

Copper(II)-Catalyzed Synthesis of Multisubstituted Indoles through Sequential Chan-Lam and Cross-dehydrogenative Coupling Reactions

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^a College of Chemistry, Chemical Engineering and Resource Utilization, Northeast Forestry University, No. 26 Hexing Road, Harbin, 150040, P. R. China.

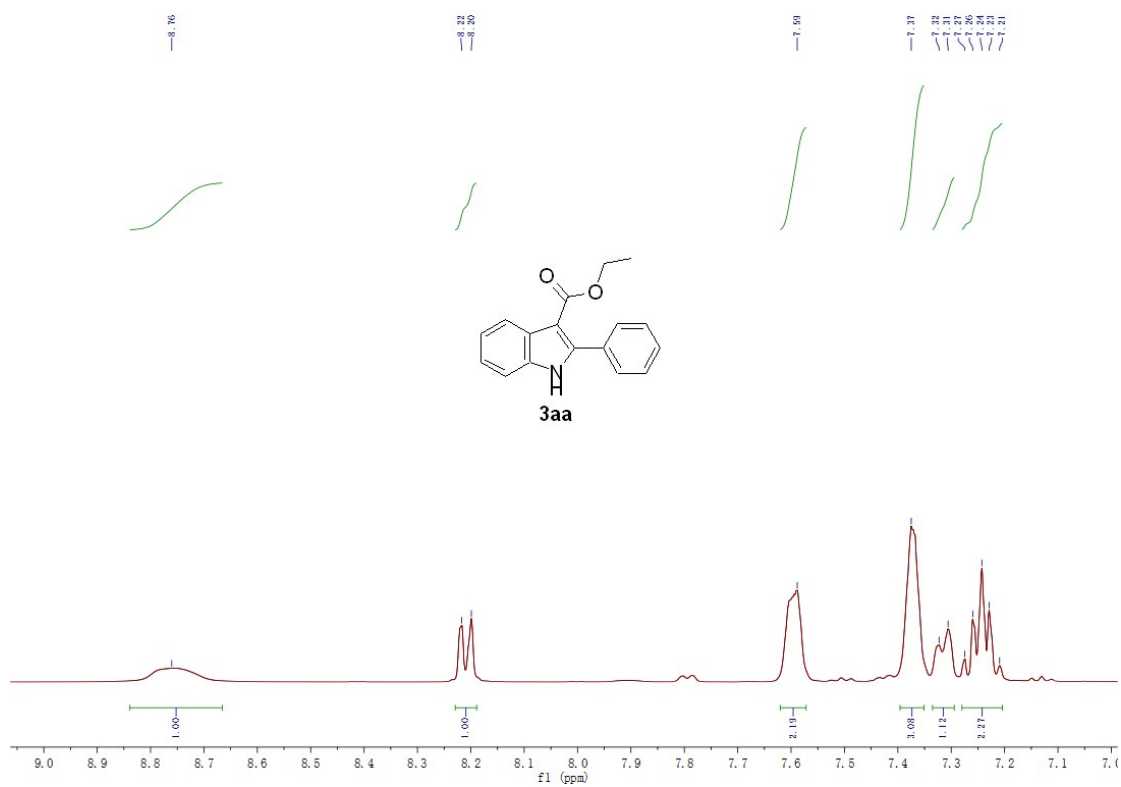
^b Material Science and Engineering College, Northeast Forestry University, No. 26 Hexing Road, Harbin, 150040, P. R. China.

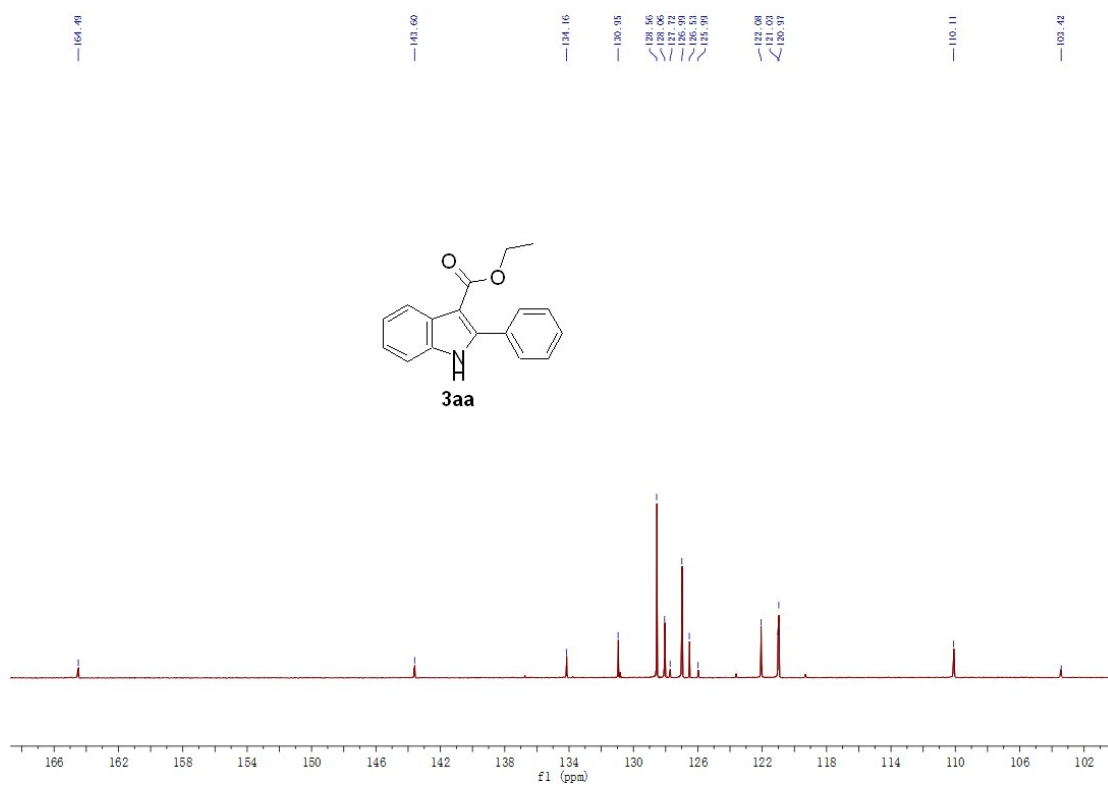
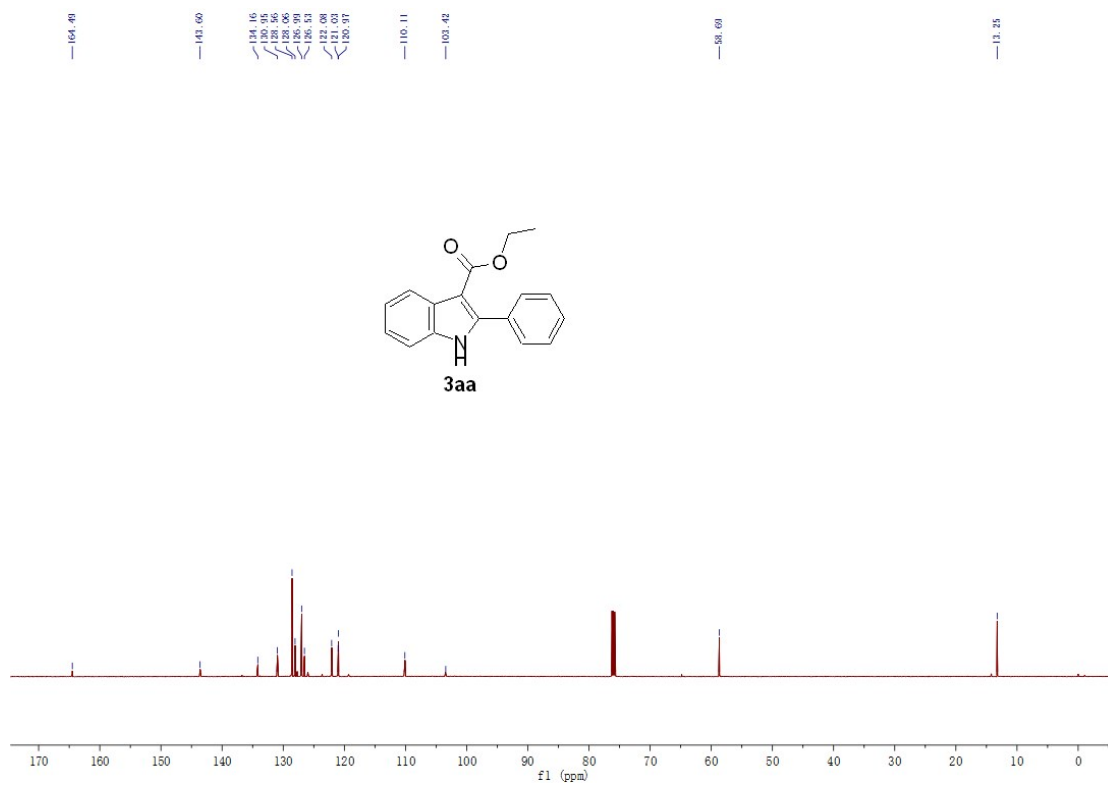
E-mail: ccx1759@163.com, jspeng1998@nefu.edu.cn

Content

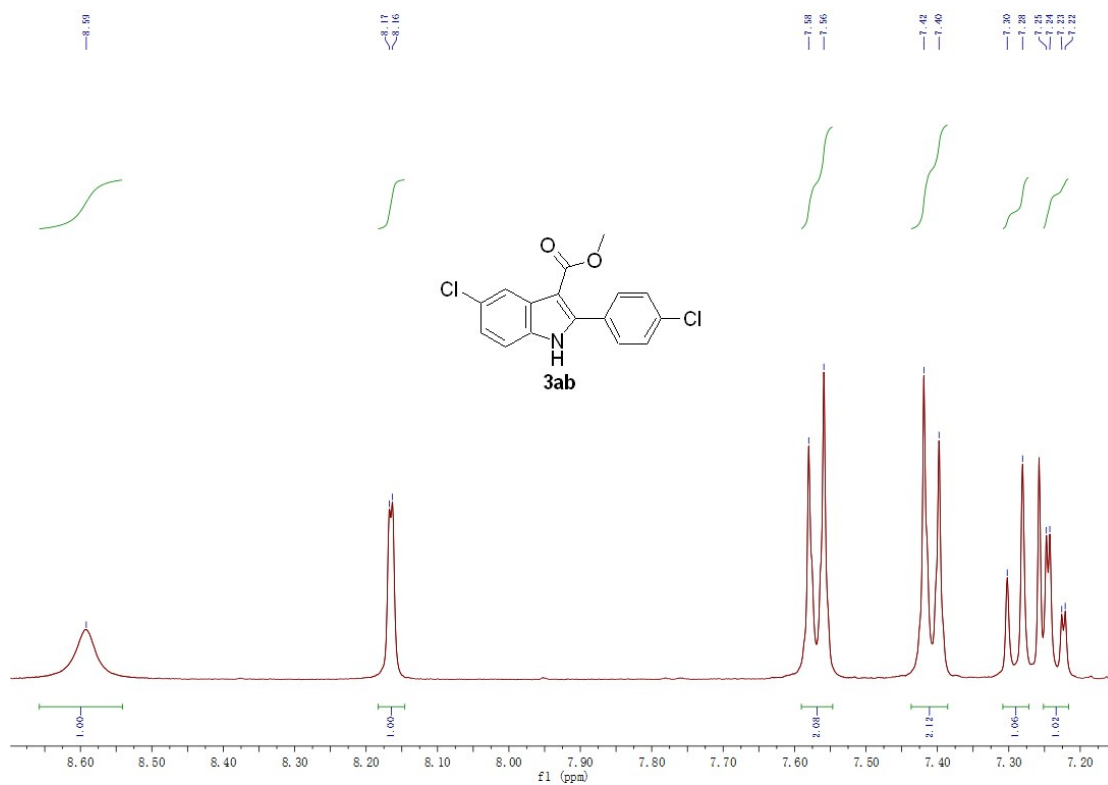
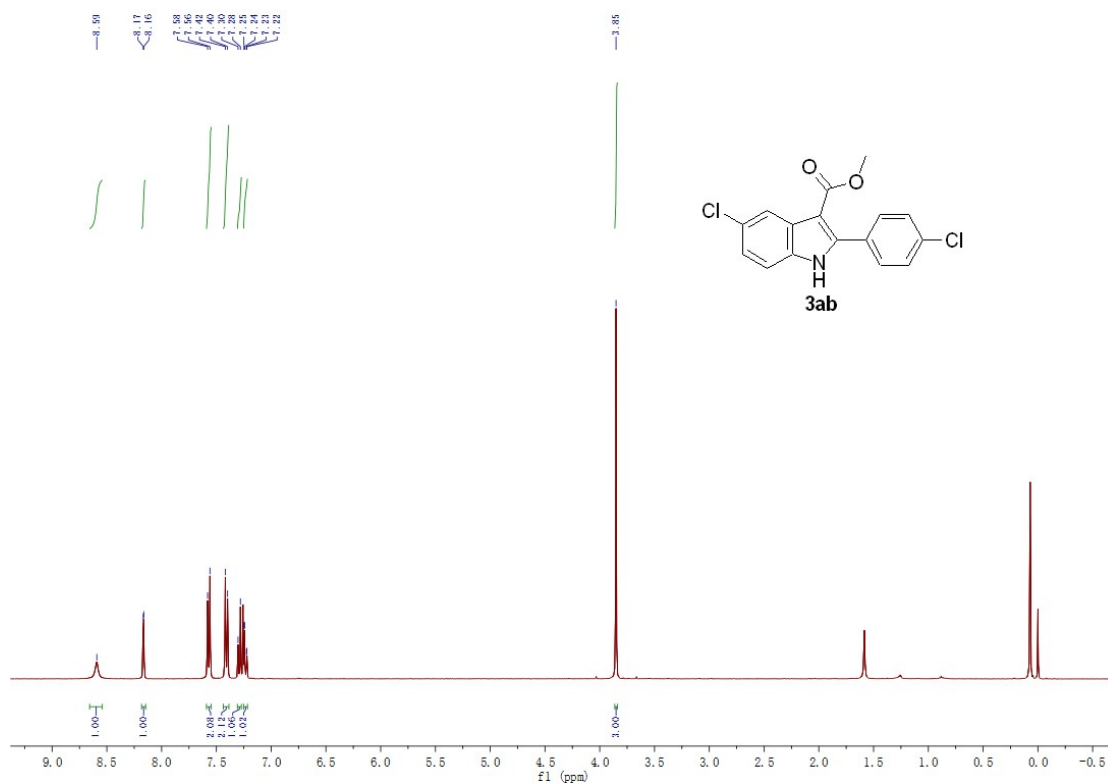
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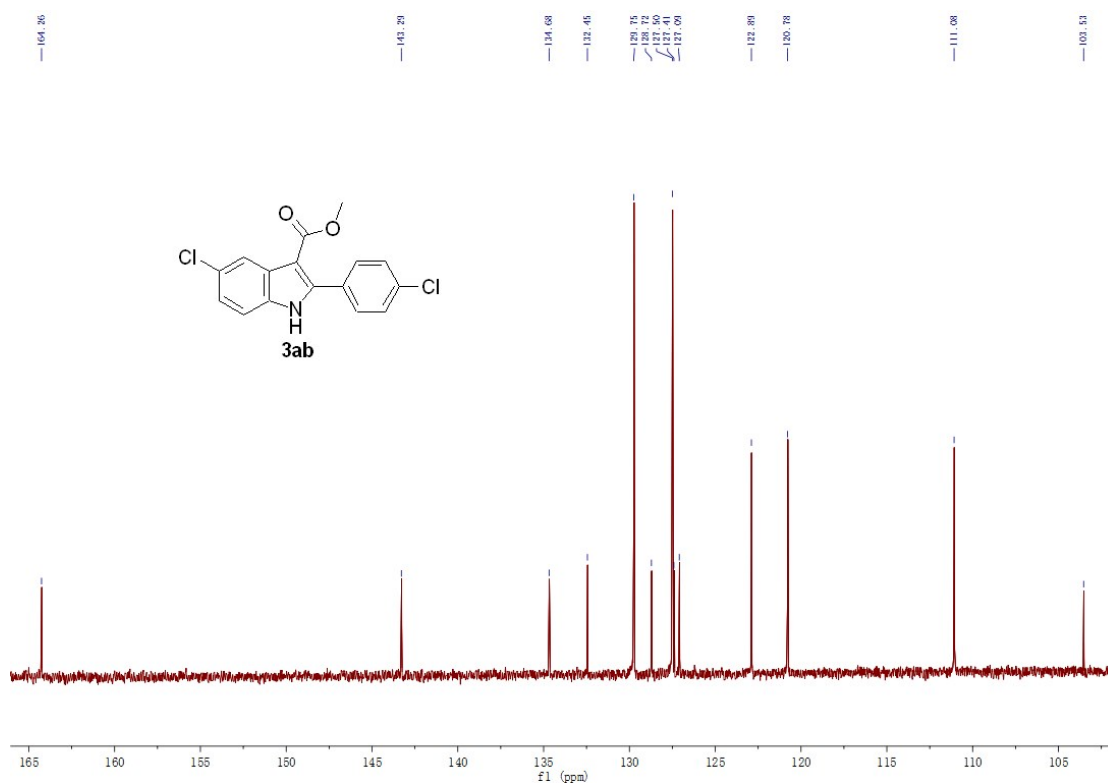
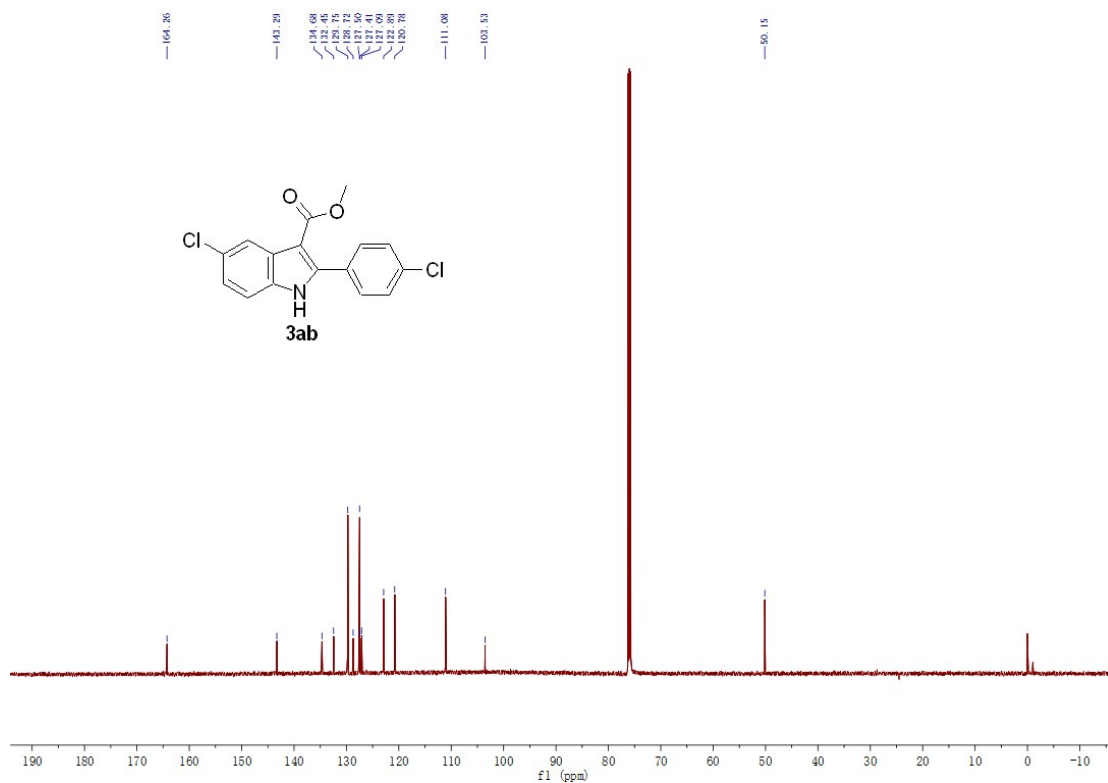
Ethyl 2-Phenyl-1*H*-indole-3-carboxylate (3aa)



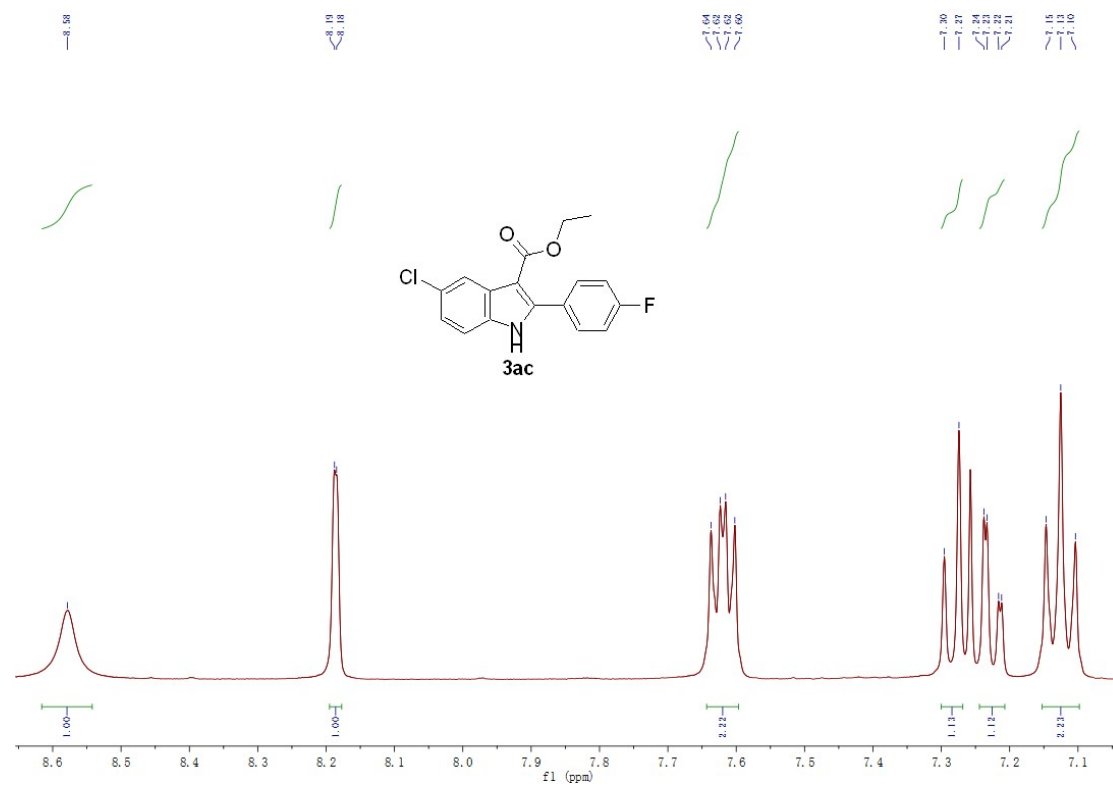
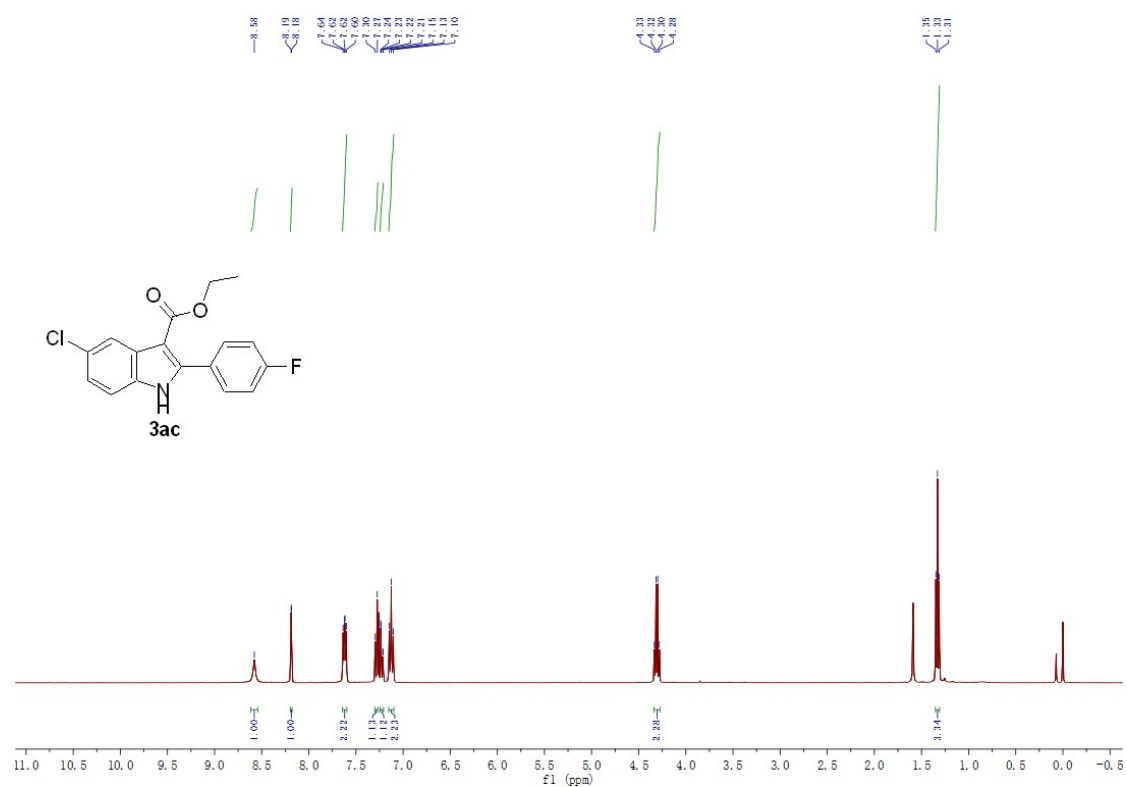


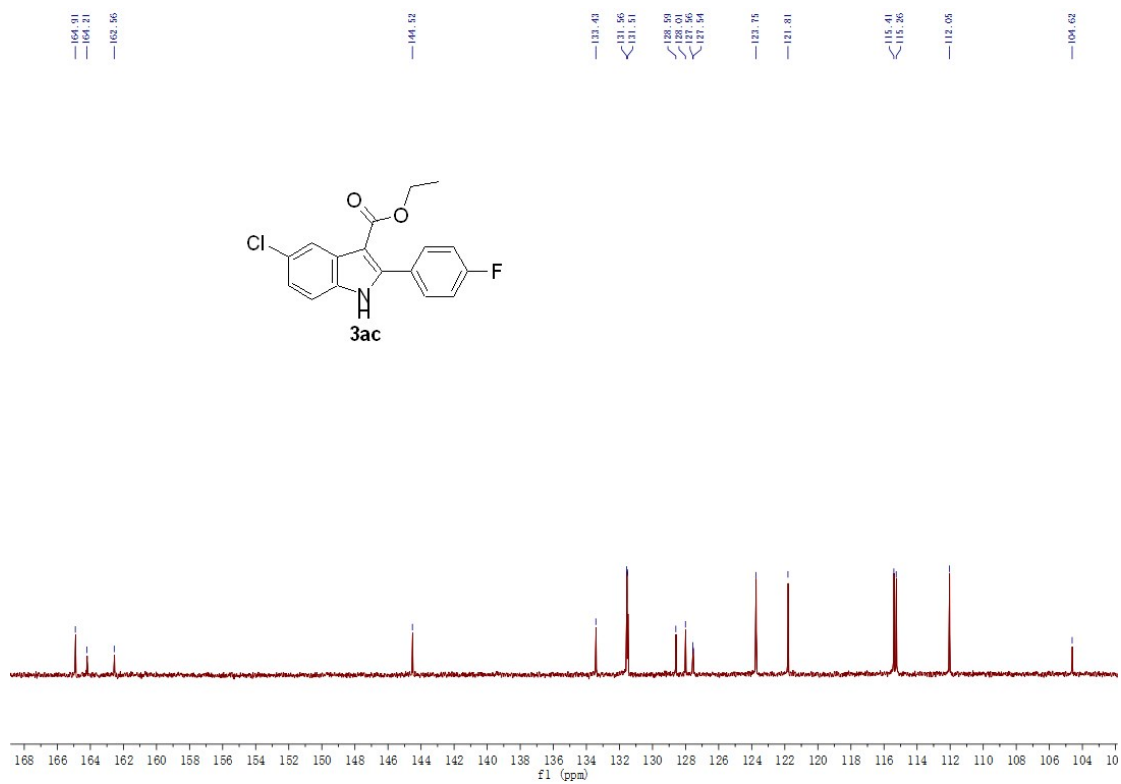
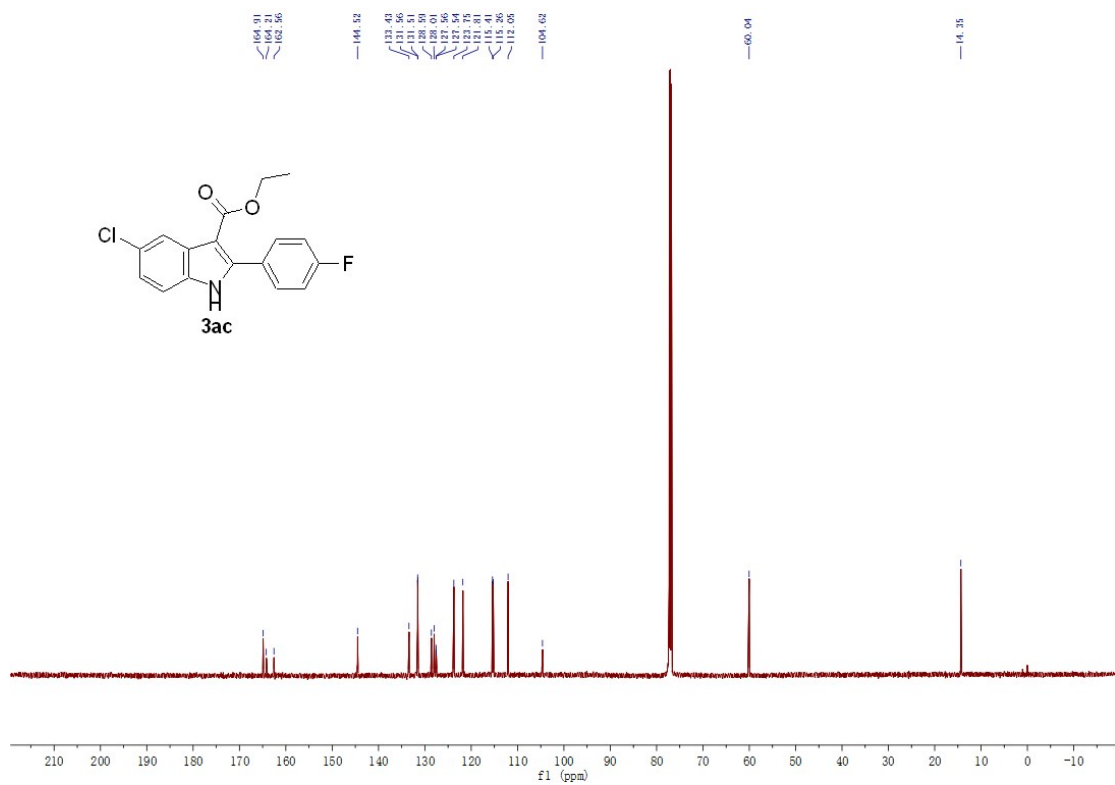
Methyl 5-chloro-2-(4-chlorophenyl)-1H-indole-3-carboxylate (3ab)



