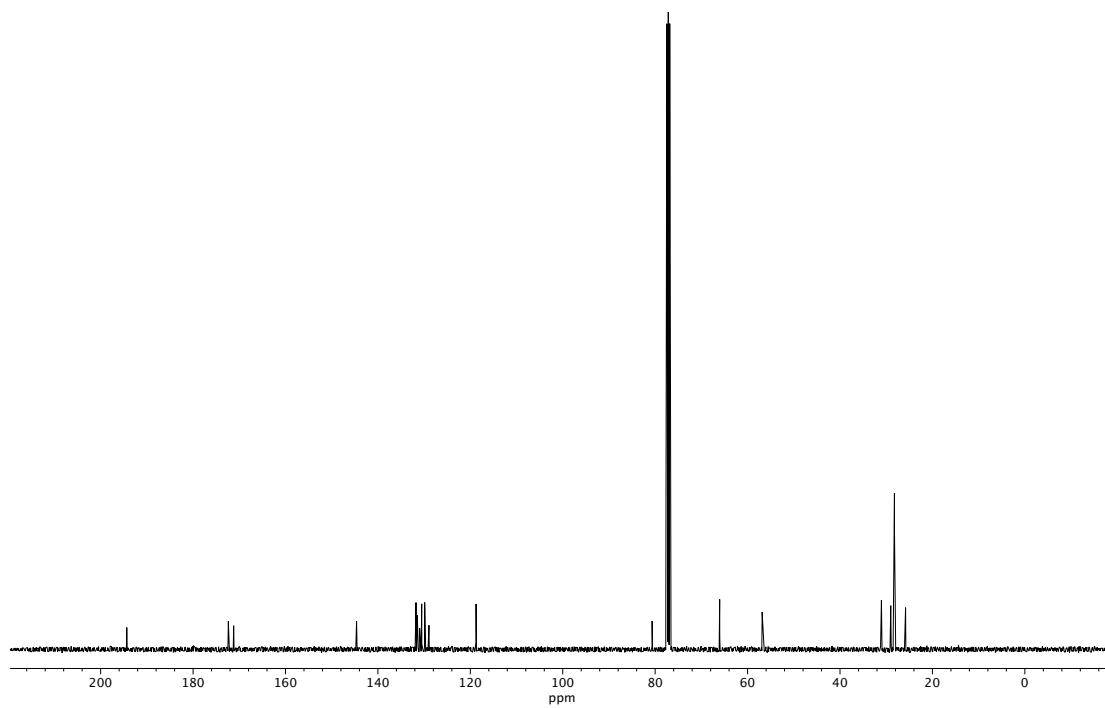


Figure A5.116 ¹³C NMR (100 MHz, CDCl₃) of compound **233**.

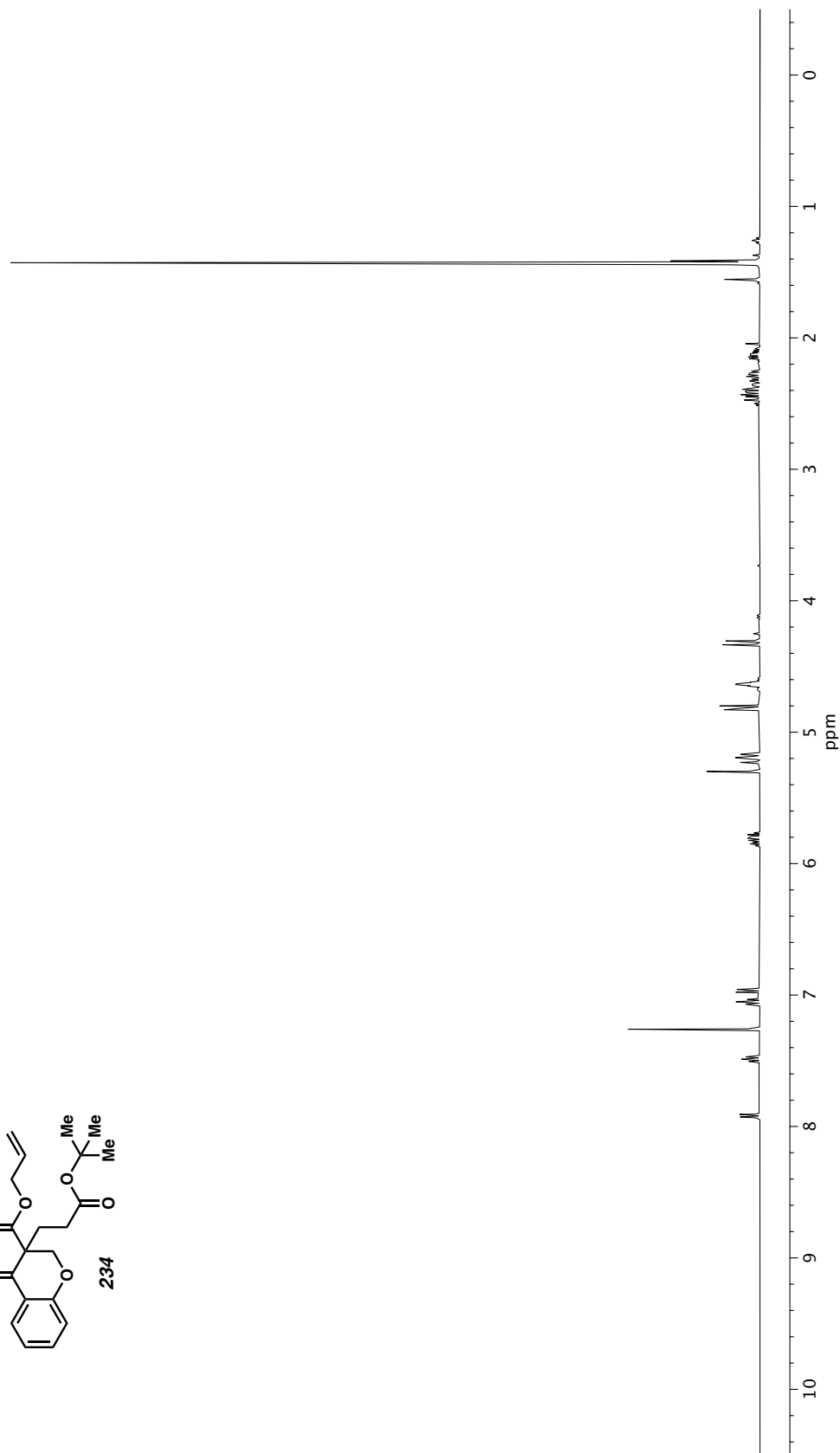
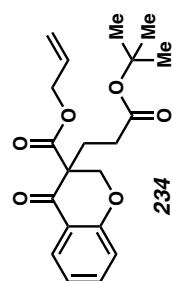


Figure A5.117 ¹H NMR (400 MHz, CDCl₃) of compound 234.

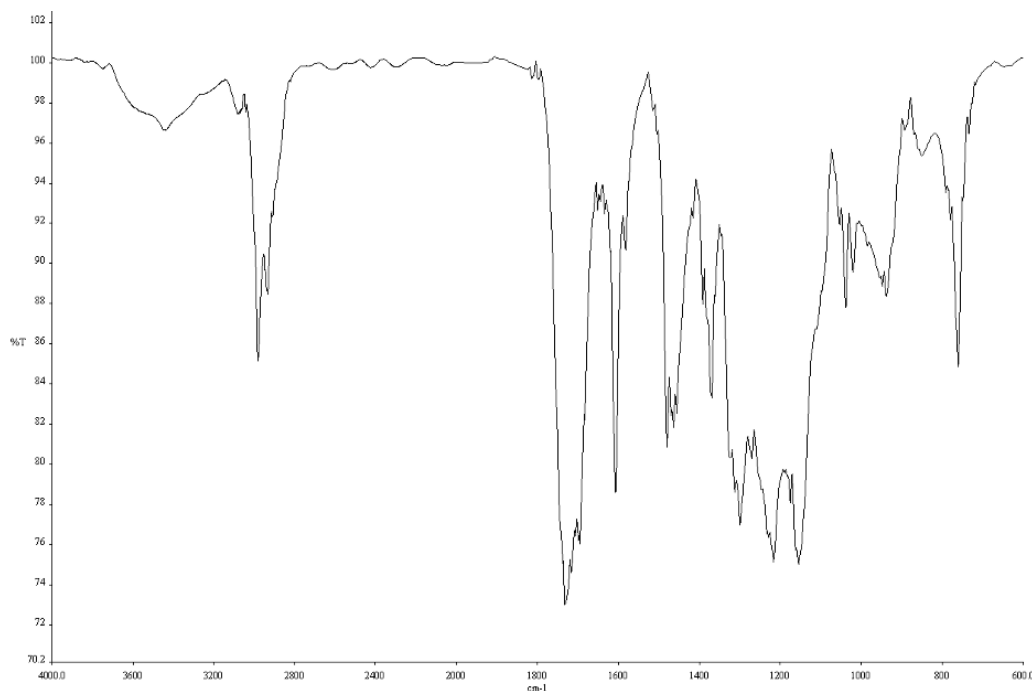


Figure A5.118 Infrared spectrum (Thin Film, NaCl) of compound **234**.

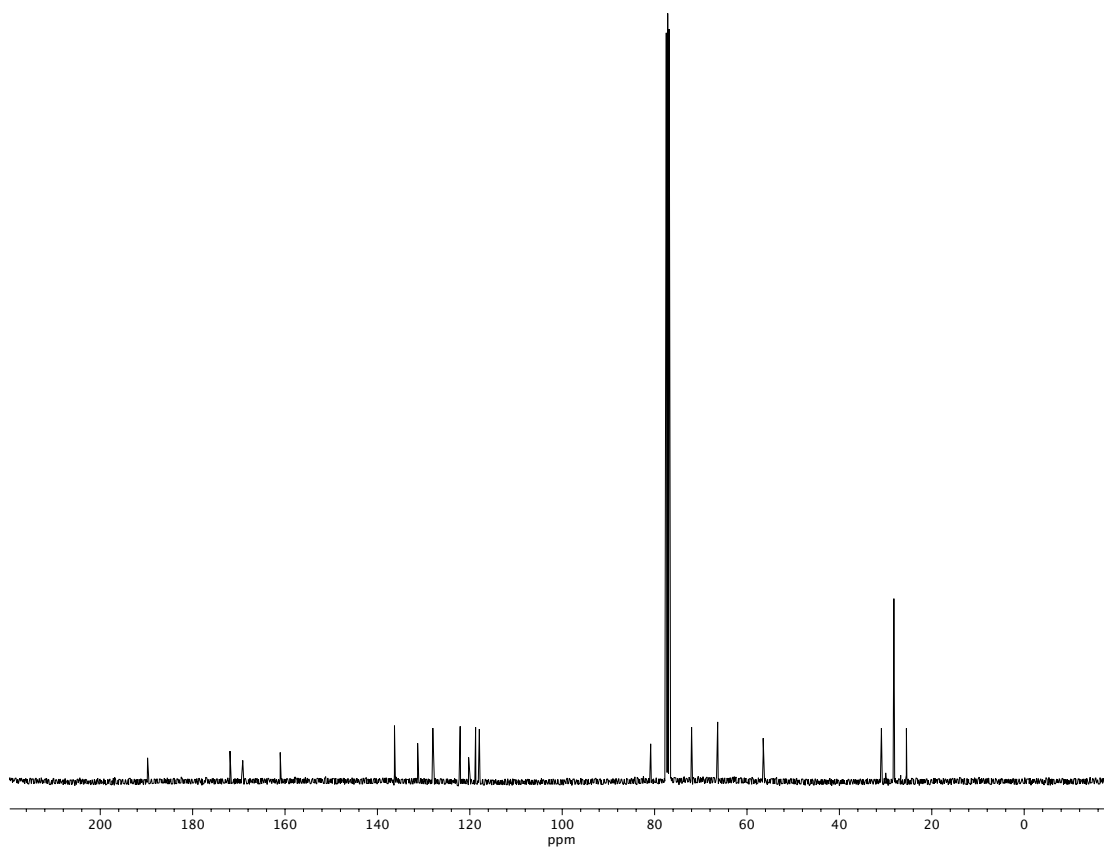


Figure A5.119 ¹³C NMR (100 MHz, CDCl₃) of compound **234**.

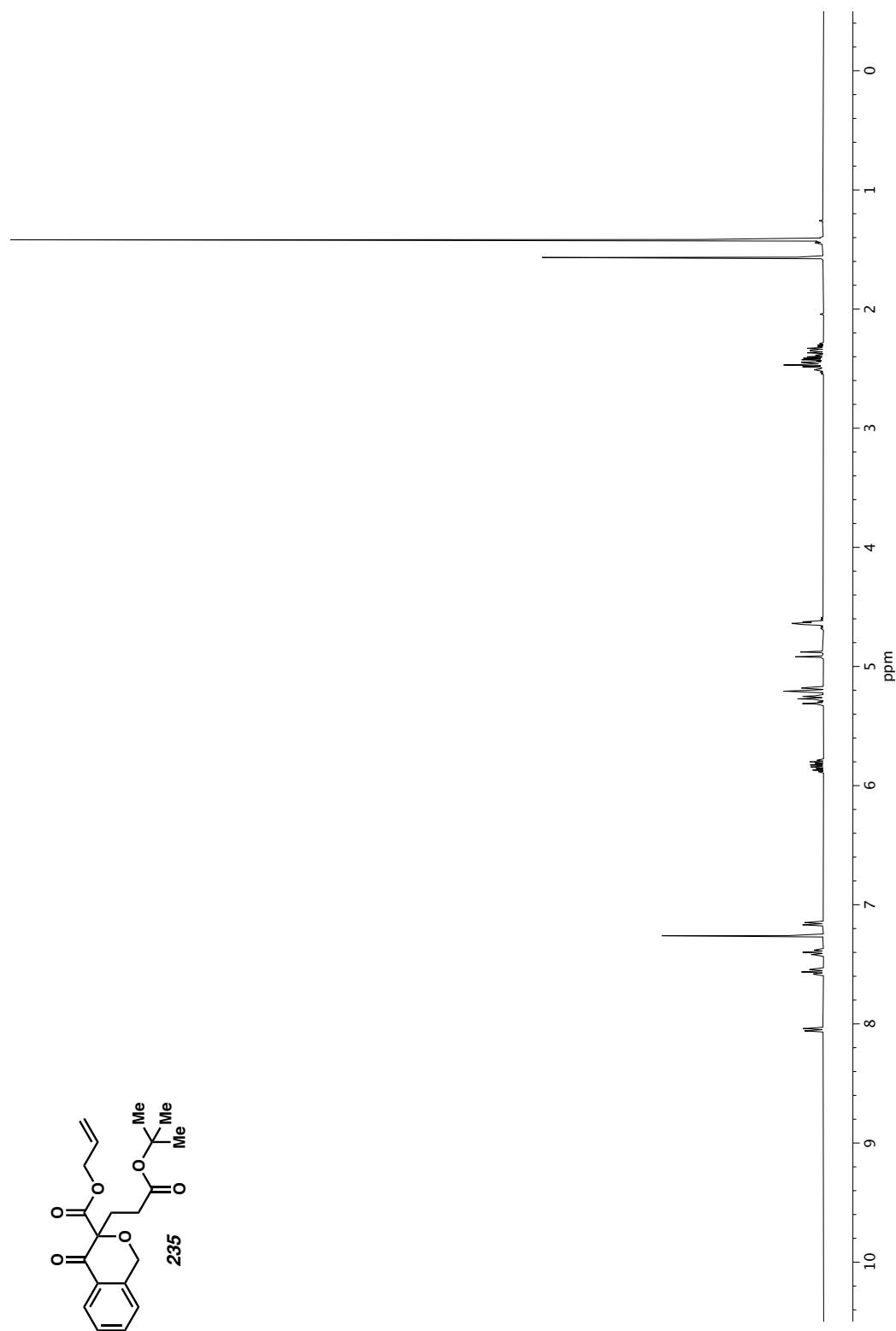


Figure A5.120 ^1H NMR (400 MHz, CDCl_3) of compound 235.

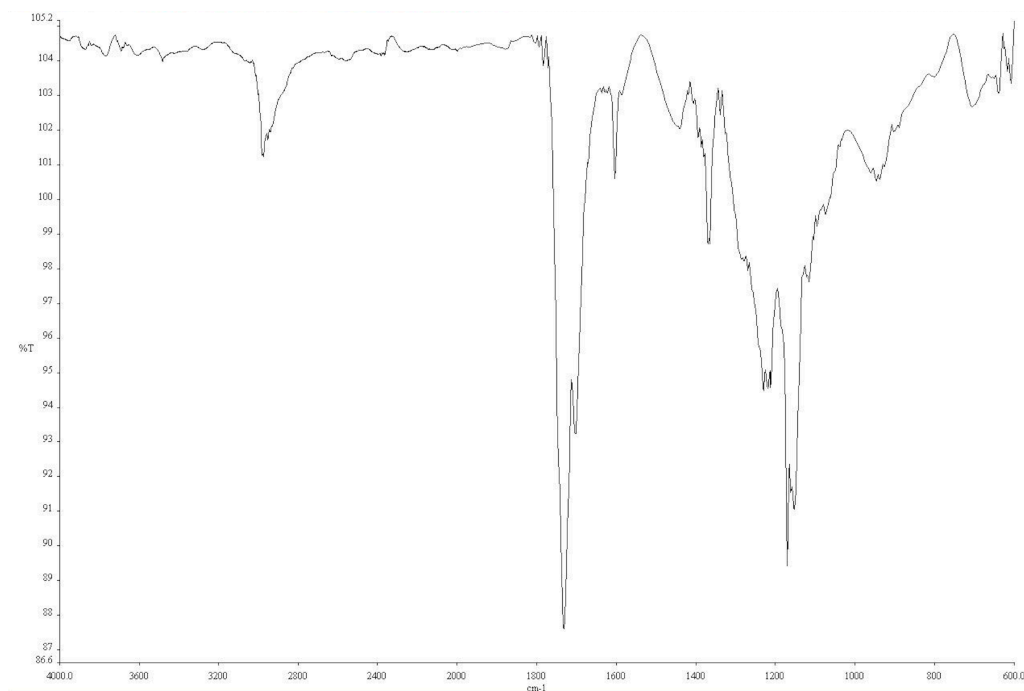


Figure A5.121 Infrared spectrum (Thin Film, NaCl) of compound **235**.

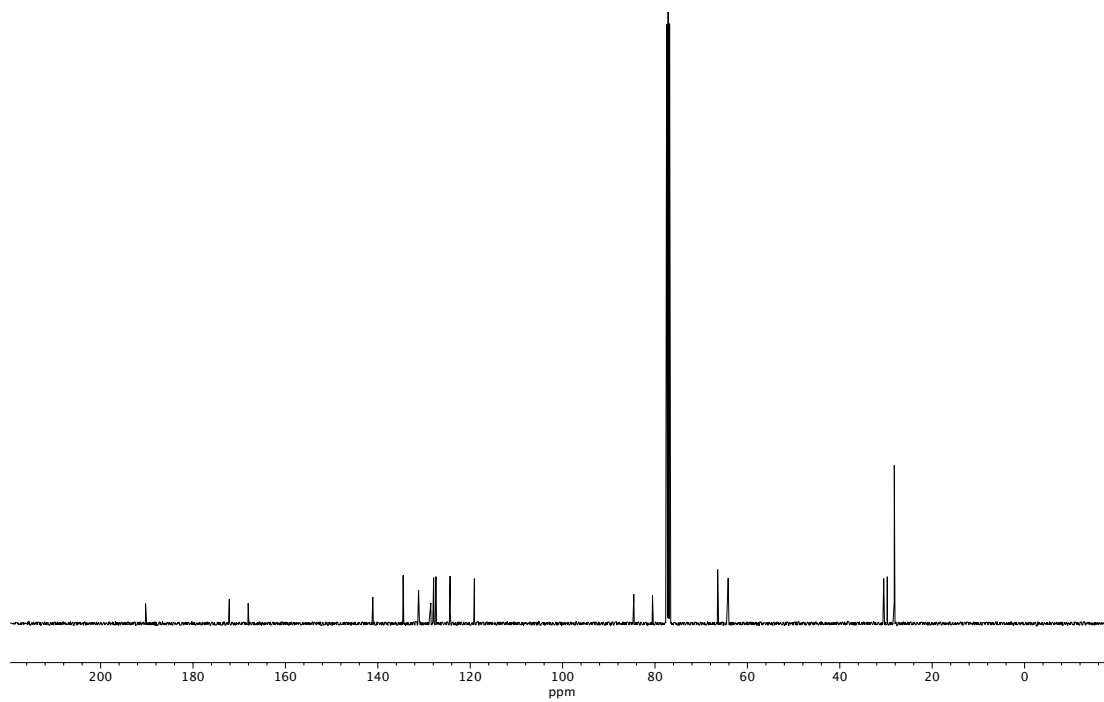


Figure A5.122 ¹³C NMR (100 MHz, CDCl₃) of compound **235**.

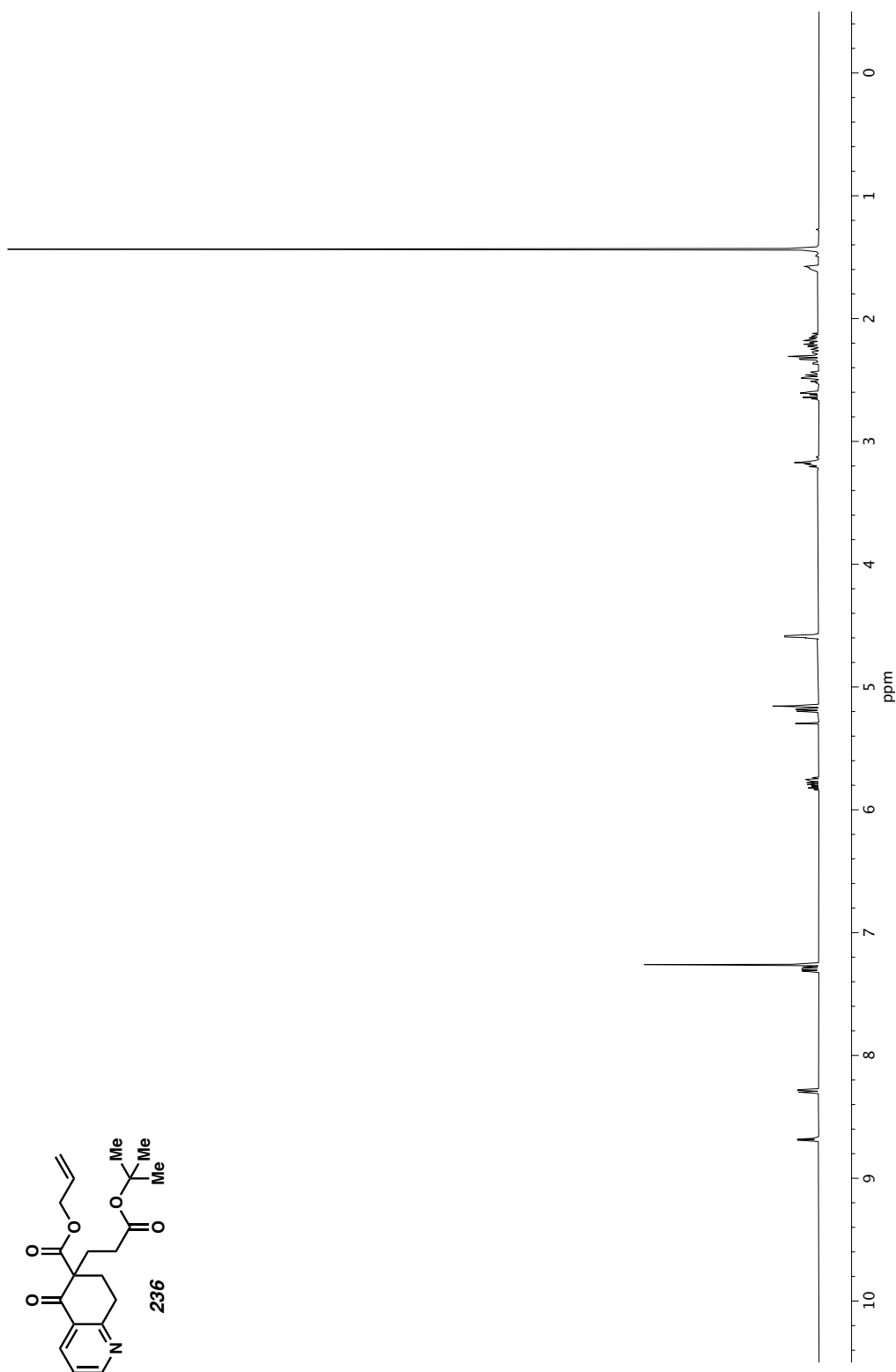


Figure A5.123 ^1H NMR (400 MHz, CDCl_3) of compound **236**.