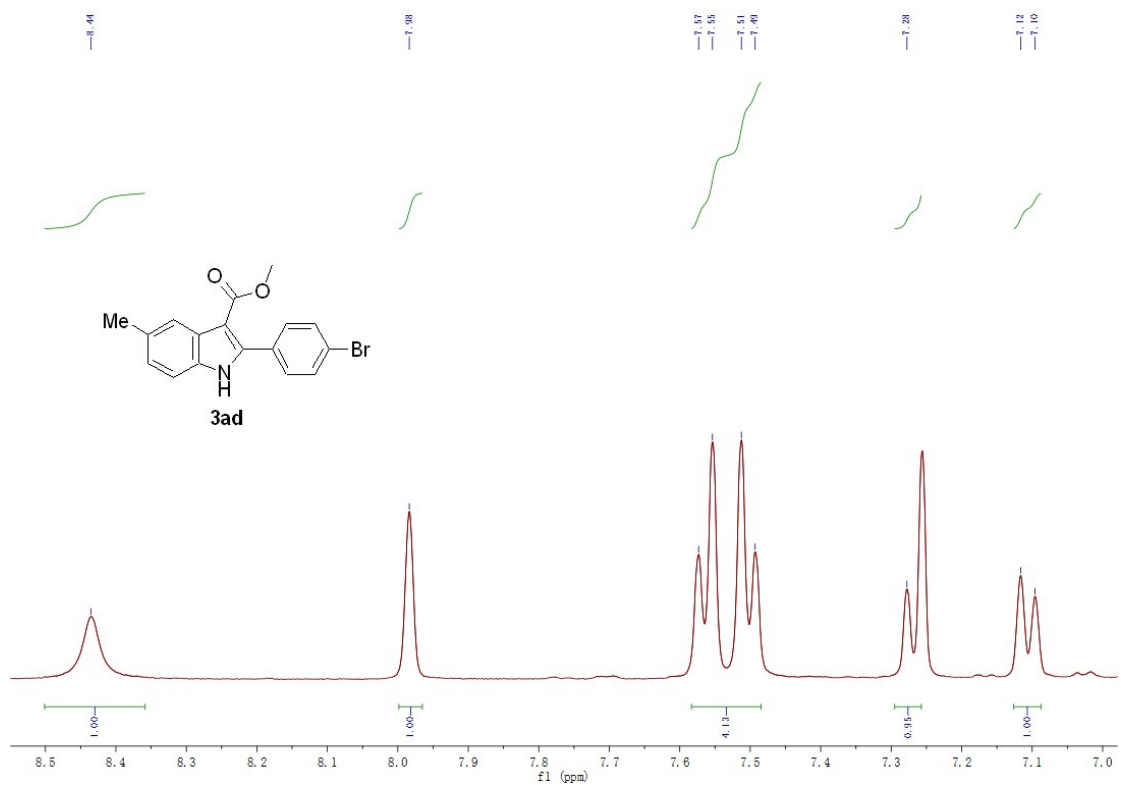
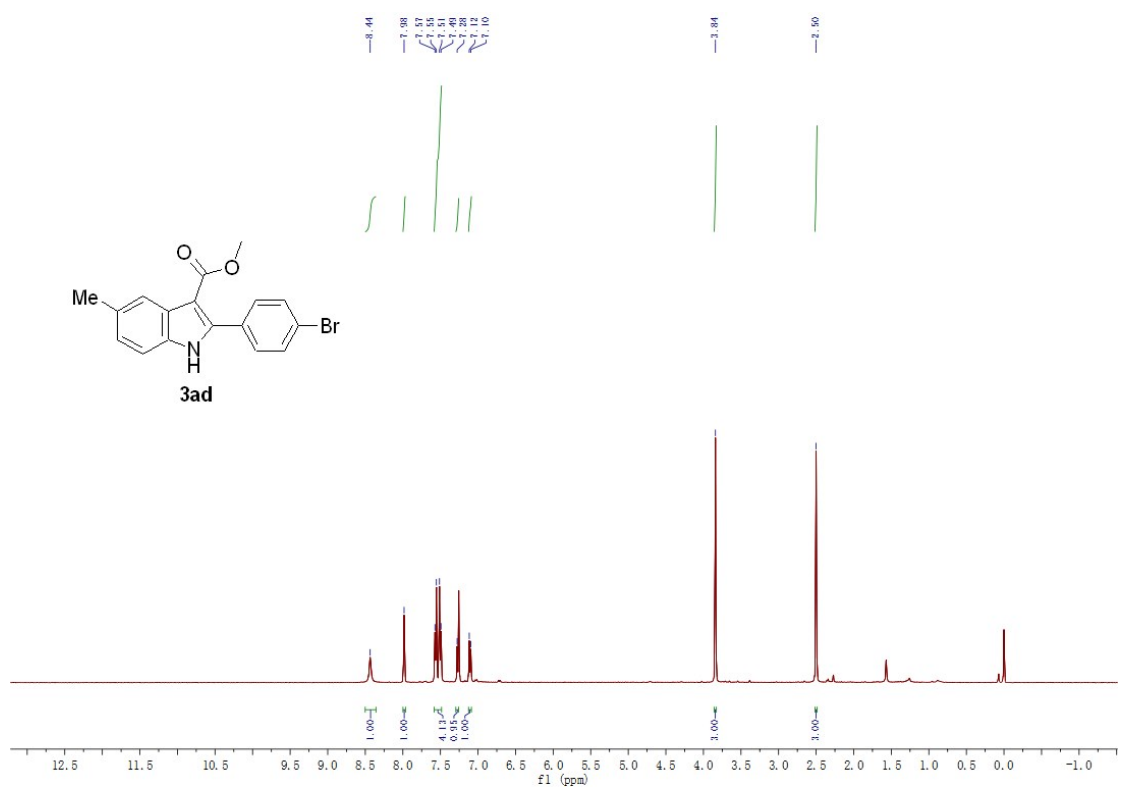


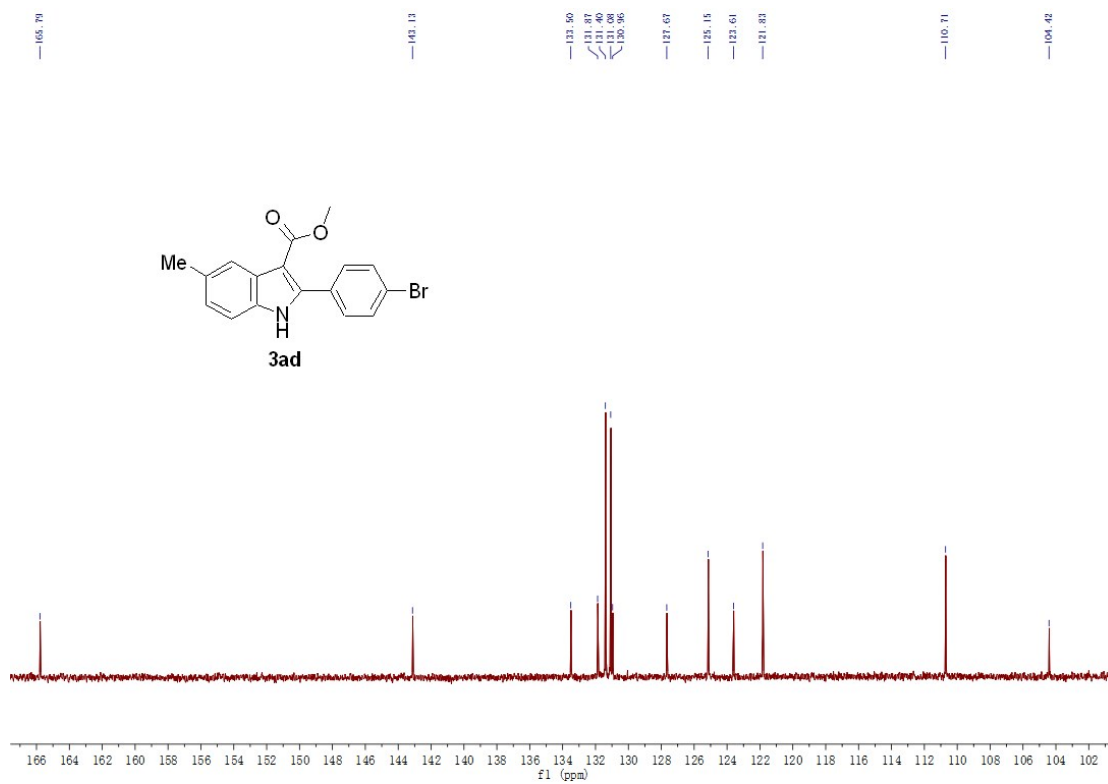
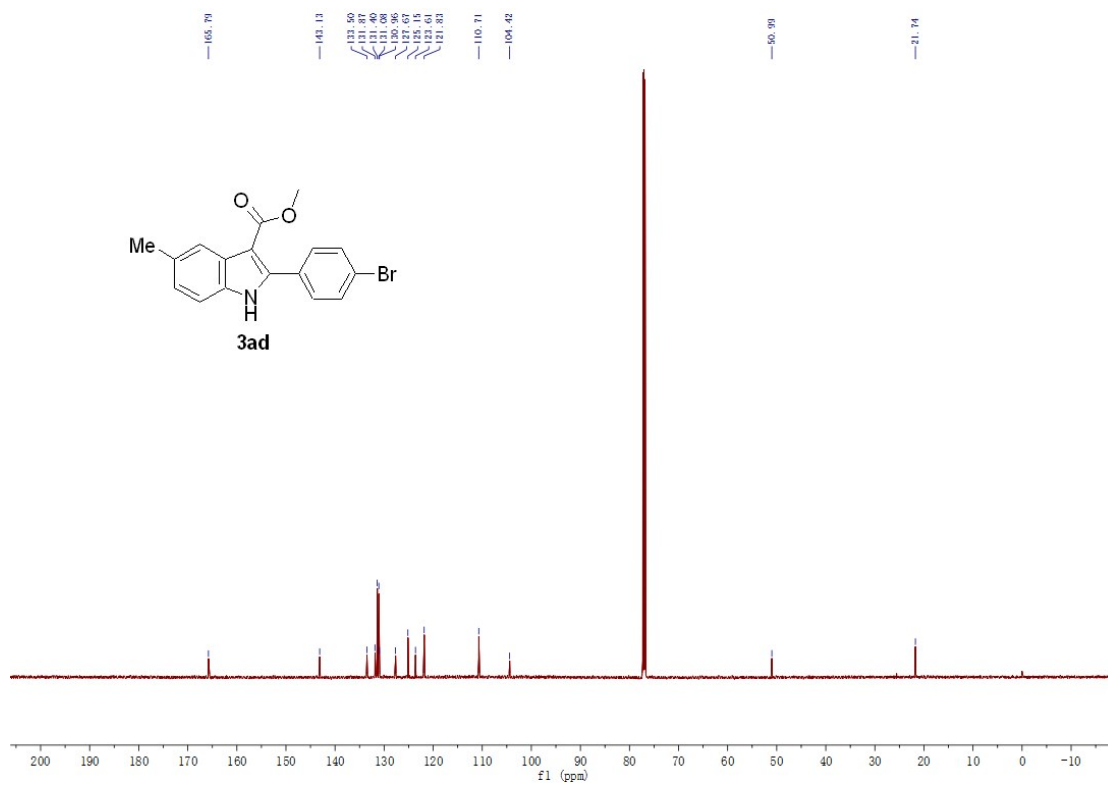
Ethyl 5-chloro-2-(4-fluorophenyl)-1H-indole-3-carboxylate (**3ac**)



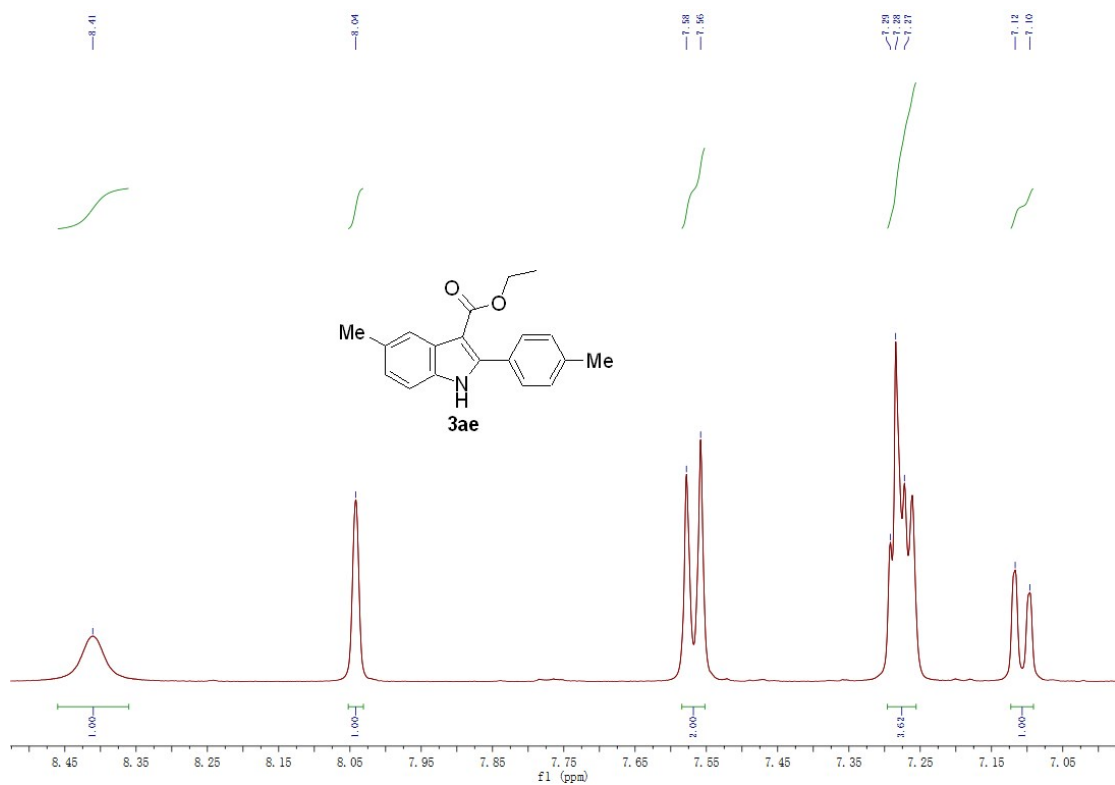
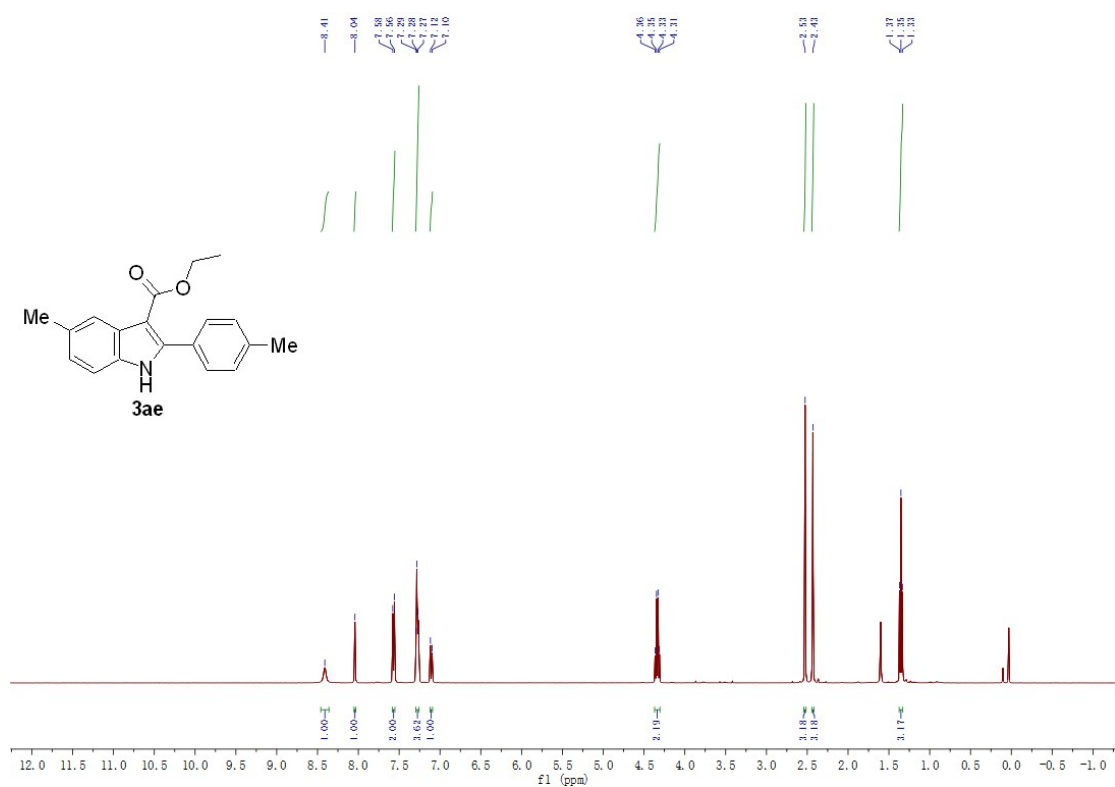


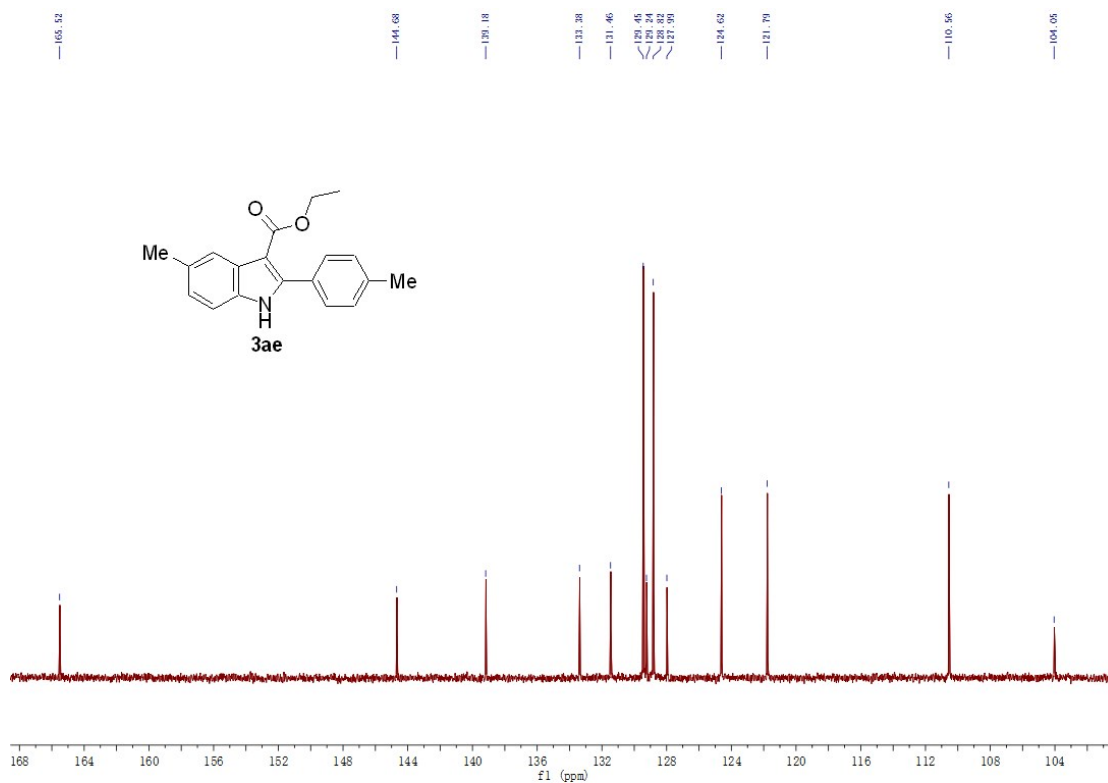
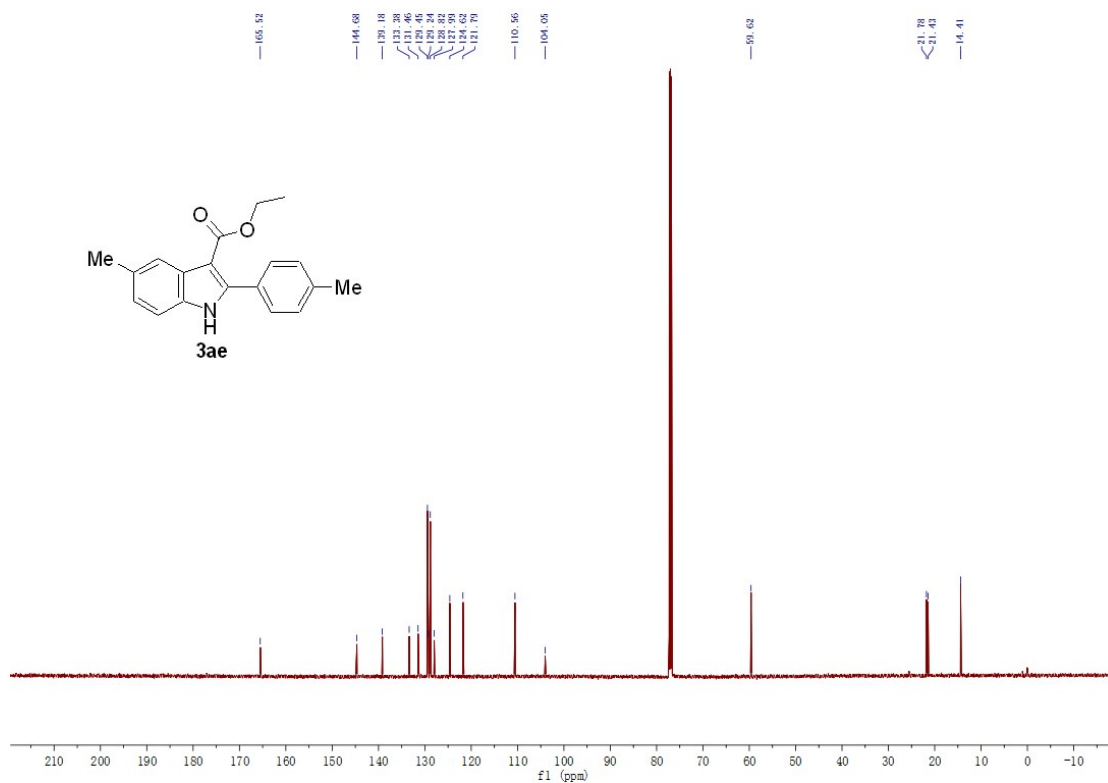
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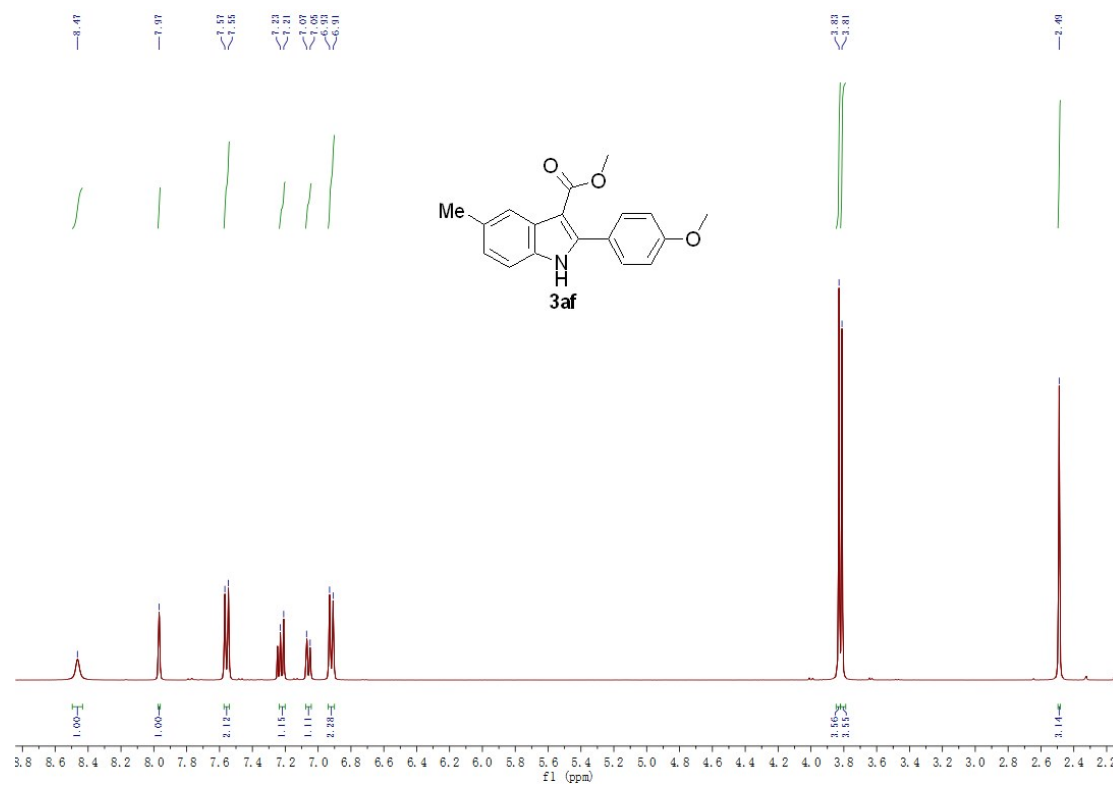
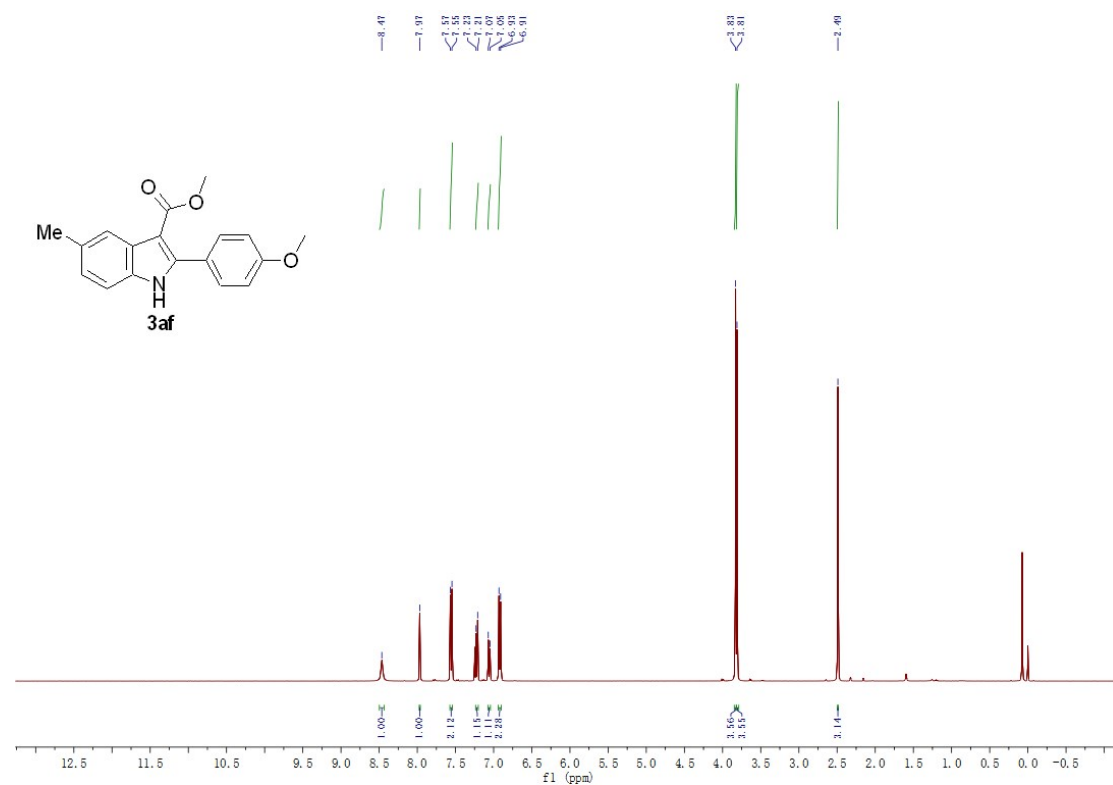


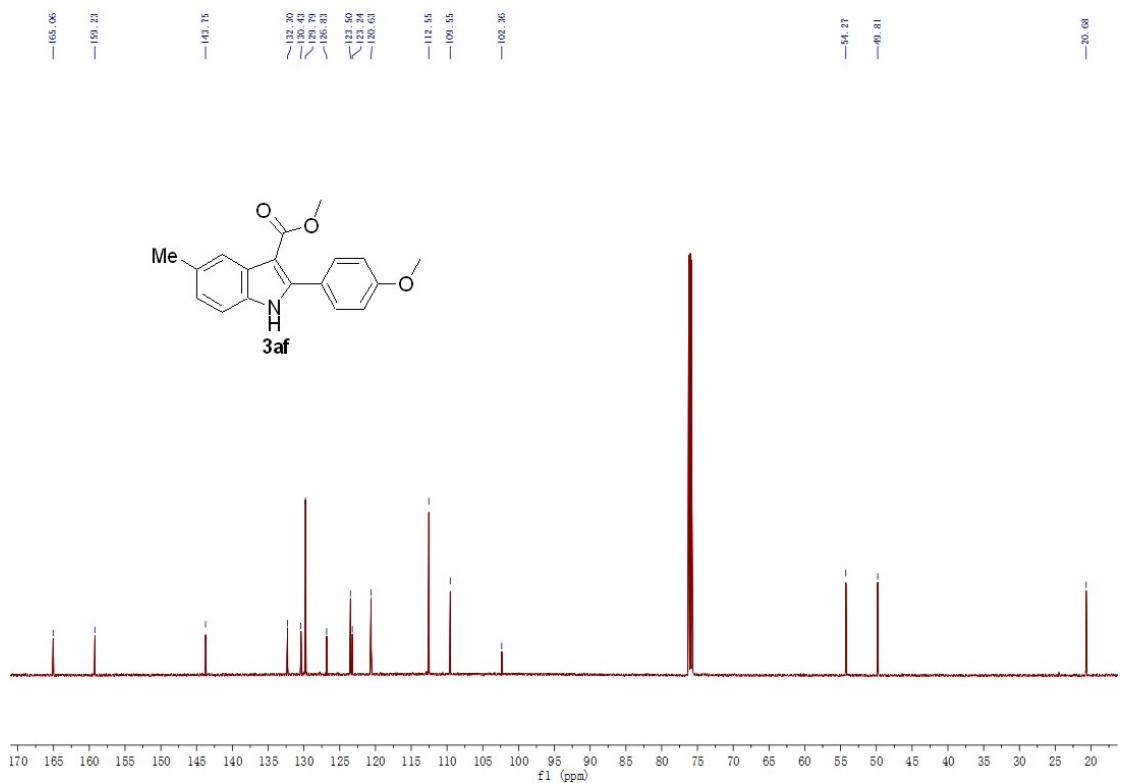
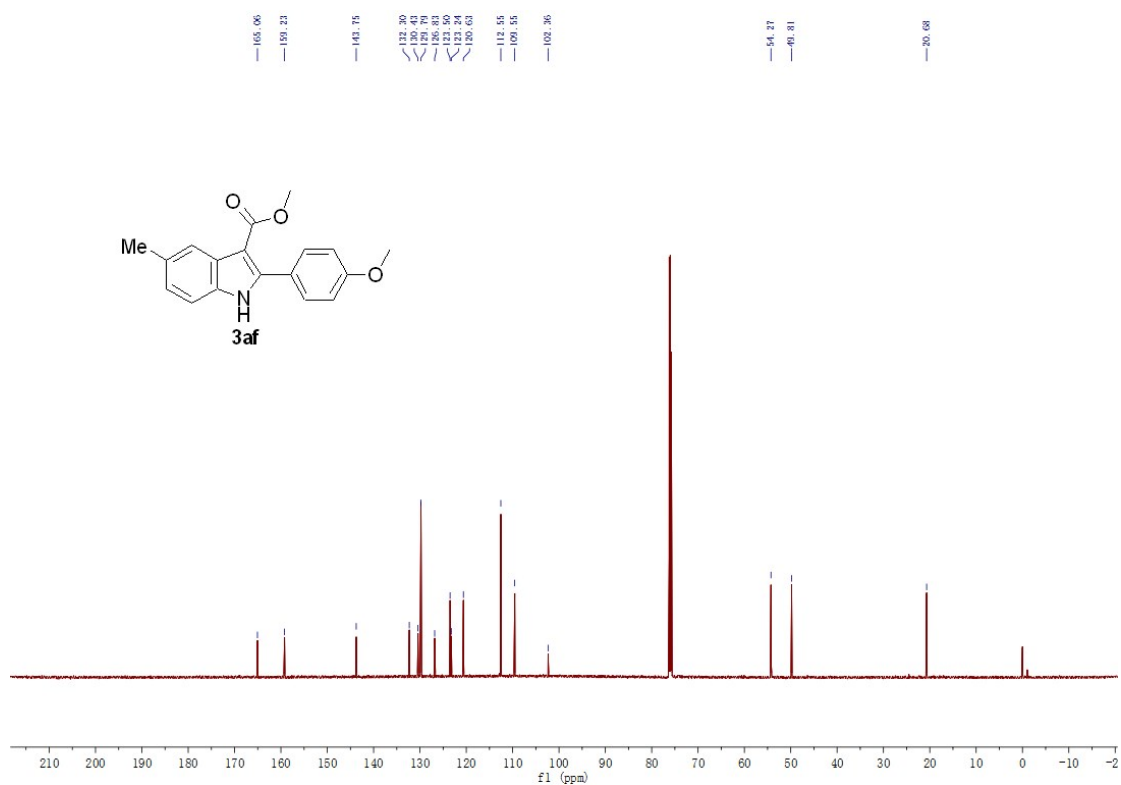
Ethyl 5-methyl-2-(*p*-tolyl)-1*H*-indole-3-carboxylate (**3ae**)



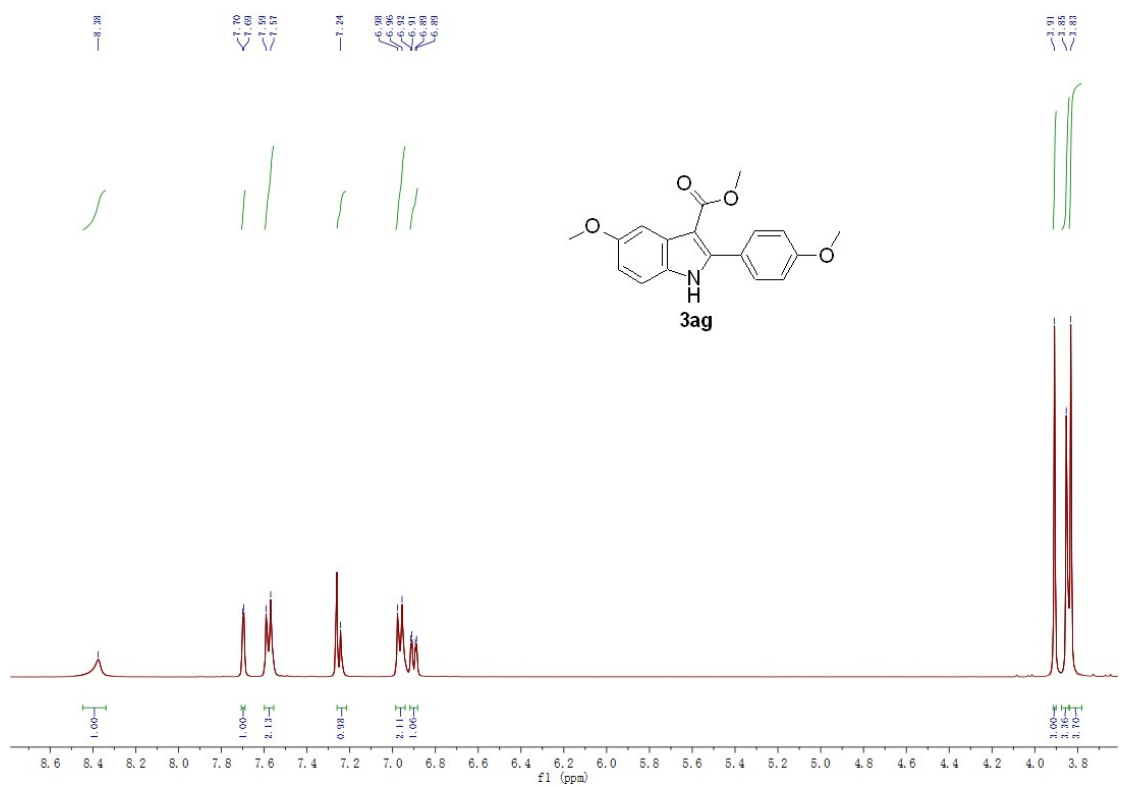
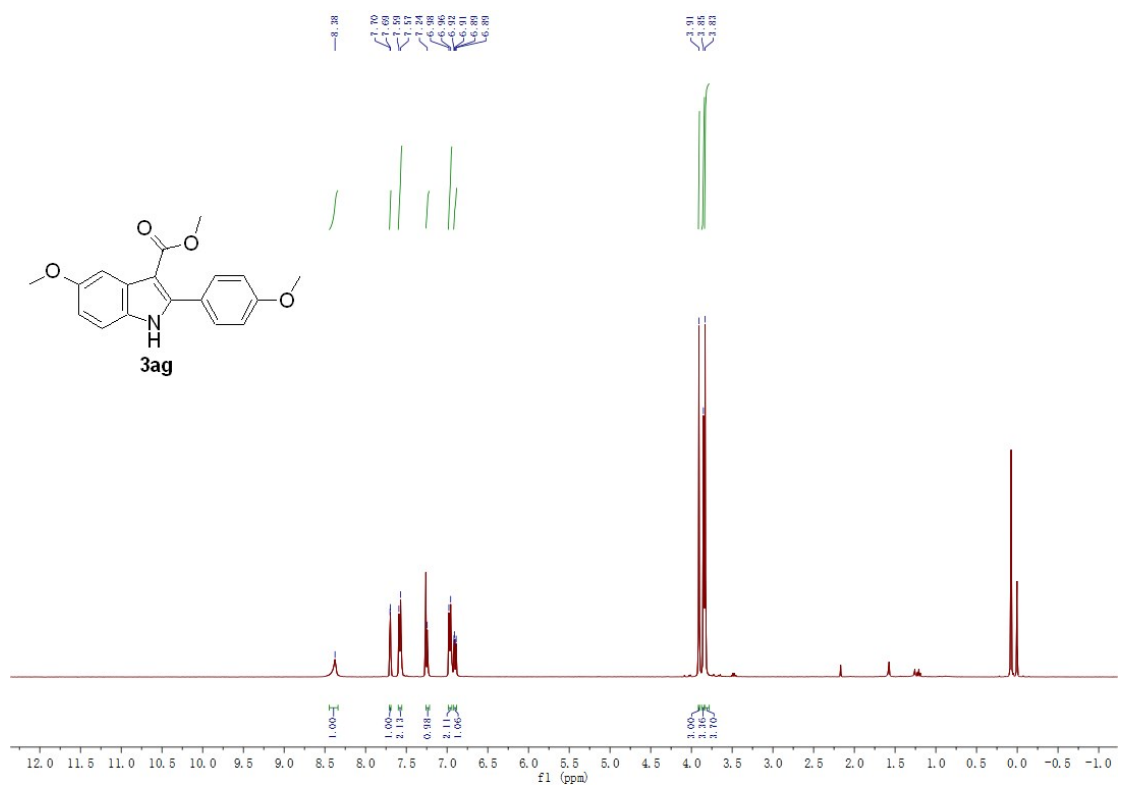


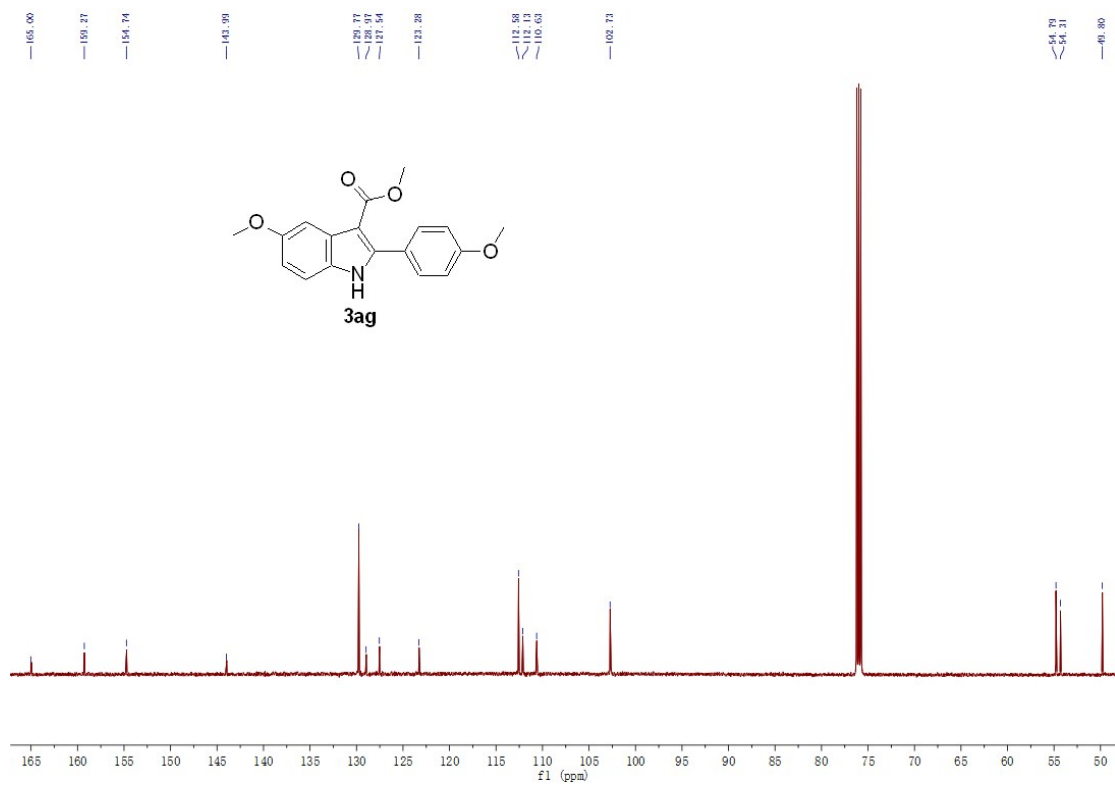
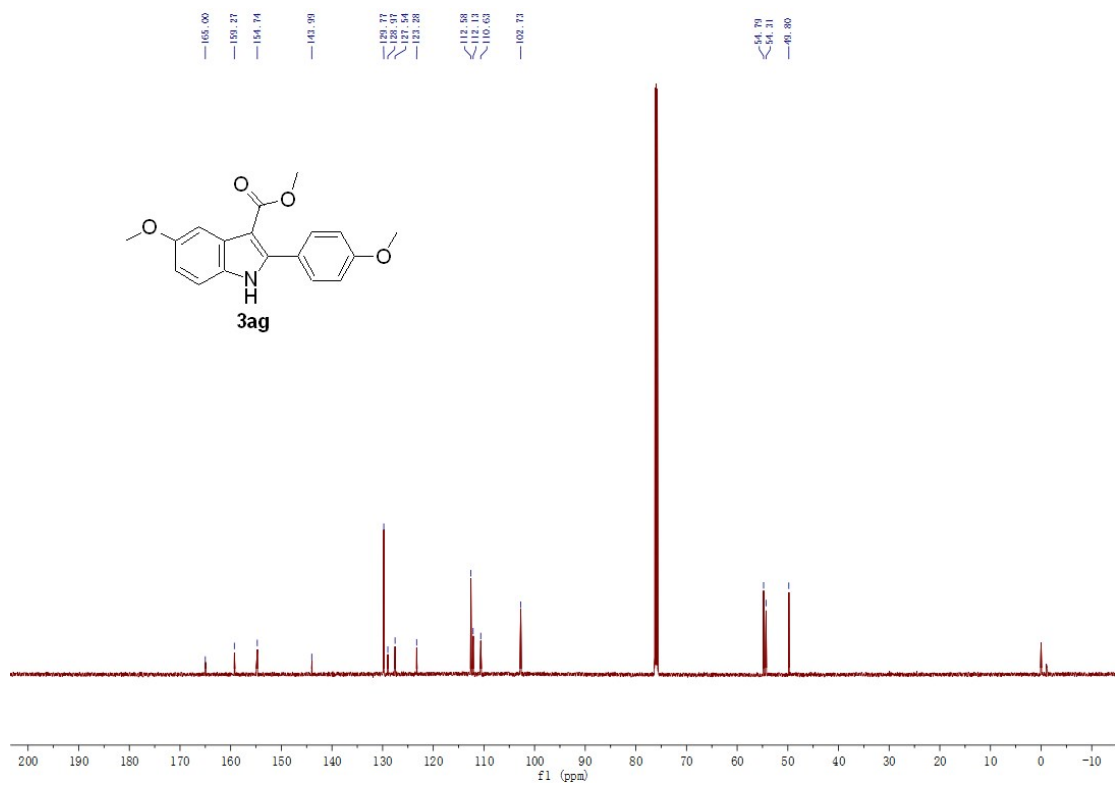
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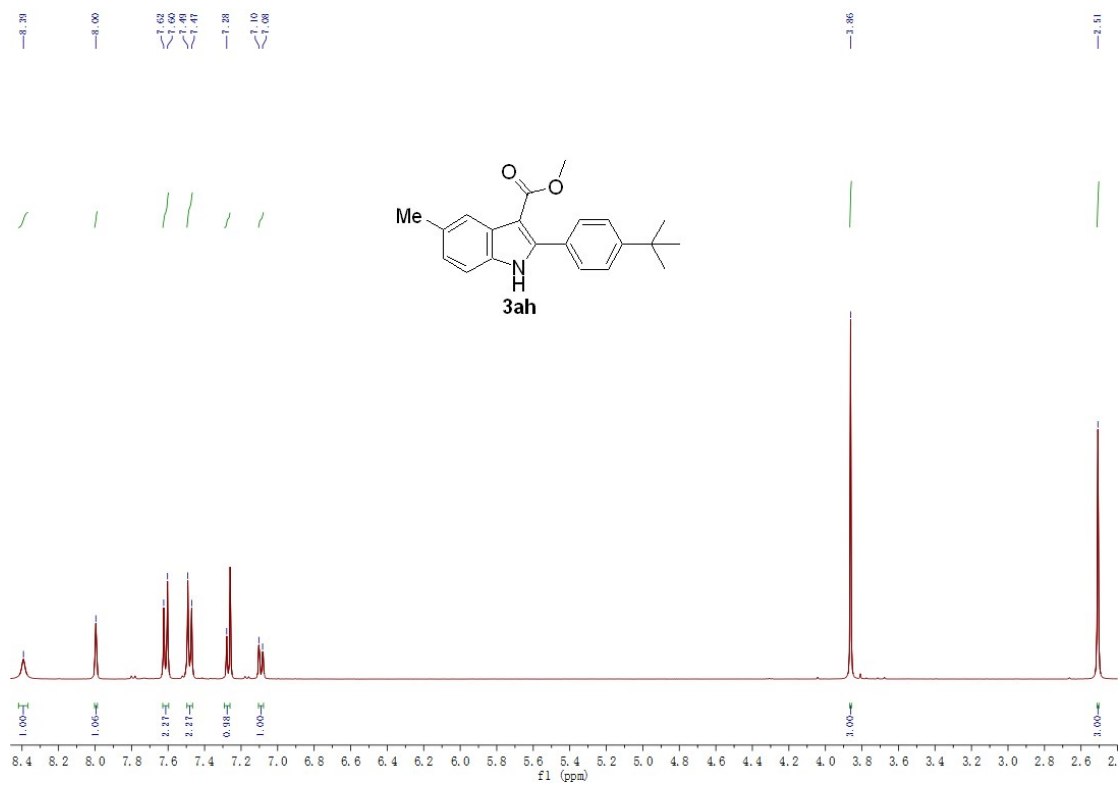
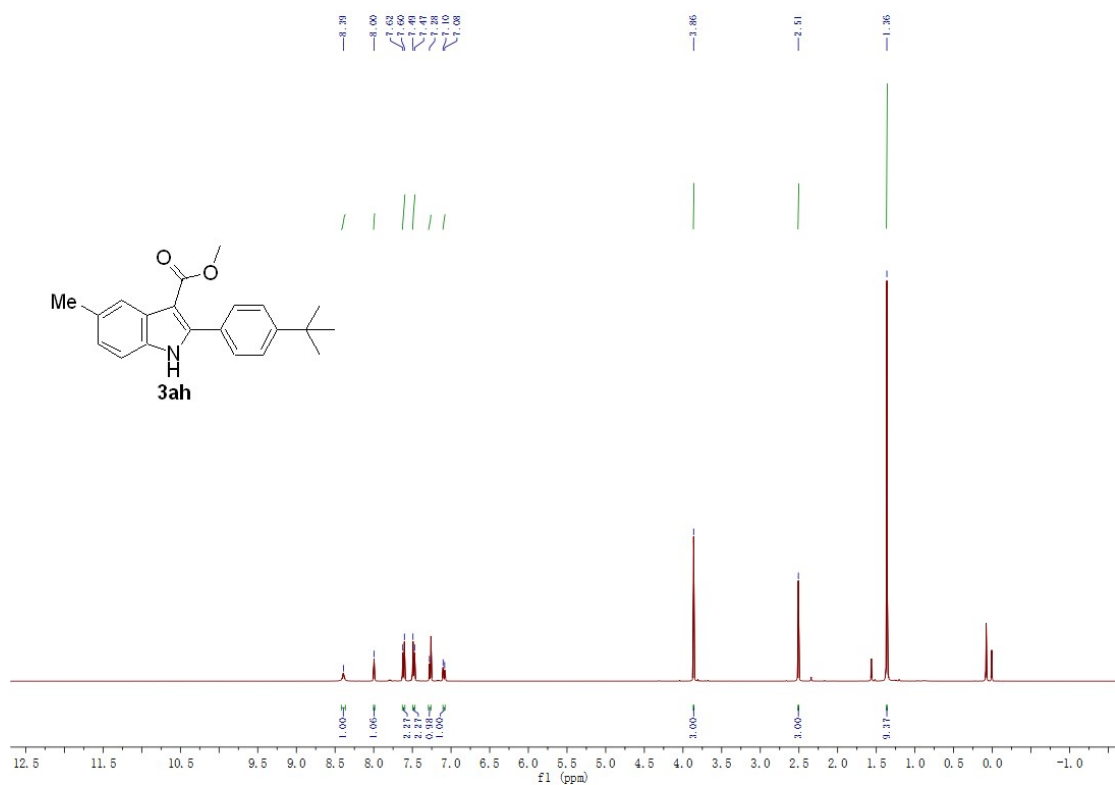


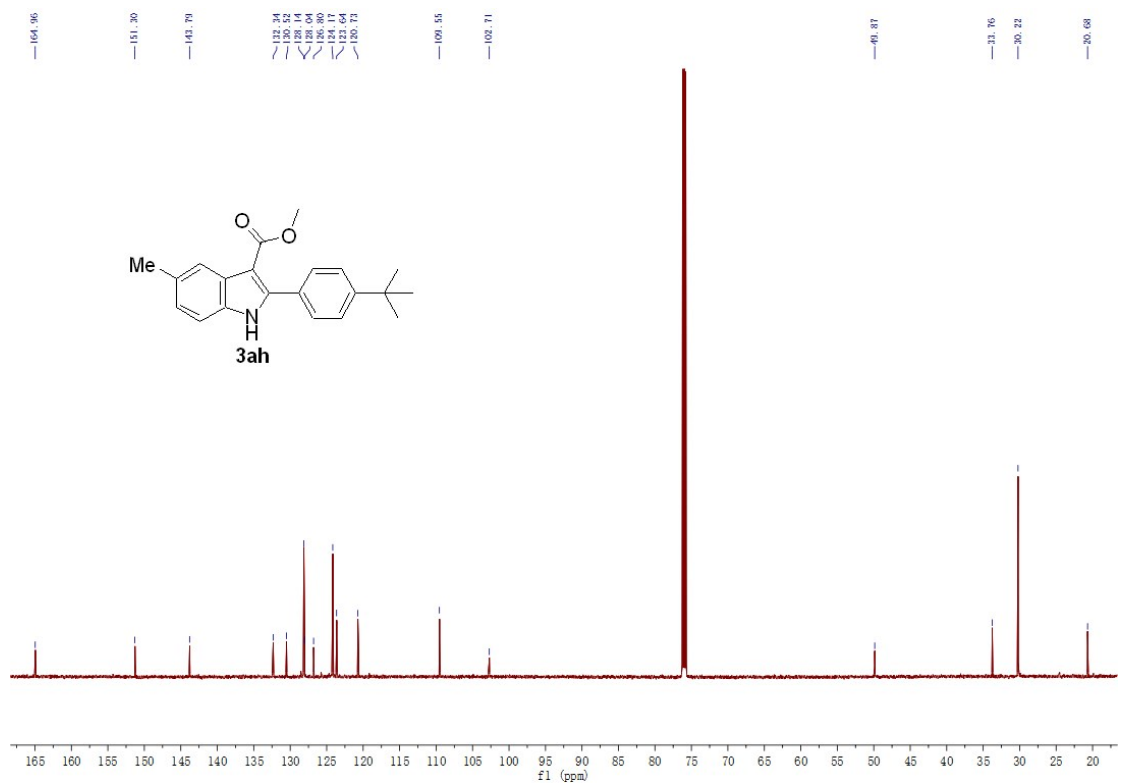
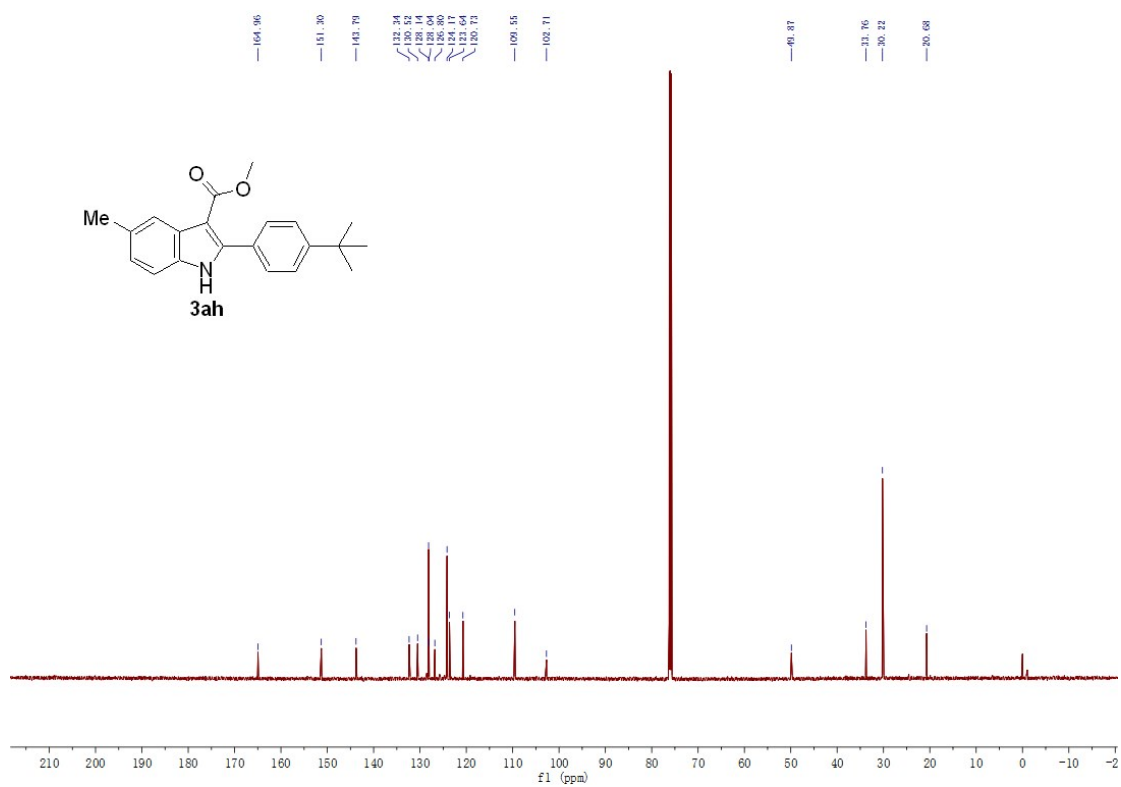
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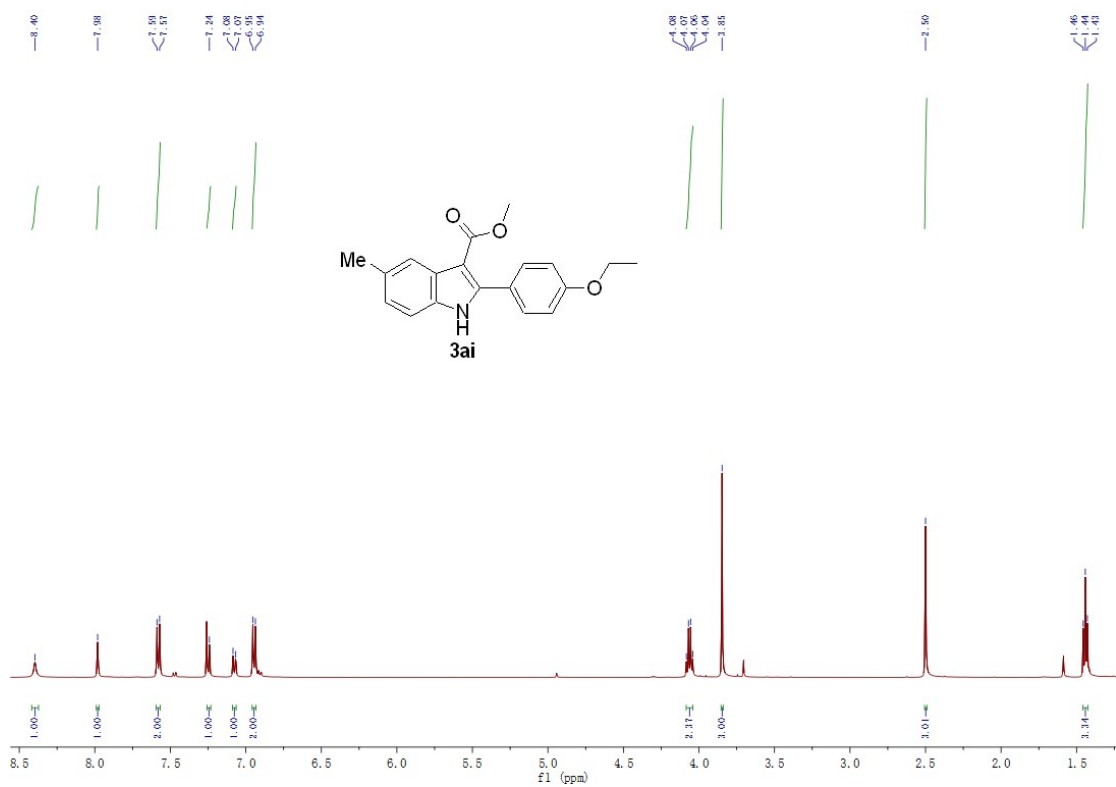
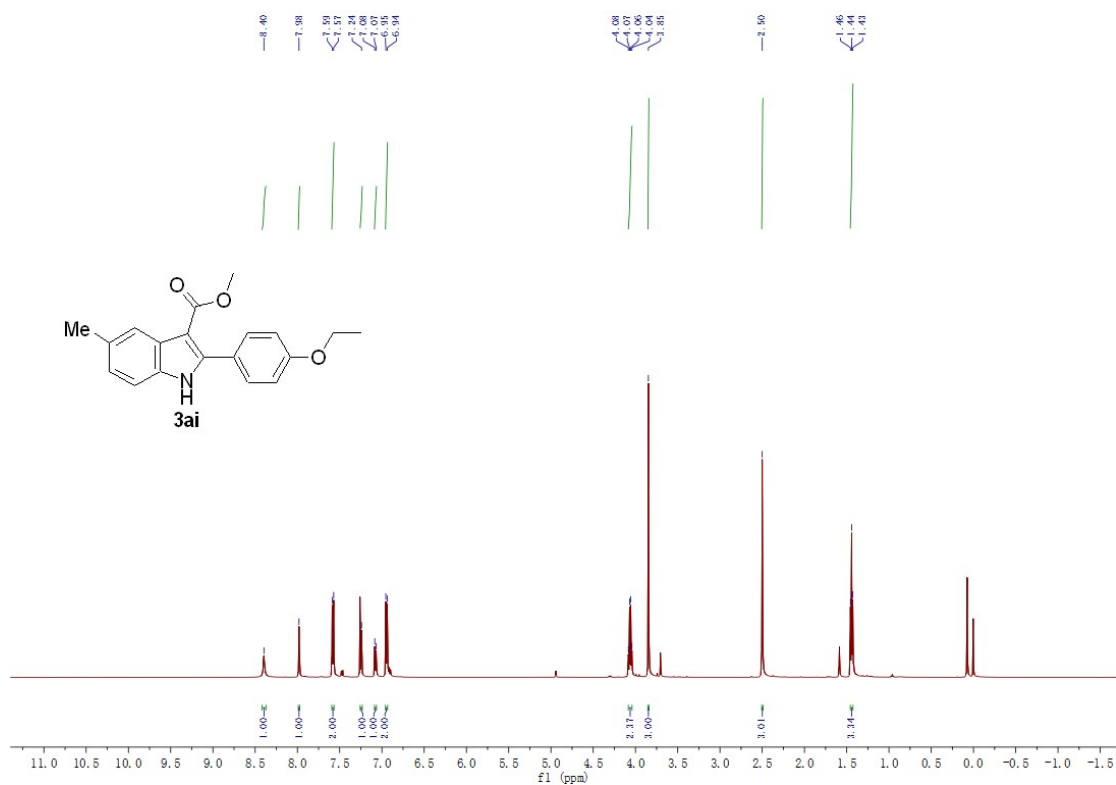


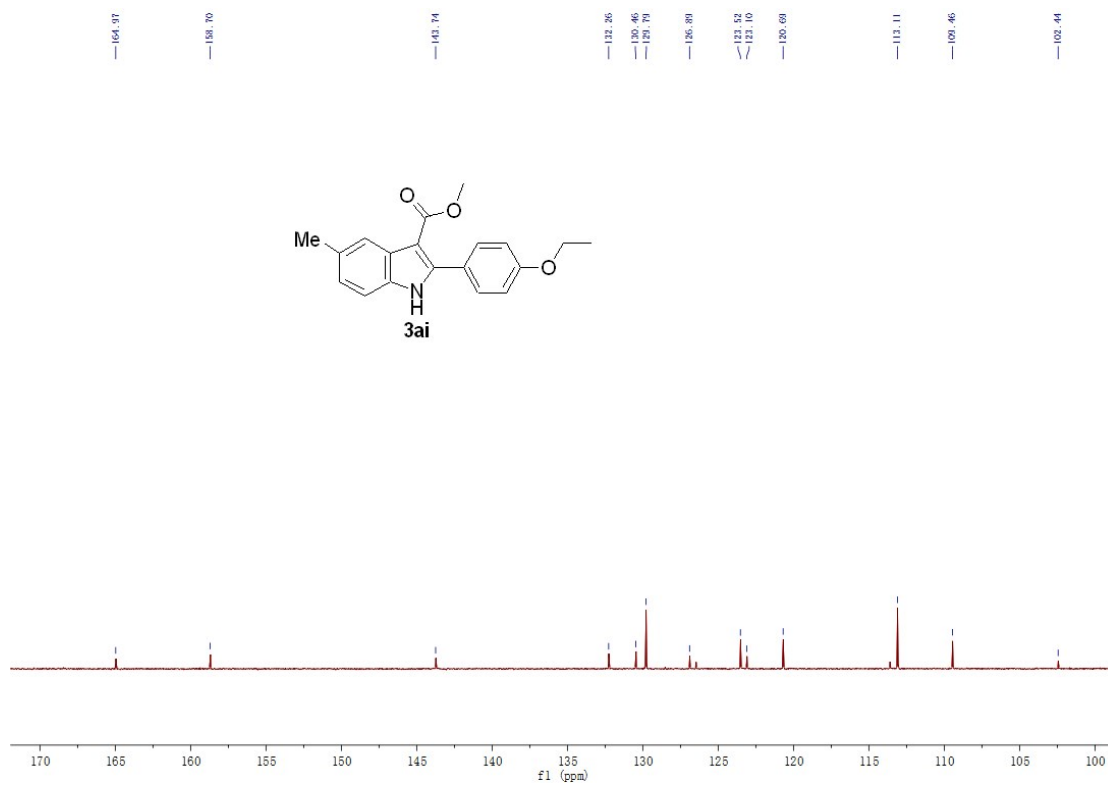
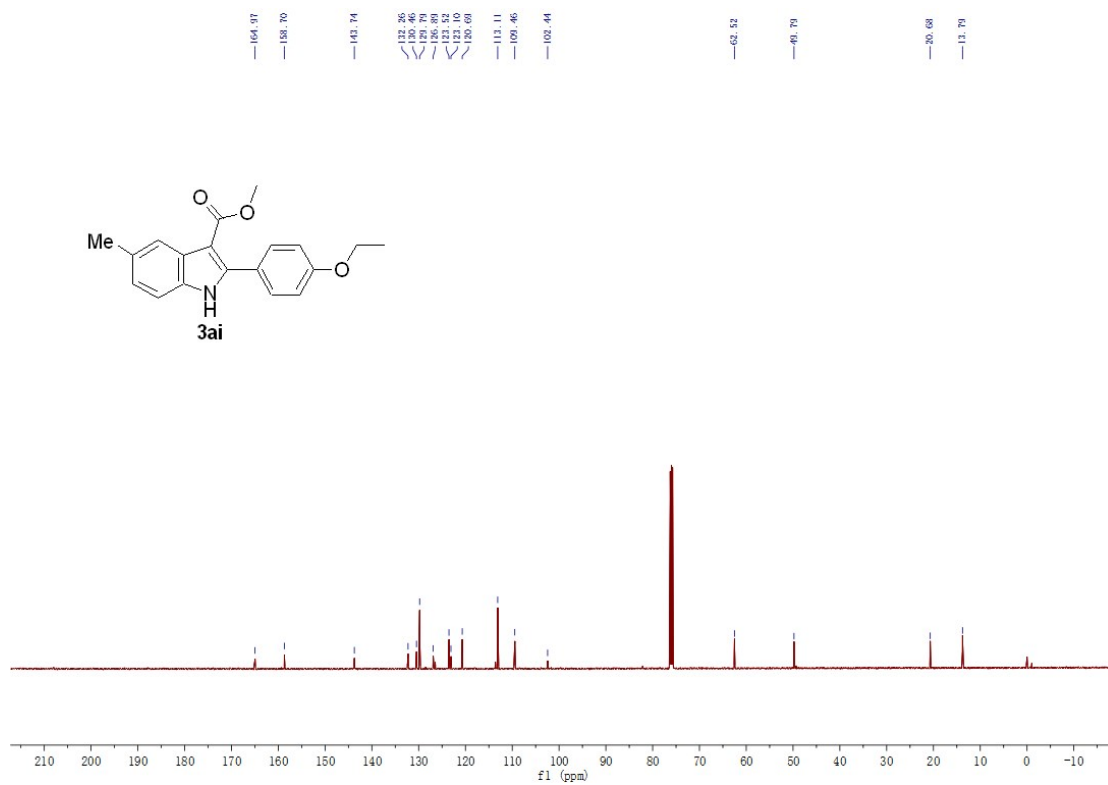
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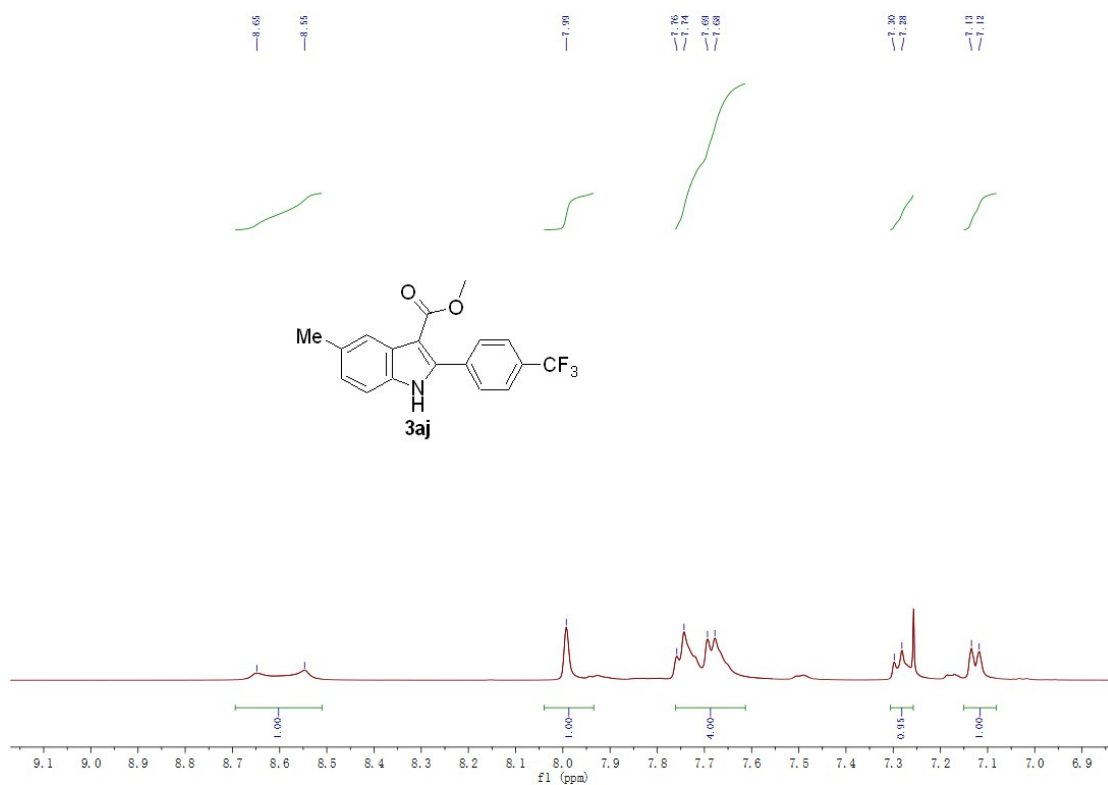
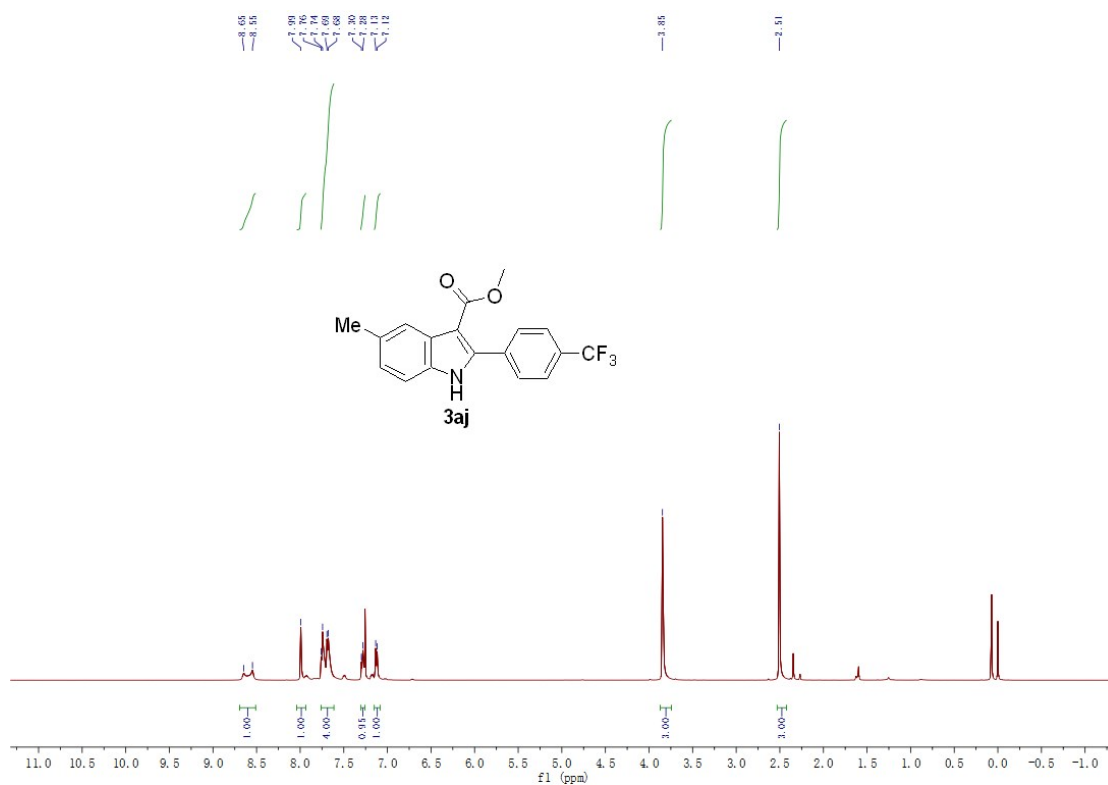