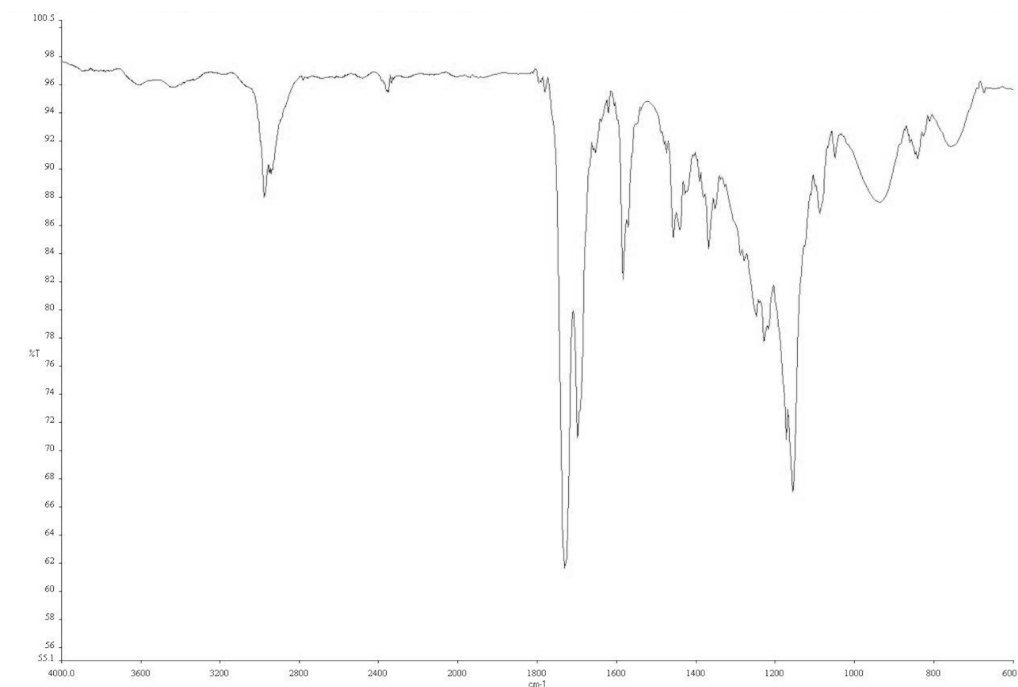


Figure A5.124 Infrared spectrum (Thin Film, NaCl) of compound **236**.

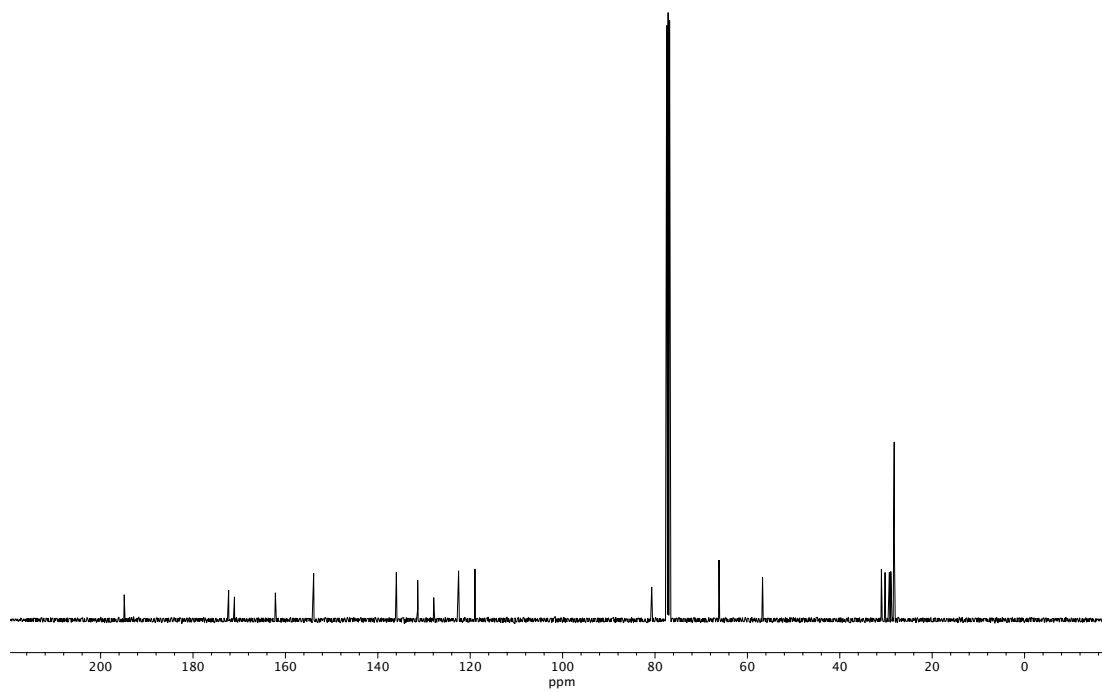


Figure A5.125 ¹³C NMR (100 MHz, CDCl₃) of compound **236**.

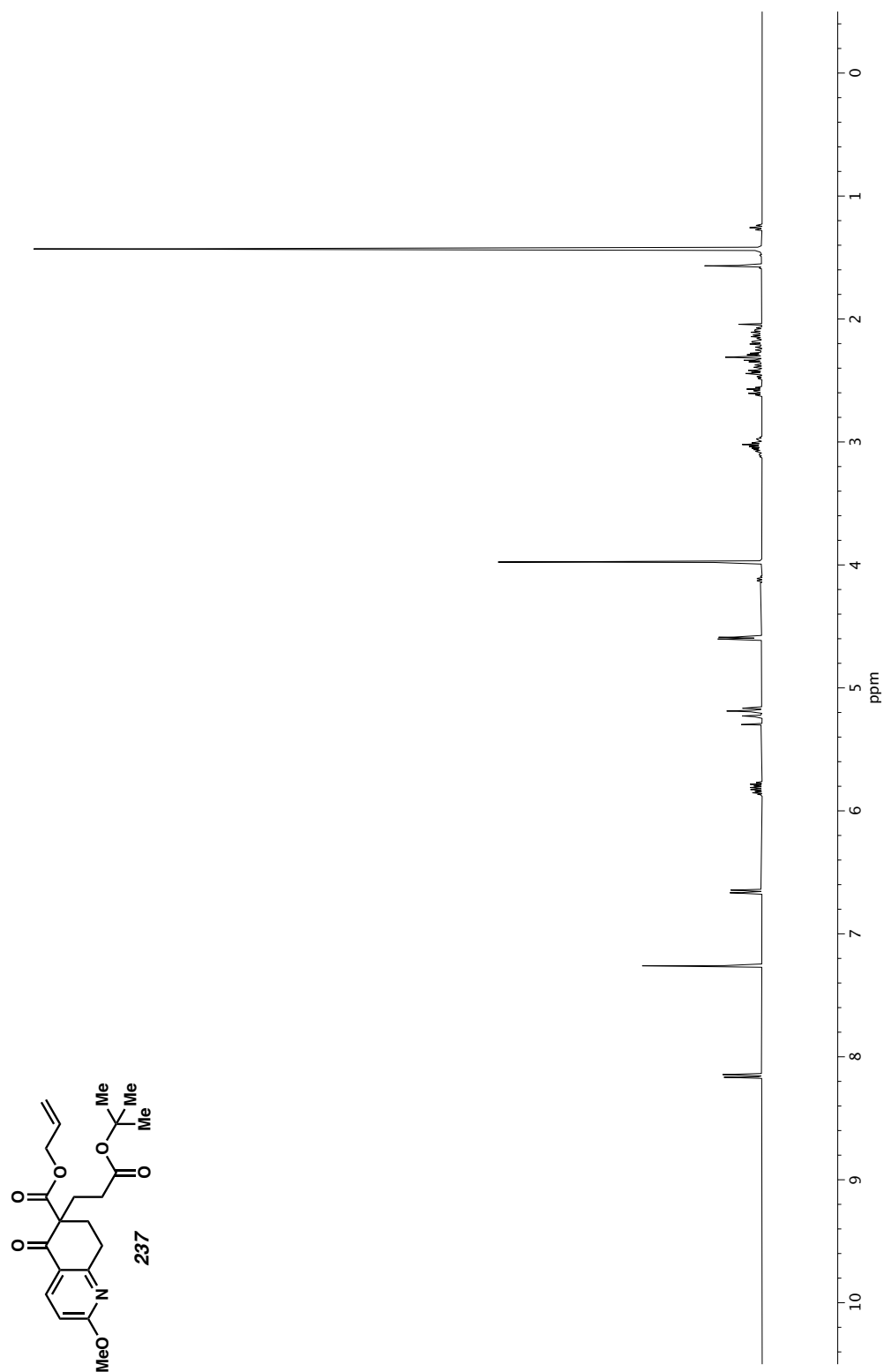


Figure A5.126 ¹H NMR (400 MHz, CDCl₃) of compound 237.

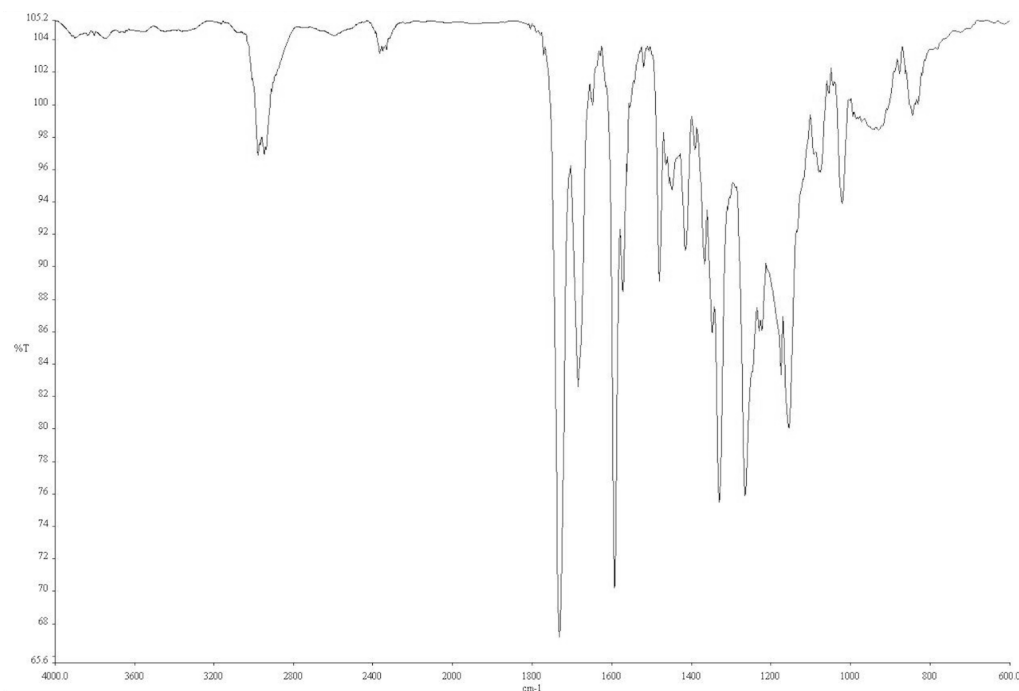


Figure A5.127 Infrared spectrum (Thin Film, NaCl) of compound **237**.

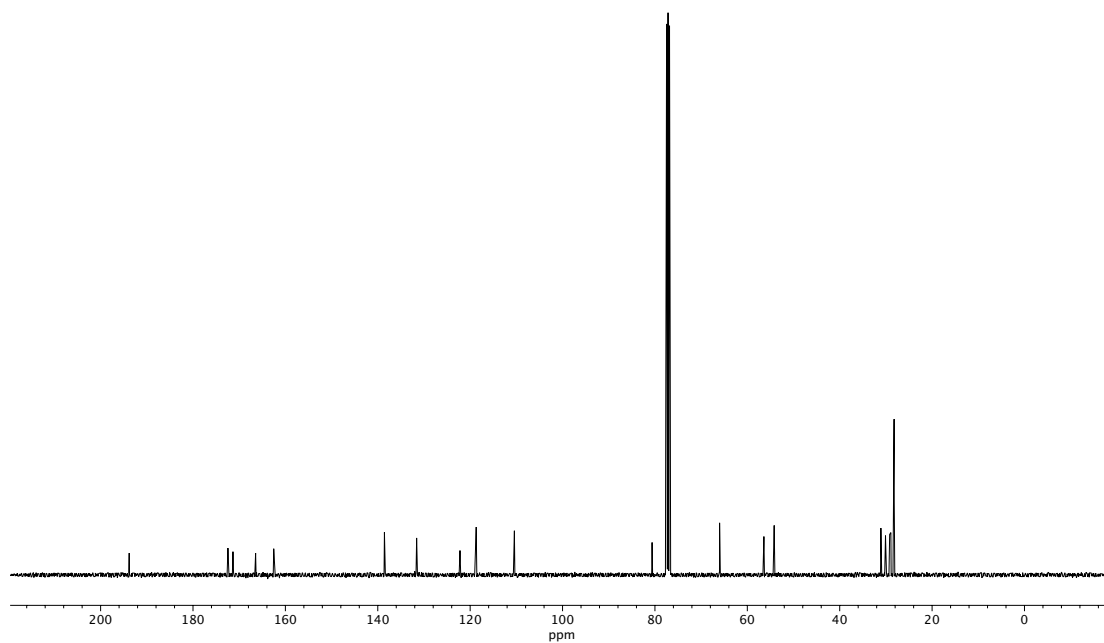


Figure A5.128 ¹³C NMR (100 MHz, CDCl₃) of compound **237**.

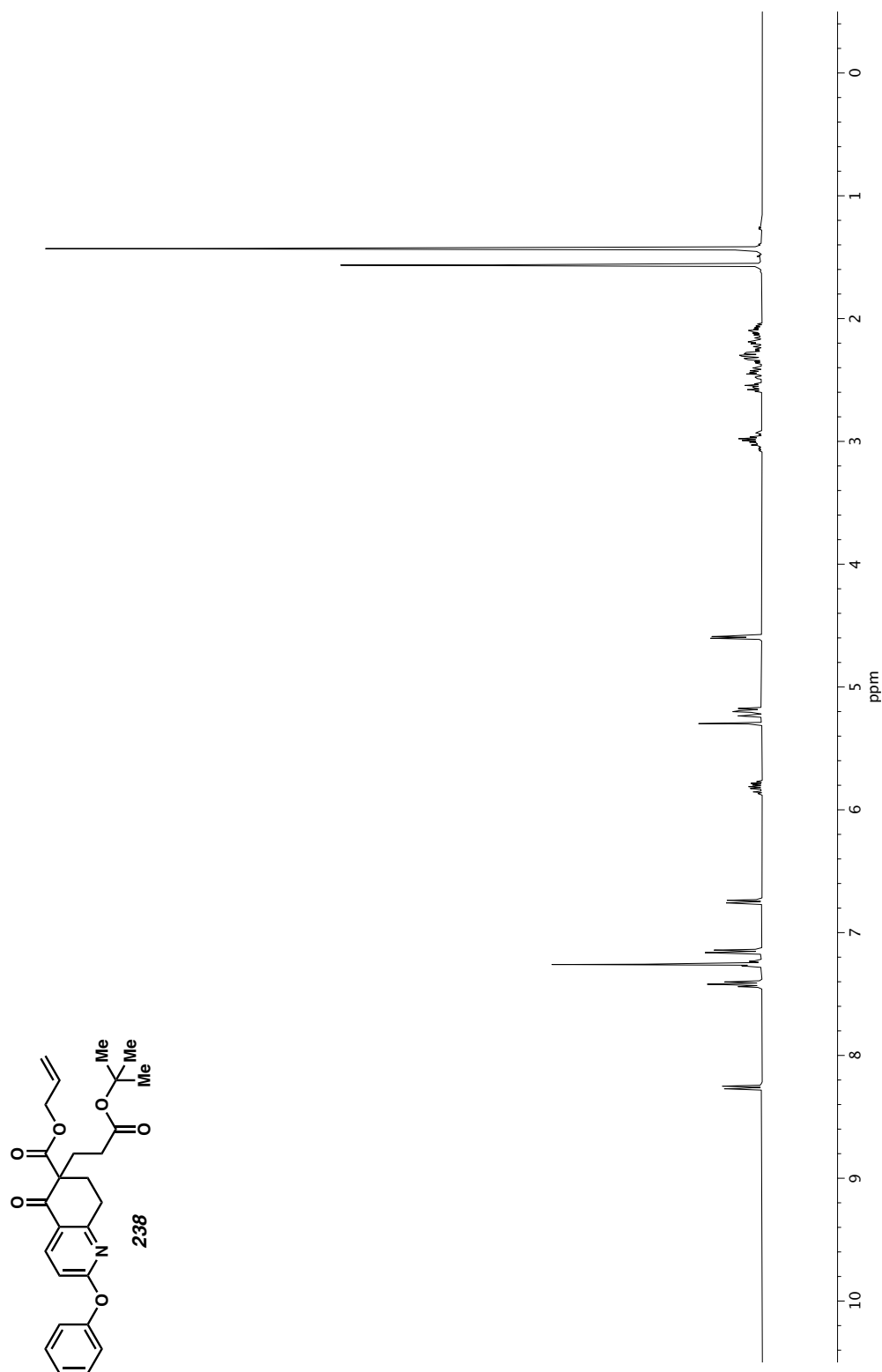


Figure A5.129 ¹H NMR (400 MHz, CDCl₃) of compound 238.

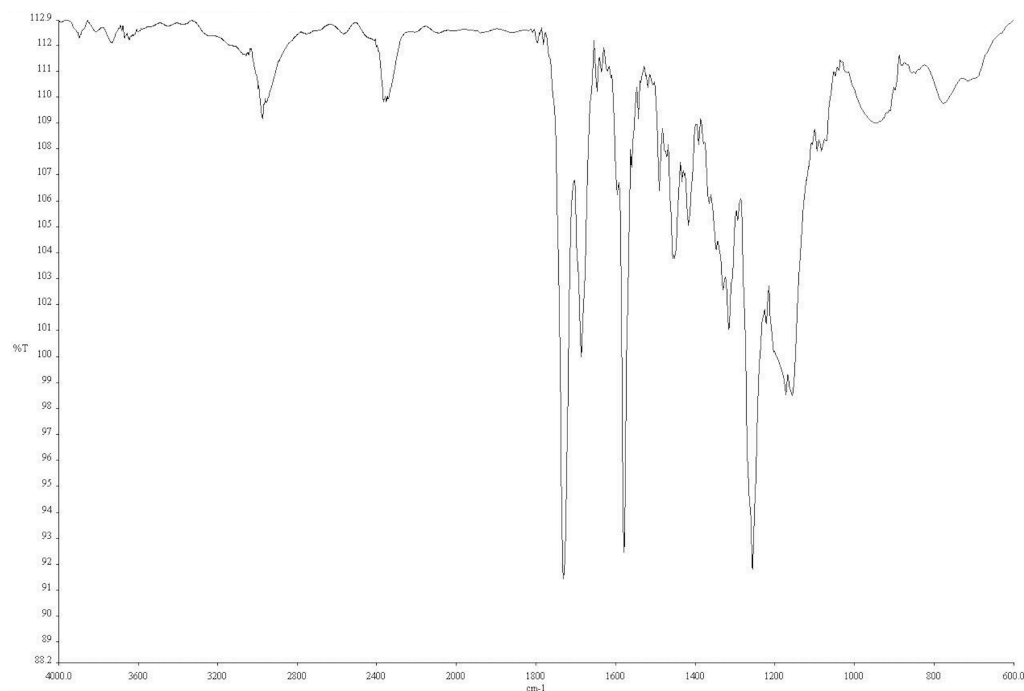


Figure A5.130 Infrared spectrum (Thin Film, NaCl) of compound **238**.

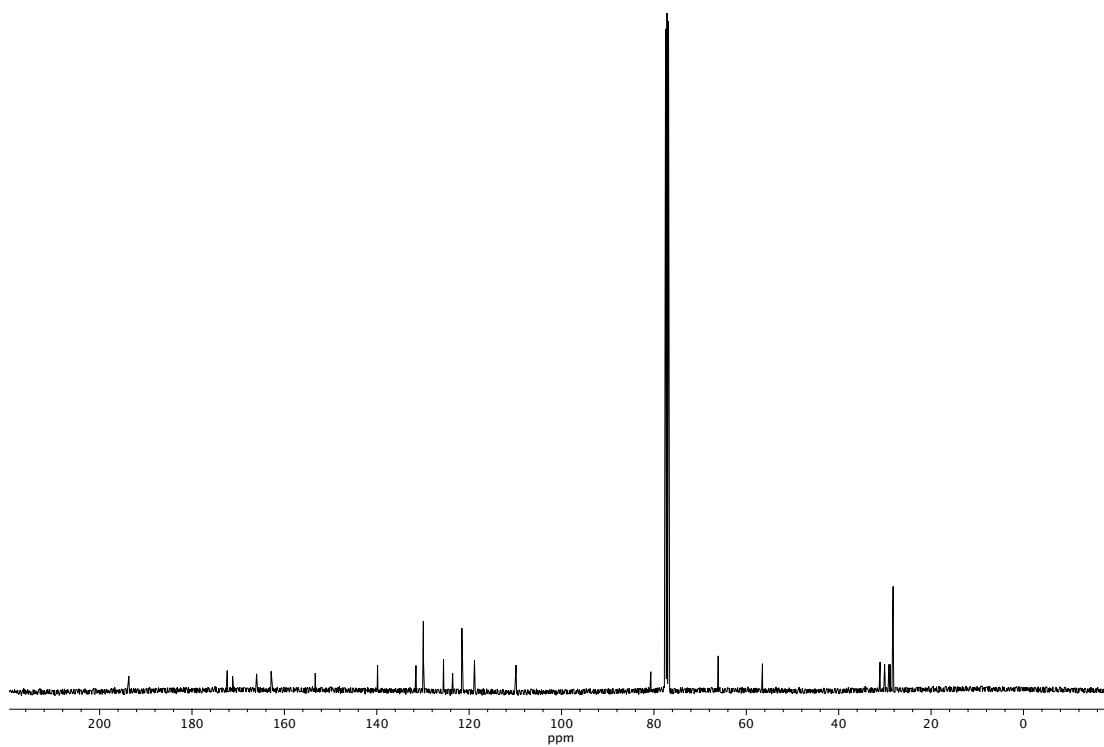


Figure A5.131 ¹³C NMR (100 MHz, CDCl₃) of compound **238**.