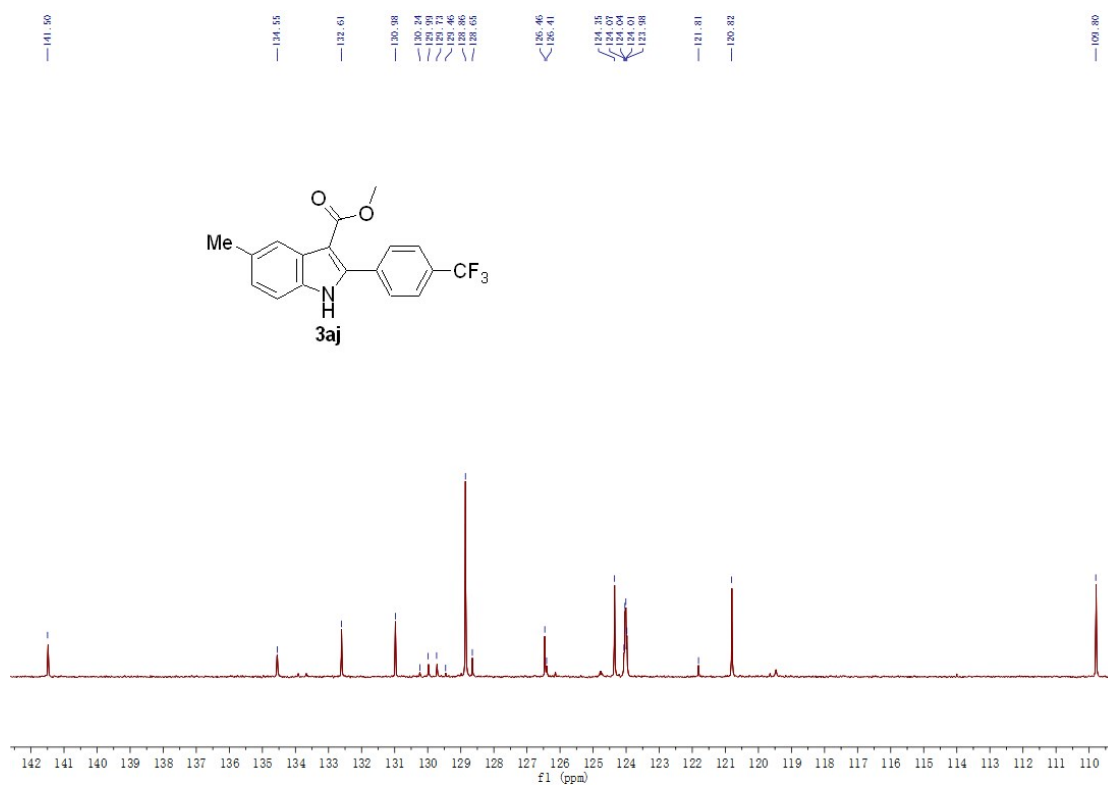
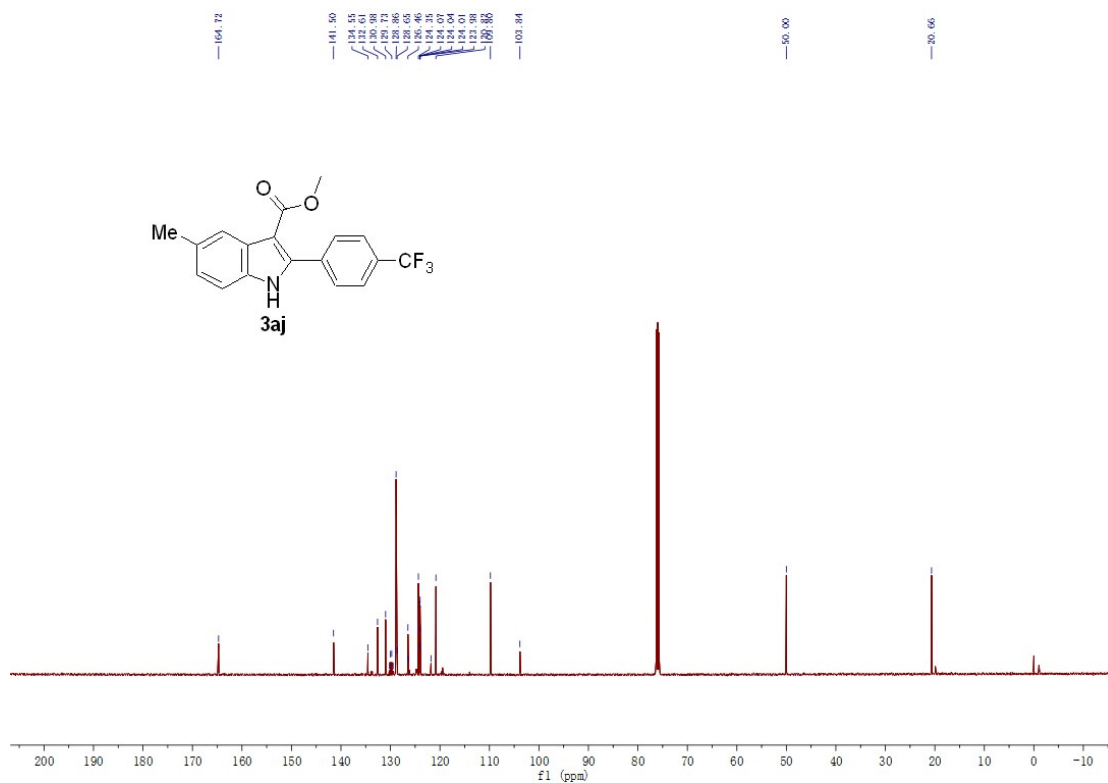
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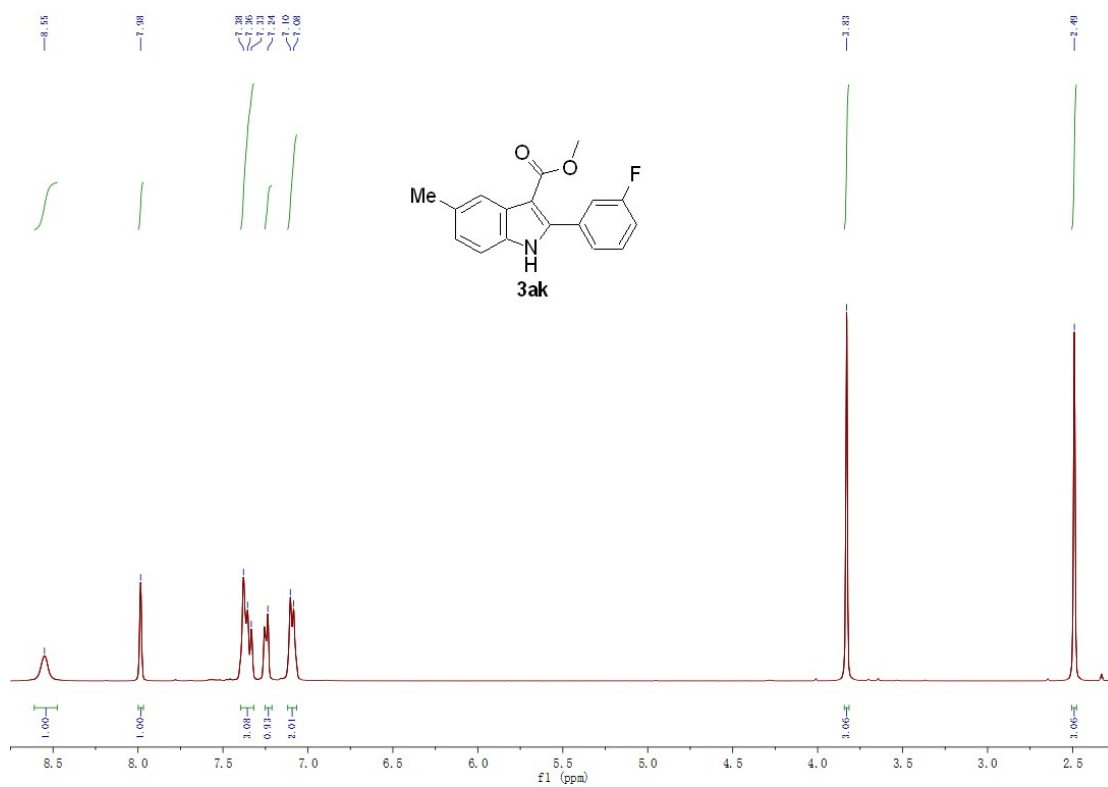
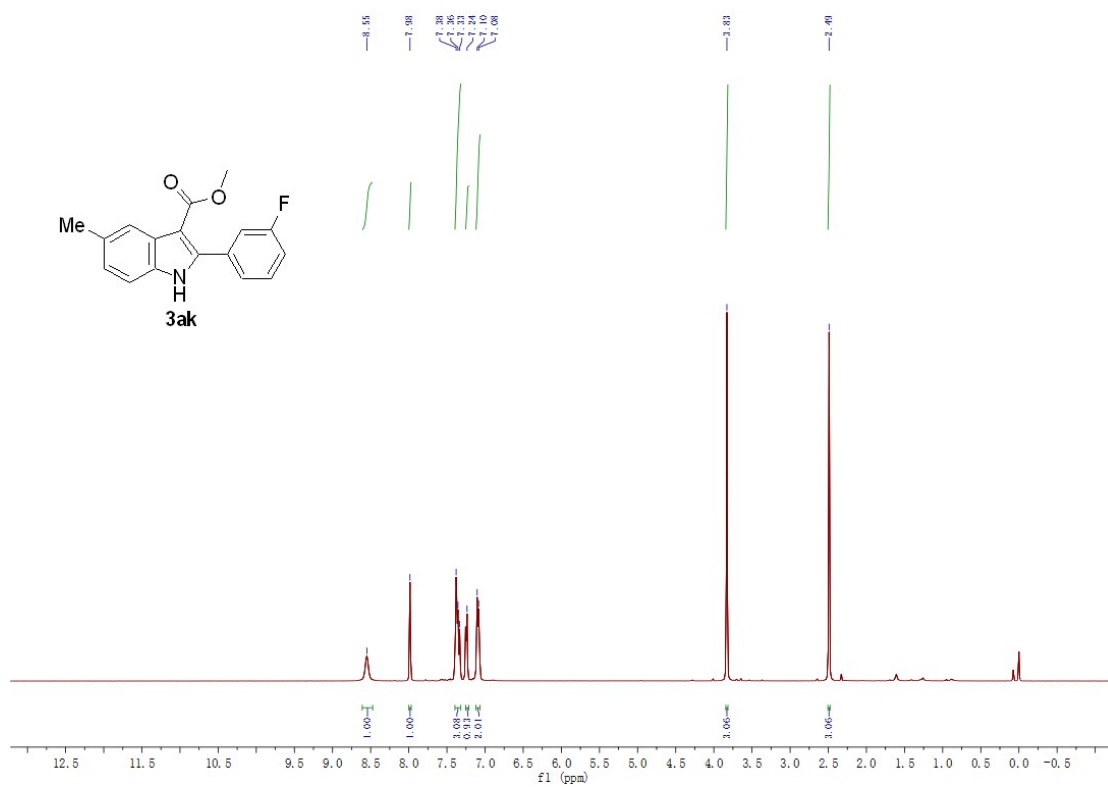


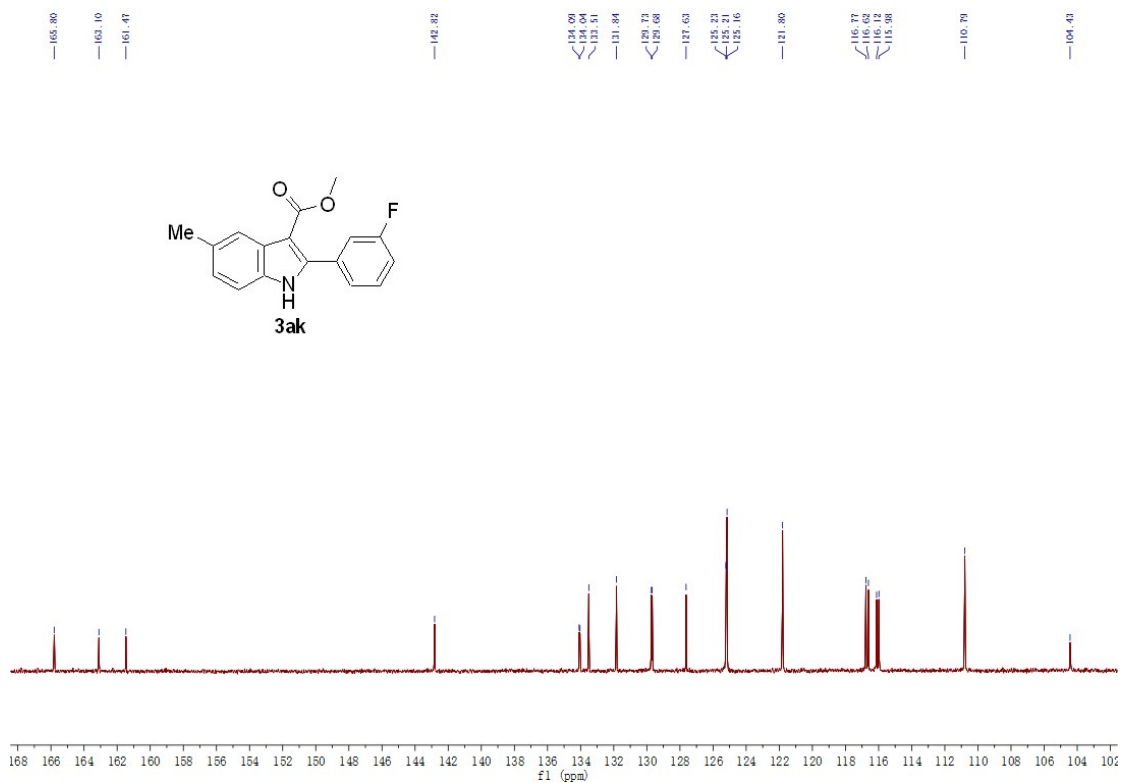
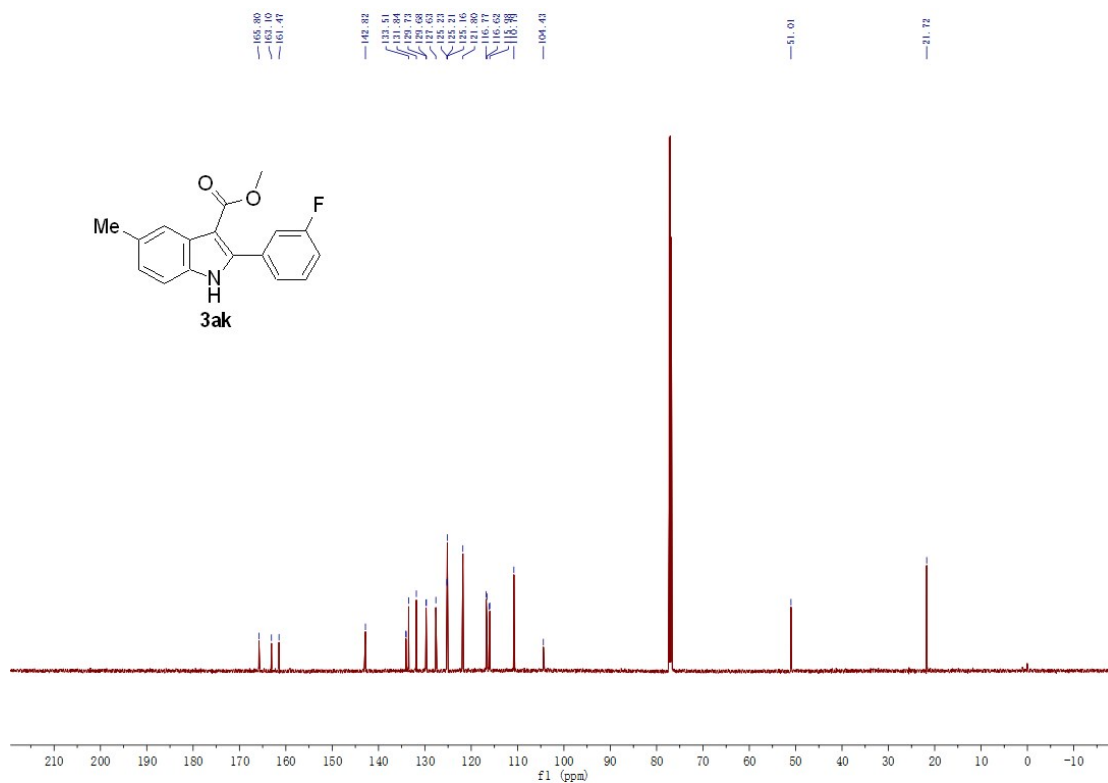
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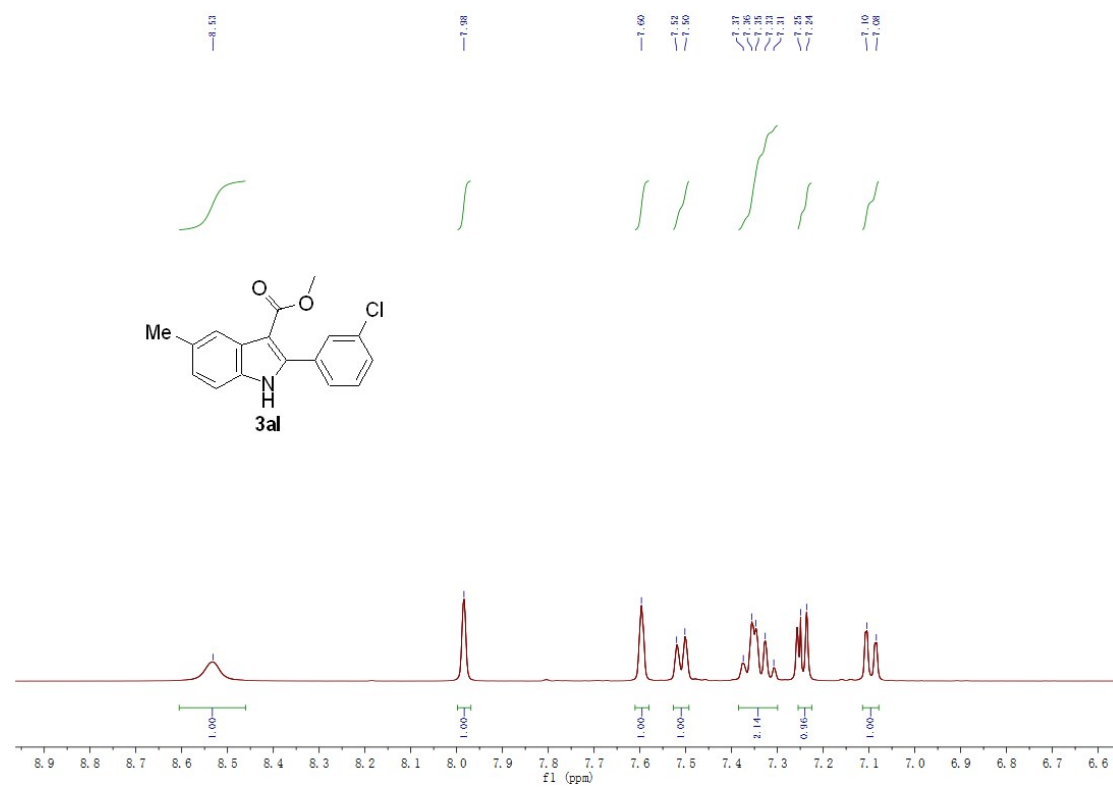
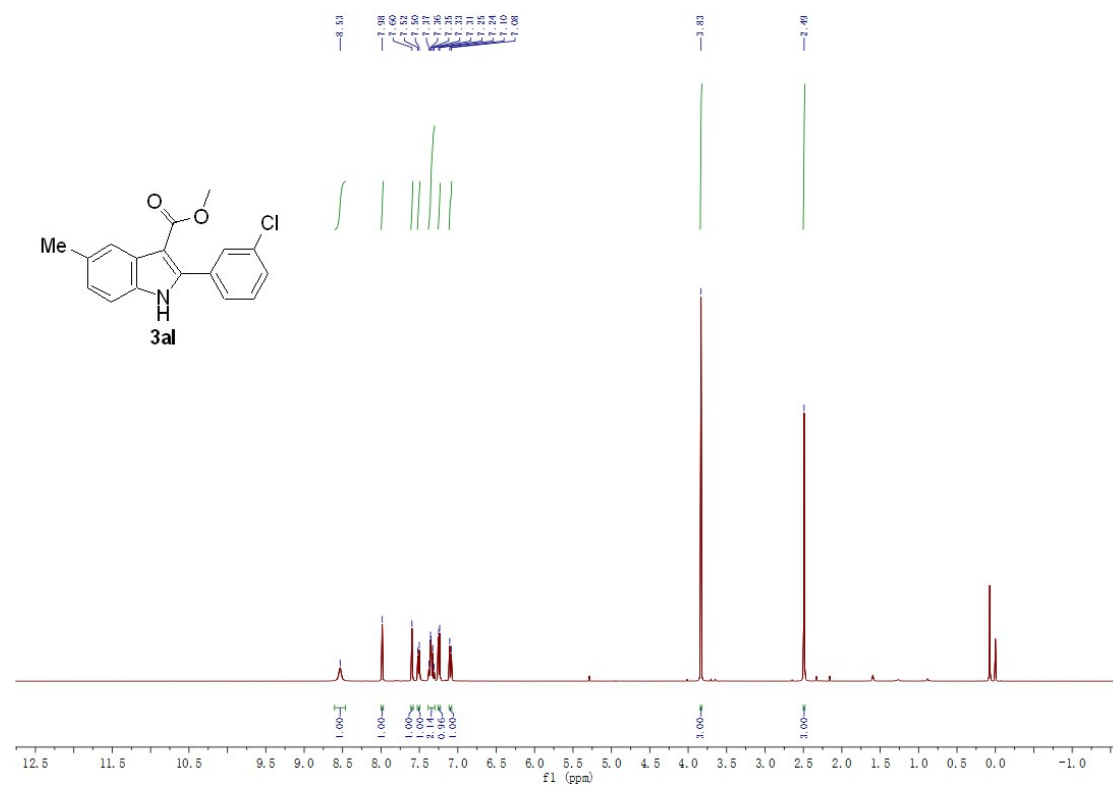


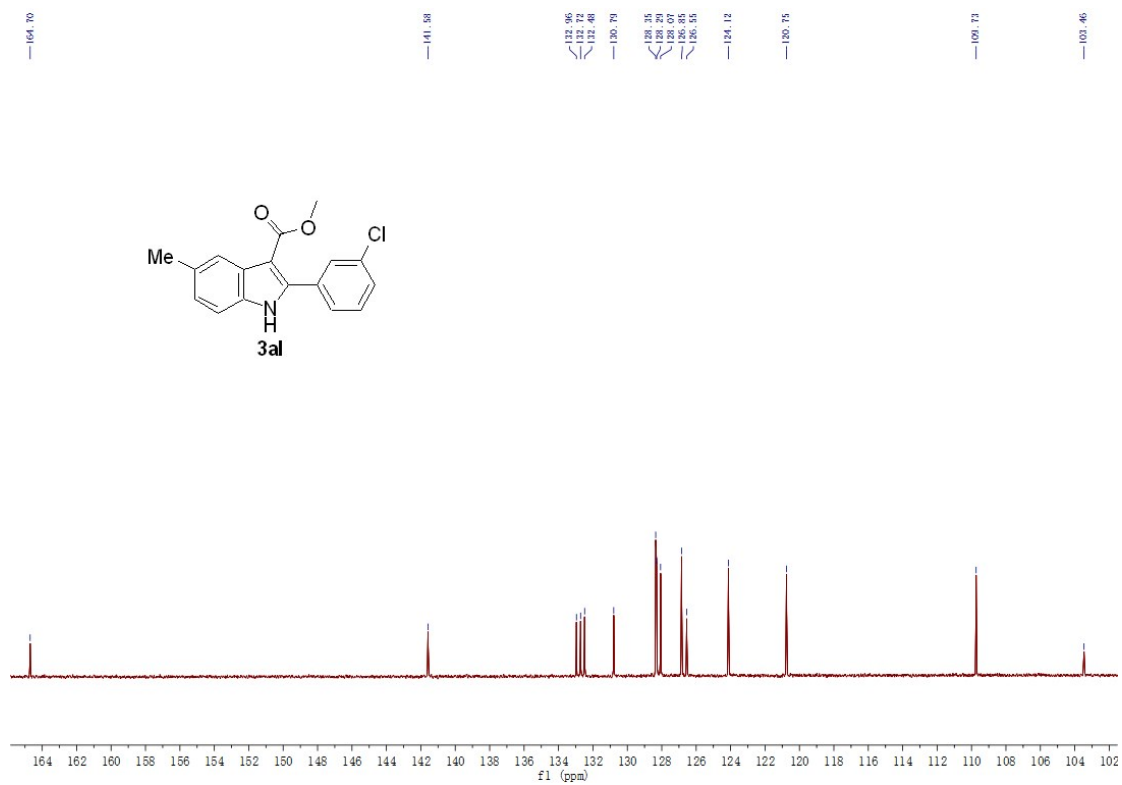
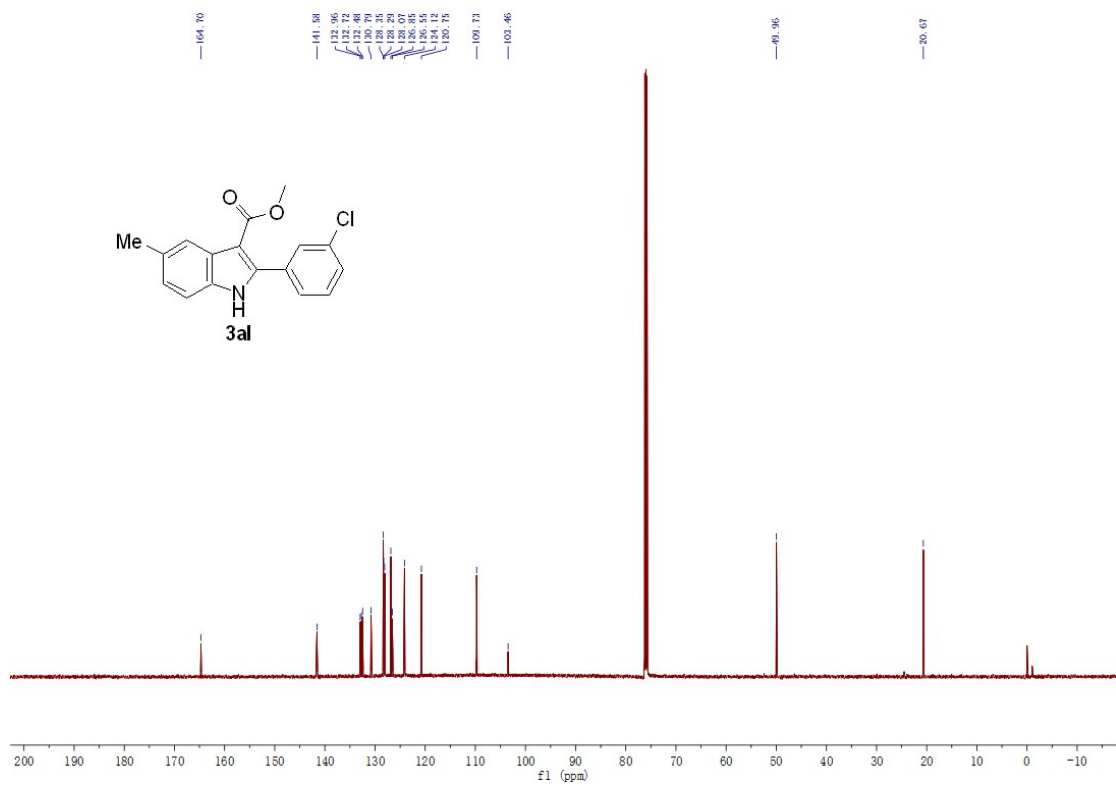
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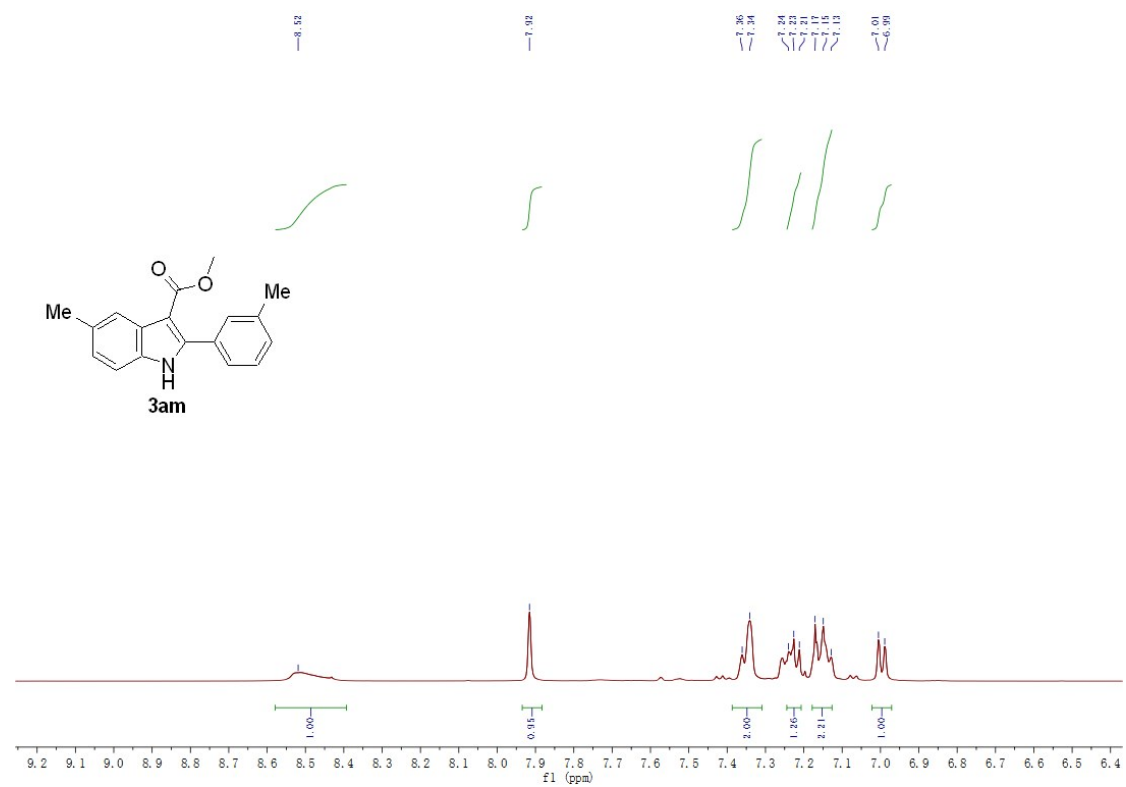
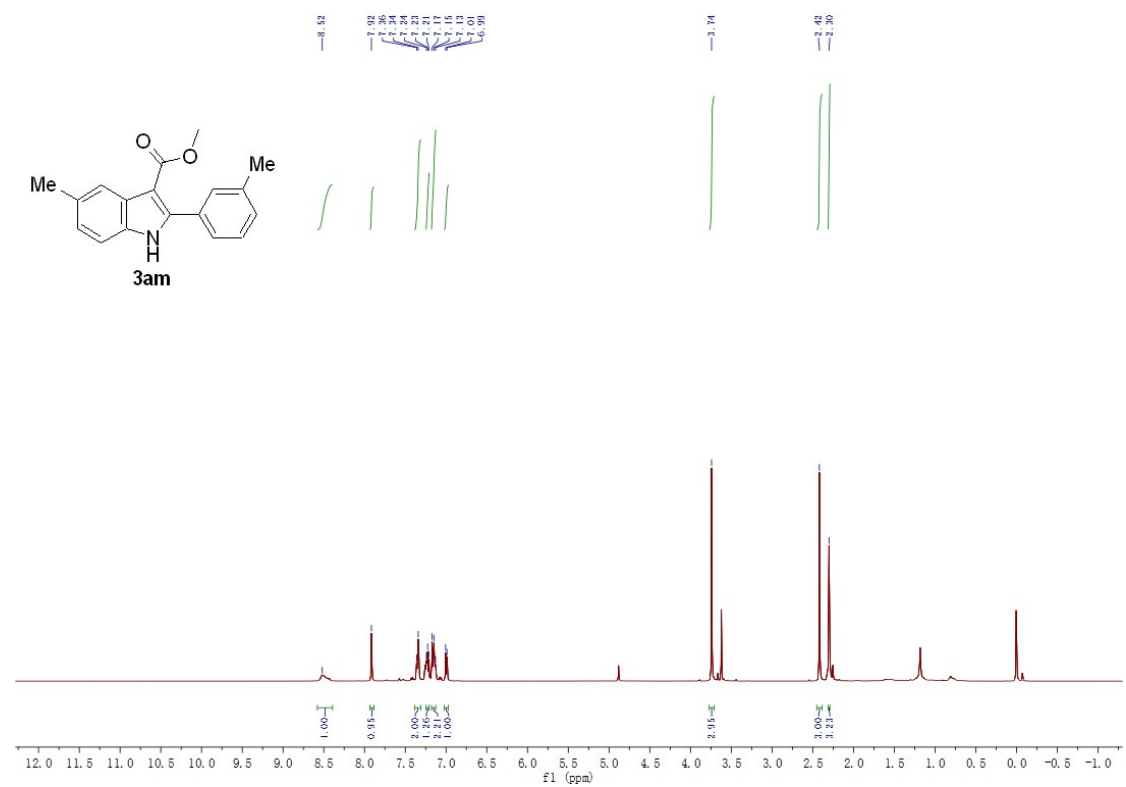


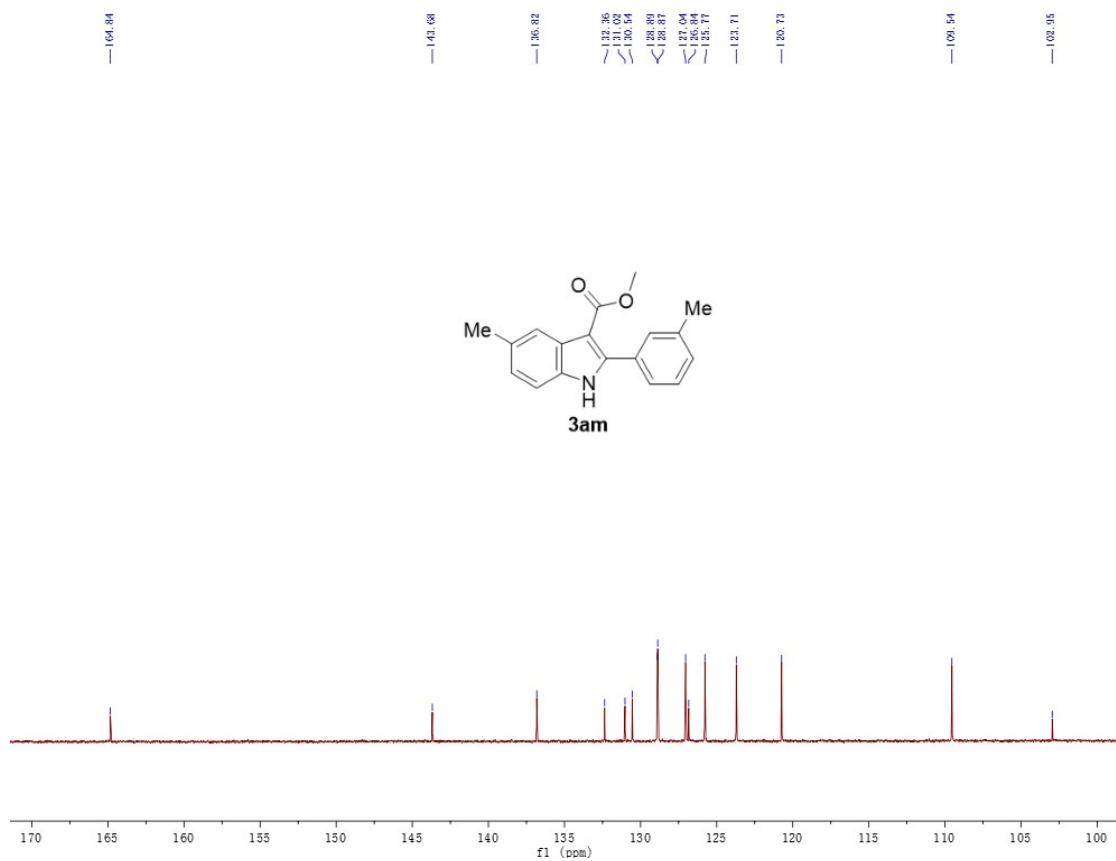
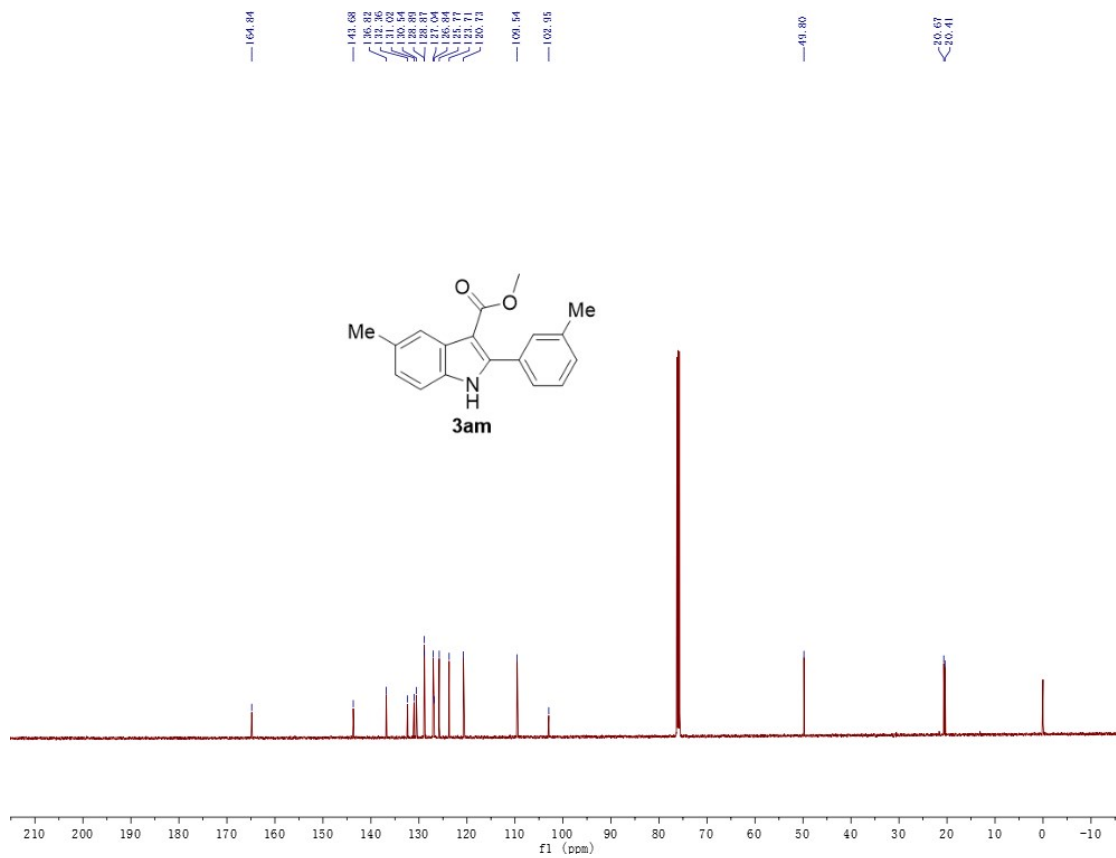
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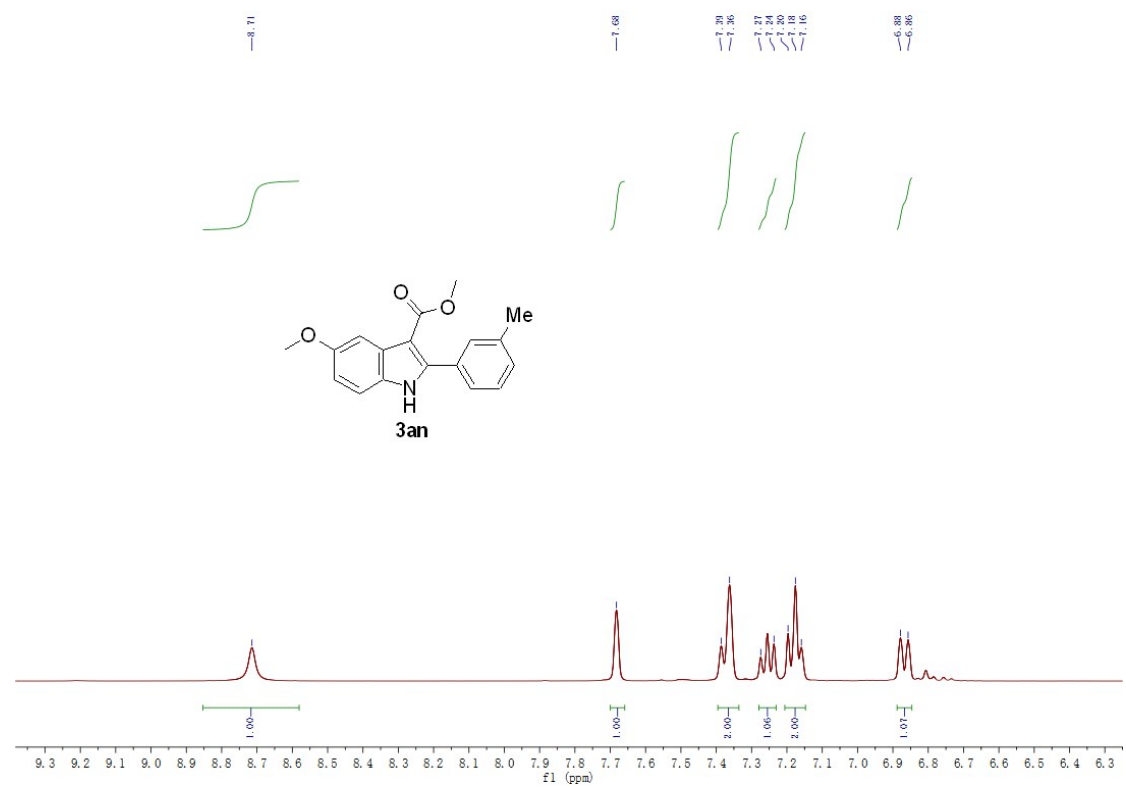
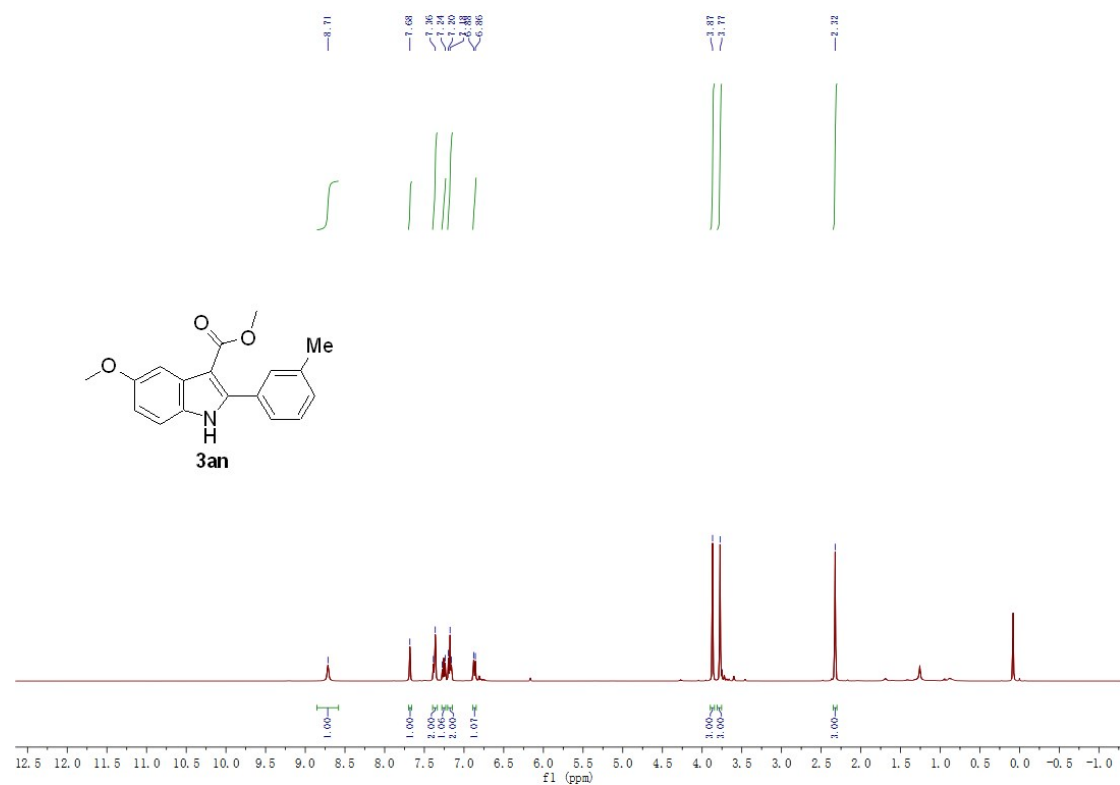


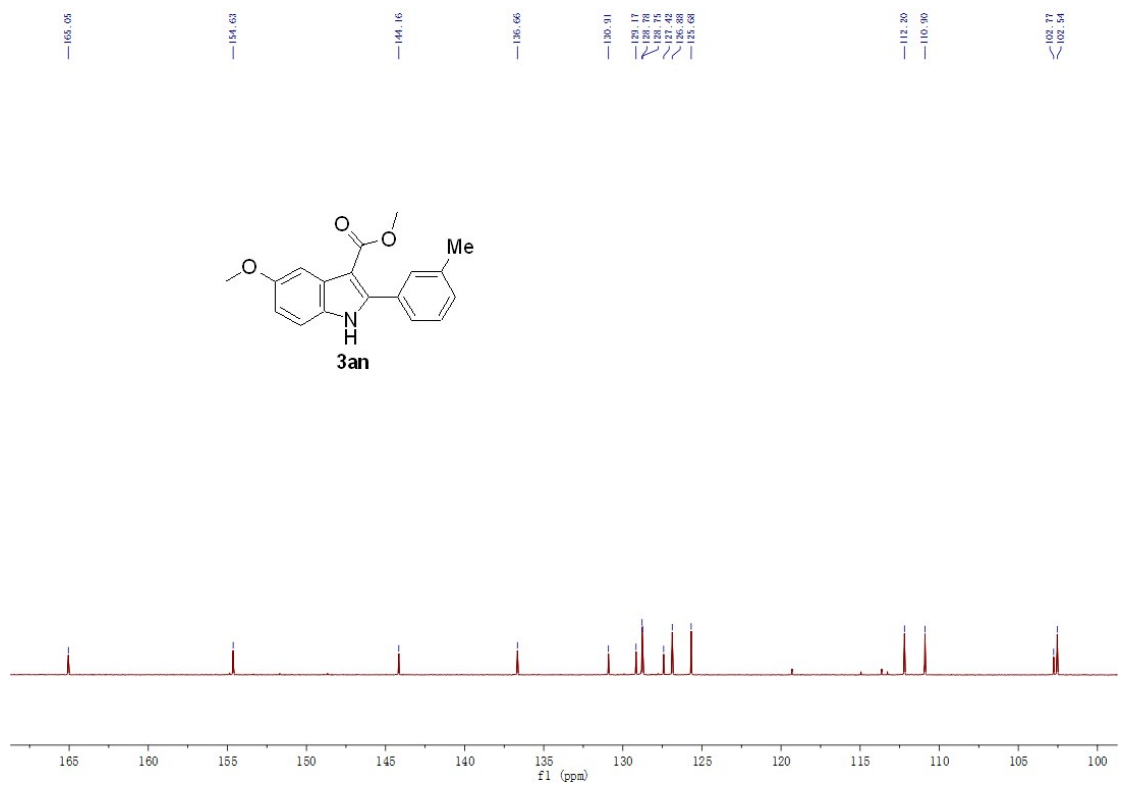
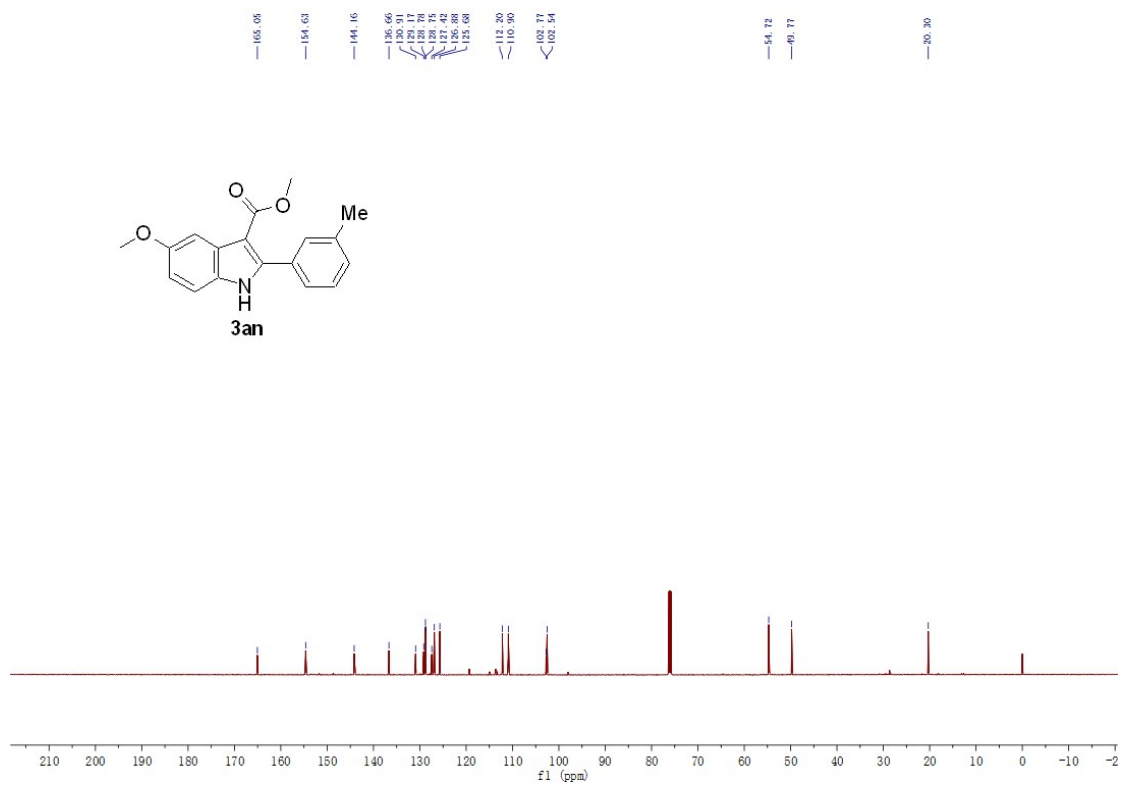
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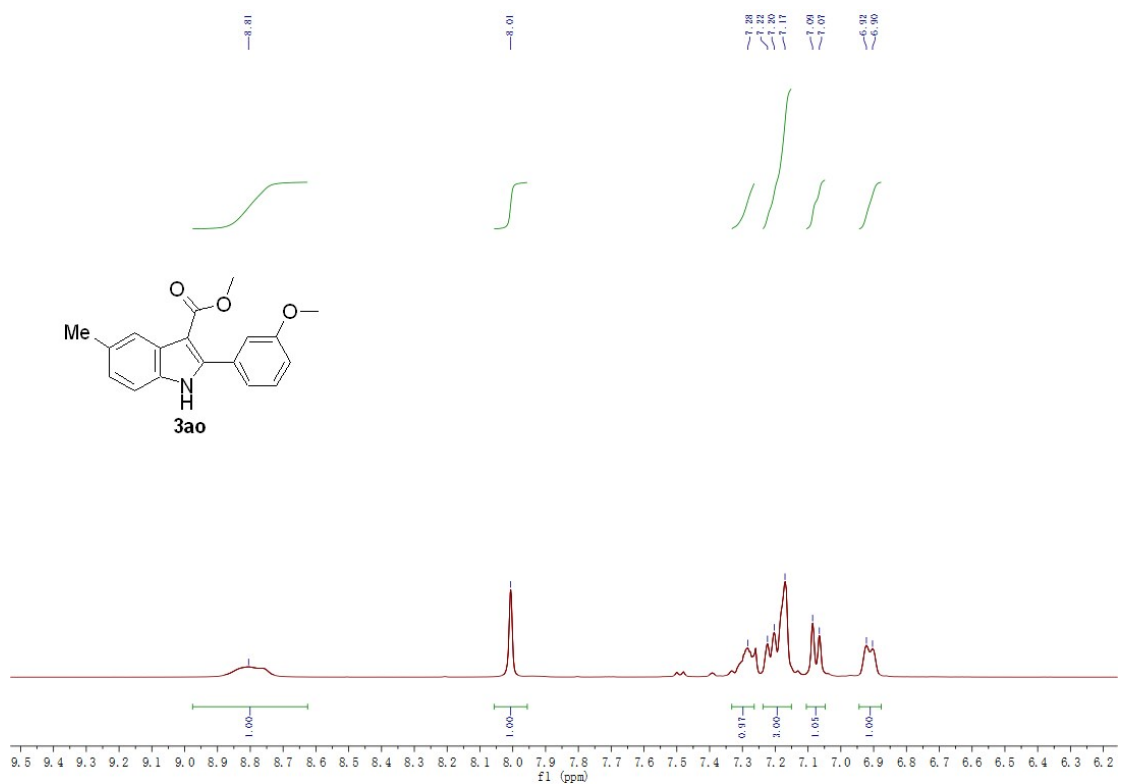
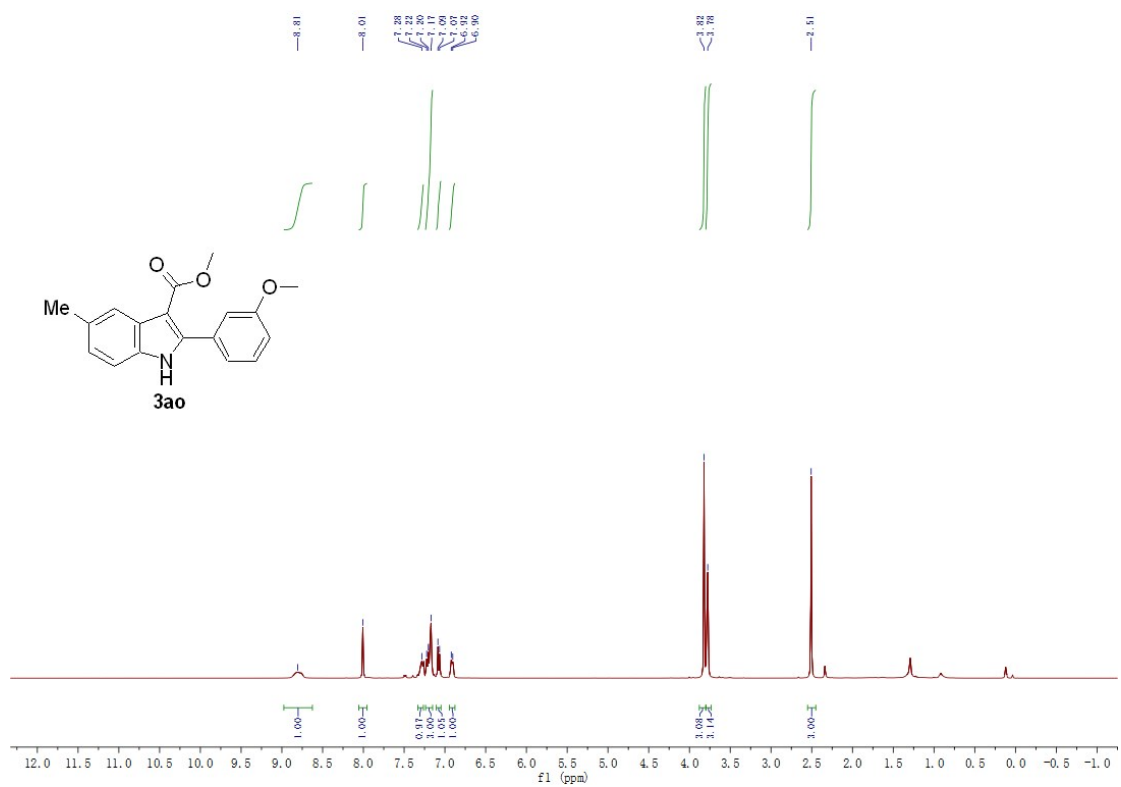


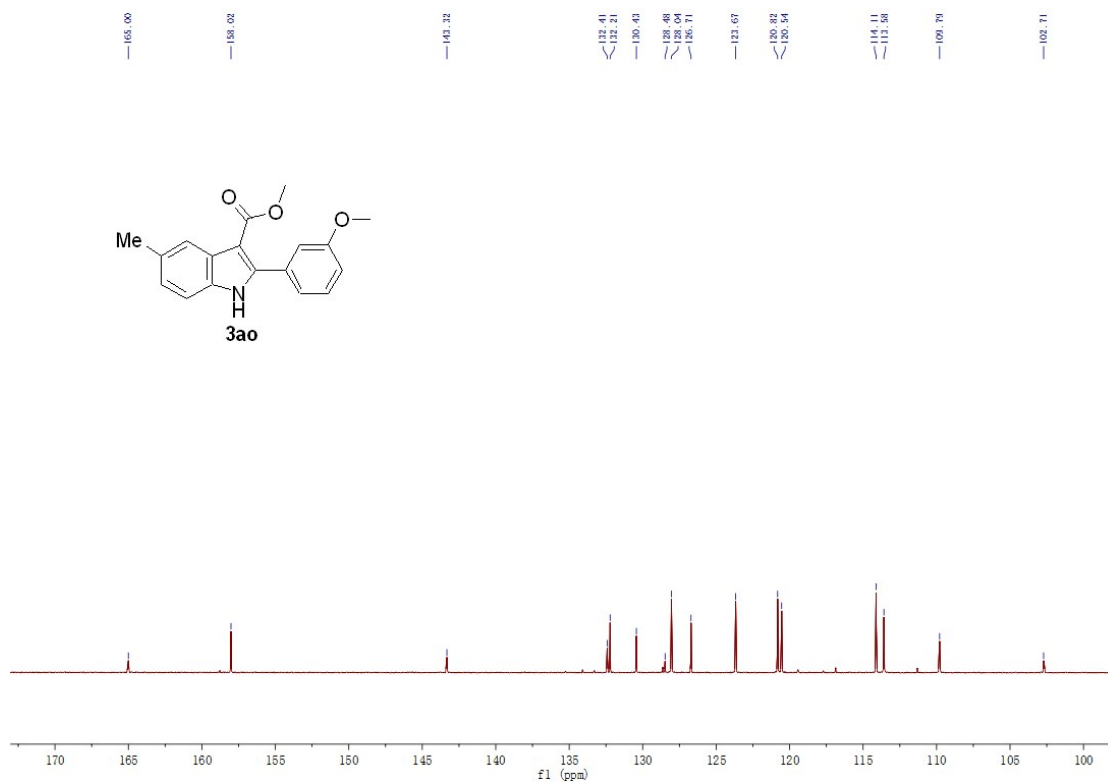
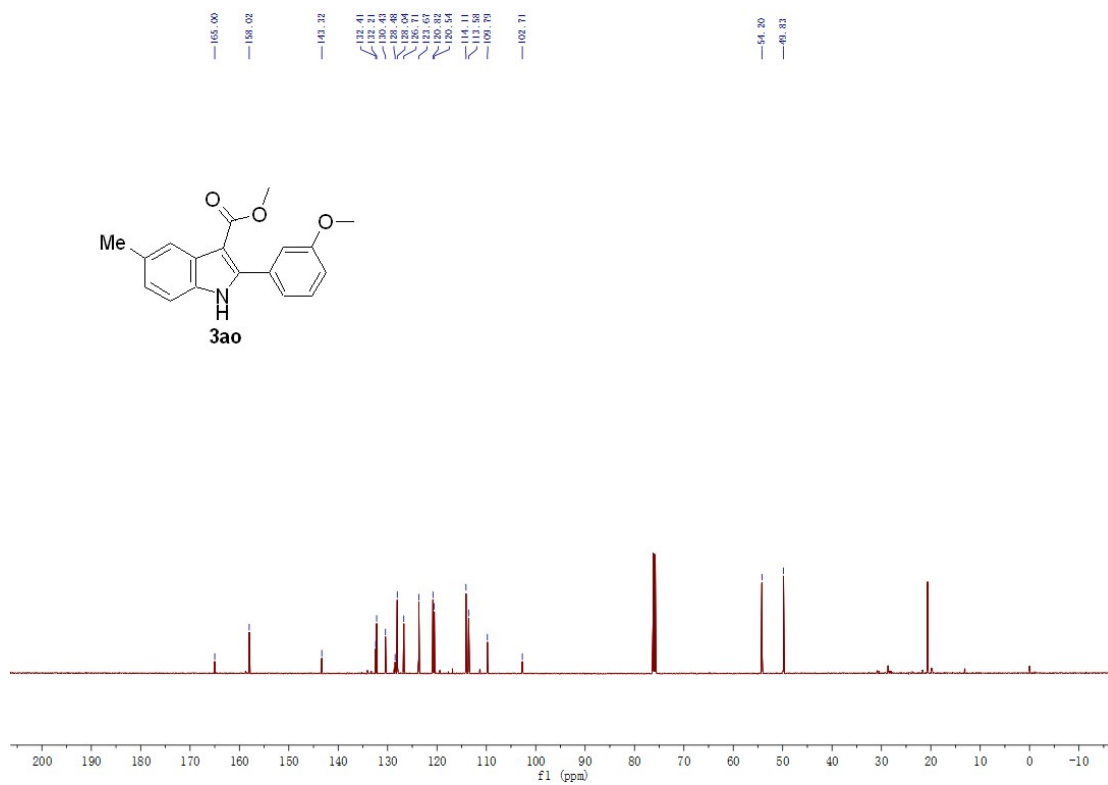
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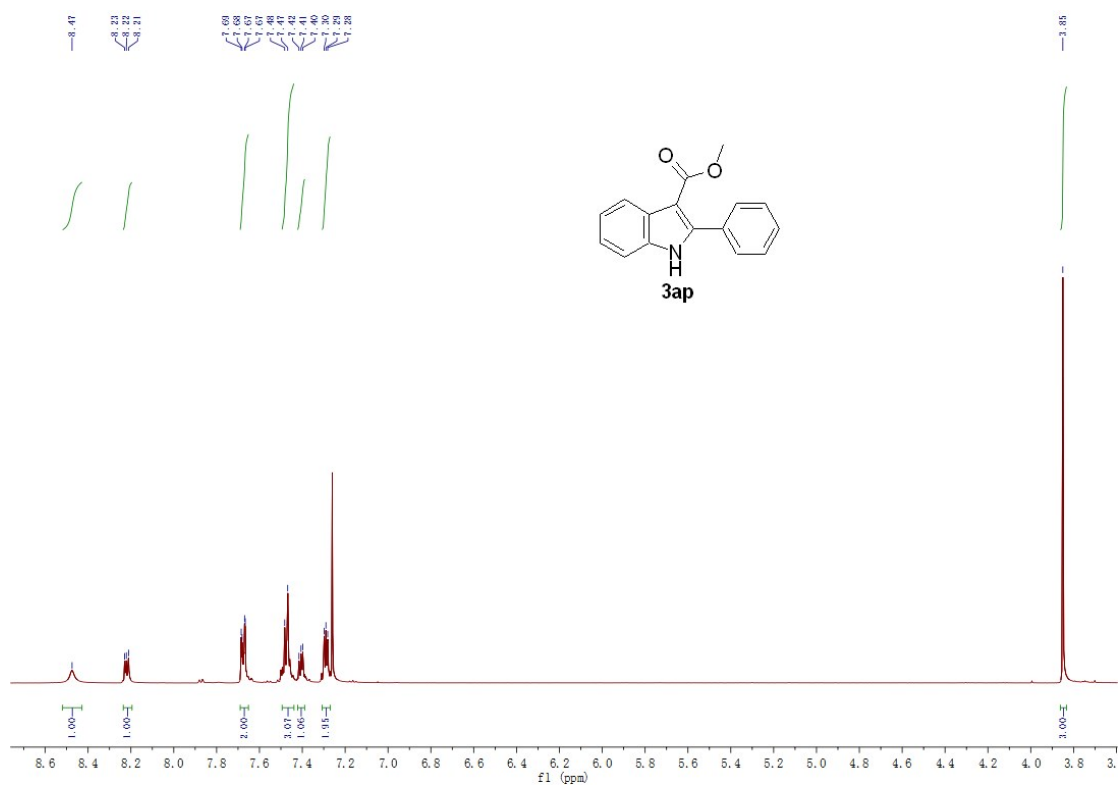
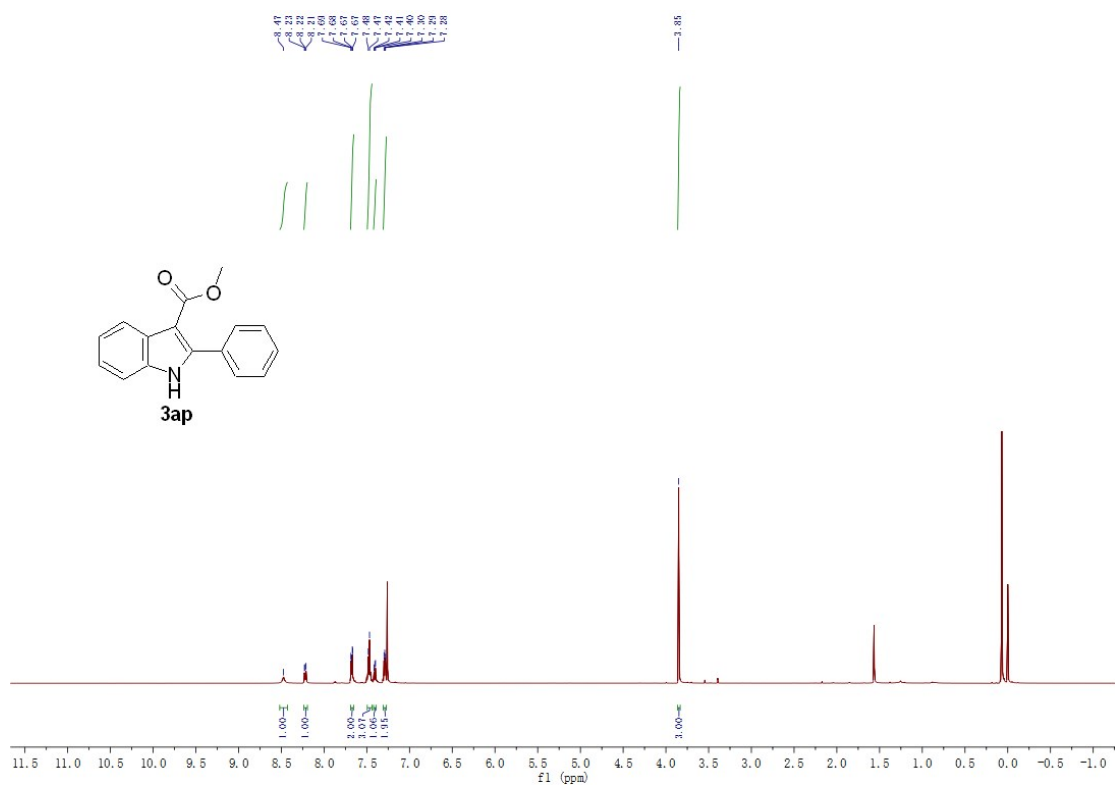