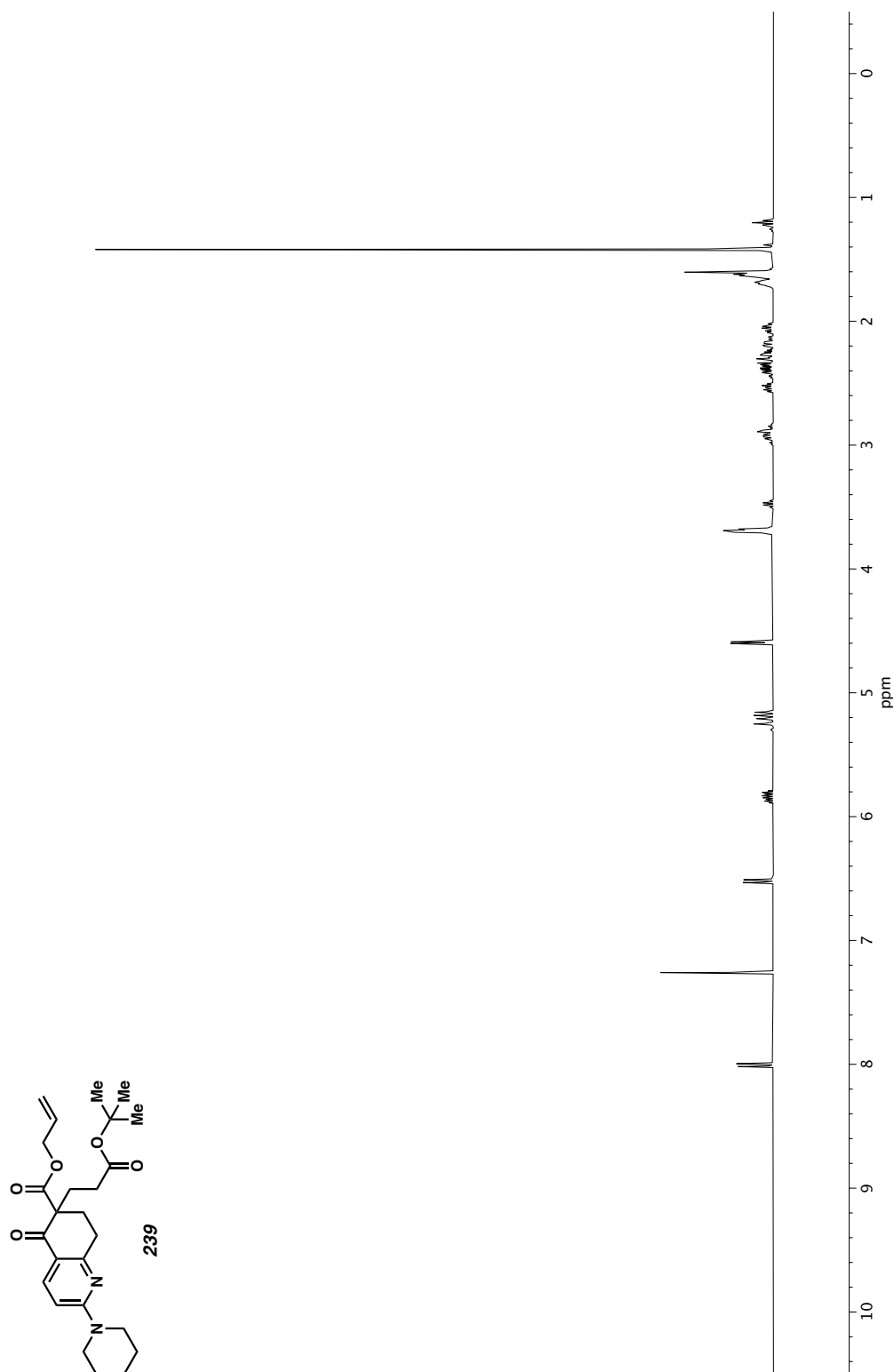


Figure A5.132 ^1H NMR (400 MHz, CDCl_3) of compound 239.

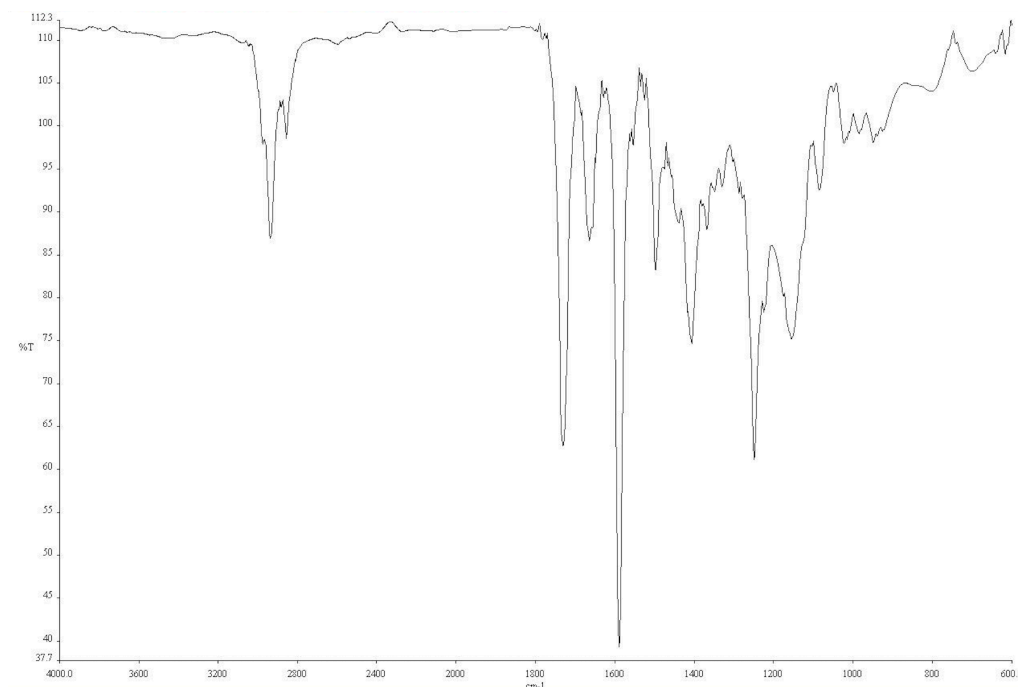


Figure A5.133 Infrared spectrum (Thin Film, NaCl) of compound **239**.

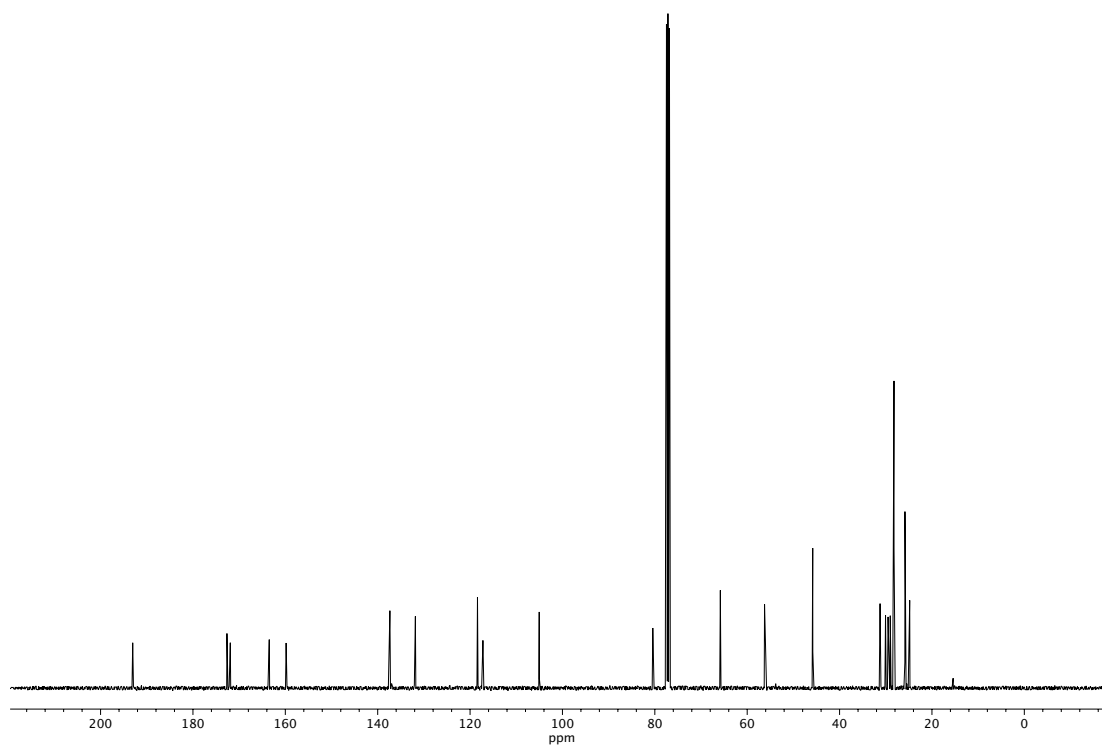


Figure A5.134 ¹³C NMR (100 MHz, CDCl₃) of compound **239**.

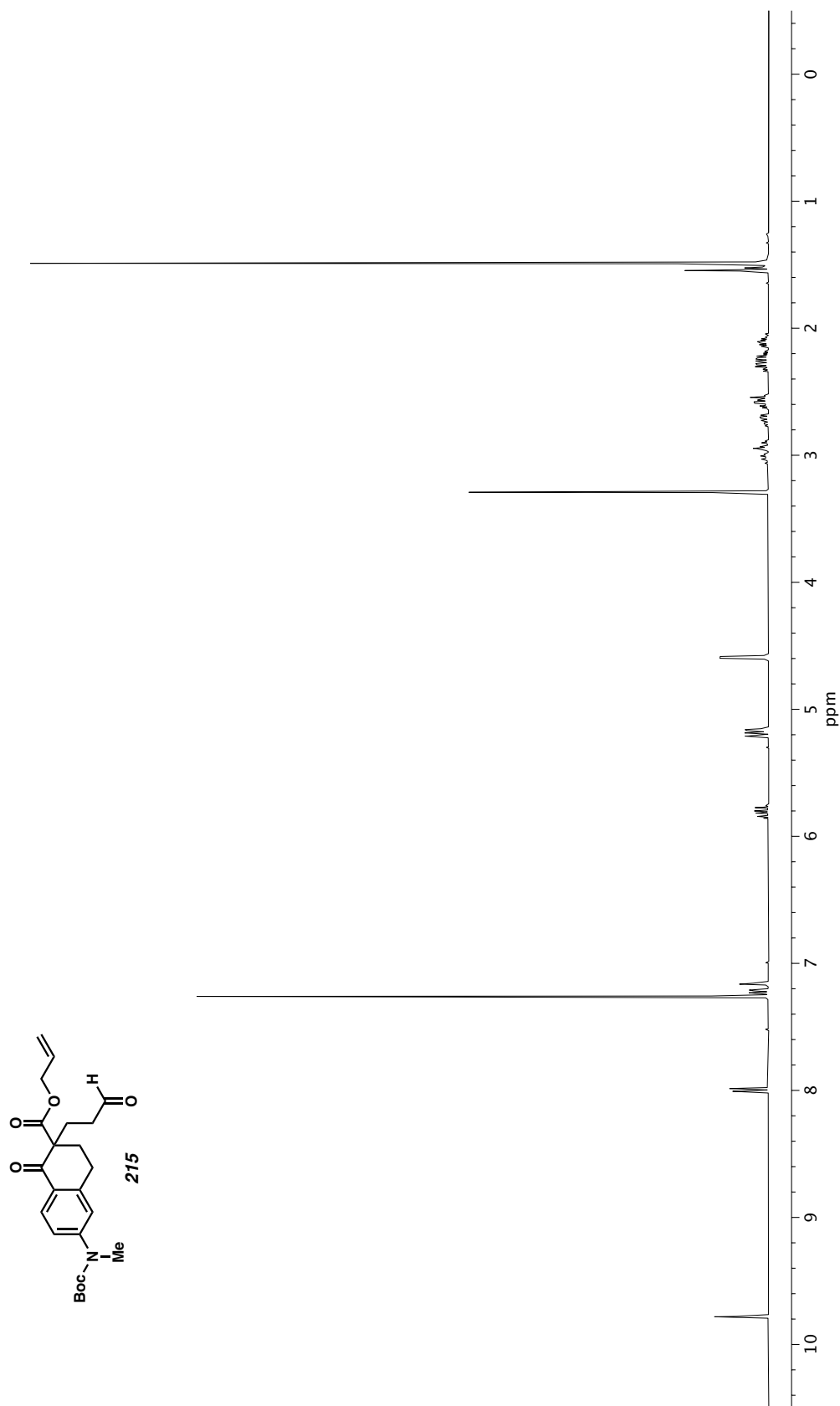


Figure A5.135 ¹H NMR (400 MHz, CDCl₃) of compound **215**.

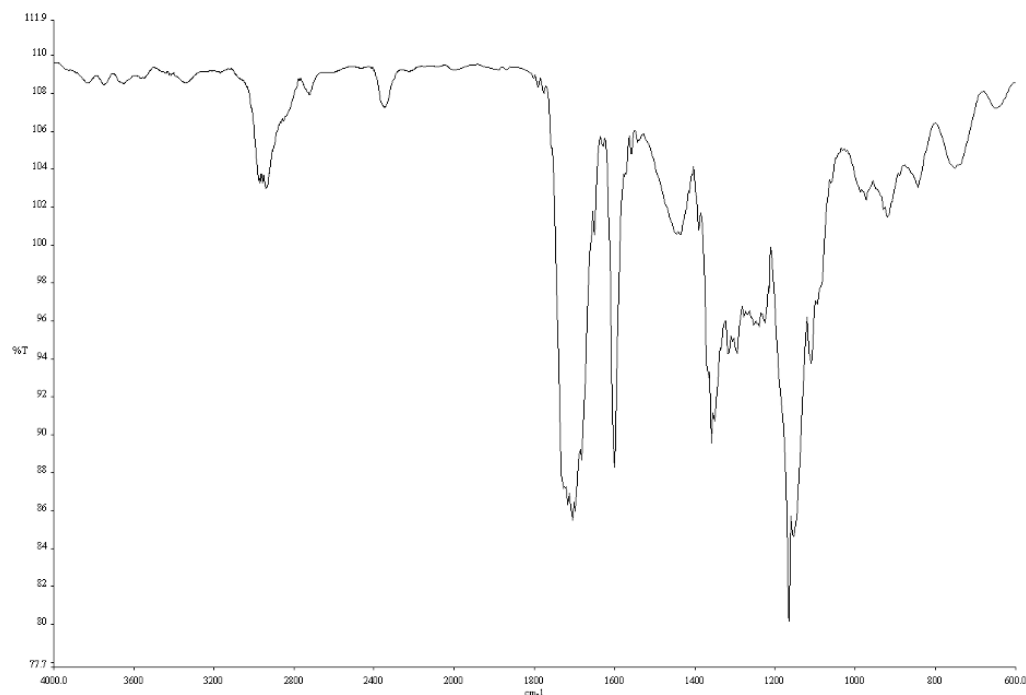


Figure A5.136 Infrared spectrum (Thin Film, NaCl) of compound **215**.

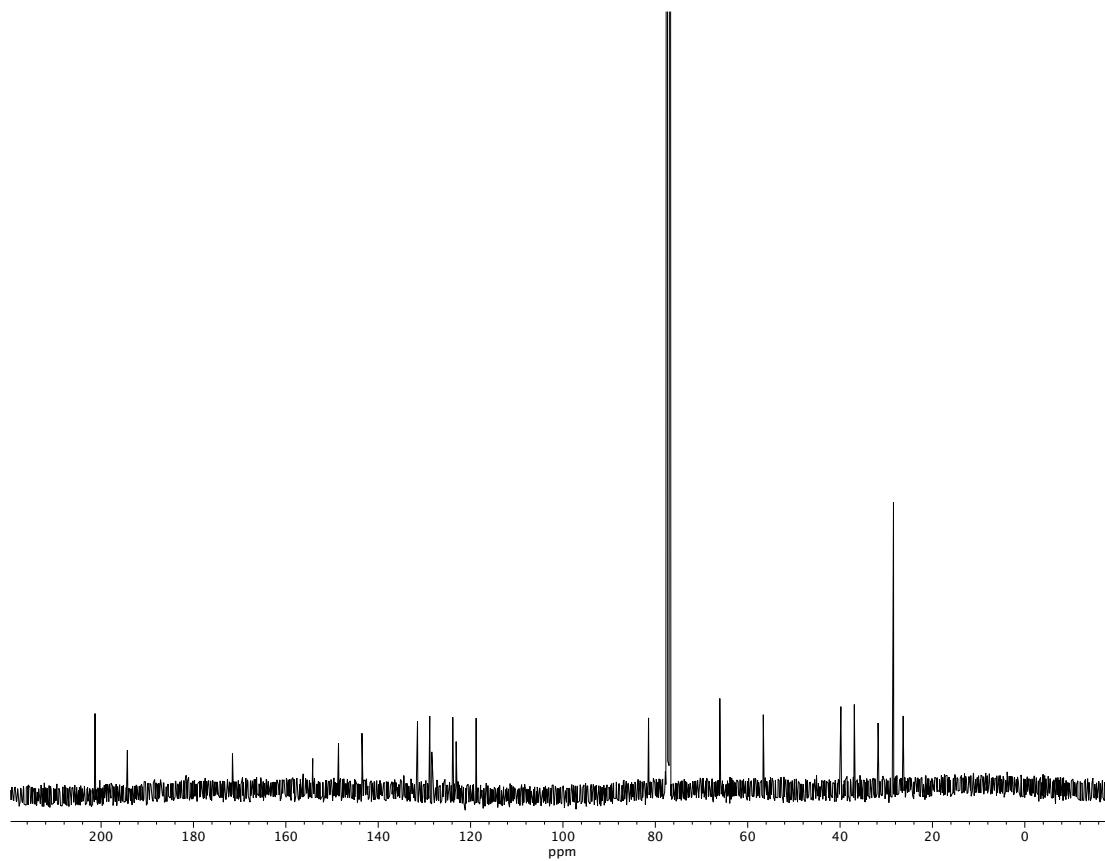


Figure A5.137 ¹³C NMR (100 MHz, CDCl₃) of compound **215**.

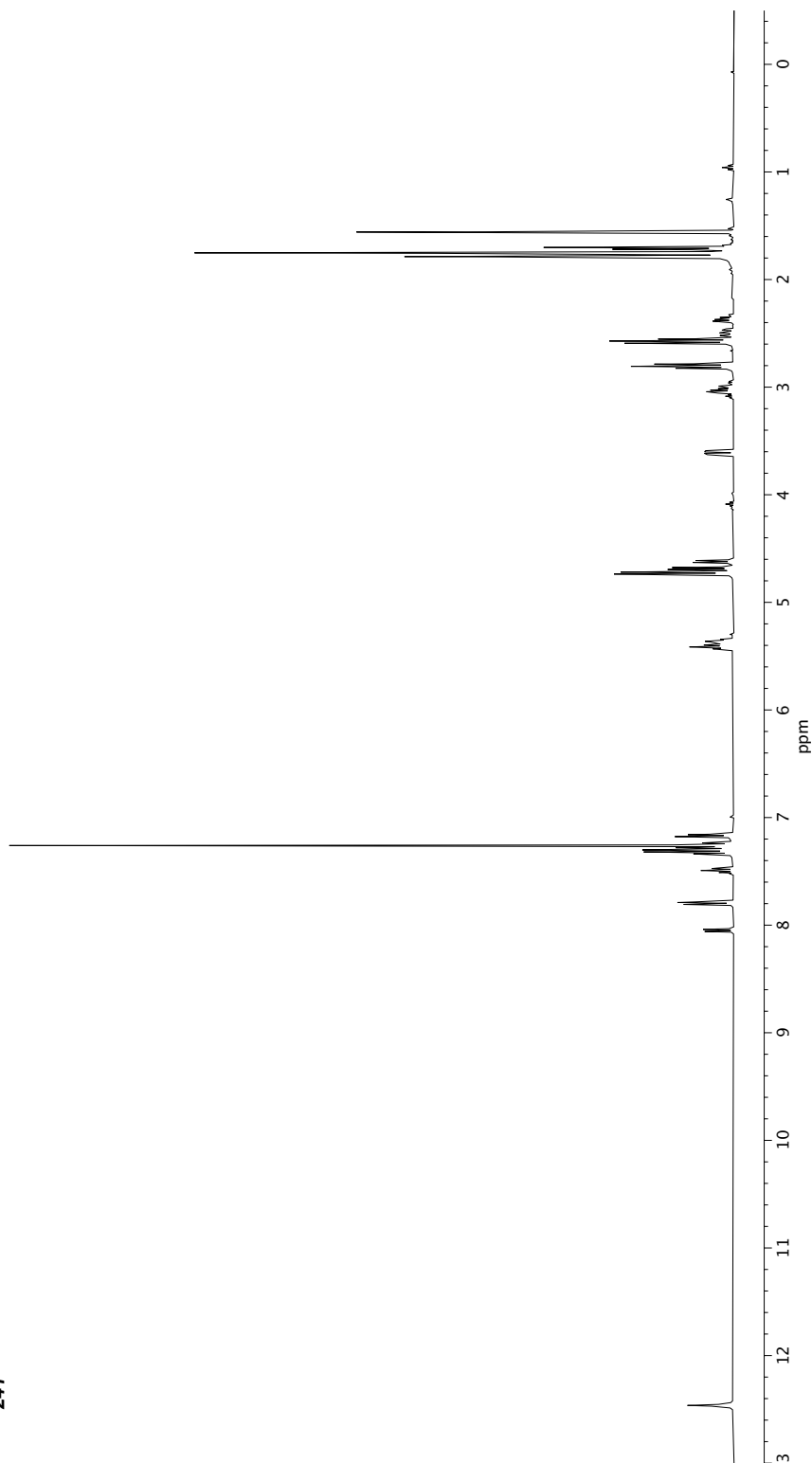
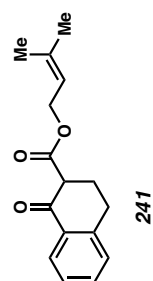


Figure A5.138 ^1H NMR (400 MHz, CDCl_3) of compound **241**.

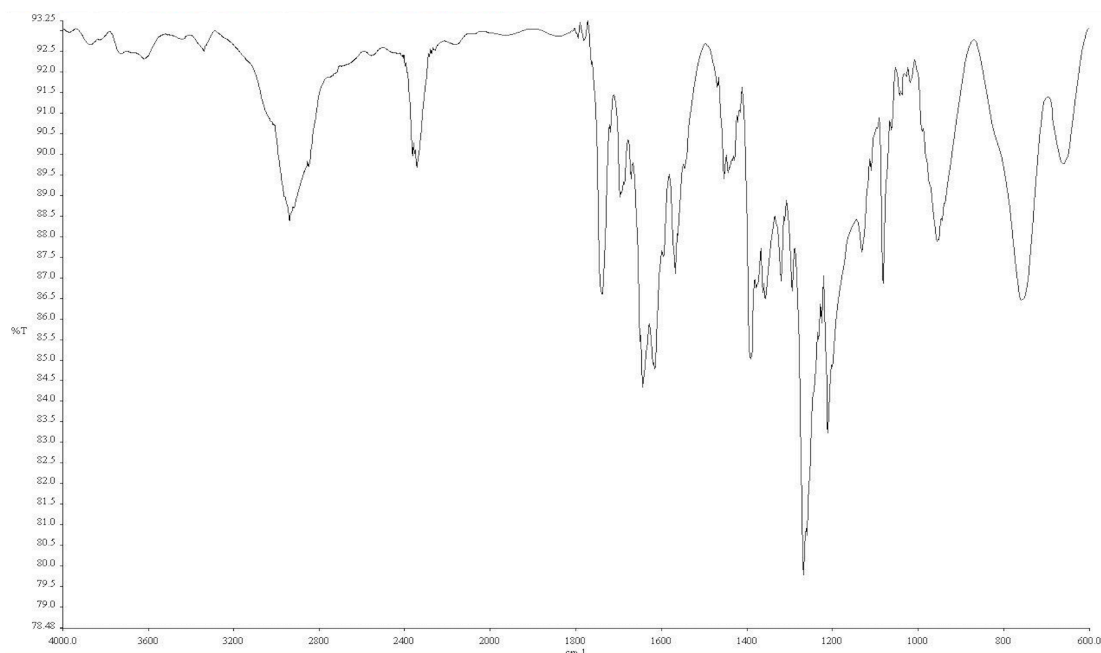


Figure A5.139 Infrared spectrum (Thin Film, NaCl) of compound **241**.

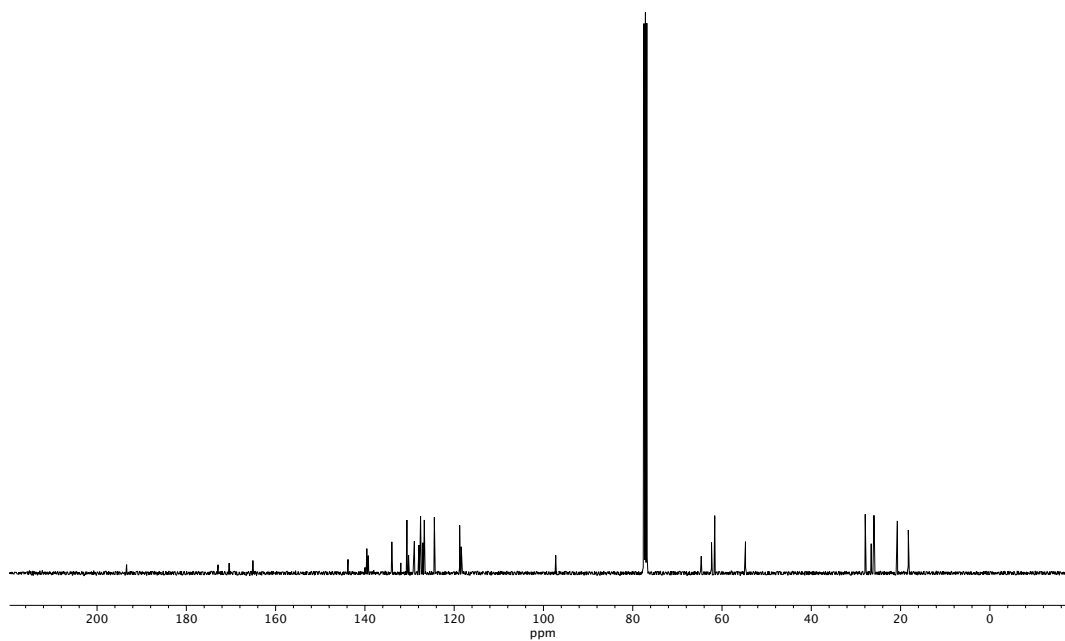


Figure A5.140 ¹³C NMR (100 MHz, CDCl₃) of compound **241**.

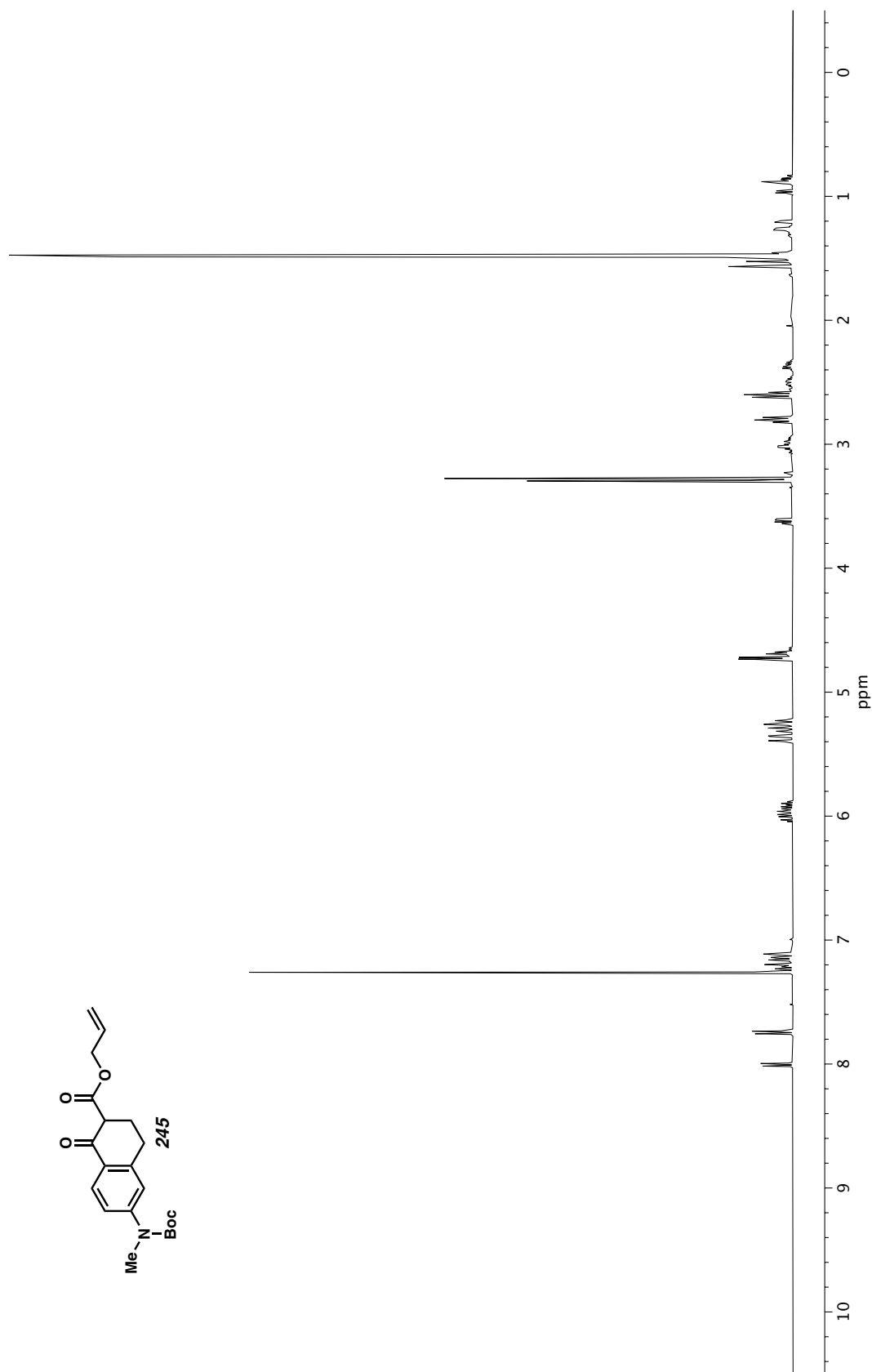


Figure A5.141 ^1H NMR (400 MHz, CDCl_3) of compound 245.

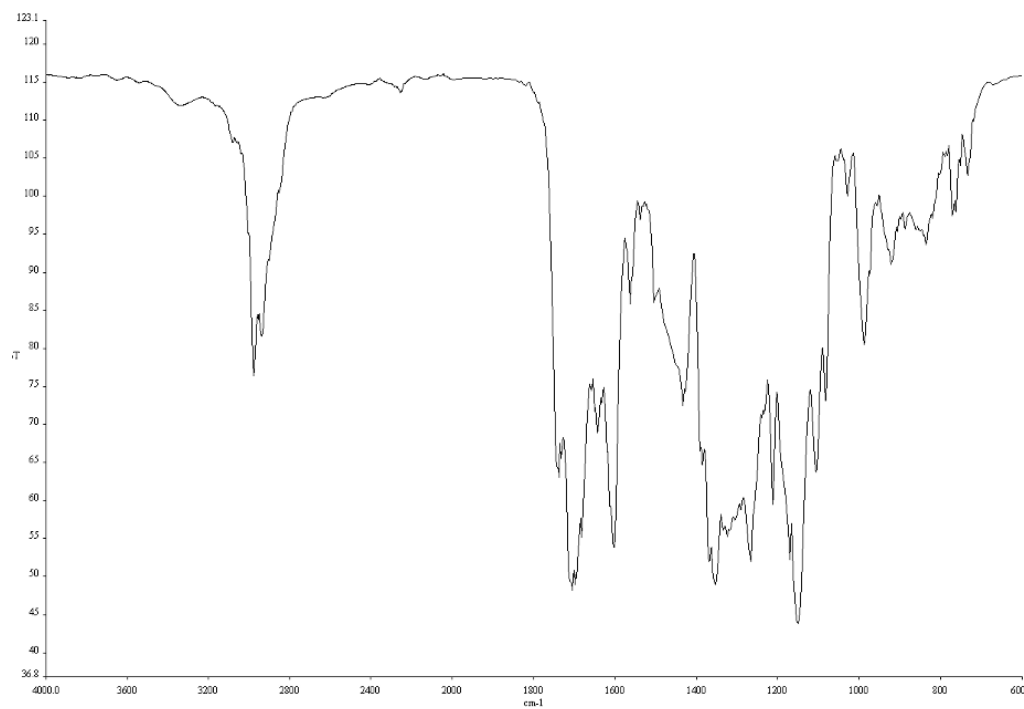


Figure A5.142 Infrared spectrum (Thin Film, NaCl) of compound **245**.

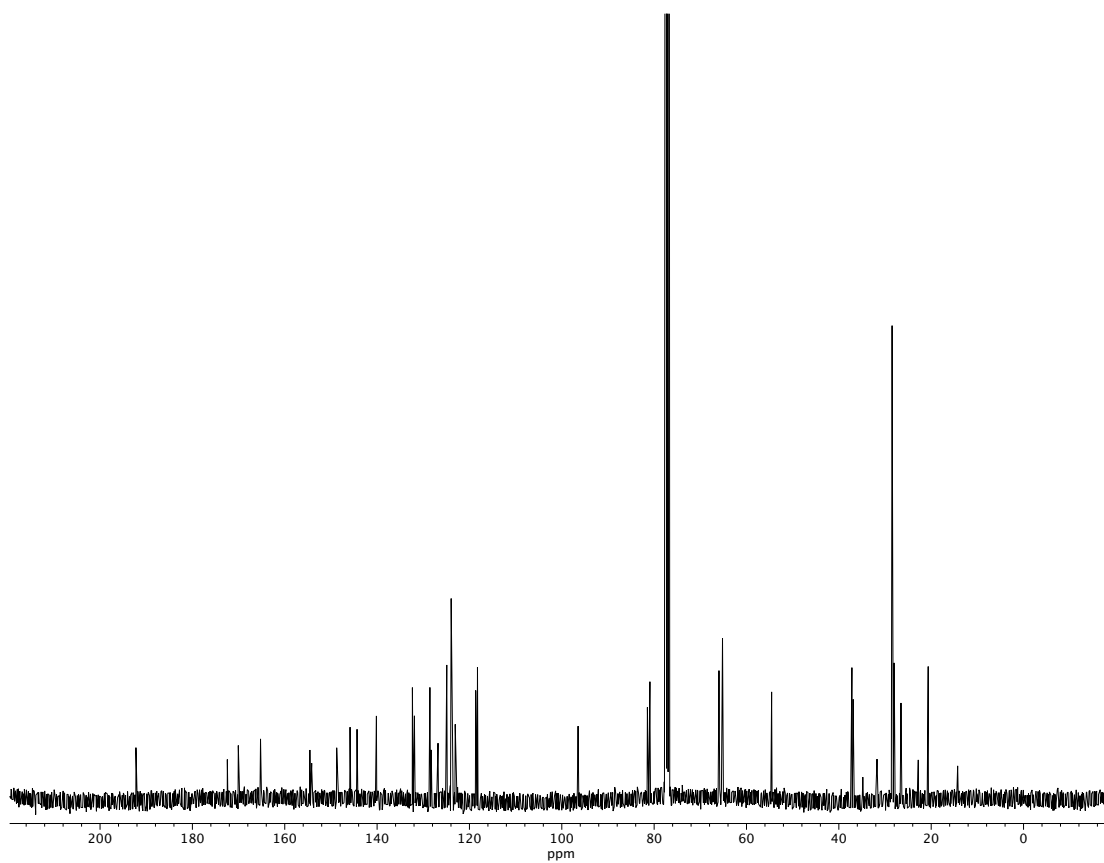


Figure A5.143 ¹³C NMR (100 MHz, CDCl₃) of compound **245**.

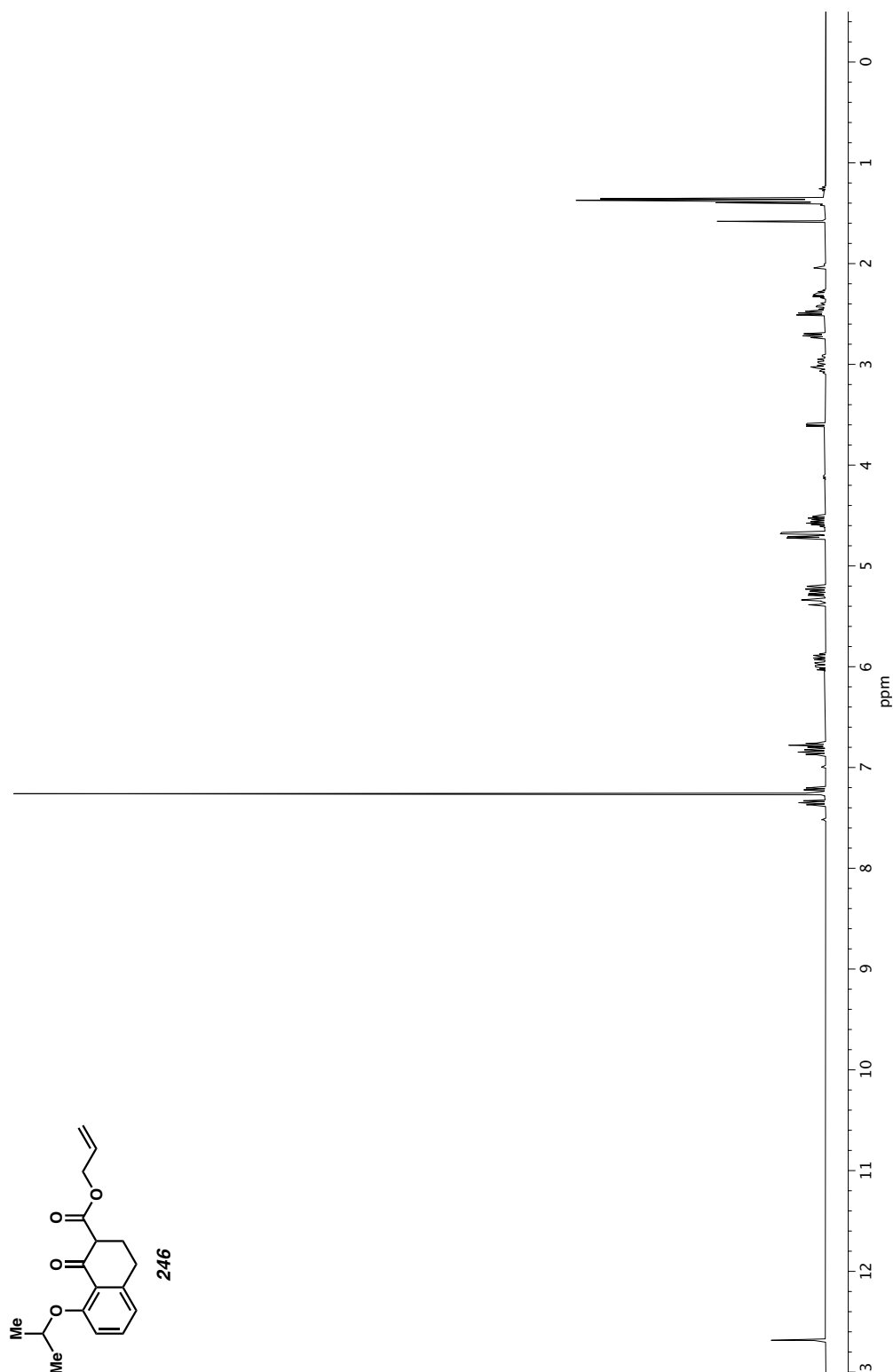


Figure A5.144 ^1H NMR (400 MHz, CDCl_3) of compound **246**.

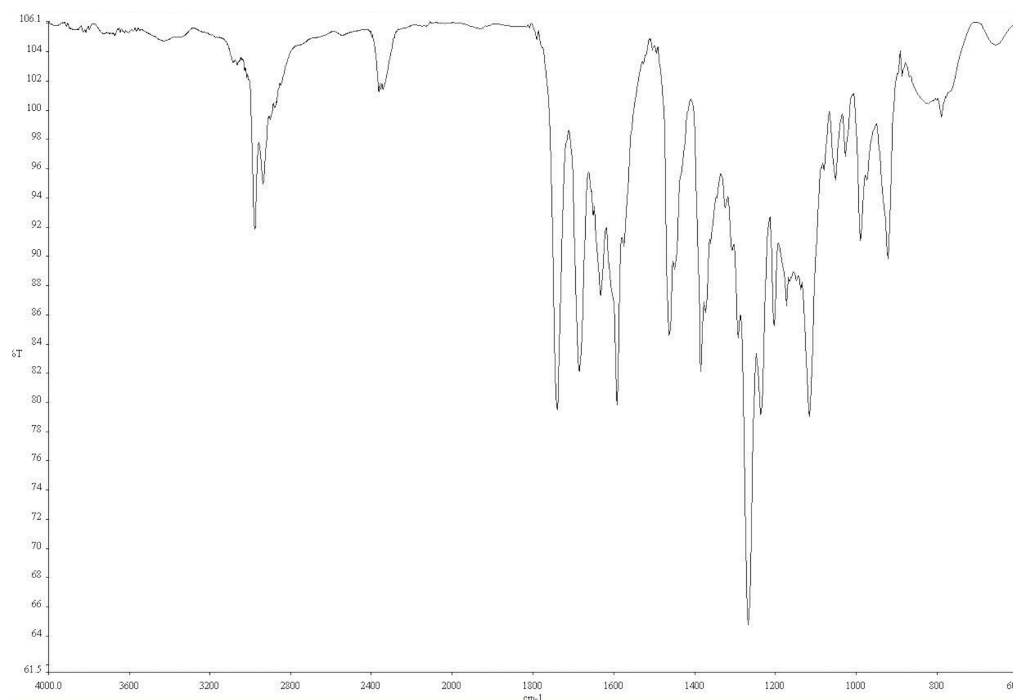


Figure A5.145 Infrared spectrum (Thin Film, NaCl) of compound **246**.

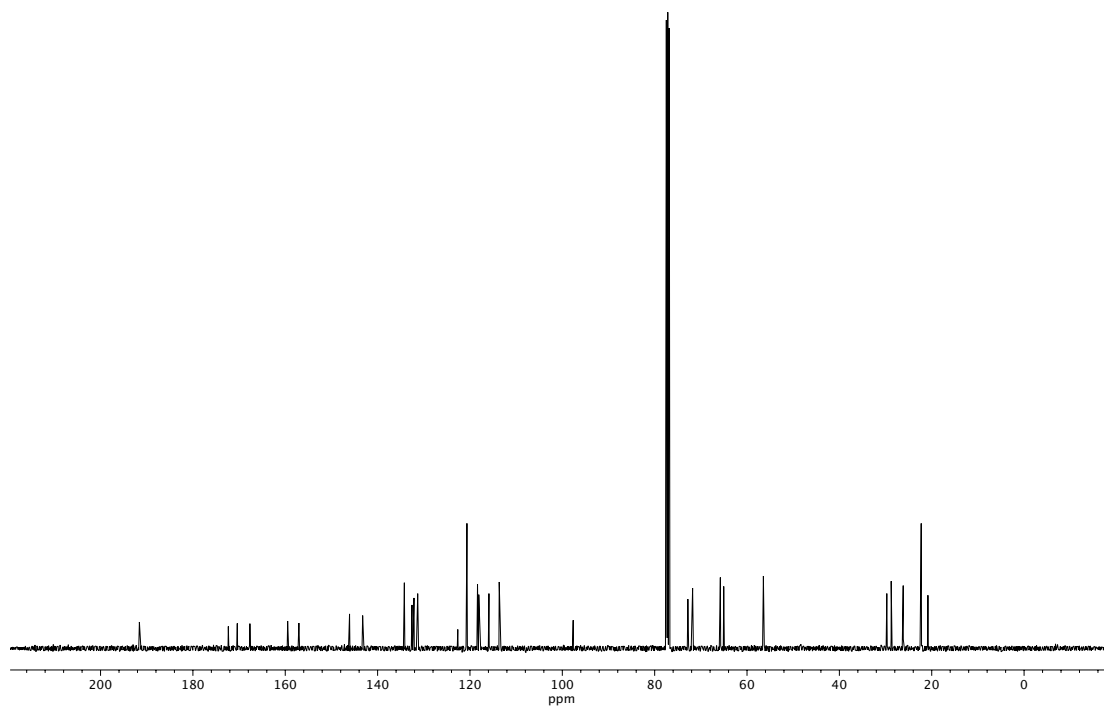


Figure A5.146 ¹³C NMR (100 MHz, CDCl₃) of compound **246**.