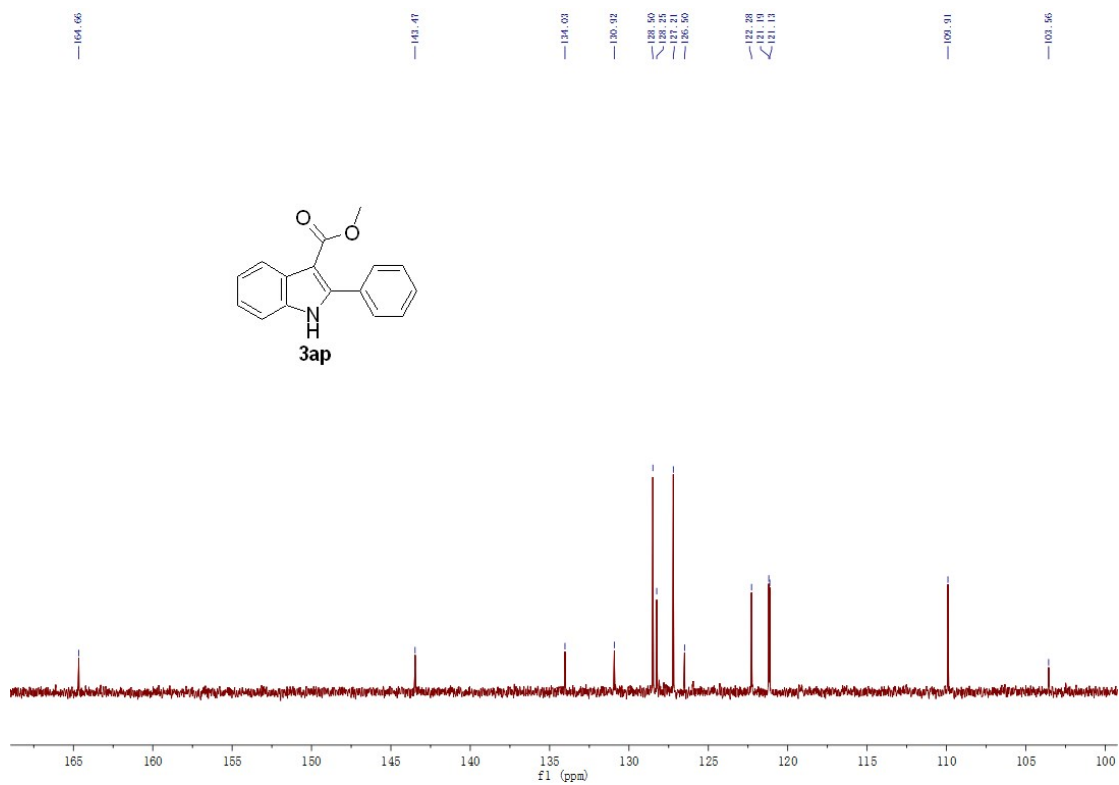
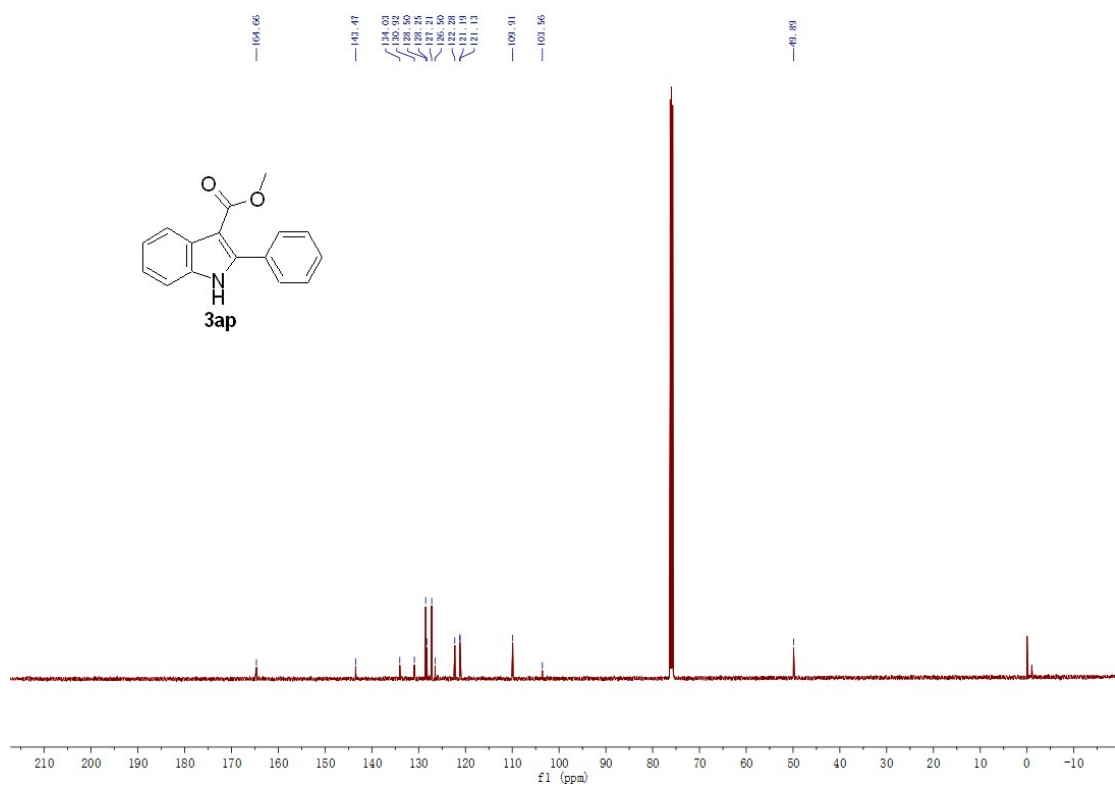
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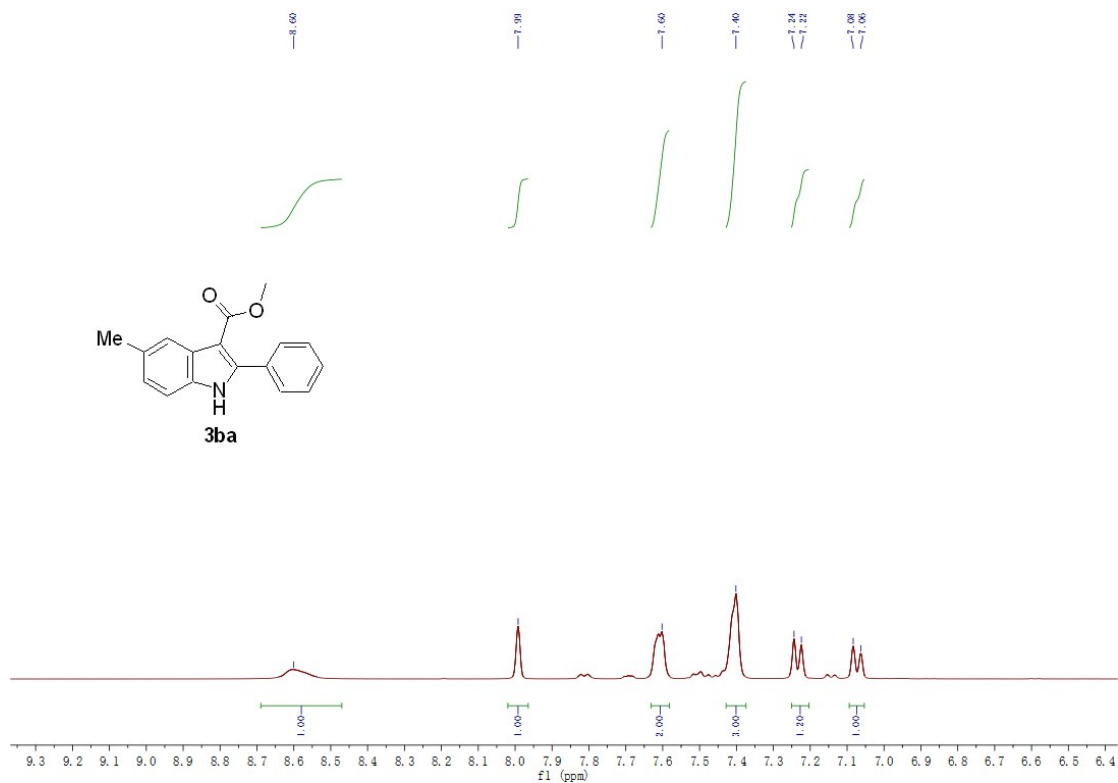
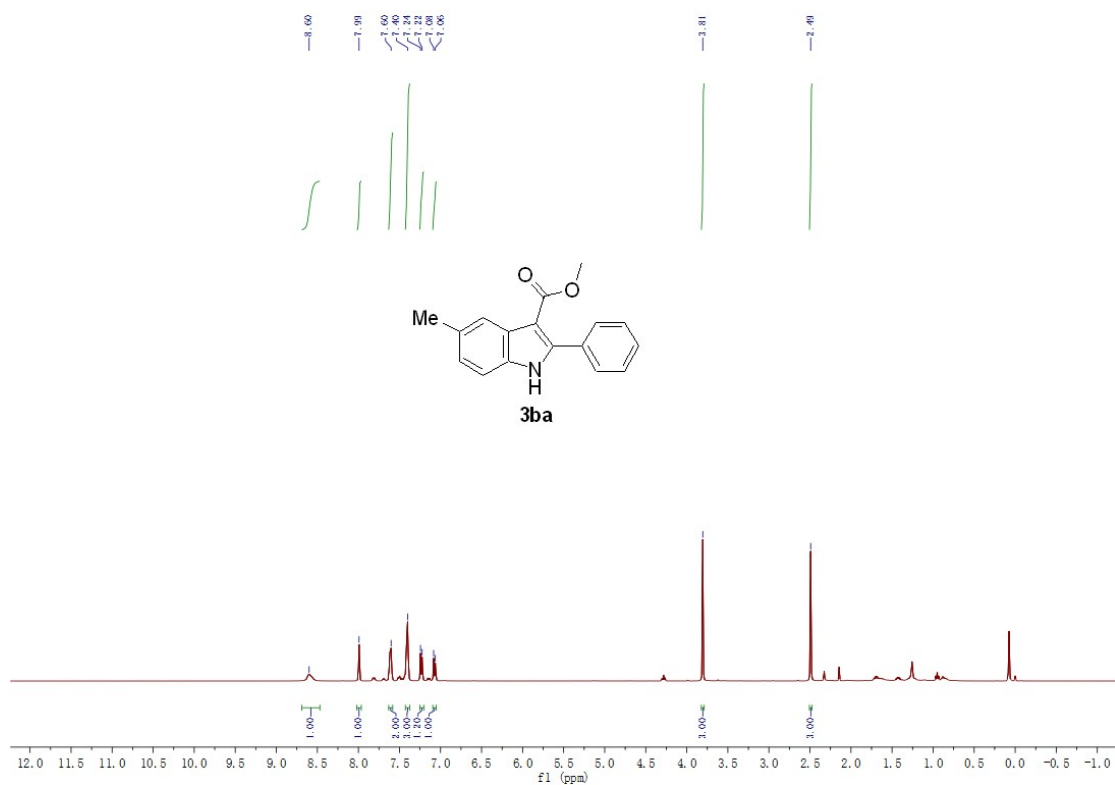


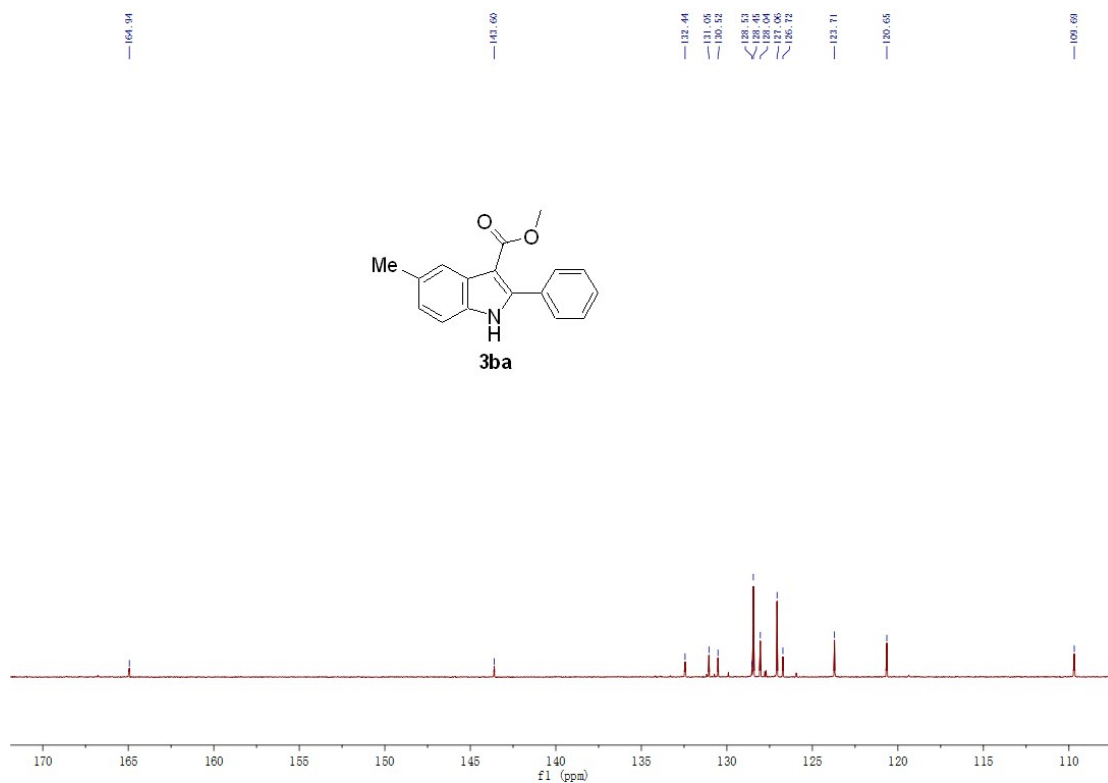
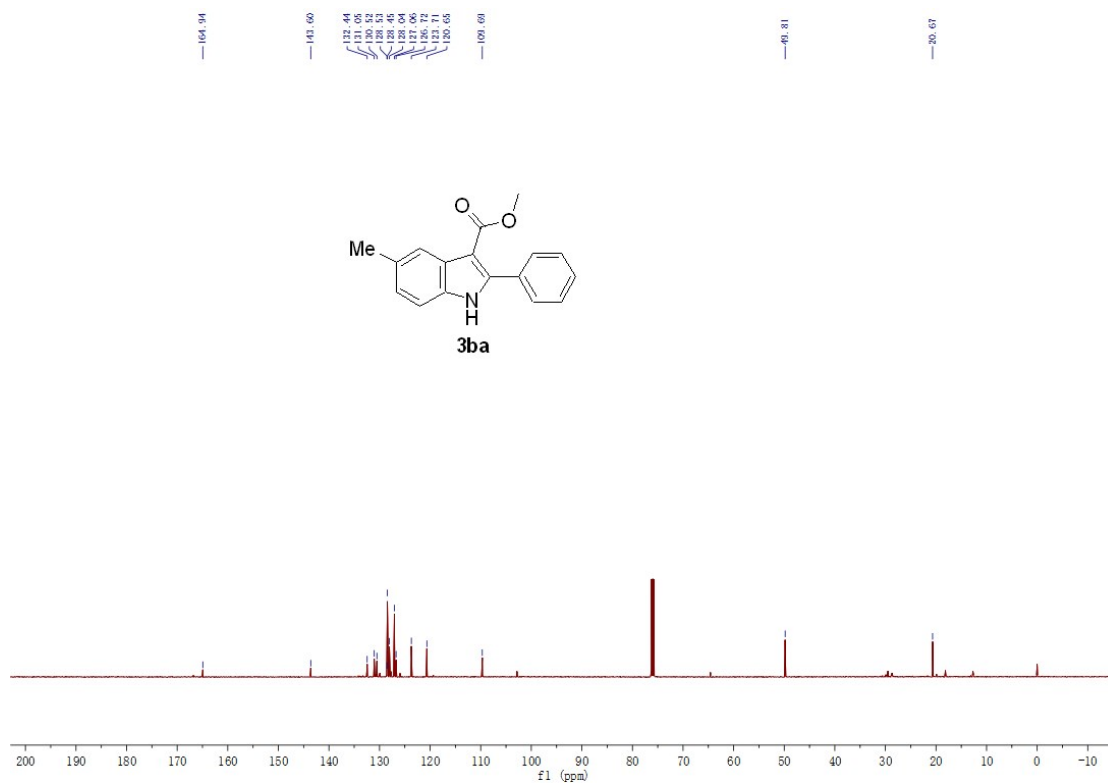
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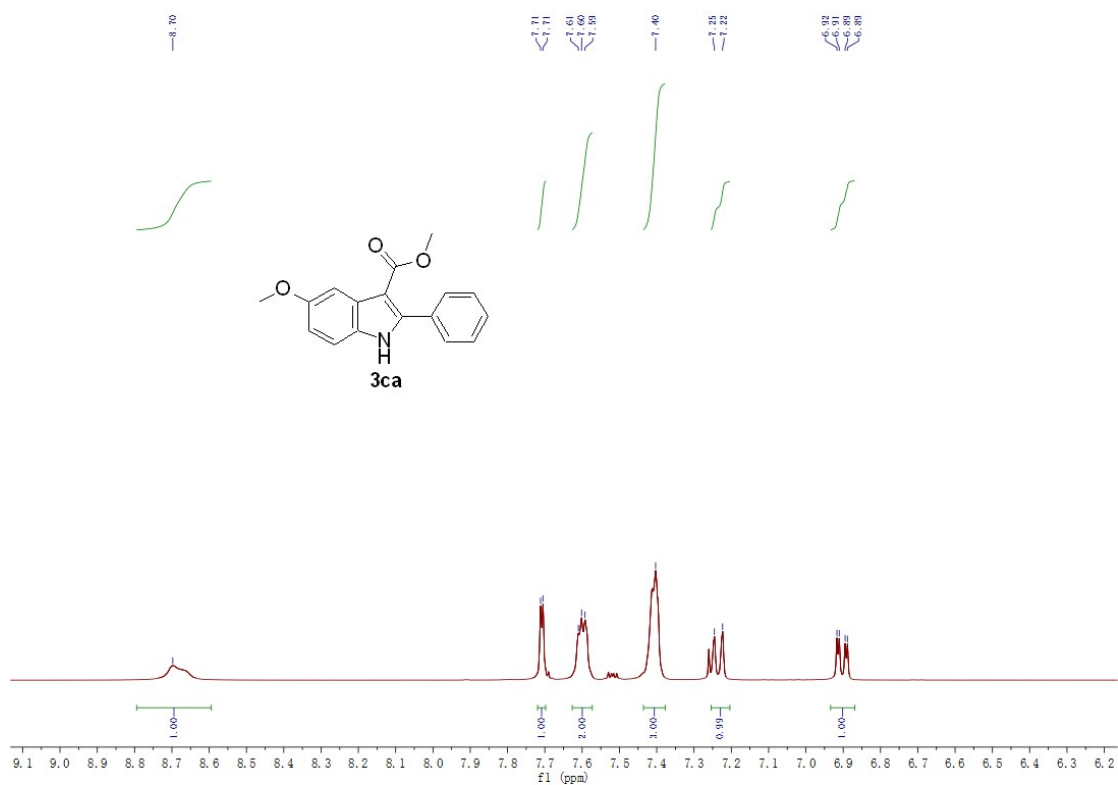
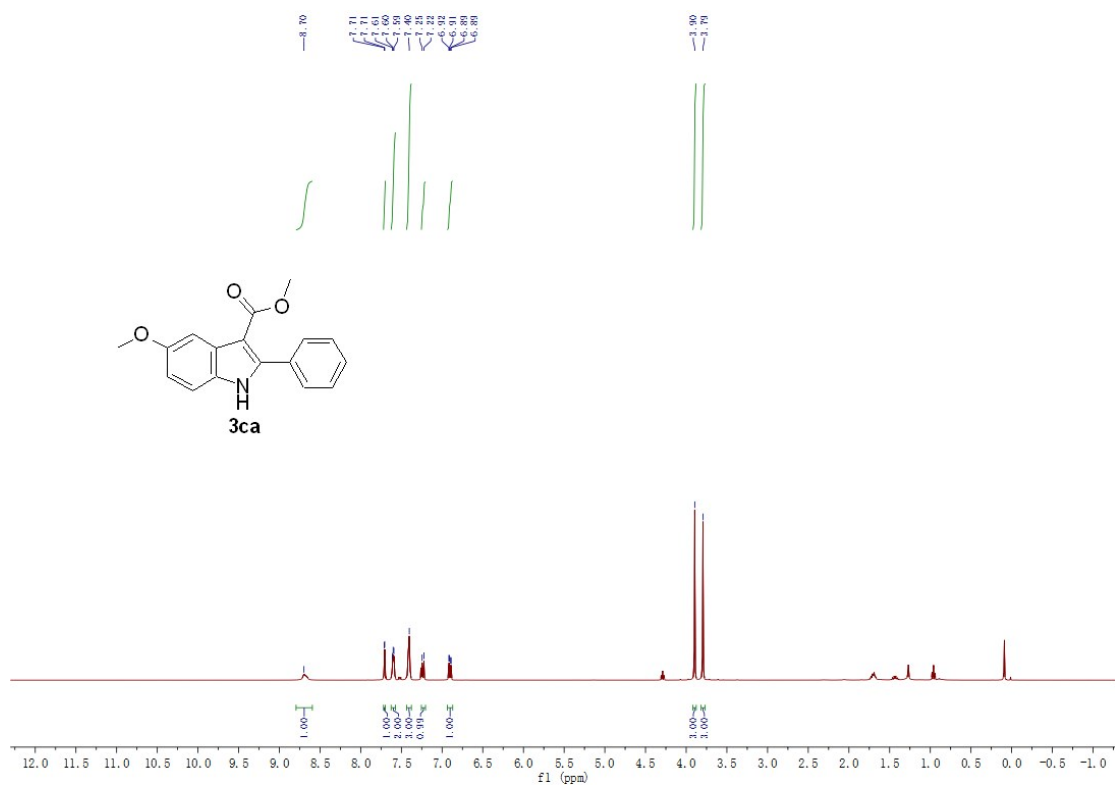


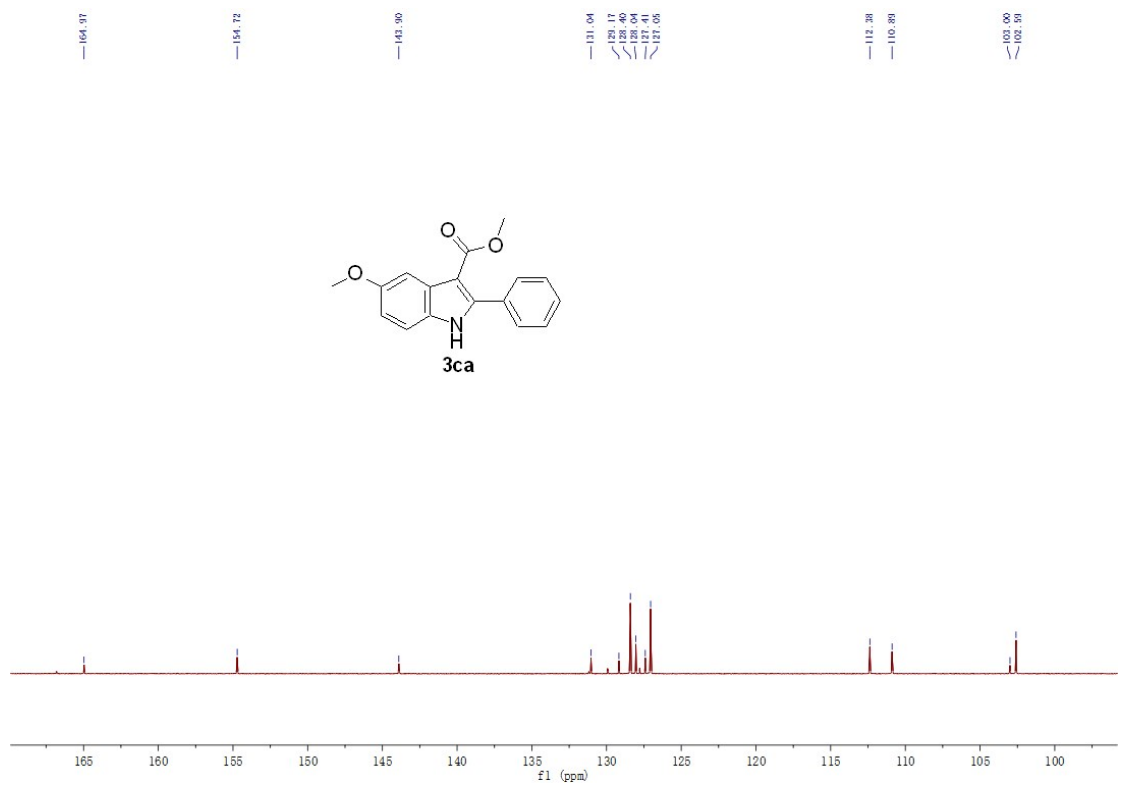
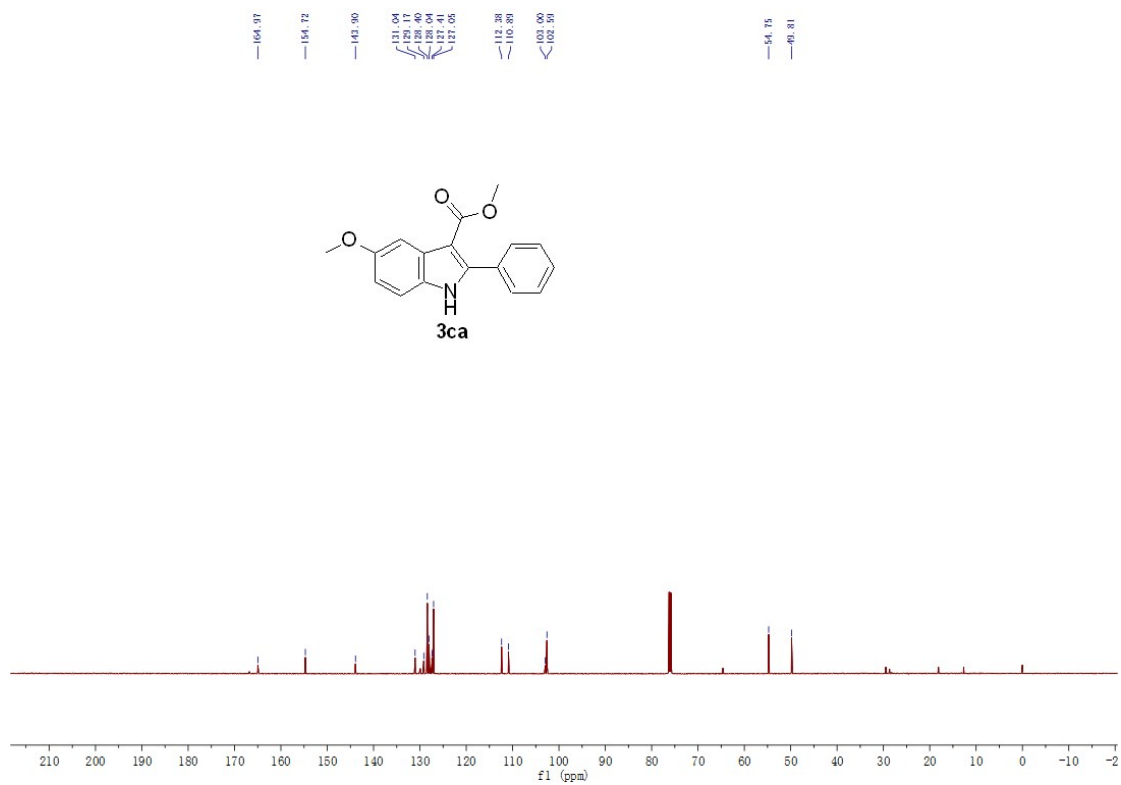
Methyl 5-methyl-2-phenyl-1H-indole-3-carboxylate (3ba)