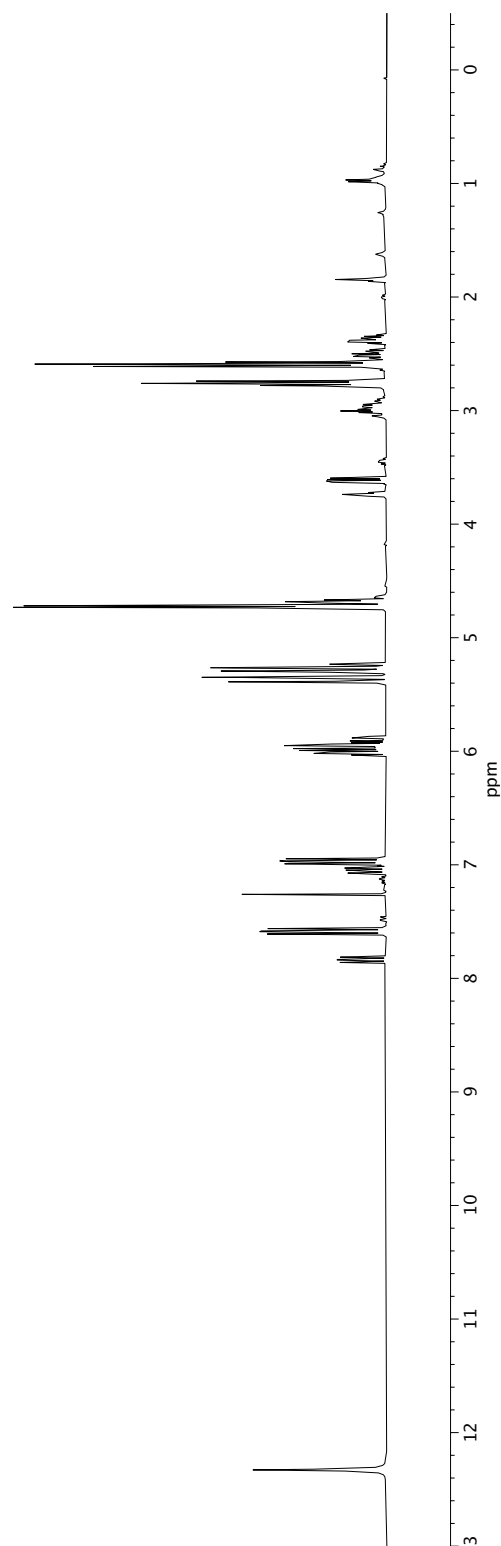
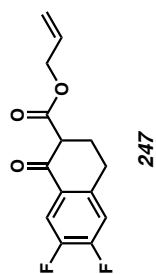


Figure A5.147 ^1H NMR (400 MHz, CDCl_3) of compound **247**.

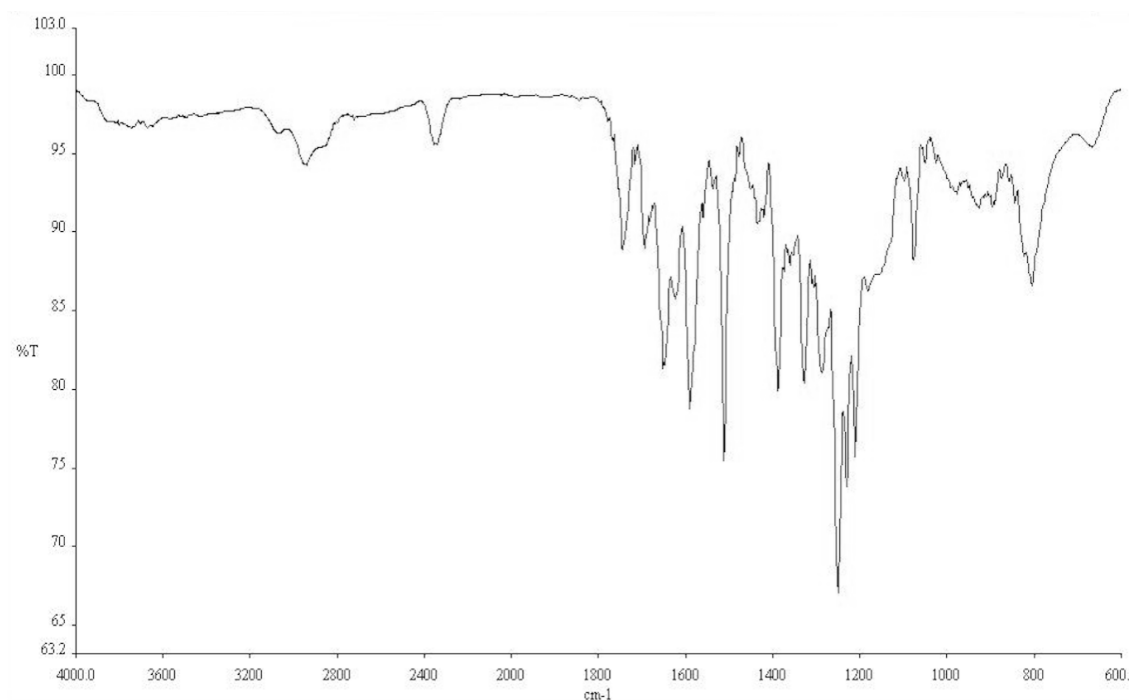


Figure A5.148 Infrared spectrum (Thin Film, NaCl) of compound **247**.

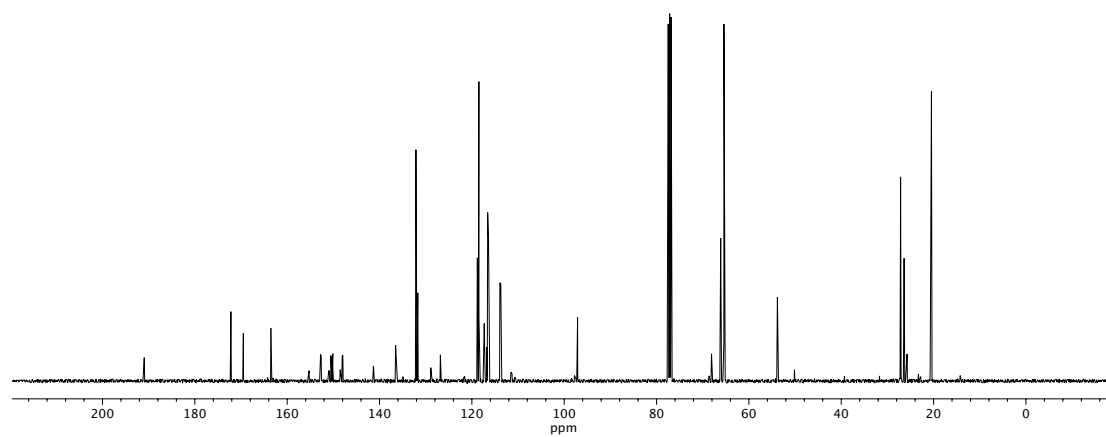


Figure A5.149 ¹³C NMR (100 MHz, CDCl₃) of compound **247**.

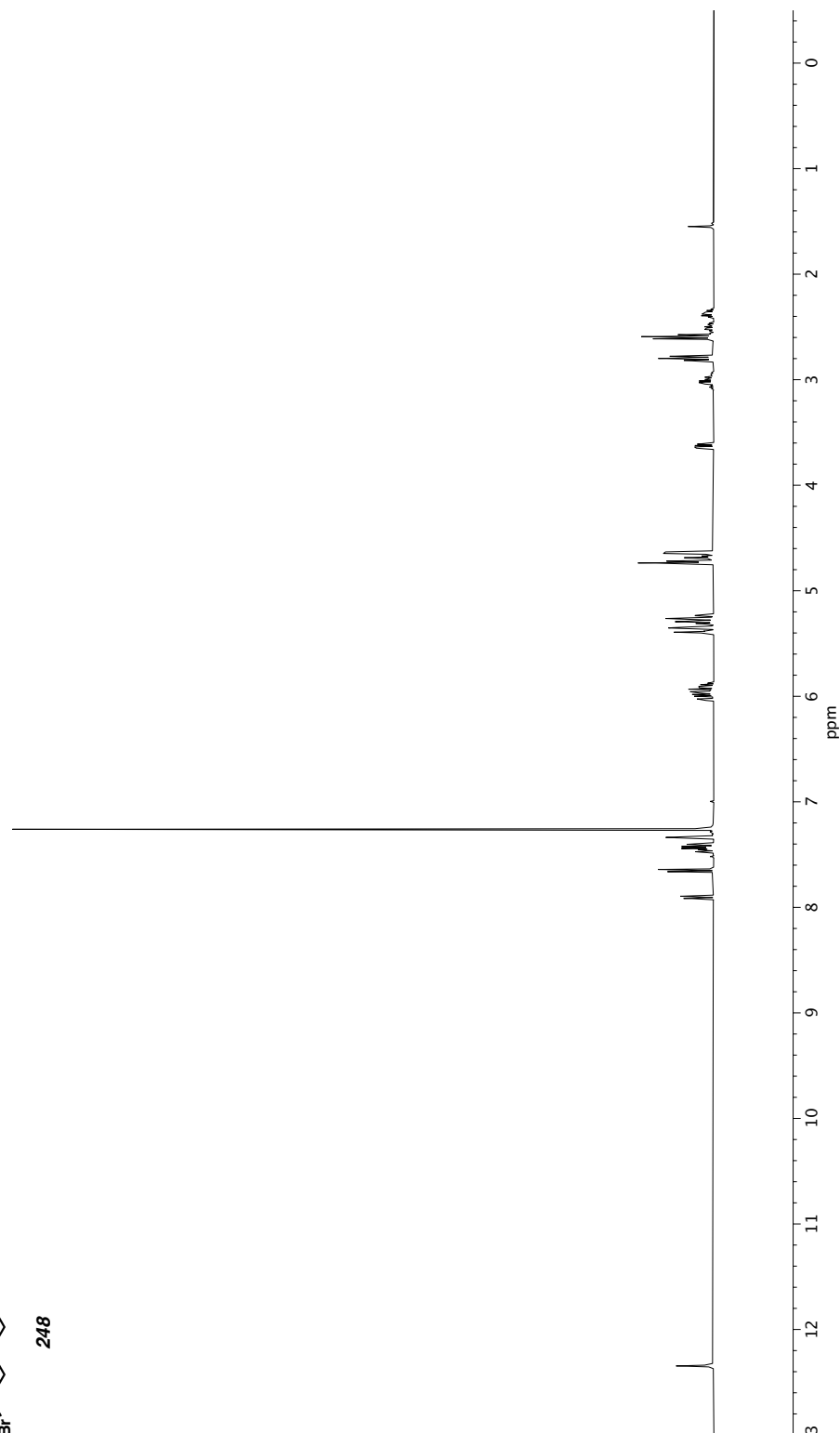
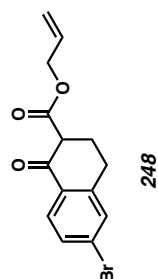


Figure A5.150 ^1H NMR (400 MHz, CDCl_3) of compound **248**.

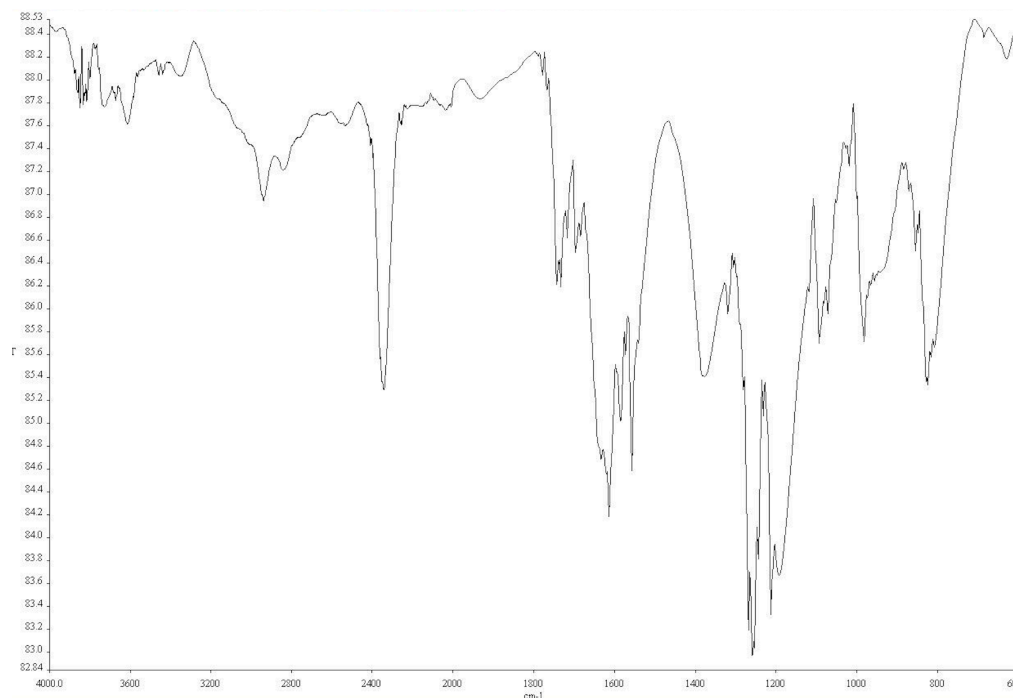


Figure A5.151 Infrared spectrum (Thin Film, NaCl) of compound **248**.

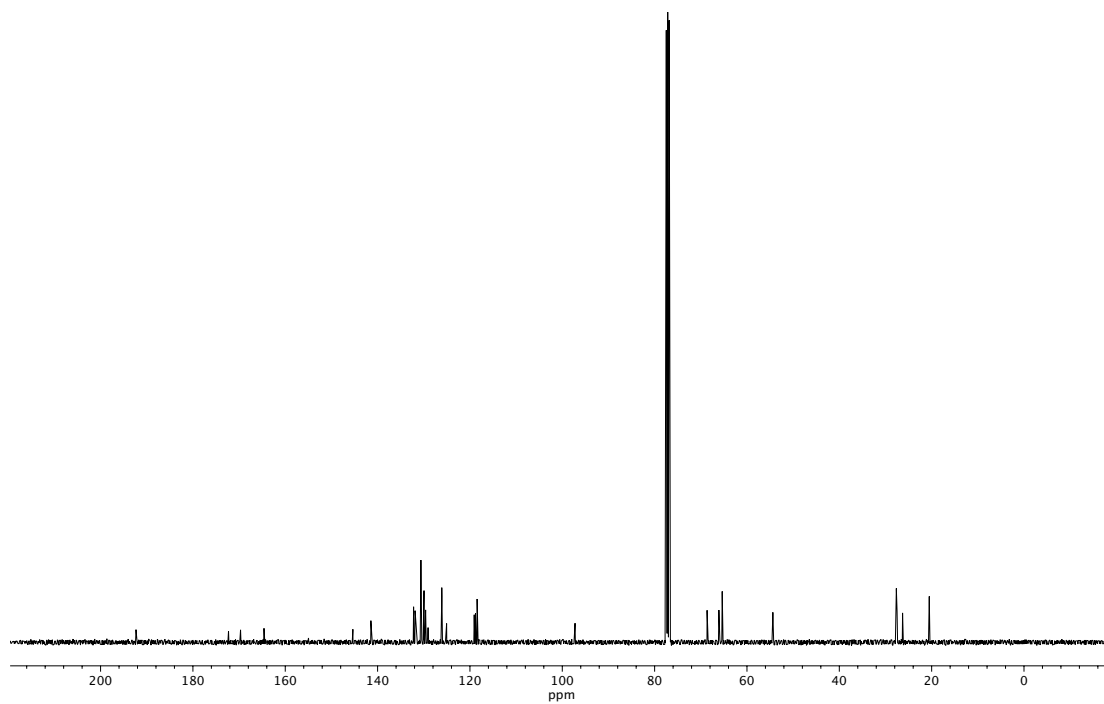
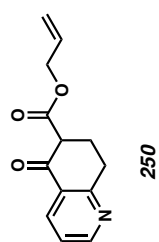


Figure A5.152 ¹³C NMR (100 MHz, CDCl₃) of compound **248**.



250

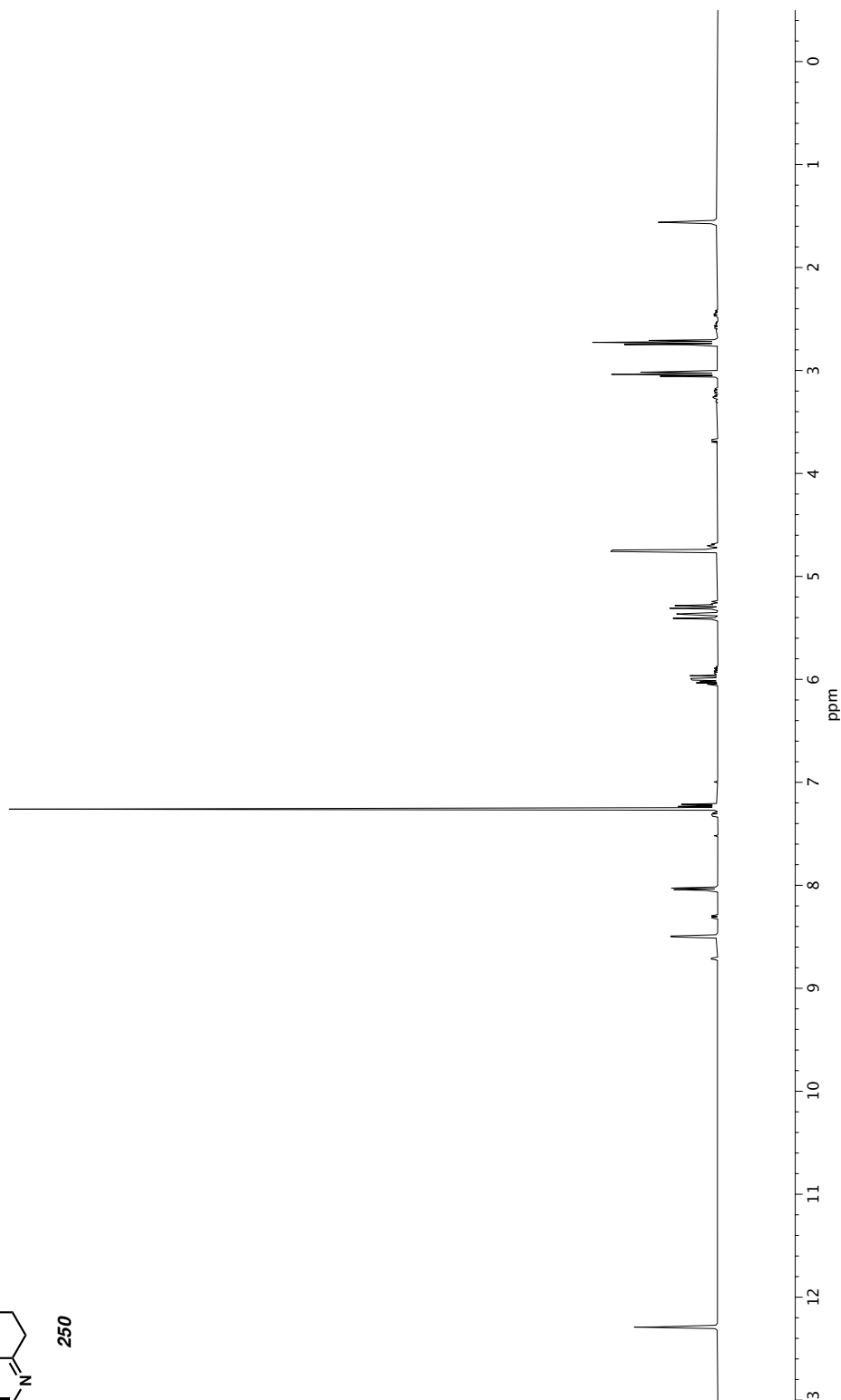


Figure A5.153 ¹H NMR (400 MHz, CDCl₃) of compound 250.

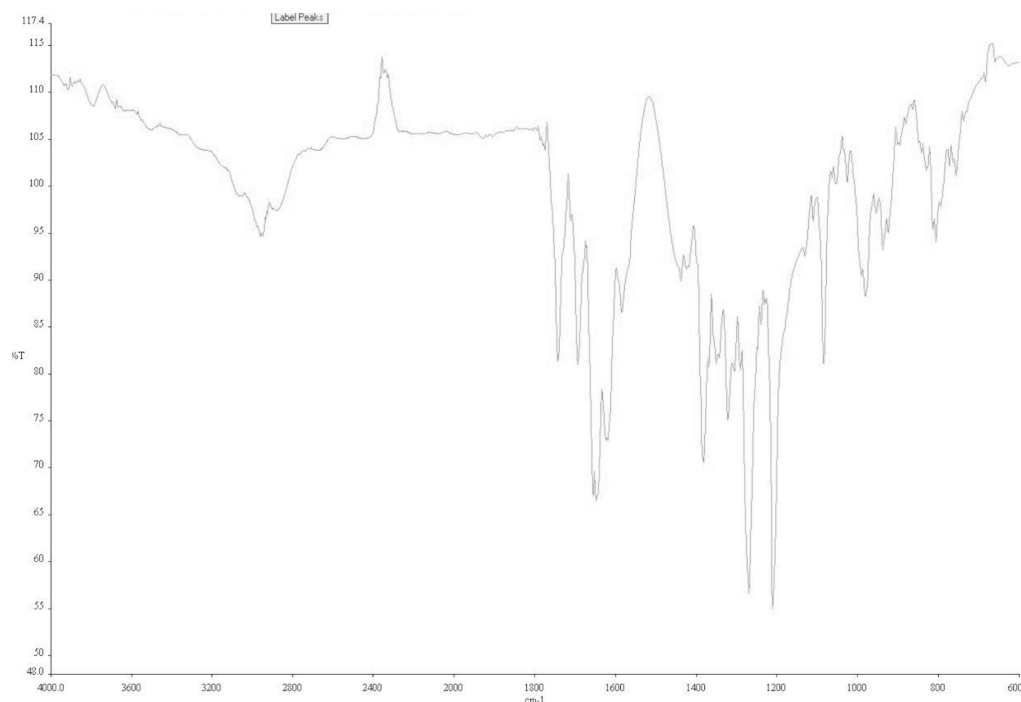


Figure A5.154 Infrared spectrum (Thin Film, NaCl) of compound **250**.

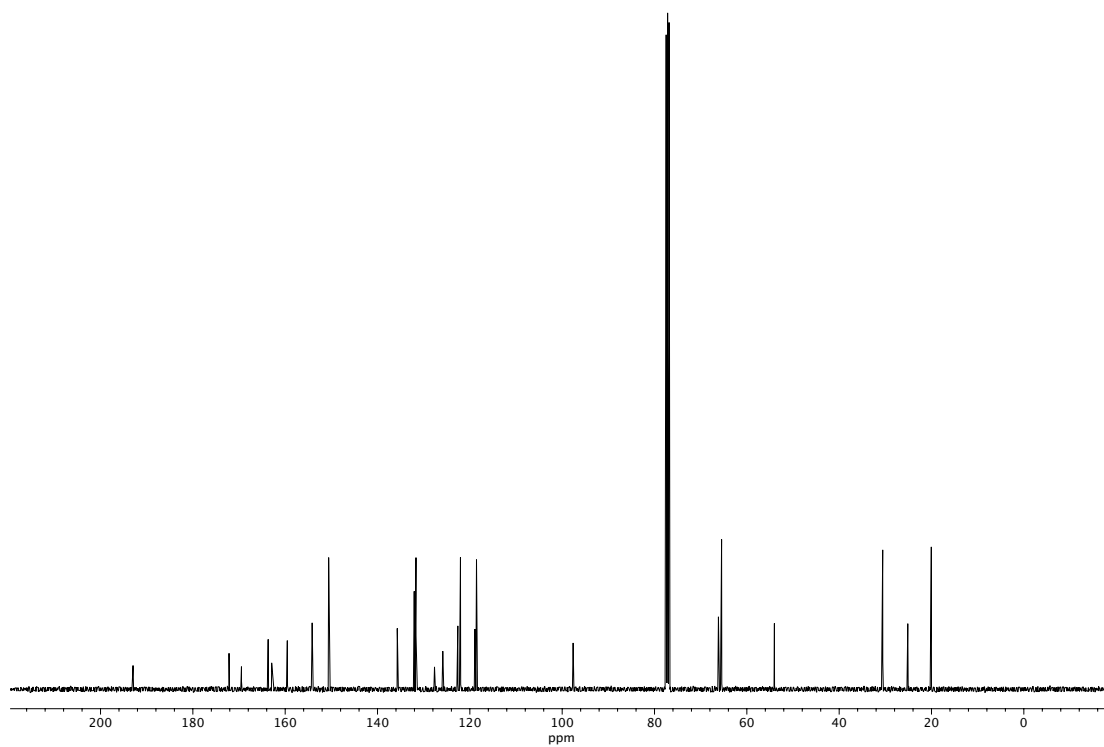


Figure A5.155 ¹³C NMR (100 MHz, CDCl₃) of compound **250**.

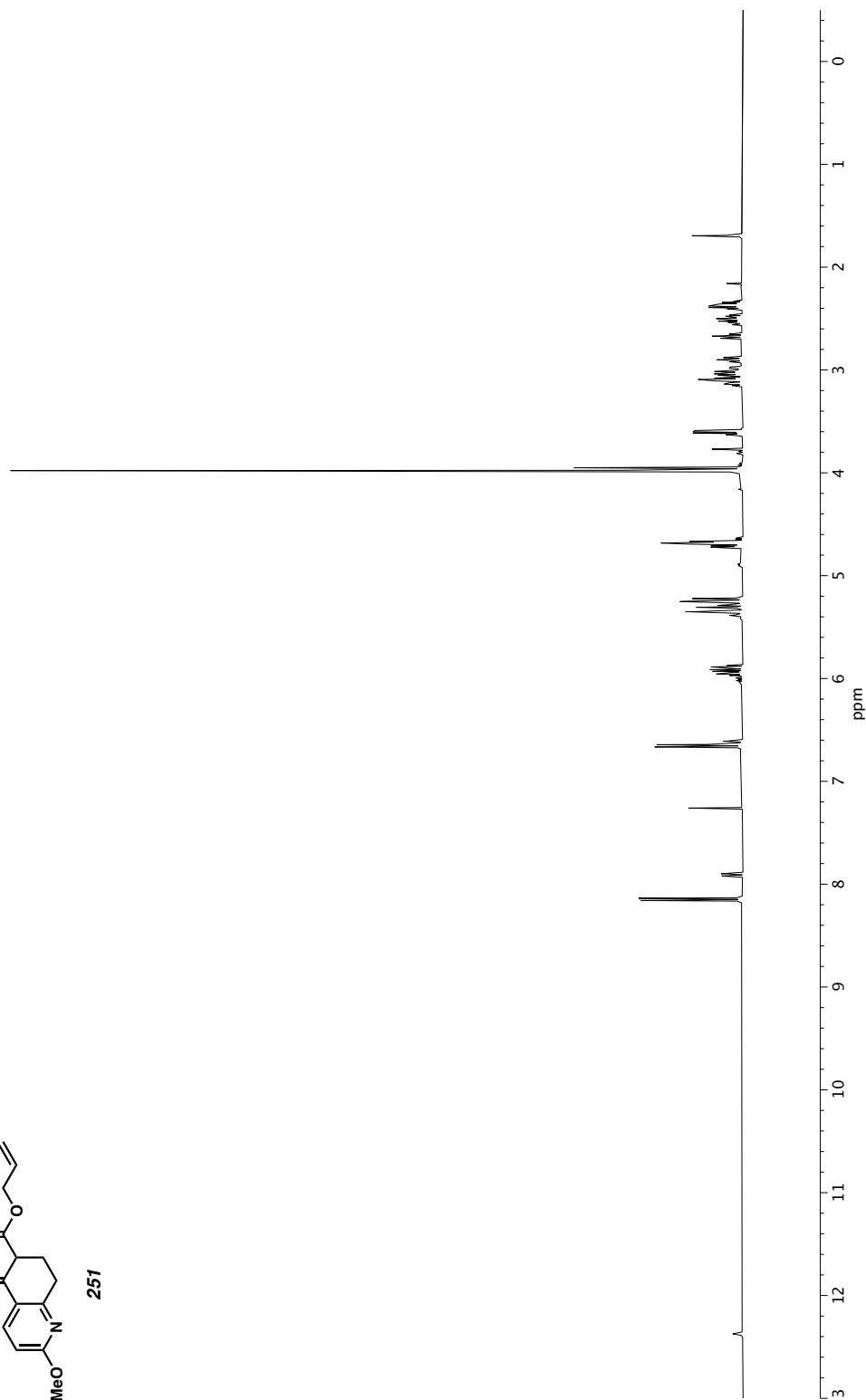
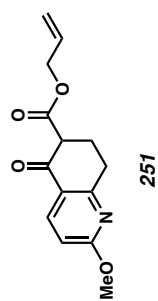


Figure A5.156 ¹H NMR (400 MHz, CDCl₃) of compound **251**.

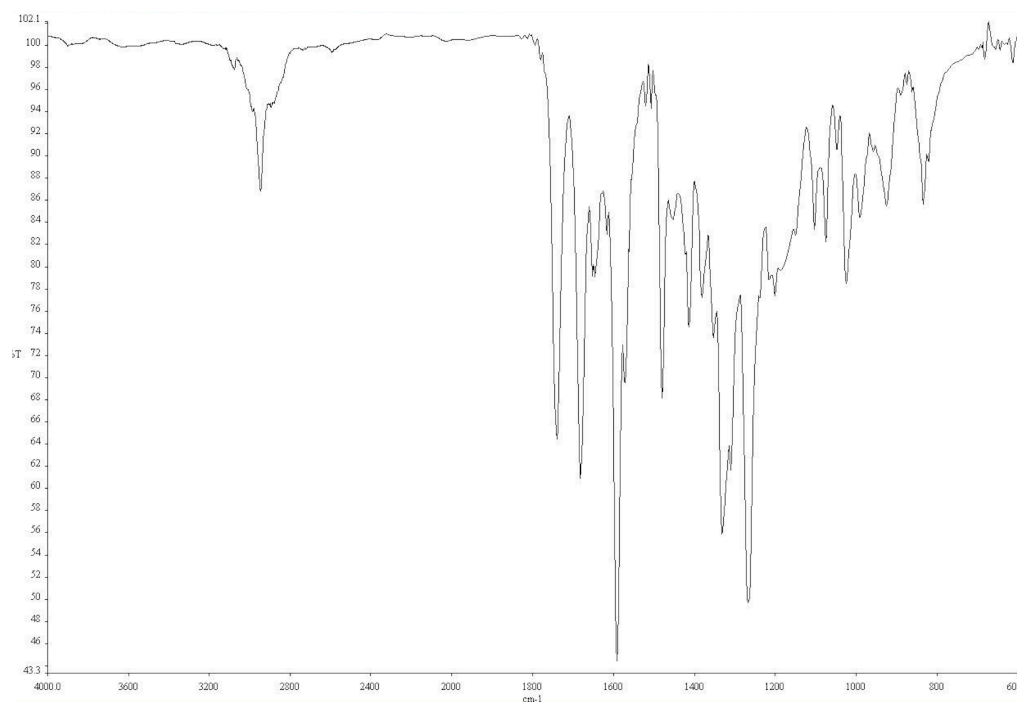


Figure A5.157 Infrared spectrum (Thin Film, NaCl) of compound **251**.

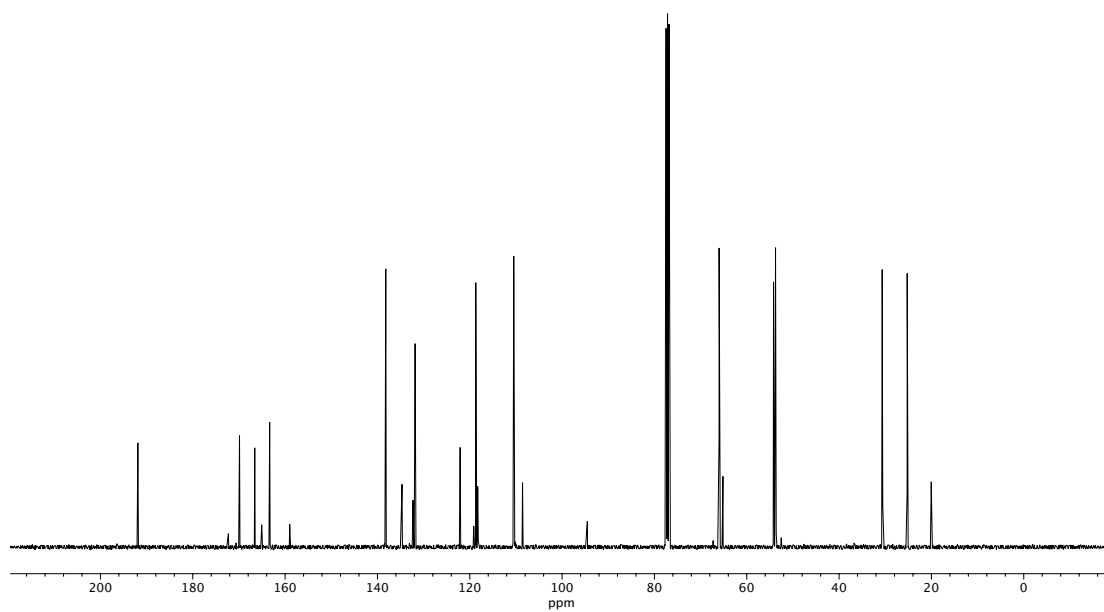


Figure A5.158 ¹³C NMR (100 MHz, CDCl₃) of compound **251**.

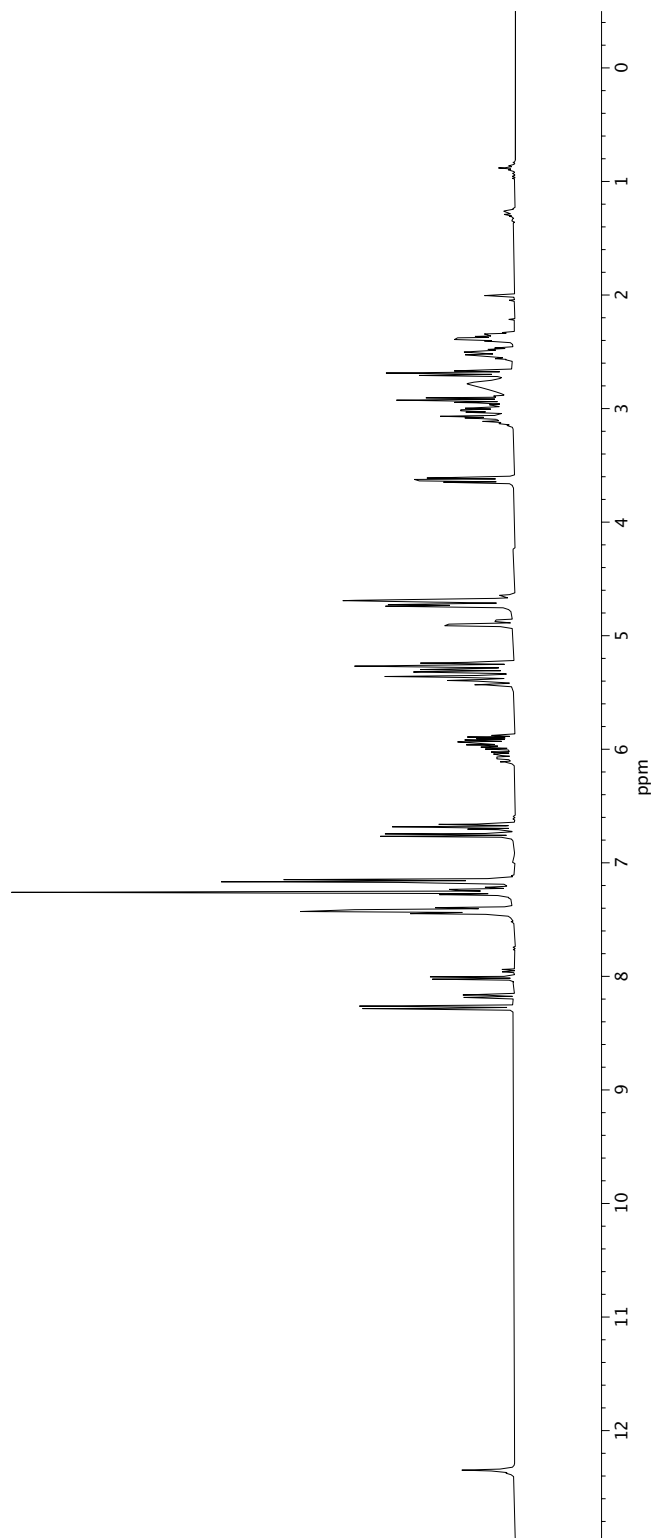
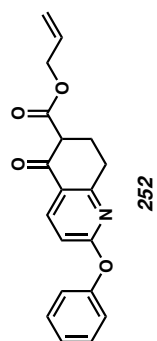


Figure A5.159 ^1H NMR (400 MHz, CDCl_3) of compound **252**.



Figure A5.160 Infrared spectrum (Thin Film, NaCl) of compound **252**.

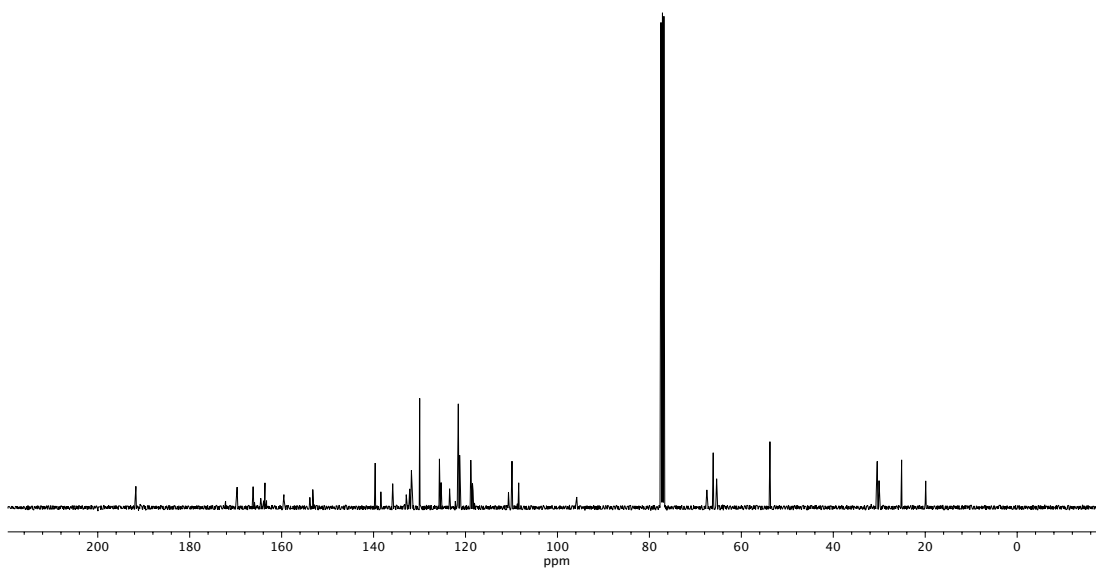
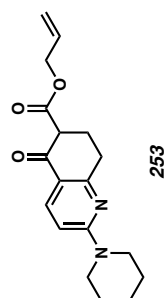


Figure A5.161 ¹³C NMR (100 MHz, CDCl₃) of compound **252**.



253

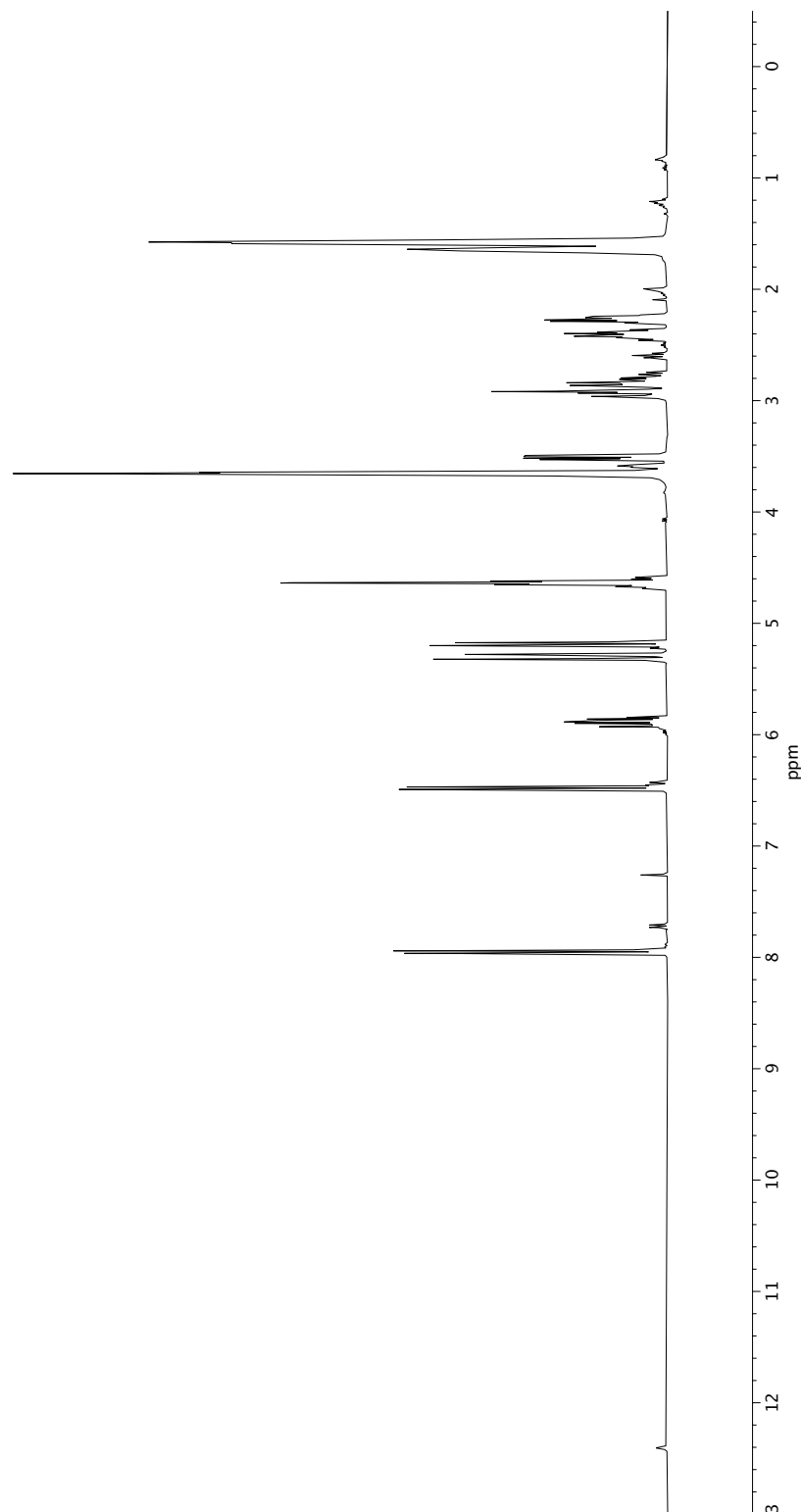


Figure A5.162 ¹H NMR (400 MHz, CDCl₃) of compound 253.

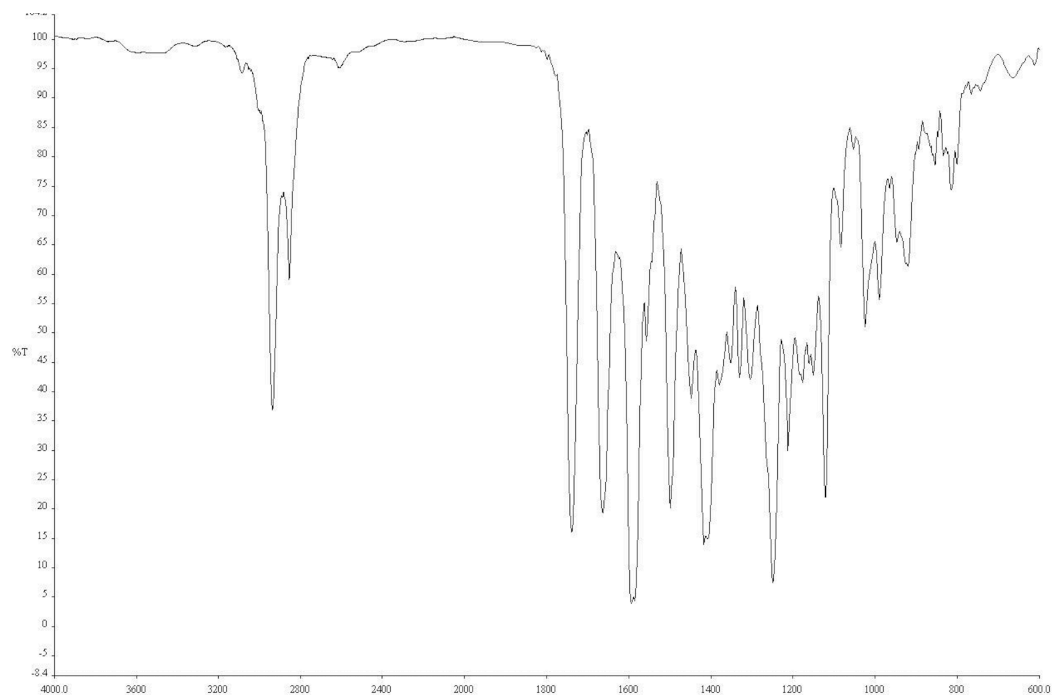


Figure A5.163 Infrared spectrum (Thin Film, NaCl) of compound **253**.

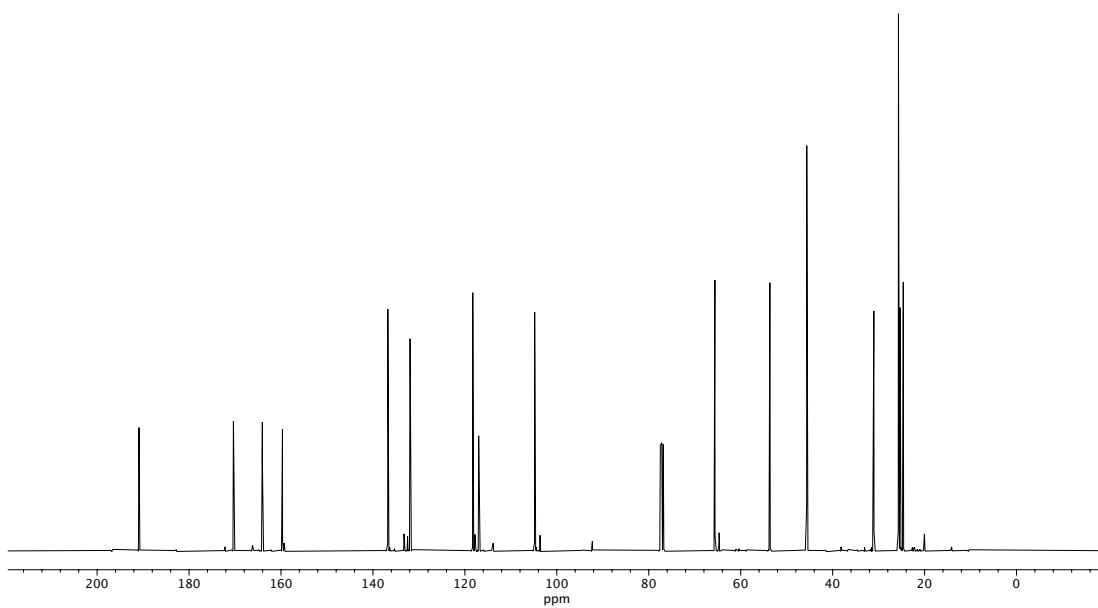


Figure A5.164 ¹³C NMR (100 MHz, CDCl₃) of compound **253**.