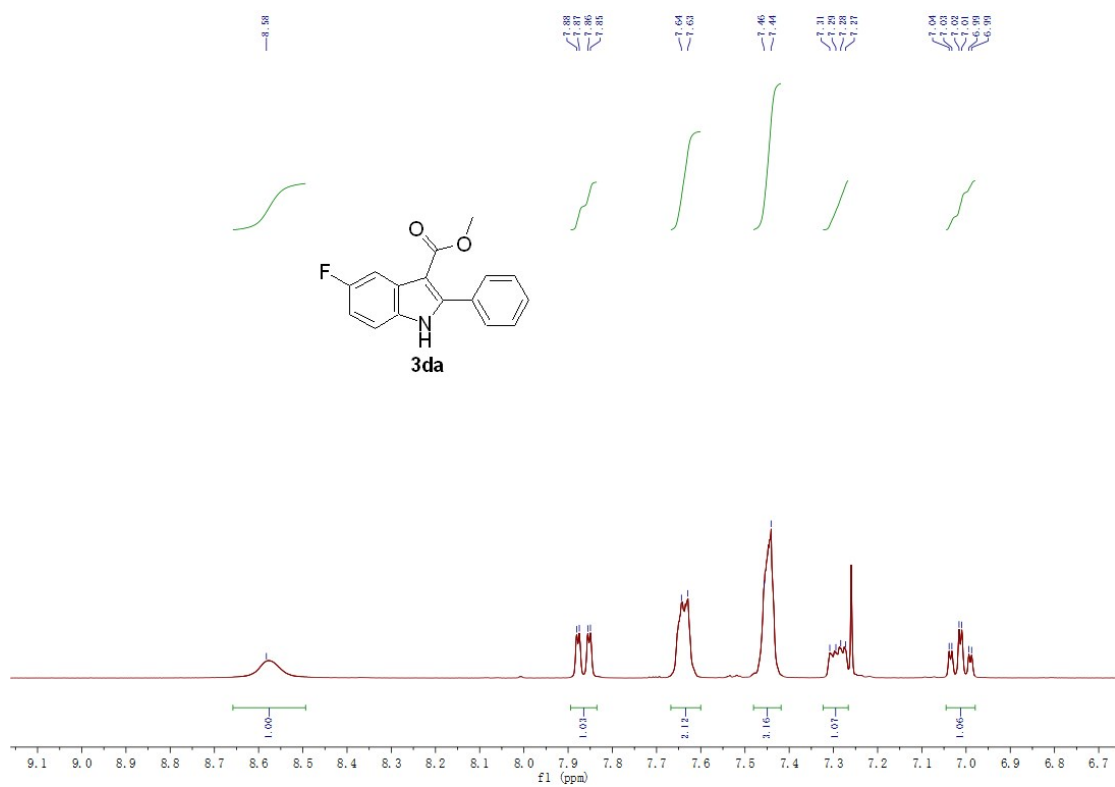
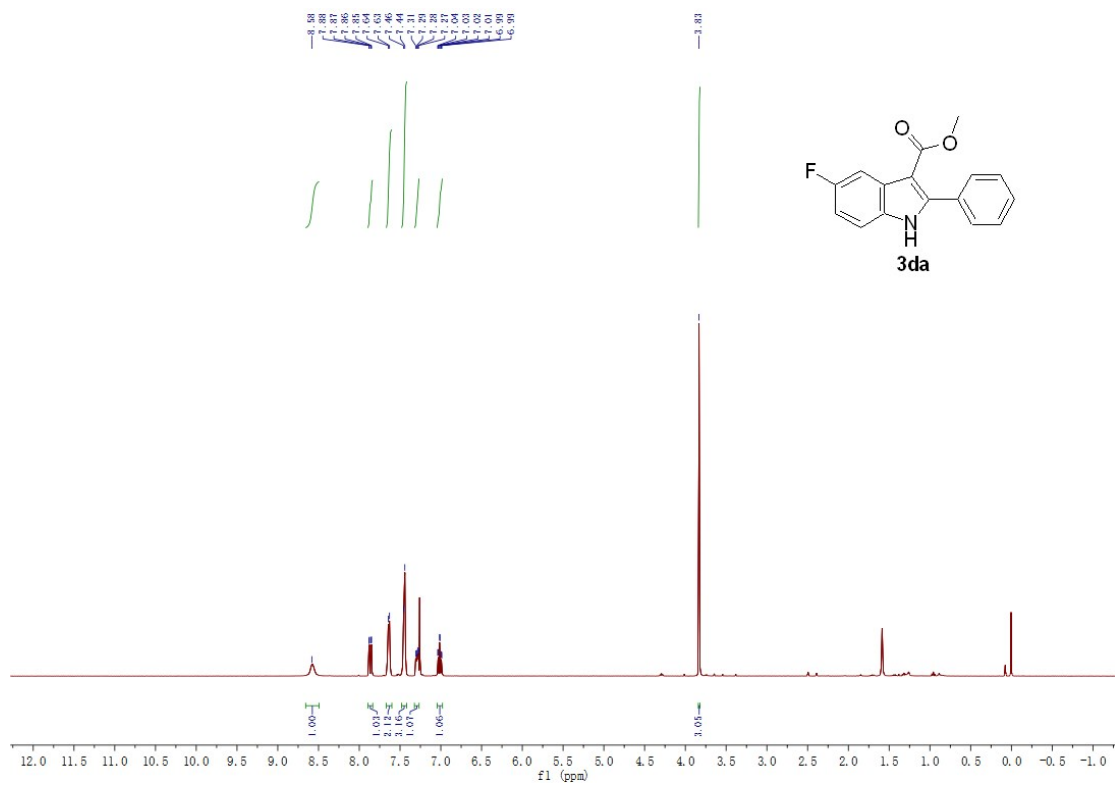


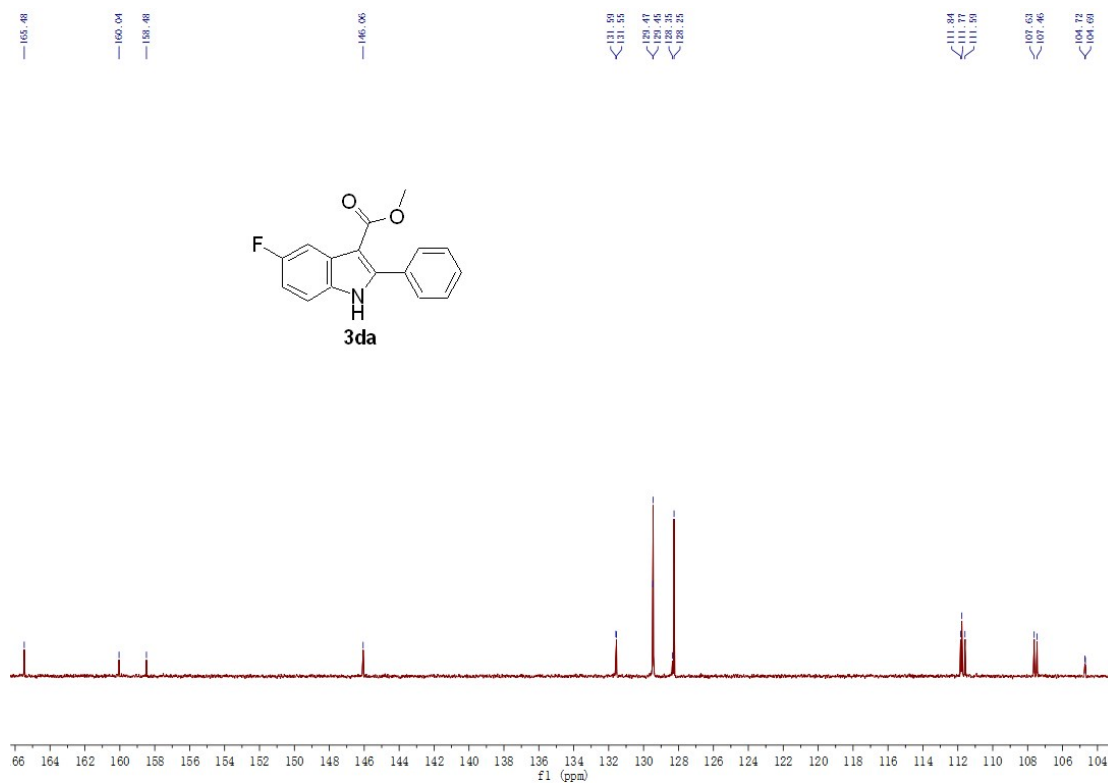
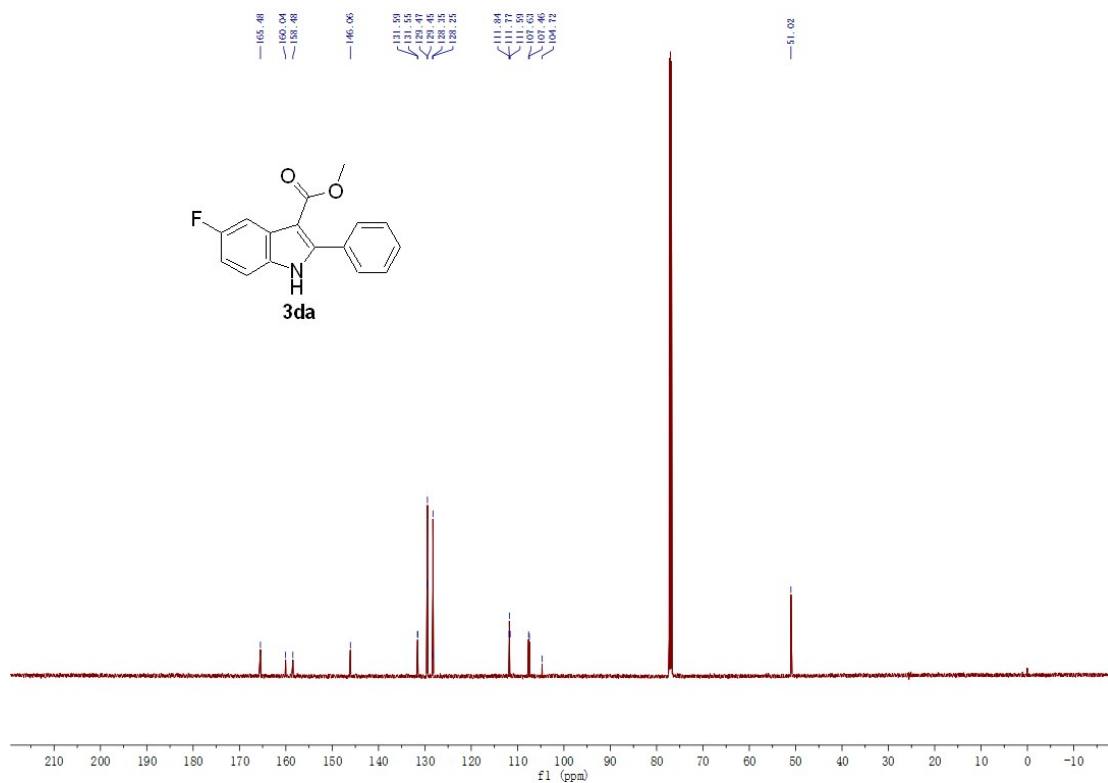
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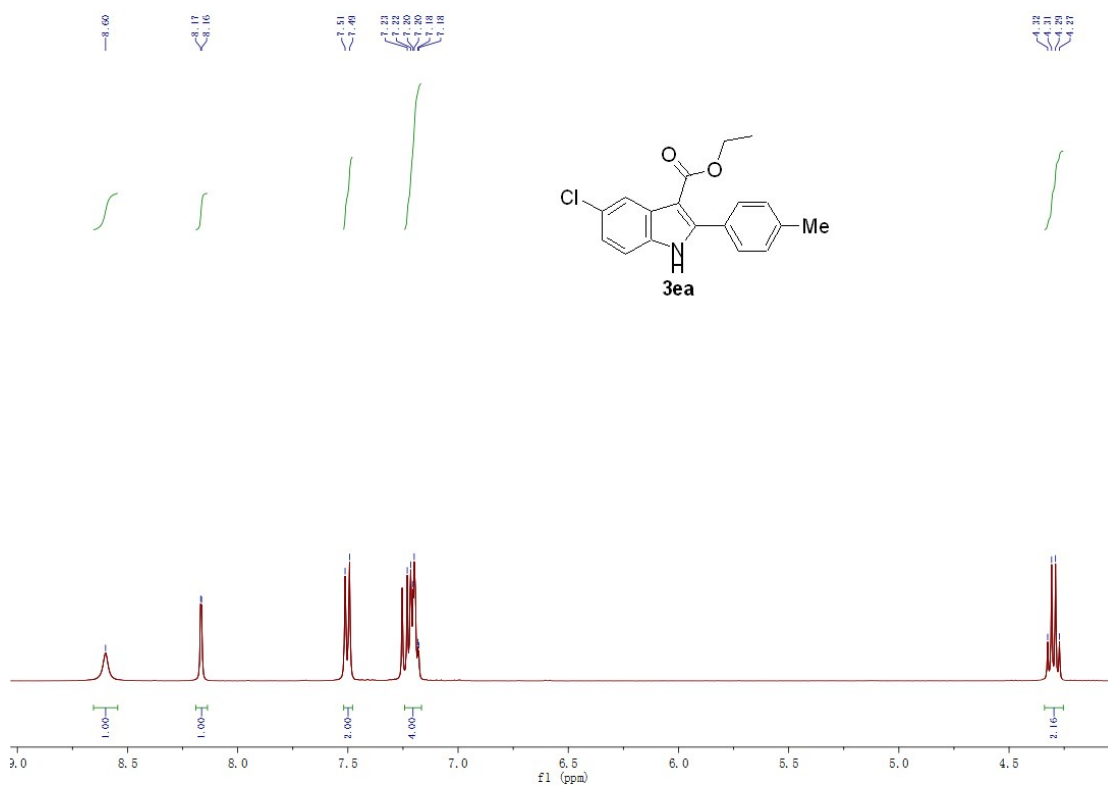
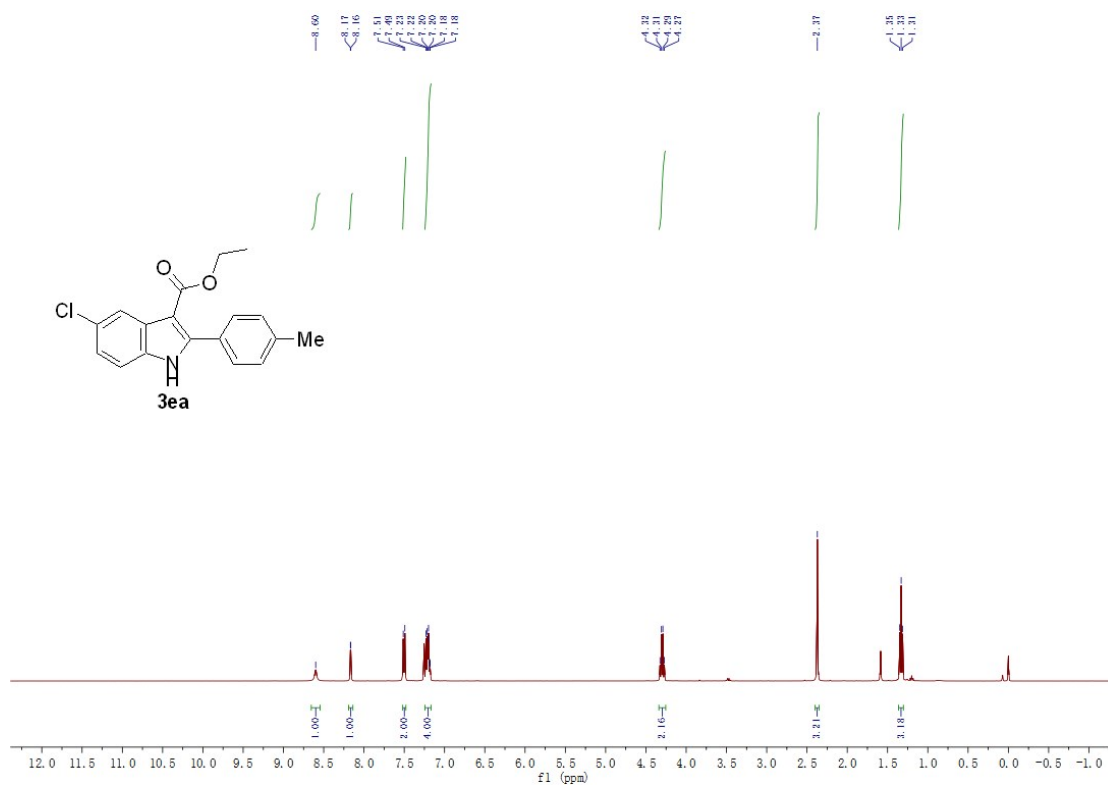


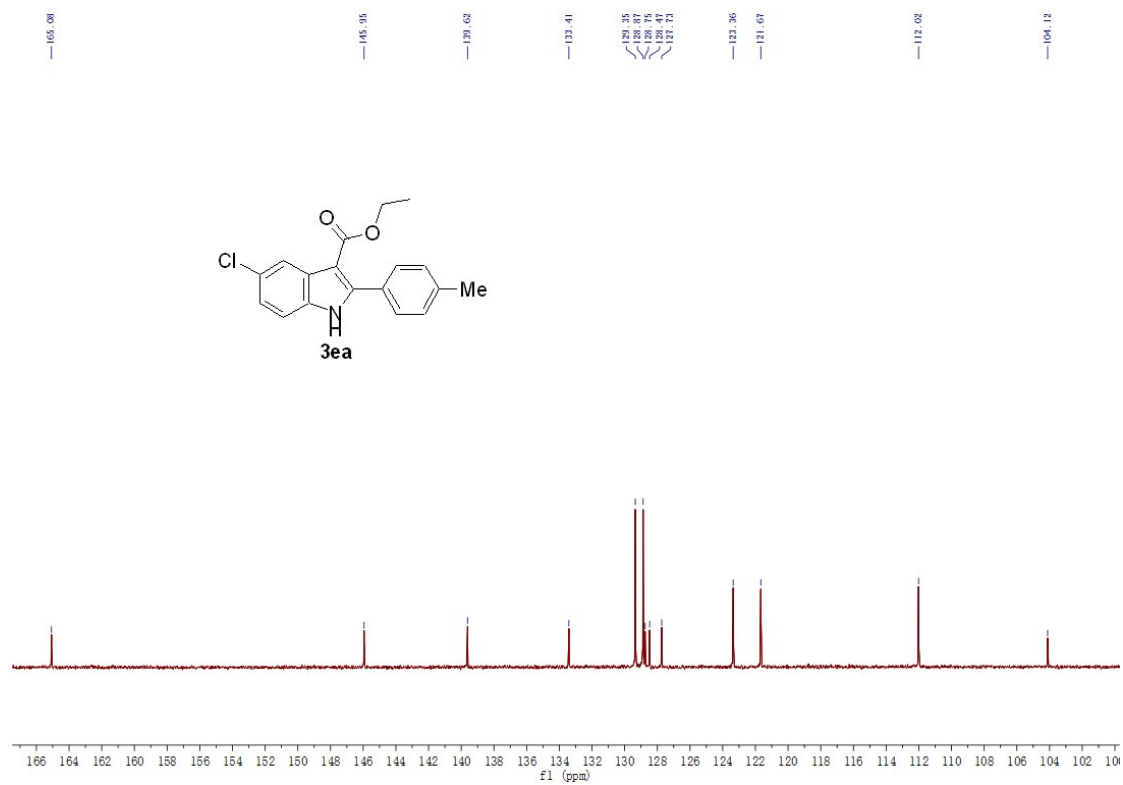
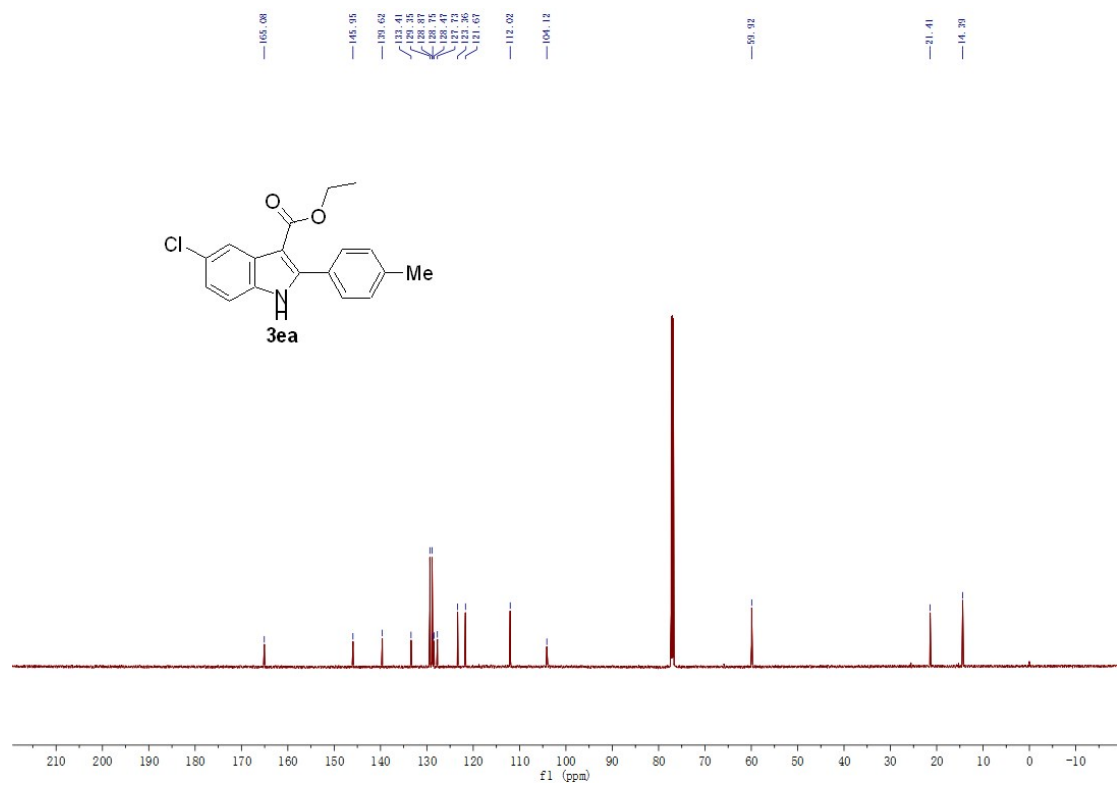
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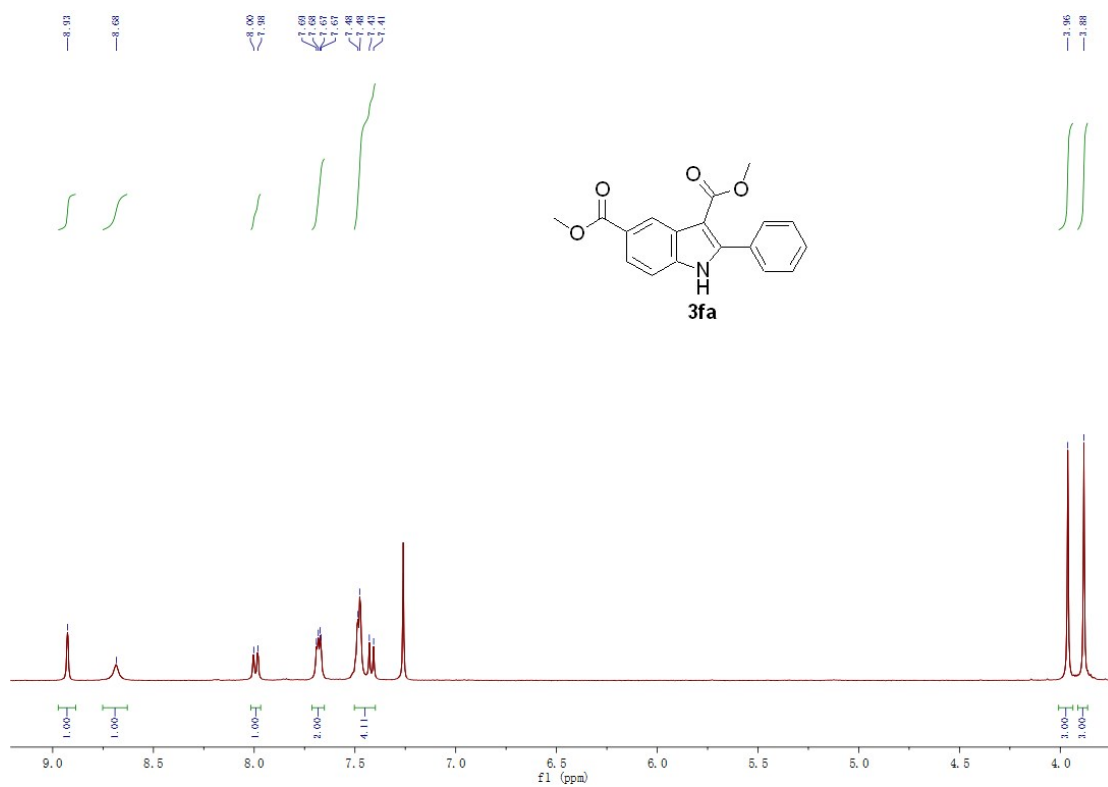
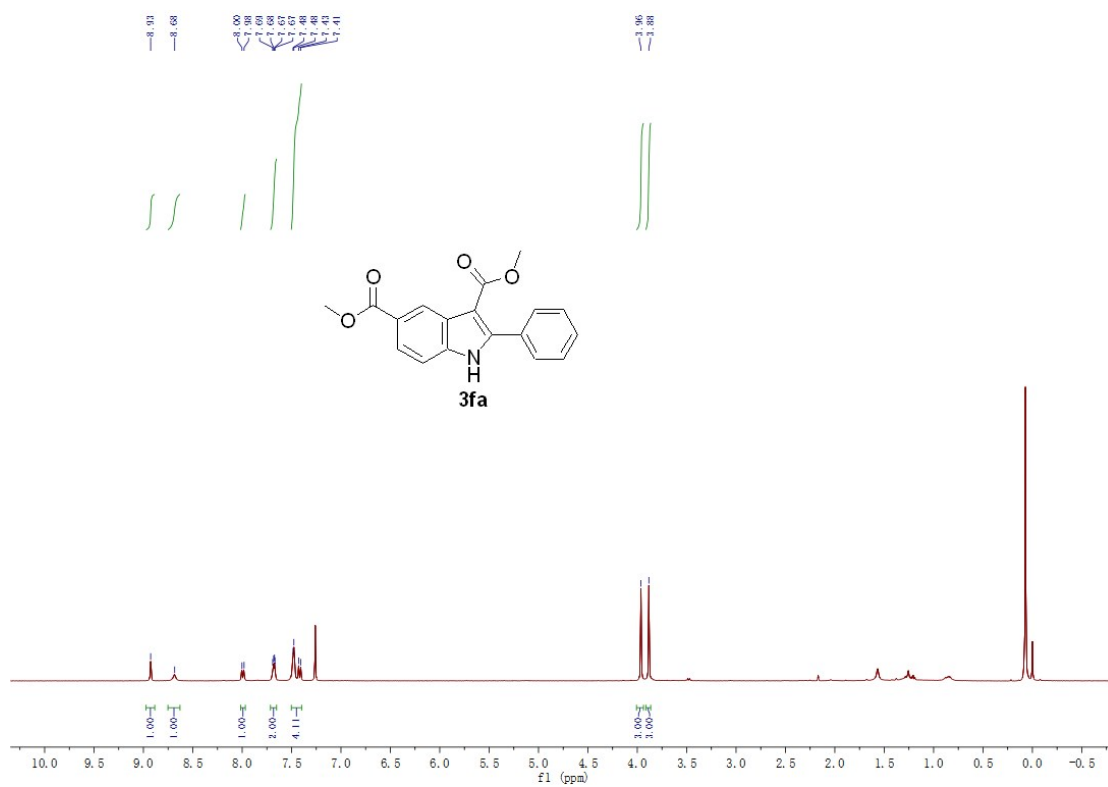


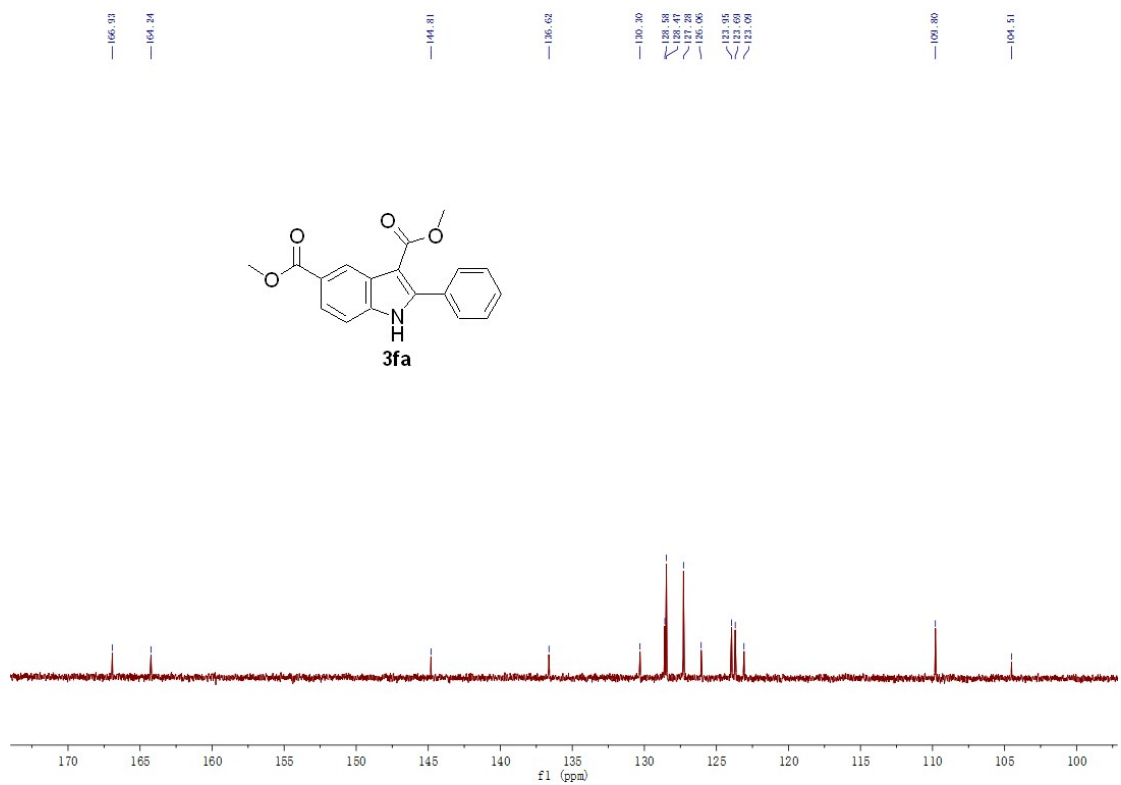
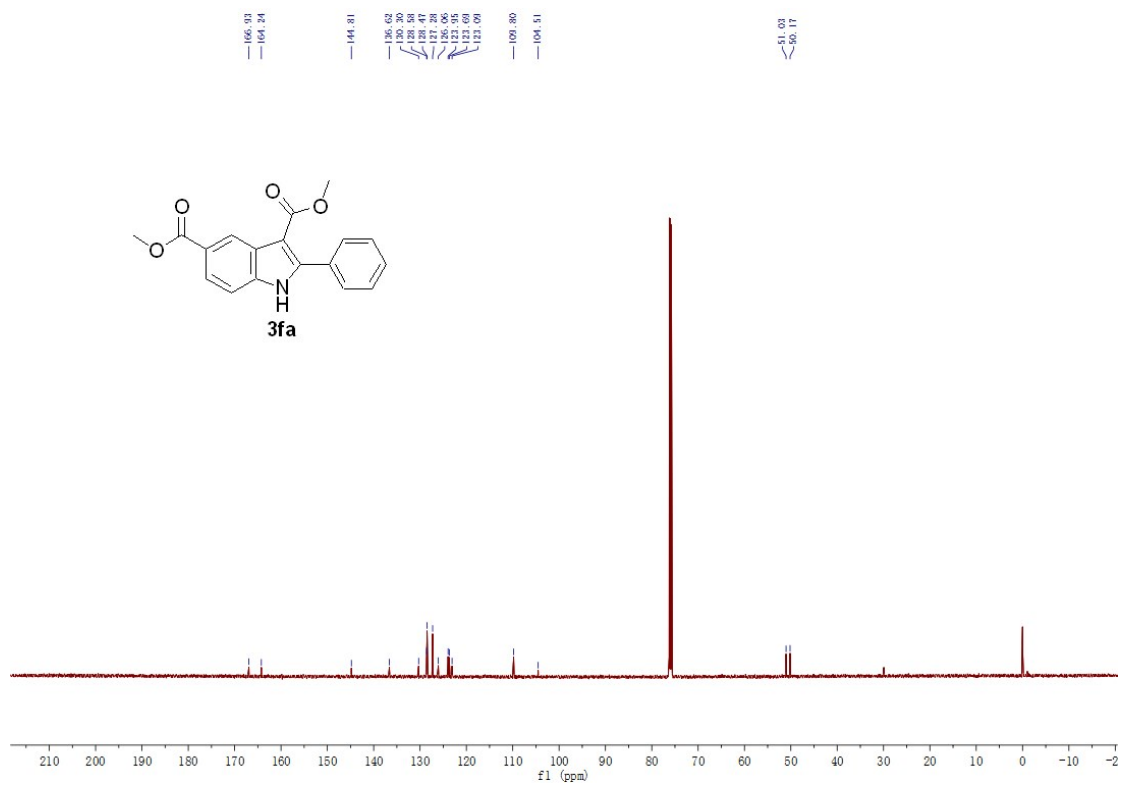
Ethyl 5-chloro-2-(*p*-tolyl)-1*H*-indole-3-carboxylate (**3ea**)