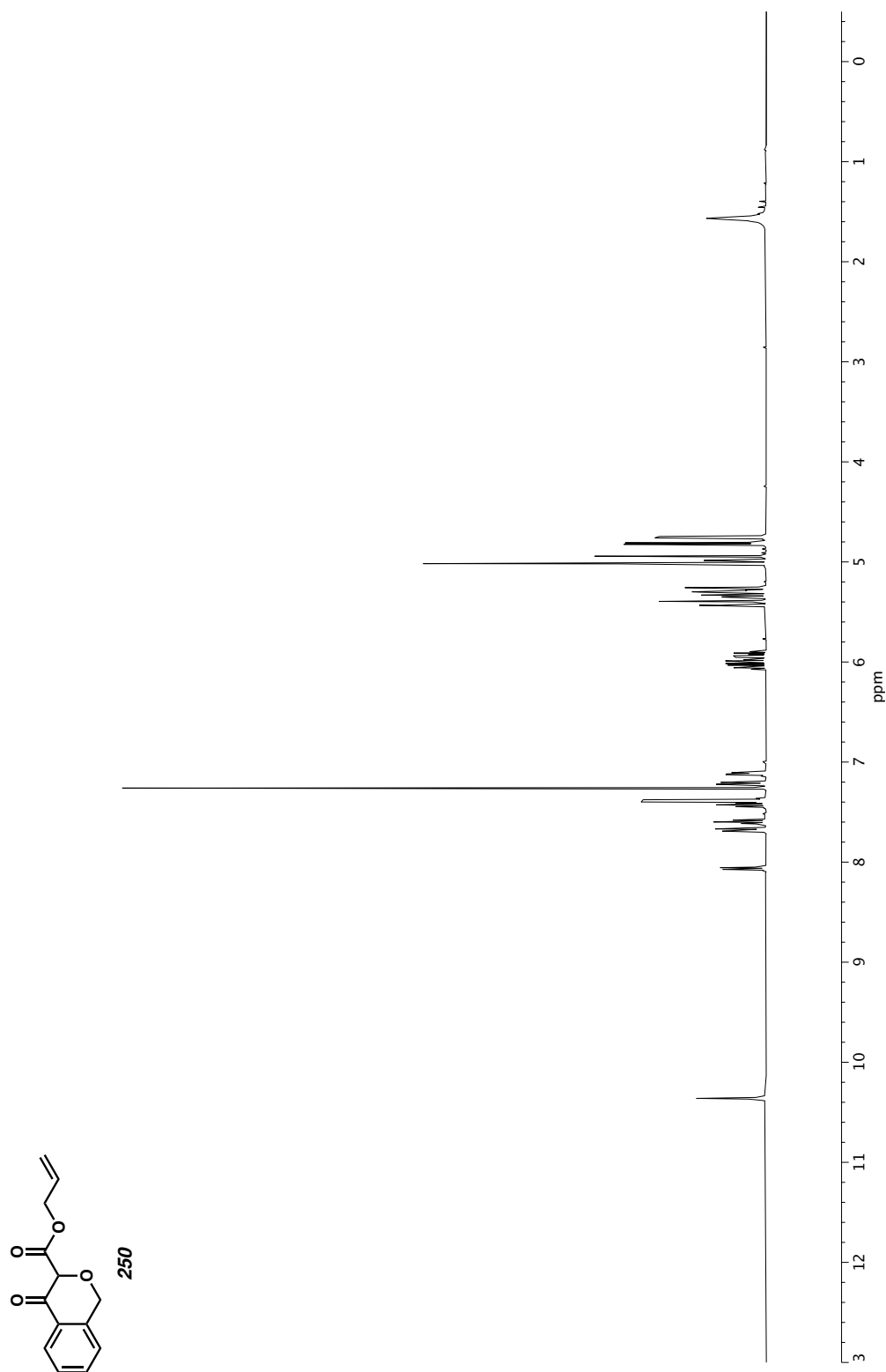


Figure A5.165 ^1H NMR (400 MHz, CDCl_3) of compound 250.

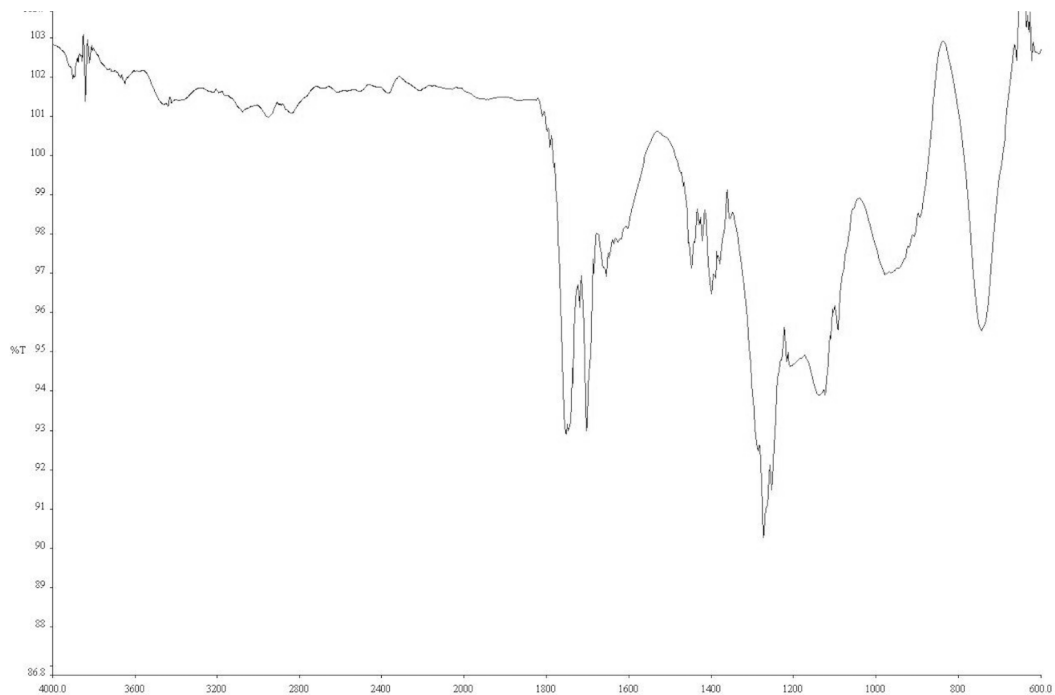


Figure A5.166 Infrared spectrum (Thin Film, NaCl) of compound **250**.

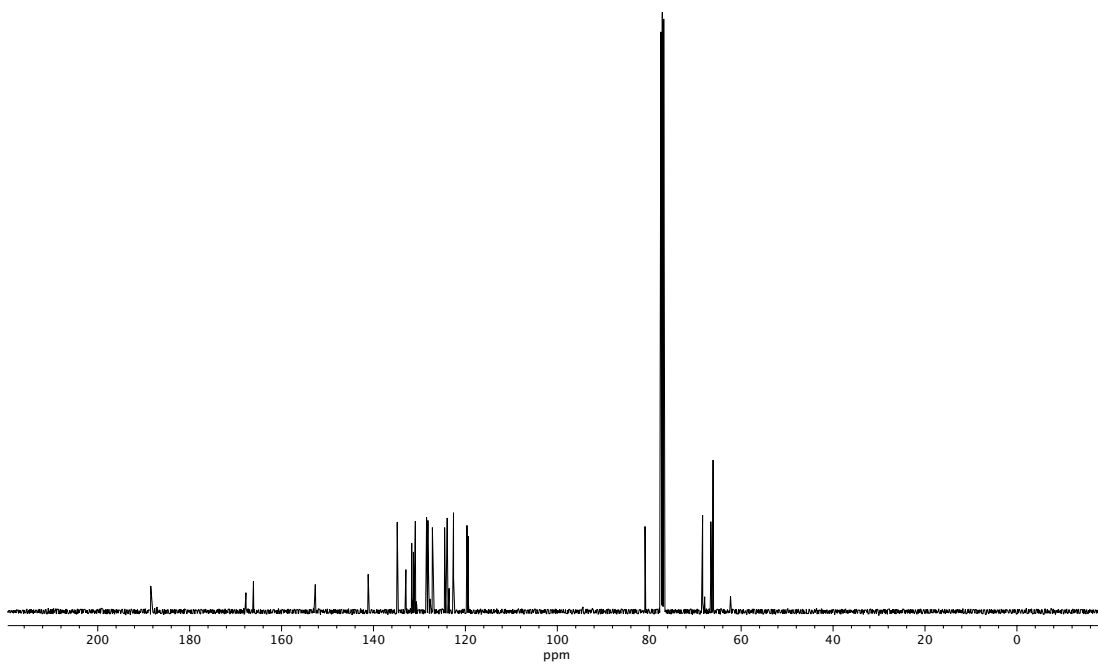


Figure A5.167 ¹³C NMR (100 MHz, CDCl₃) of compound **250**.

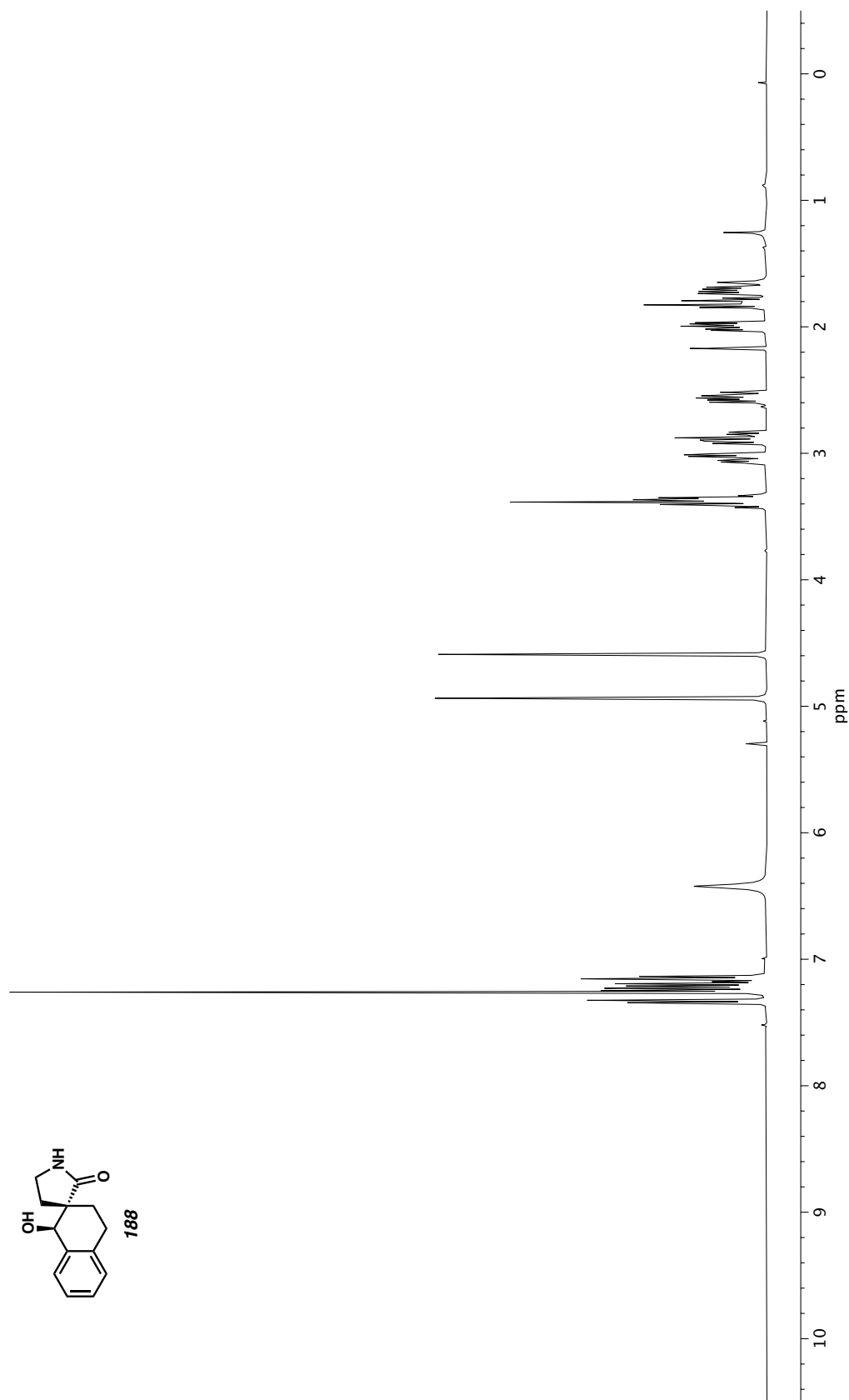


Figure A5.168 ¹H NMR (400 MHz, CDCl₃) of compound **188**.

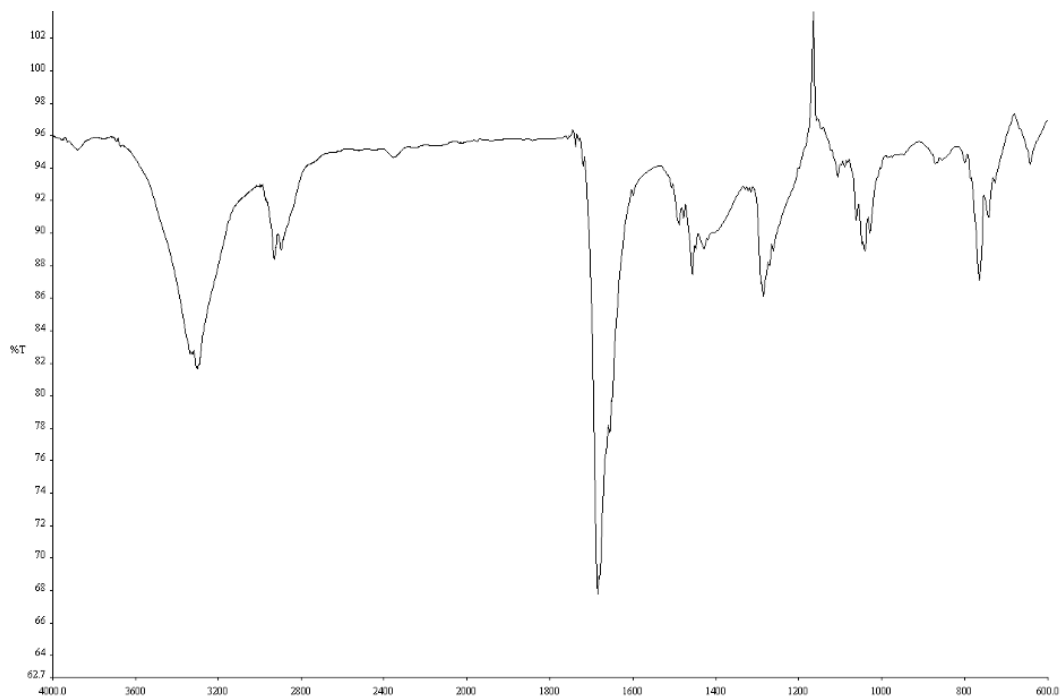


Figure A5.169 Infrared spectrum (Thin Film, NaCl) of compound **188**.

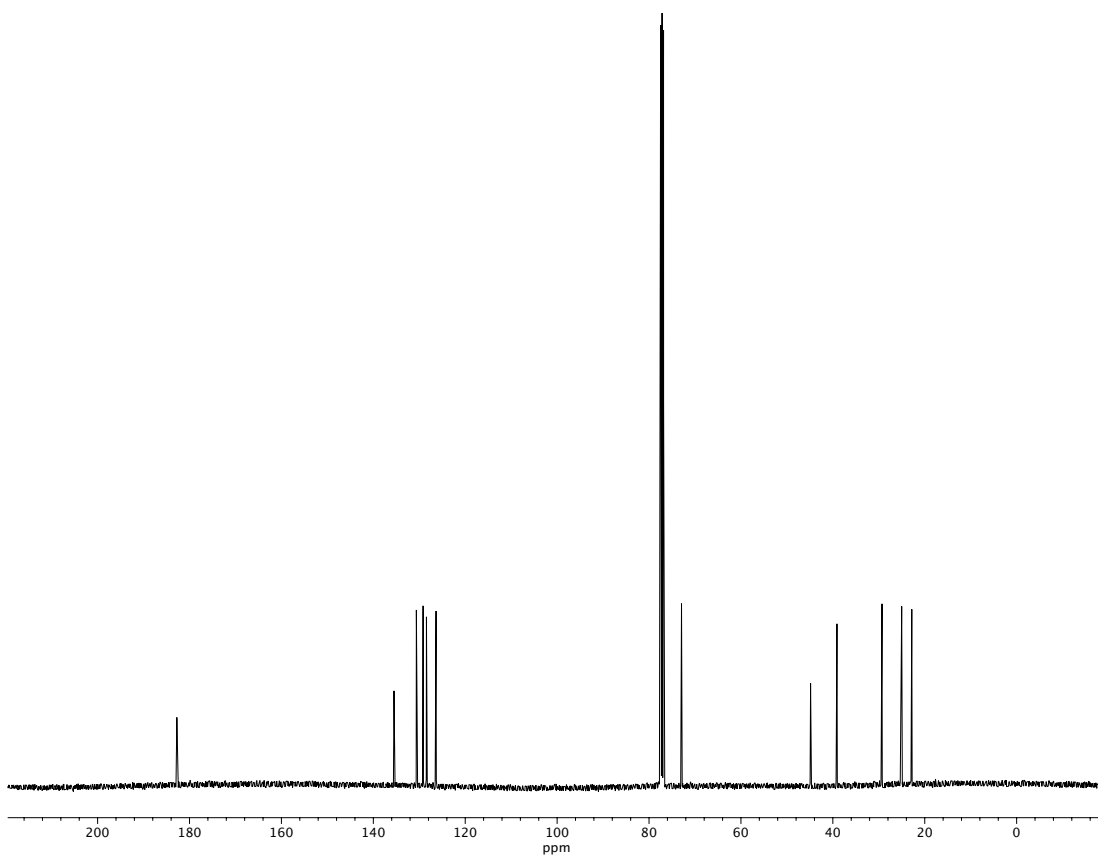


Figure A5.170 ¹³C NMR (100 MHz, CDCl₃) of compound **188**.

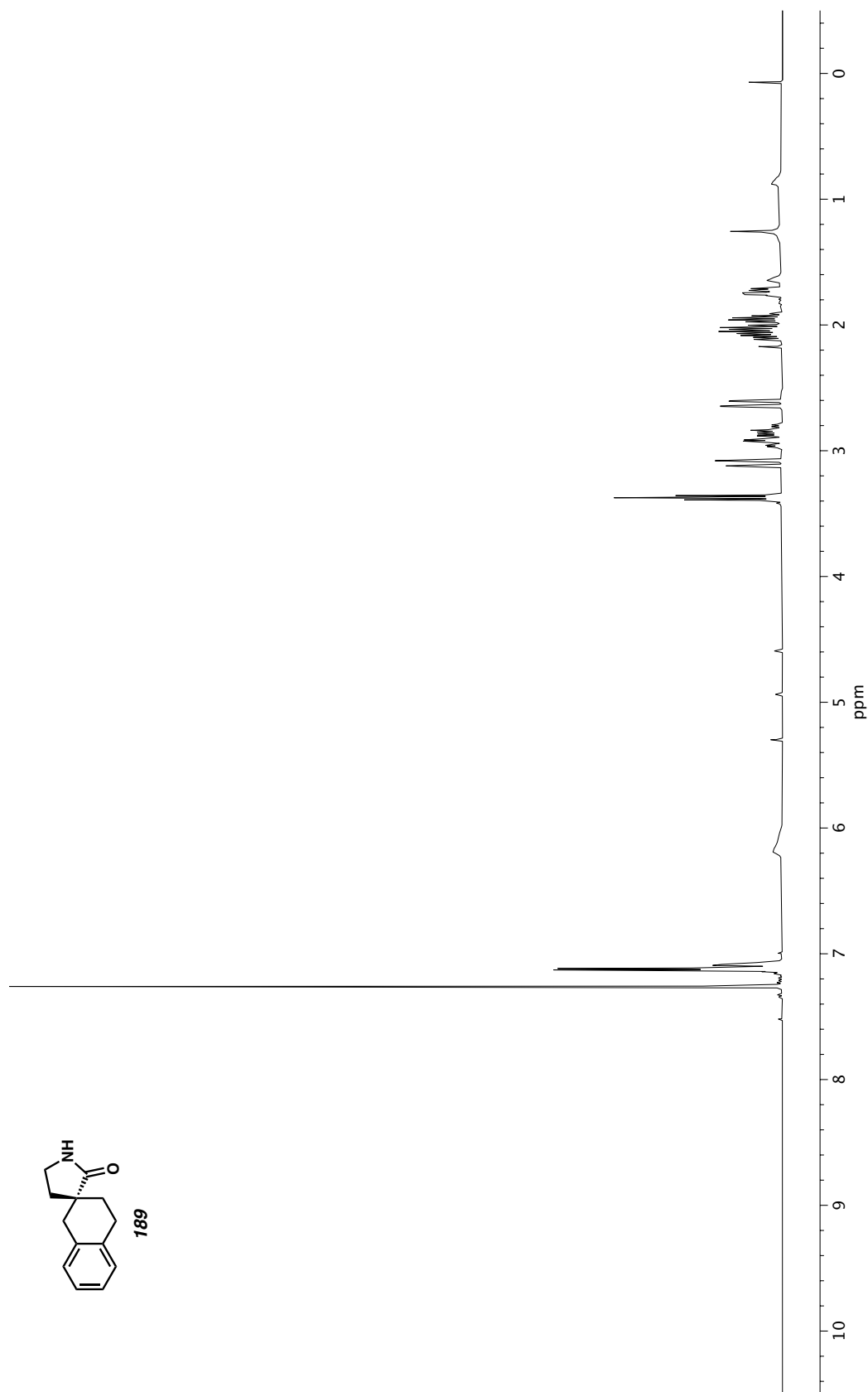


Figure A5.171 ^1H NMR (400 MHz, CDCl_3) of compound **189**.

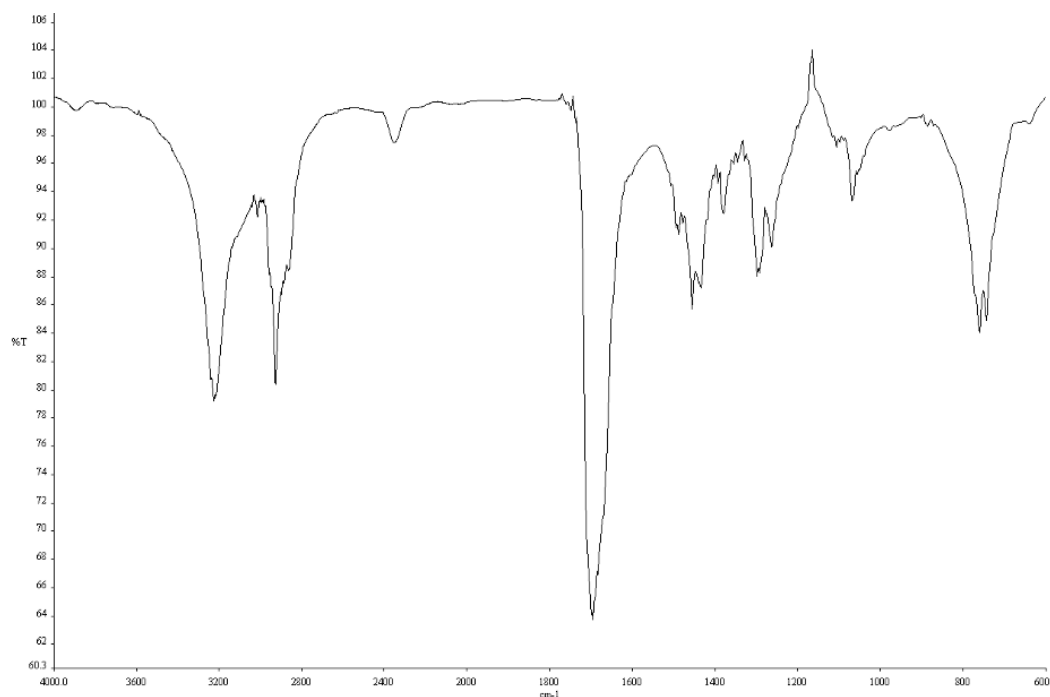


Figure A5.172 Infrared spectrum (Thin Film, NaCl) of compound **189**.

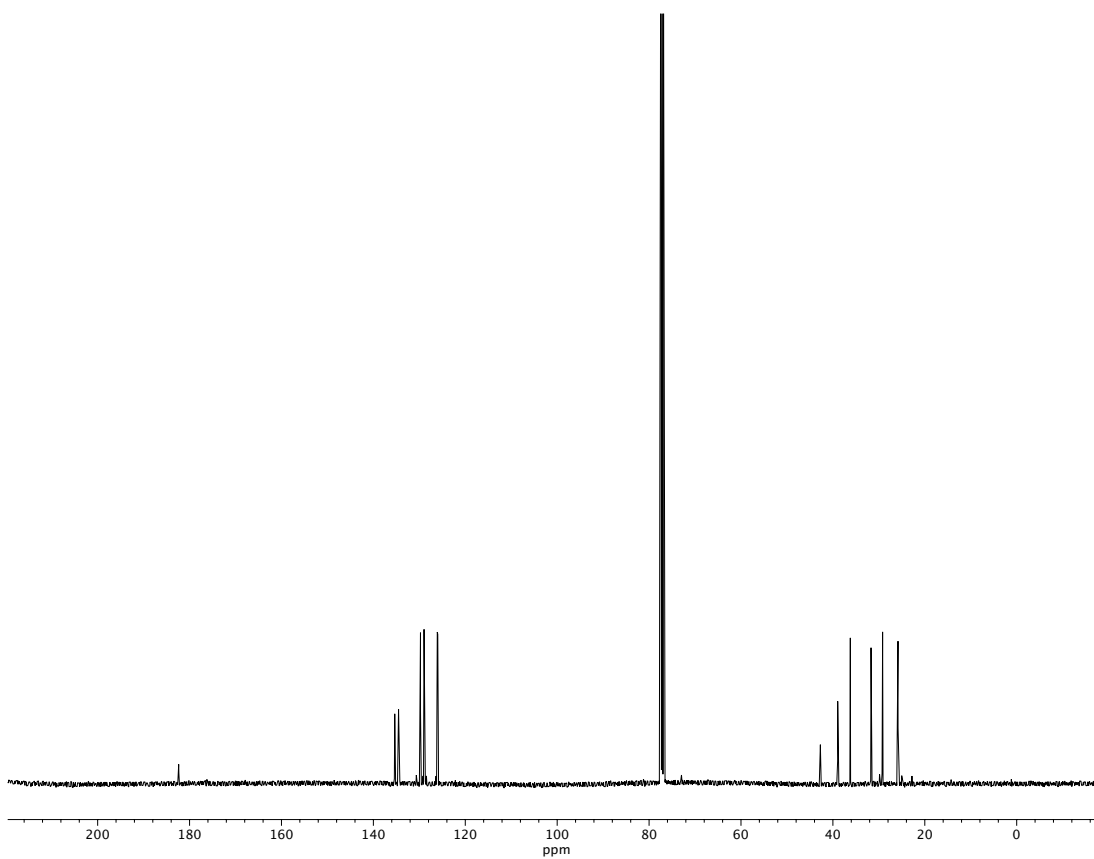


Figure A5.173 ¹³C NMR (100 MHz, CDCl₃) of compound **189**.

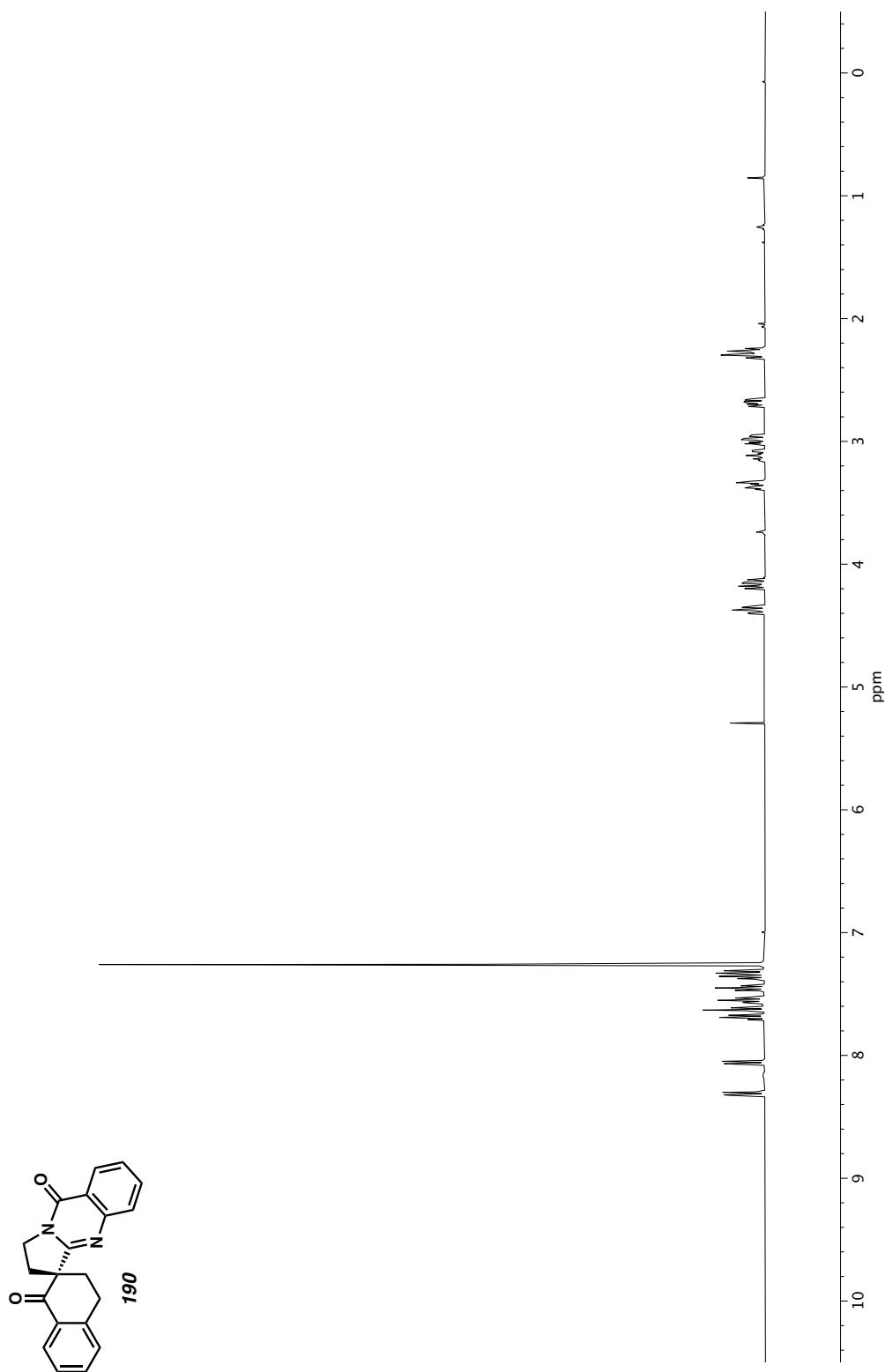


Figure A5.174 ^1H NMR (400 MHz, CDCl_3) of compound **190**.

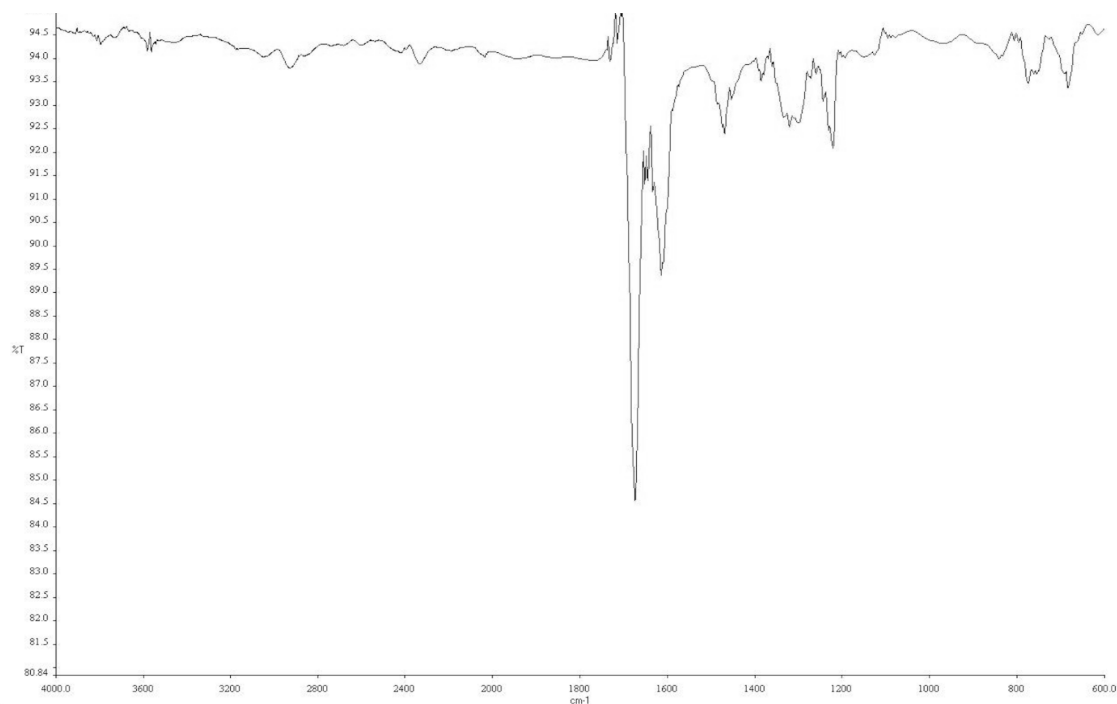


Figure A5.175 Infrared spectrum (Thin Film, NaCl) of compound **190**.

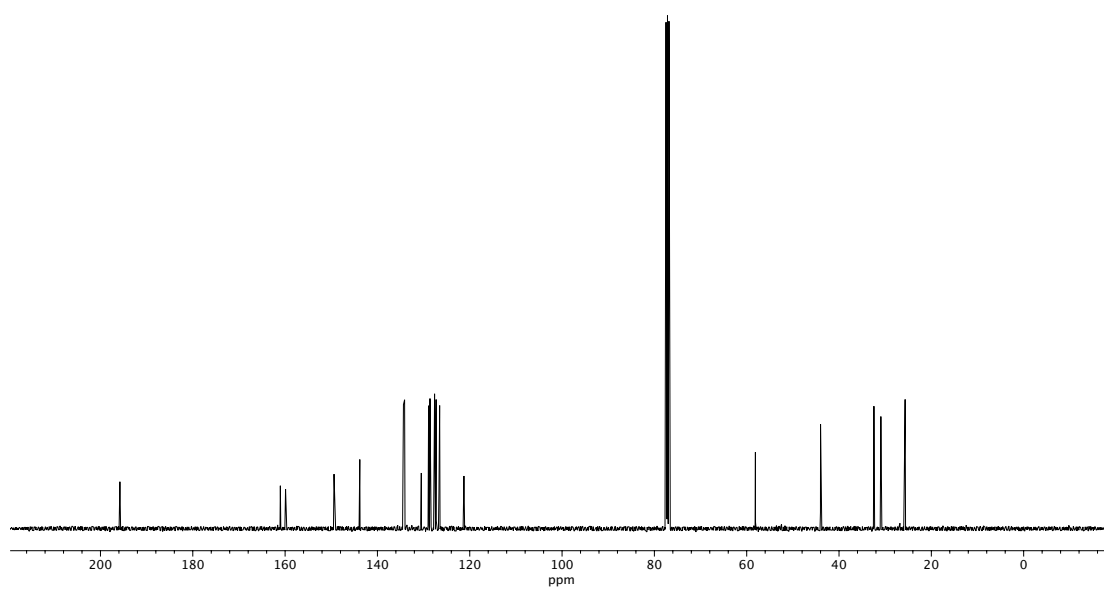


Figure A5.176 ¹³C NMR (100 MHz, CDCl₃) of compound **190**.

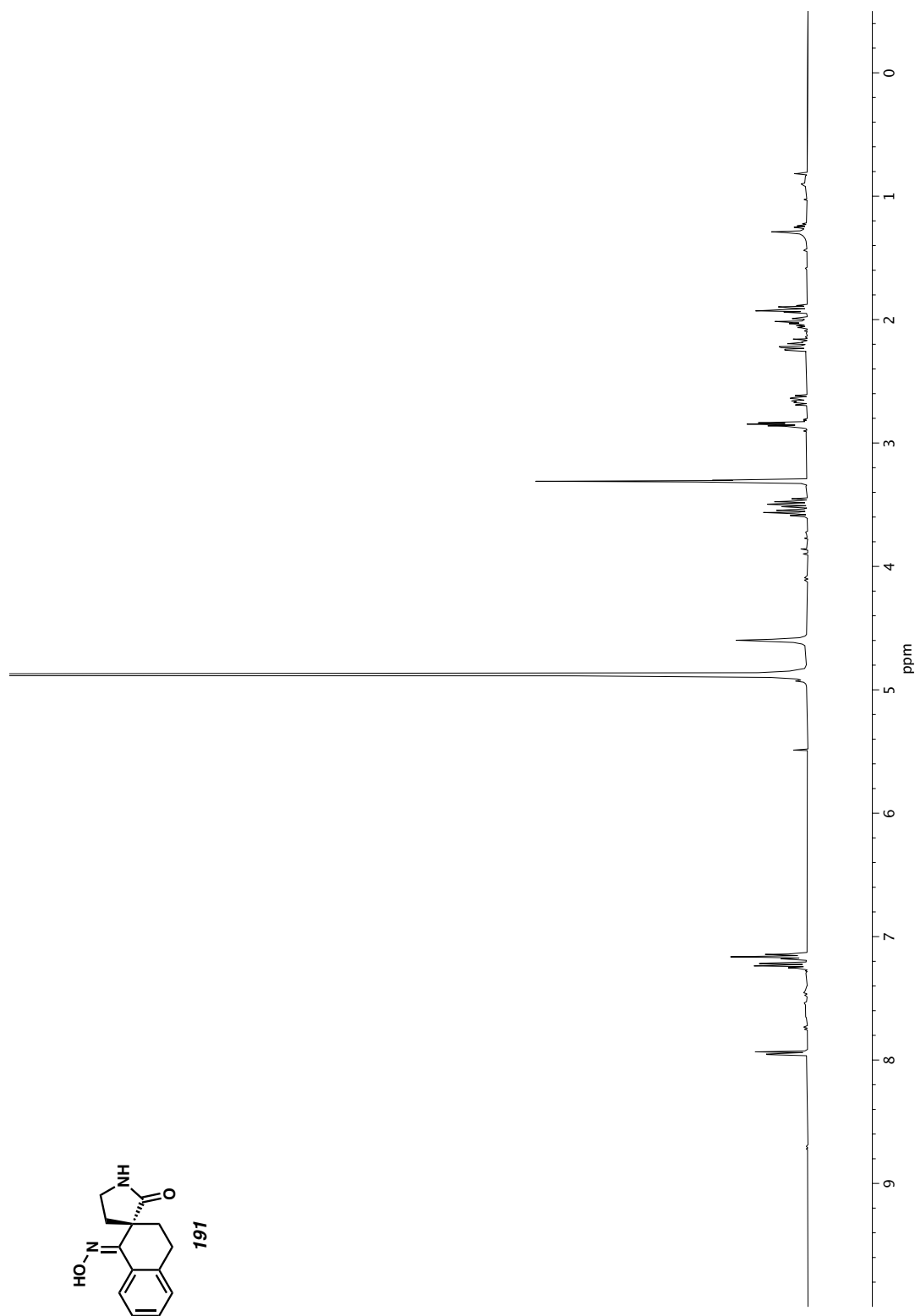


Figure A5.177 ¹H NMR (400 MHz, CD₃OD) of compound **191**.

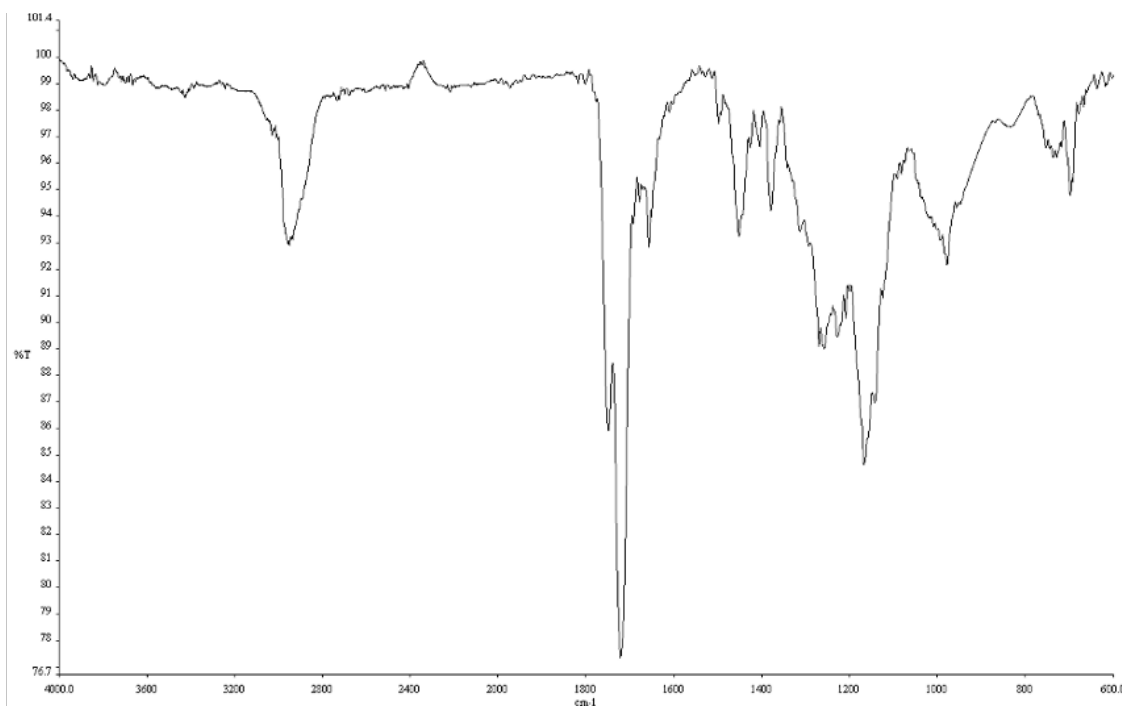


Figure A5.178 Infrared spectrum (Thin Film, NaCl) of compound **191**.

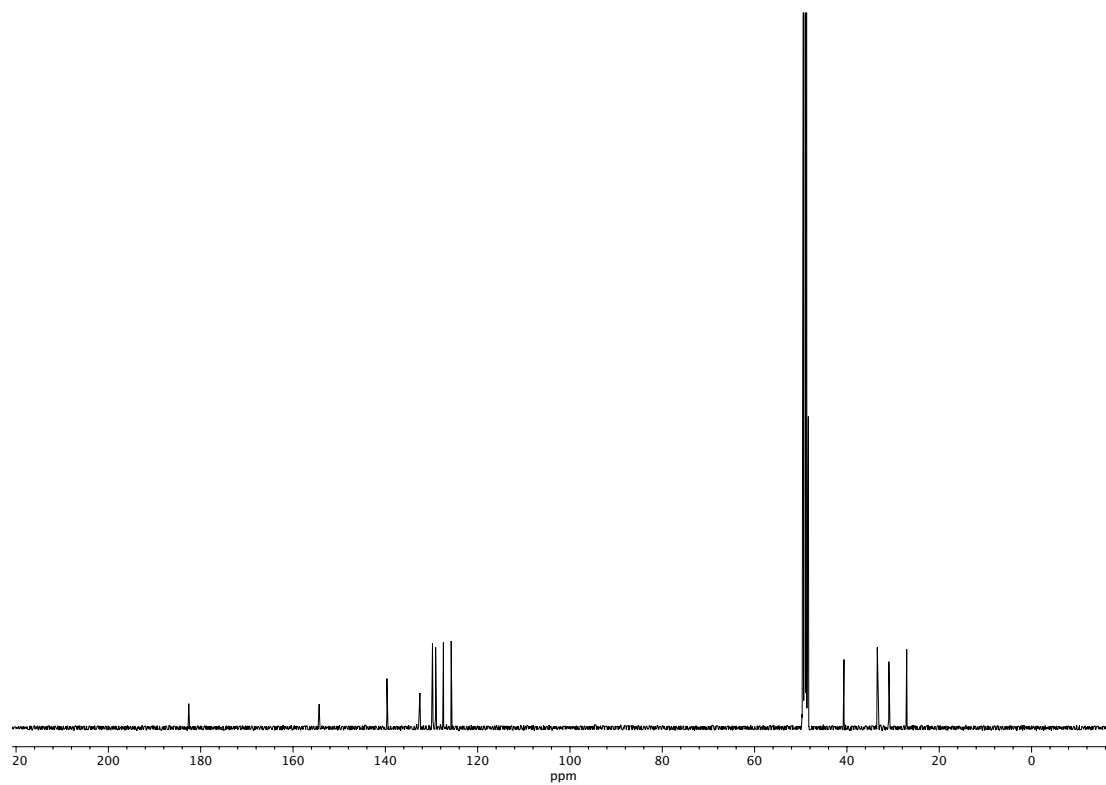


Figure A5.179 ¹³C NMR (100 MHz, CD₃OD) of compound **191**.