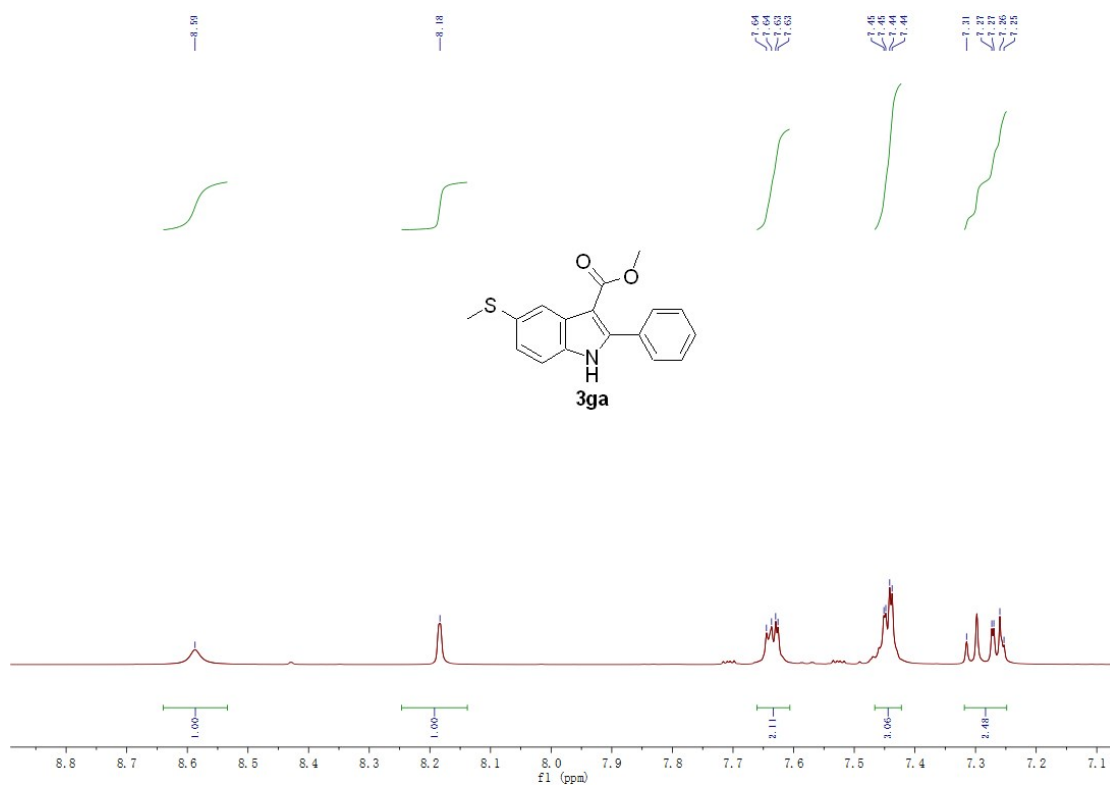
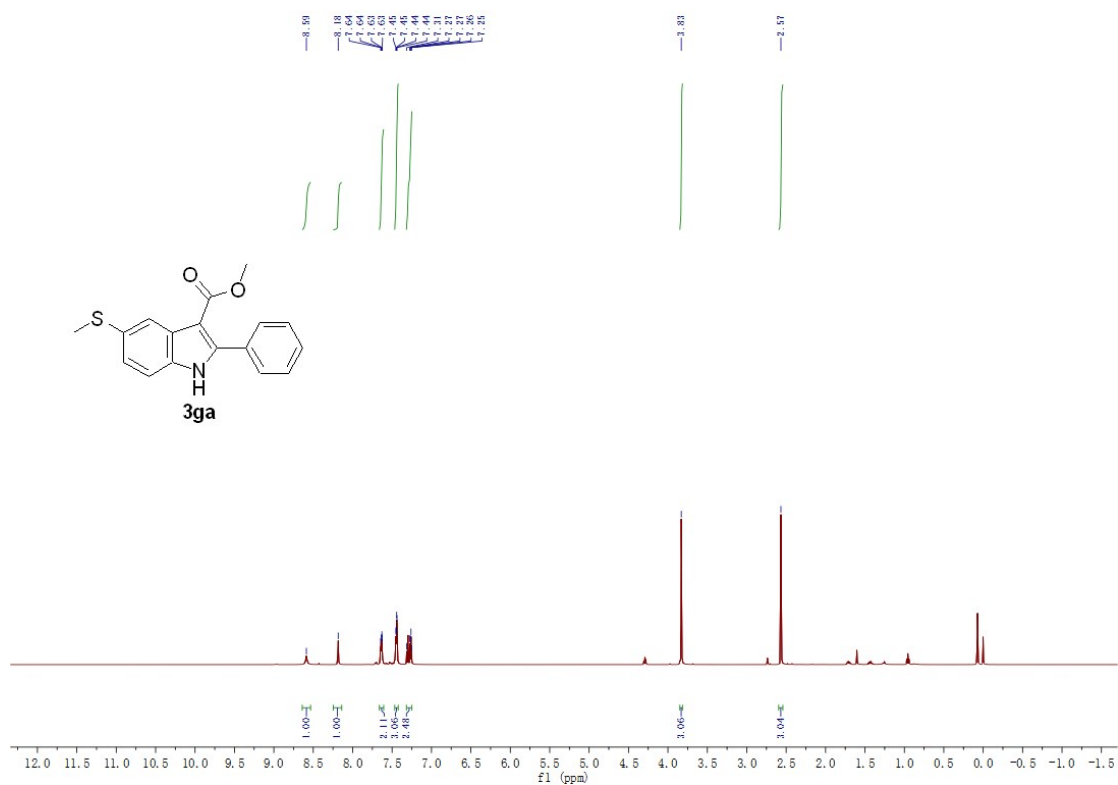


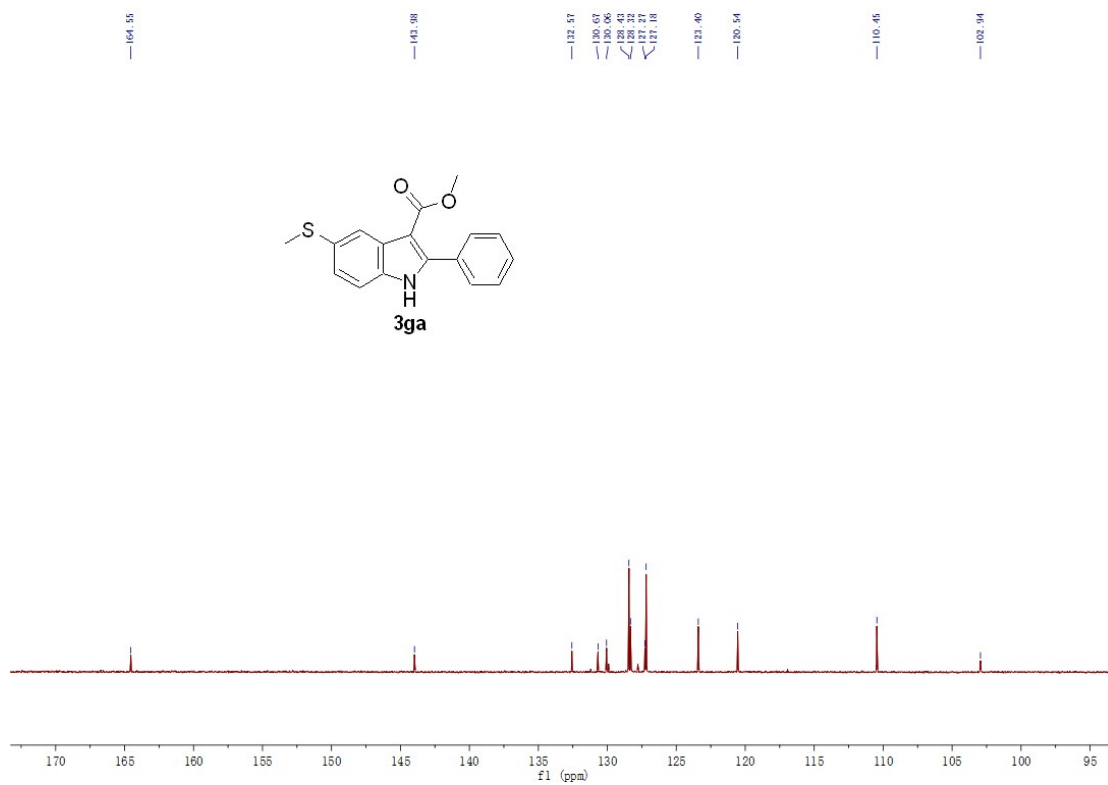
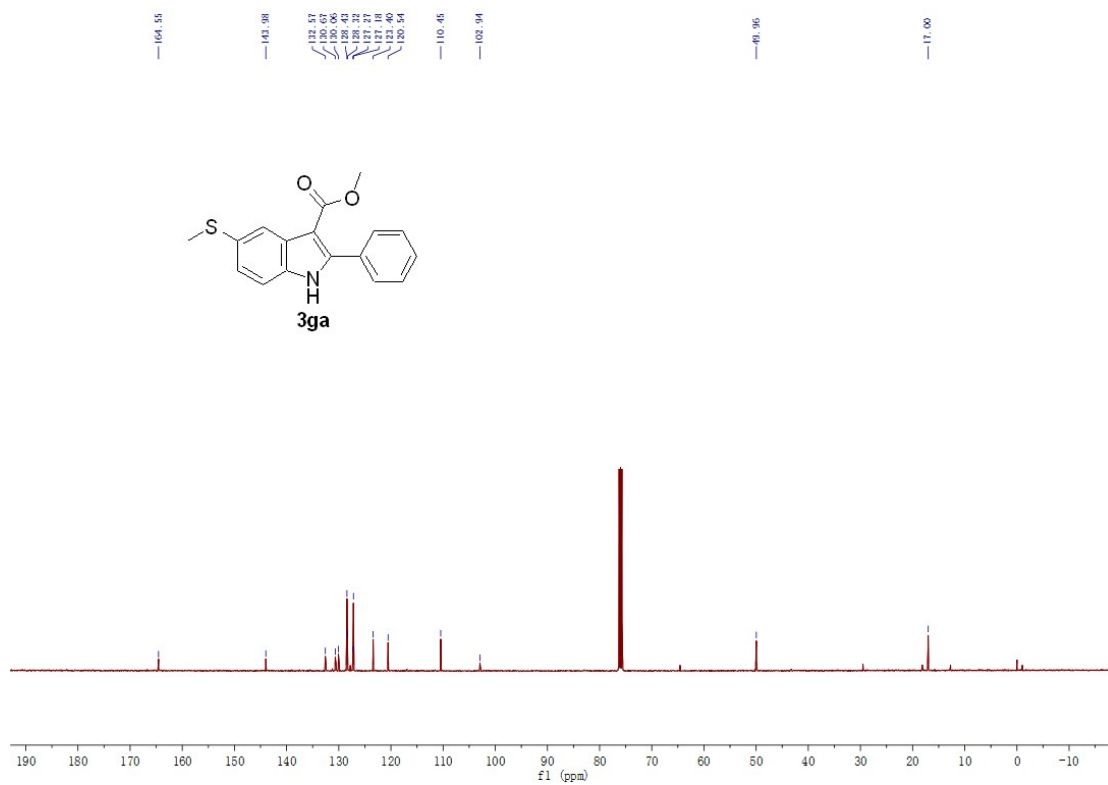
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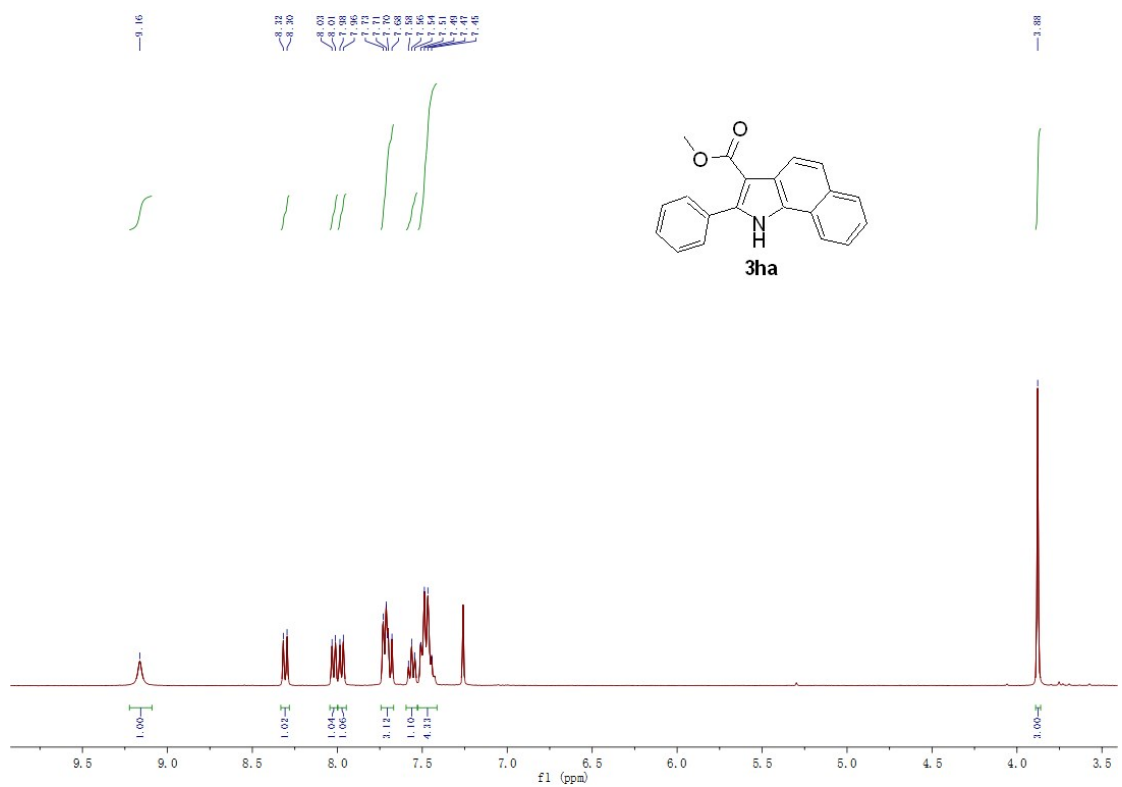
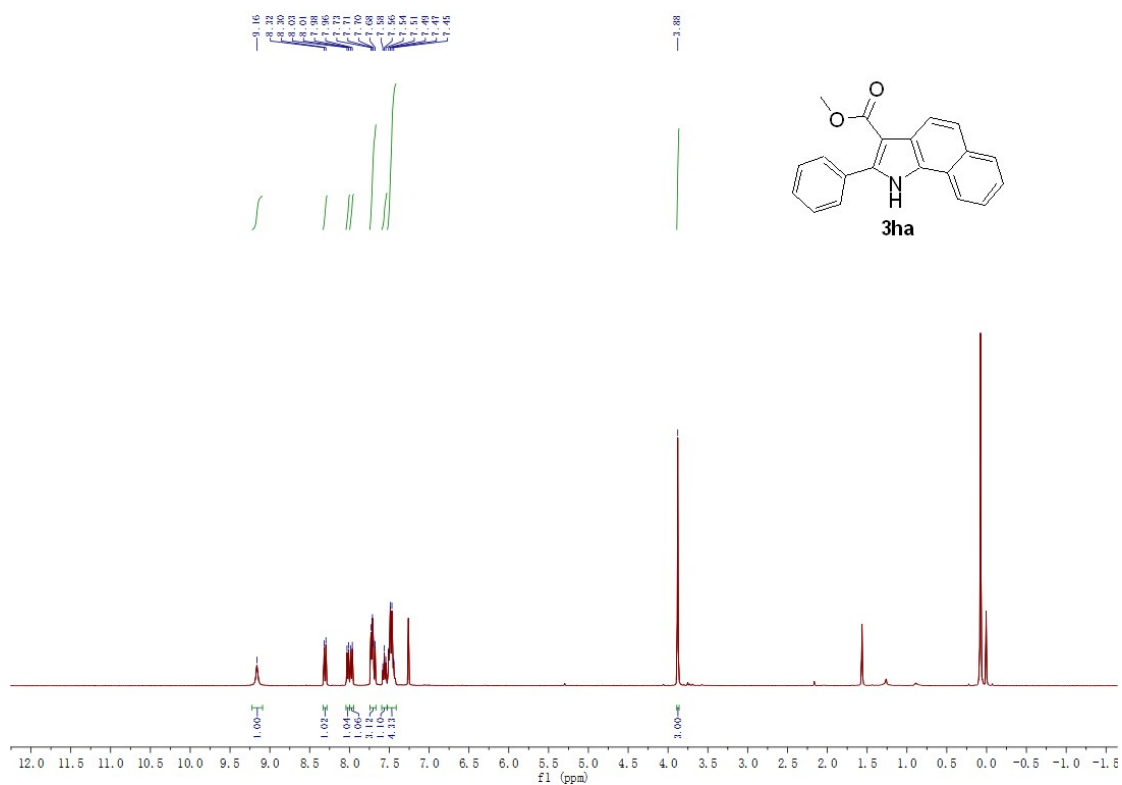


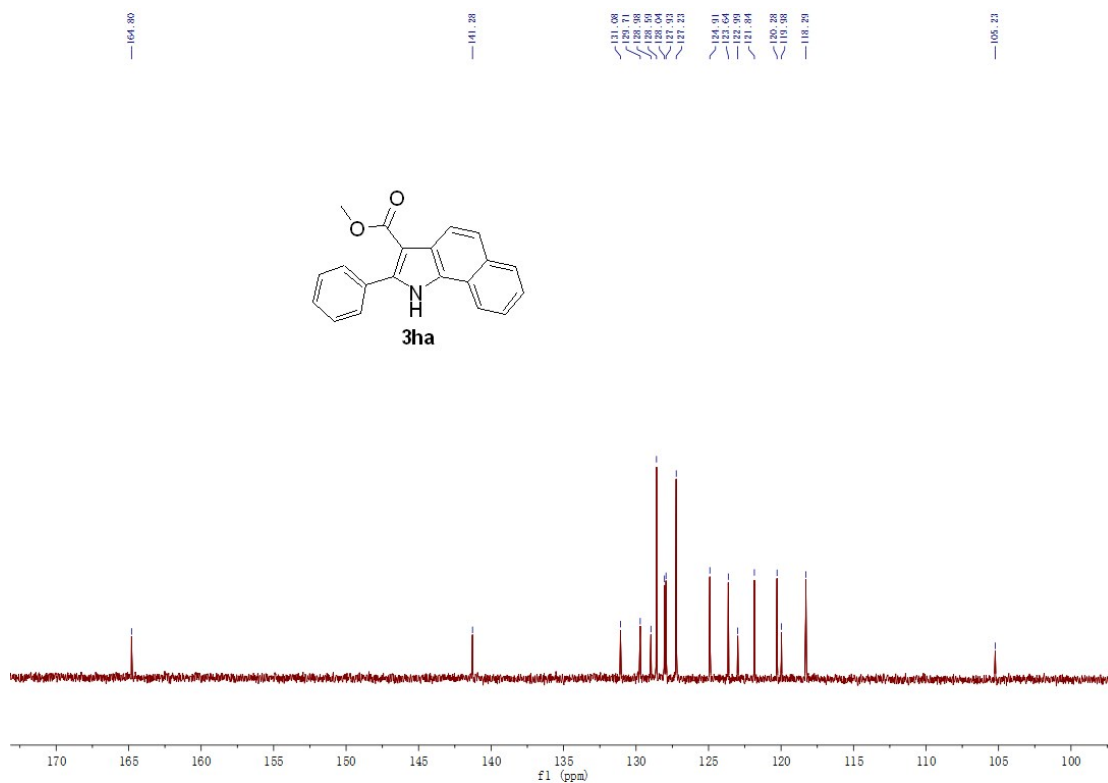
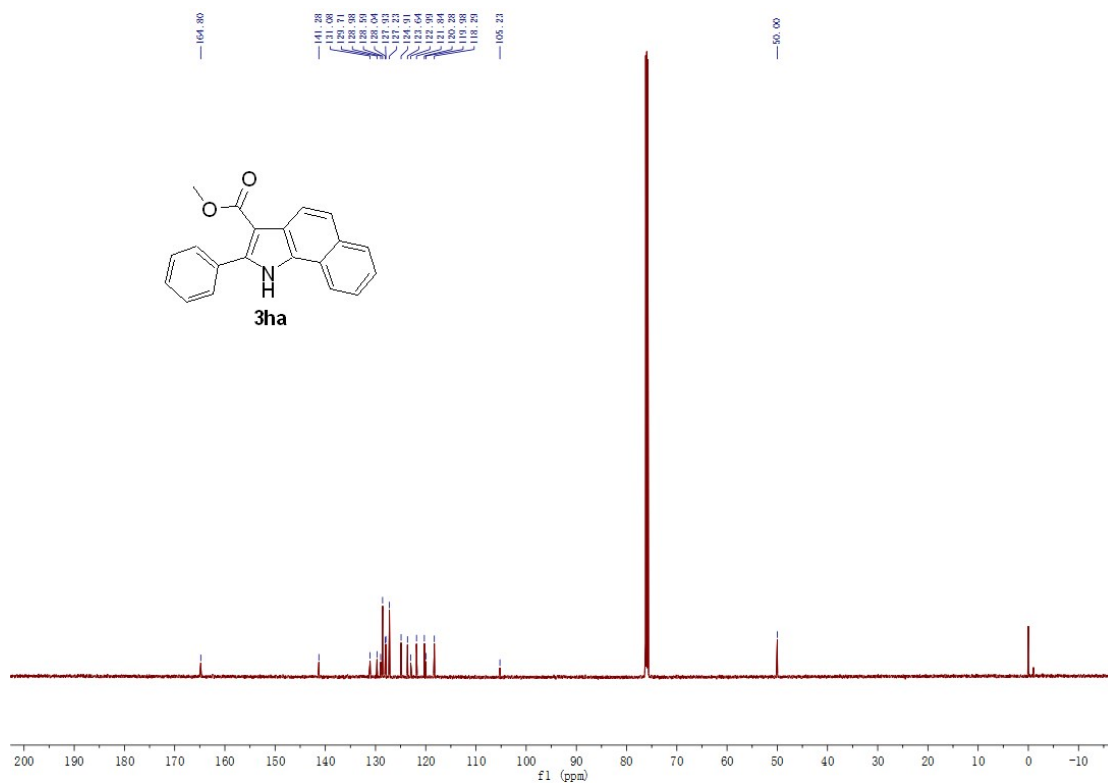
Methyl 5-(methylthio)-2-phenyl-1H-indole-3-carboxylate (3ga)



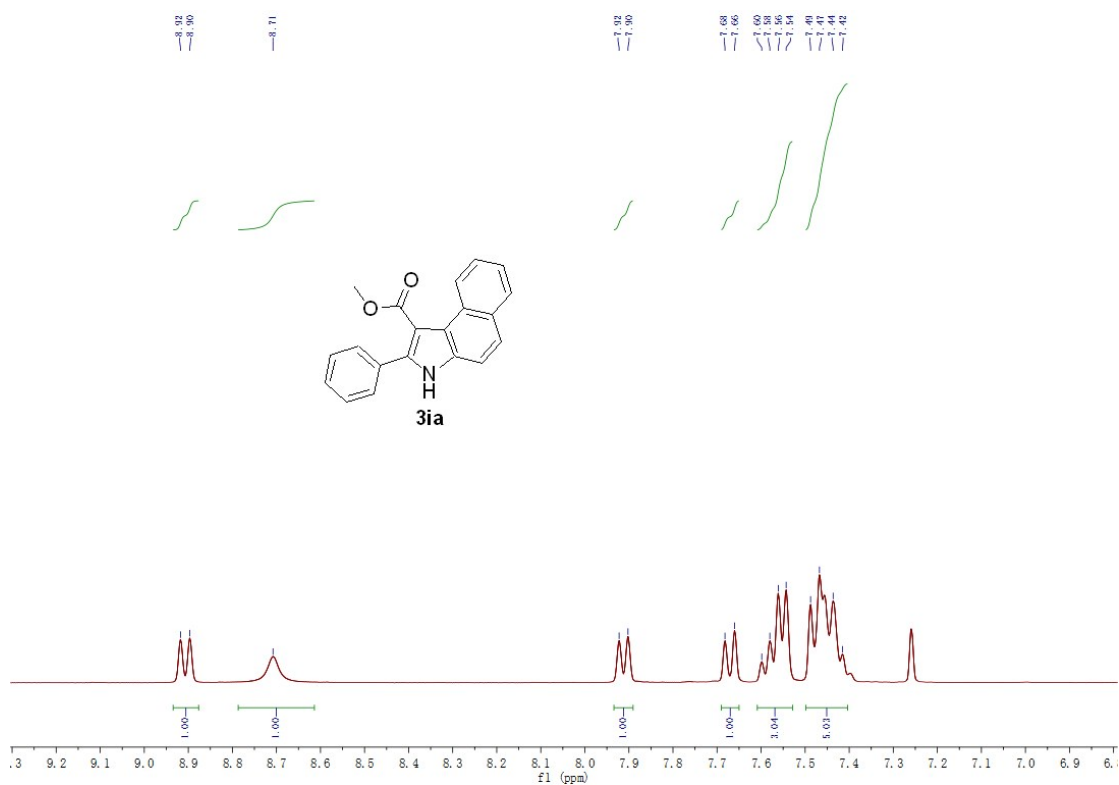
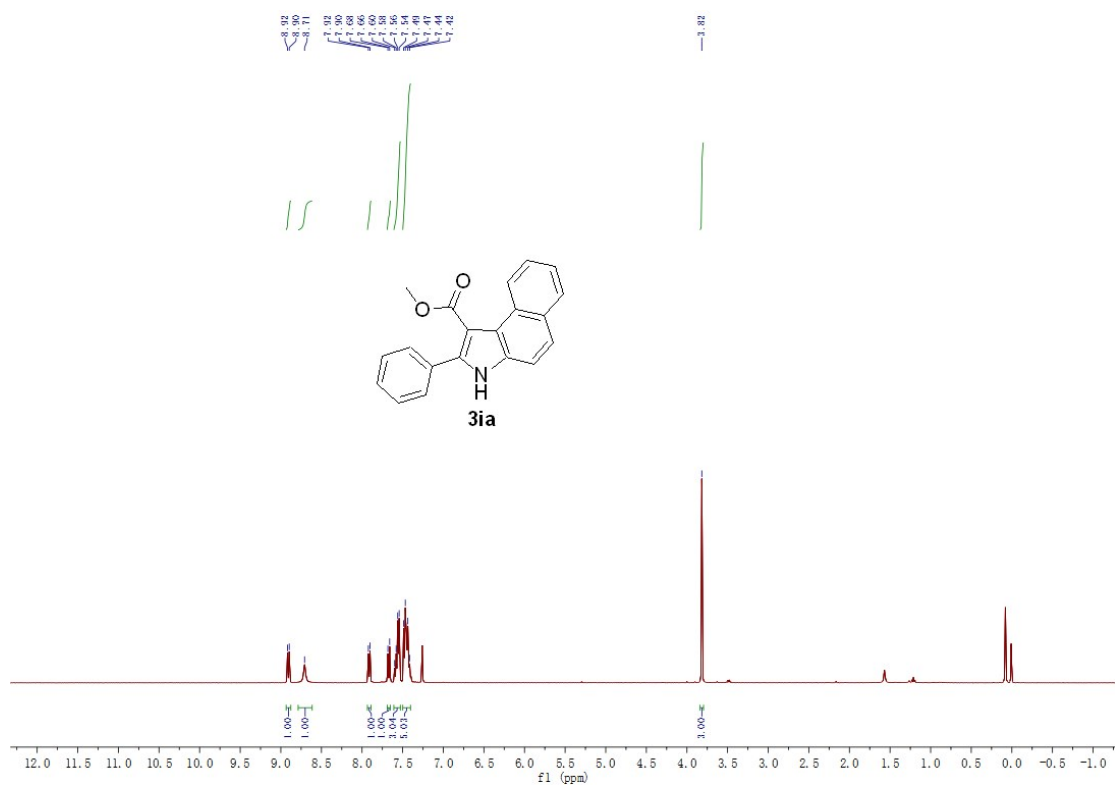


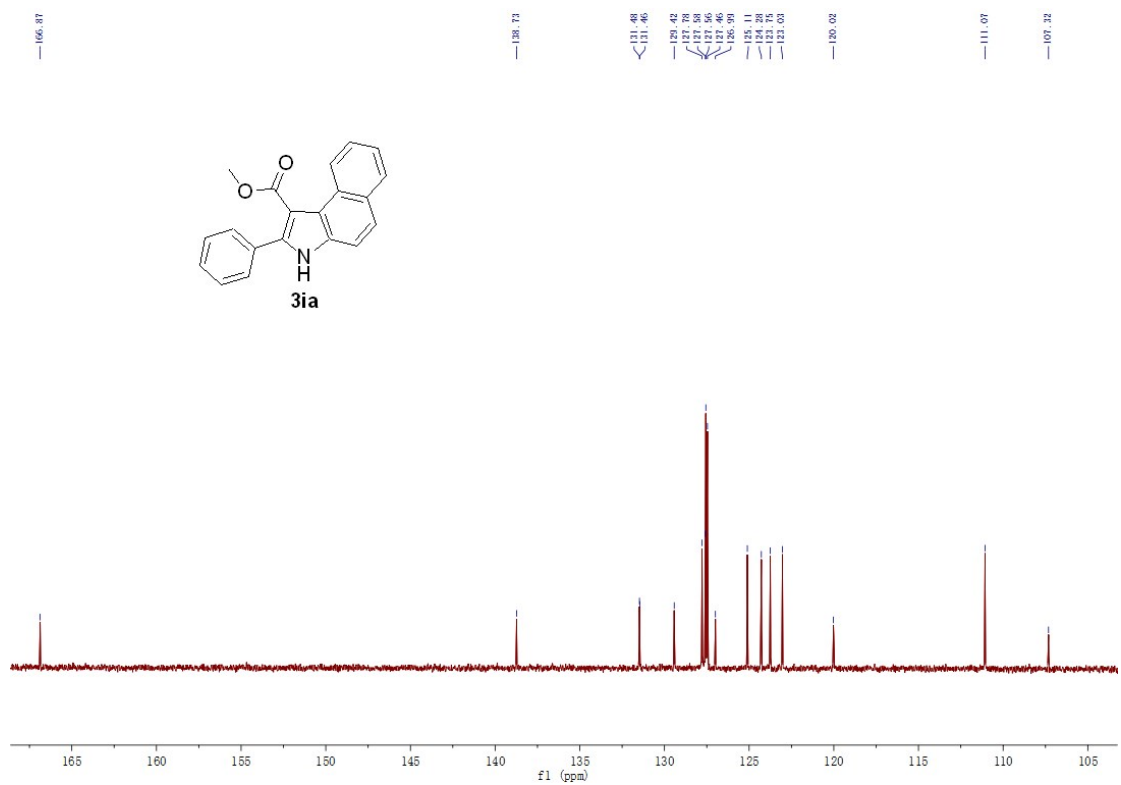
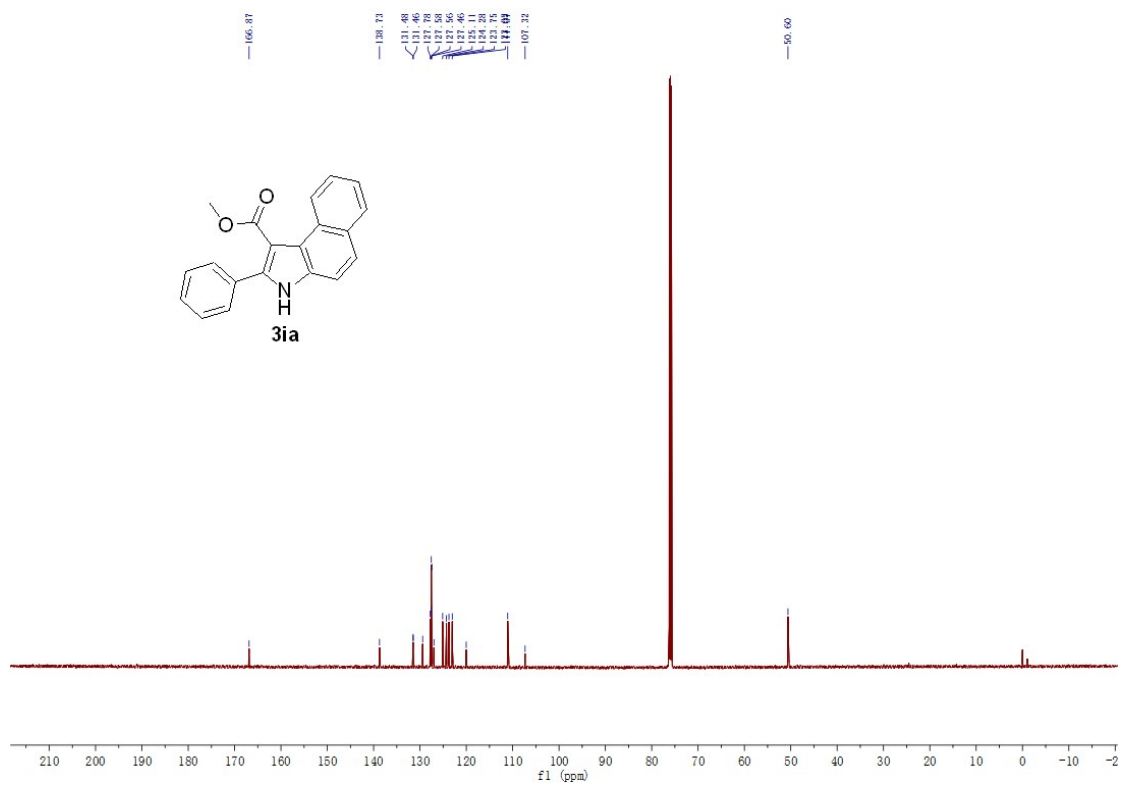
Methyl 2-phenyl-1*H*-benzo[*g*]indole-3-carboxylate (3ha)



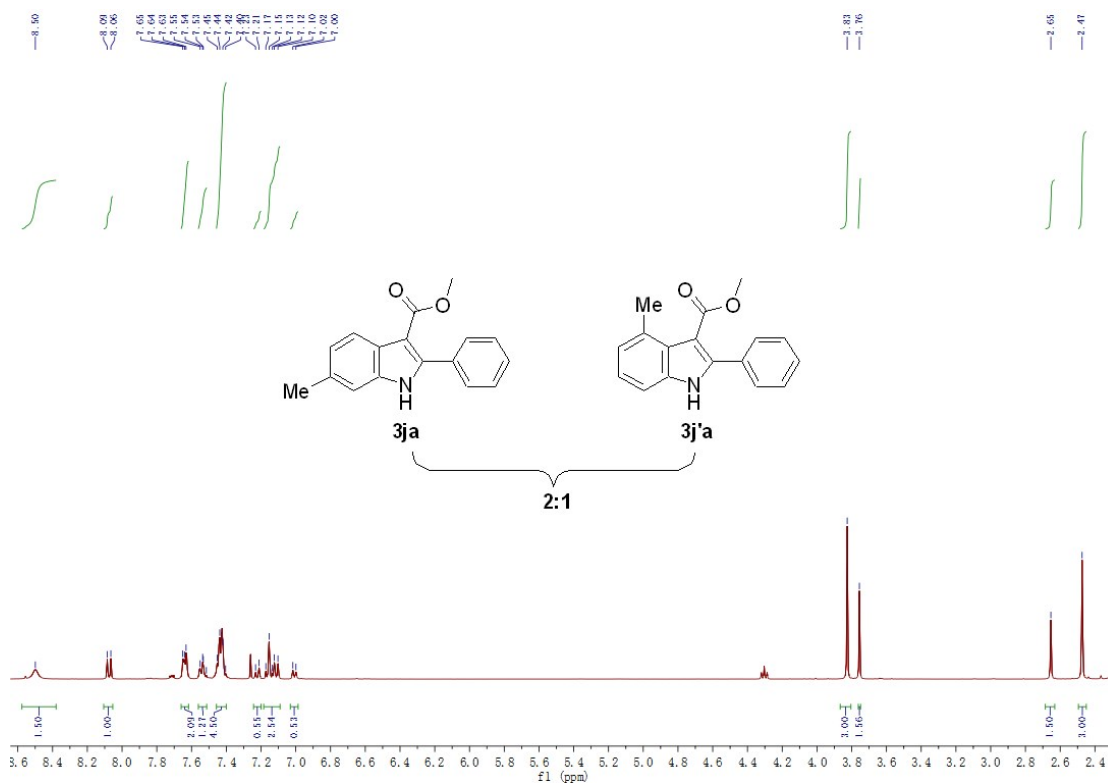
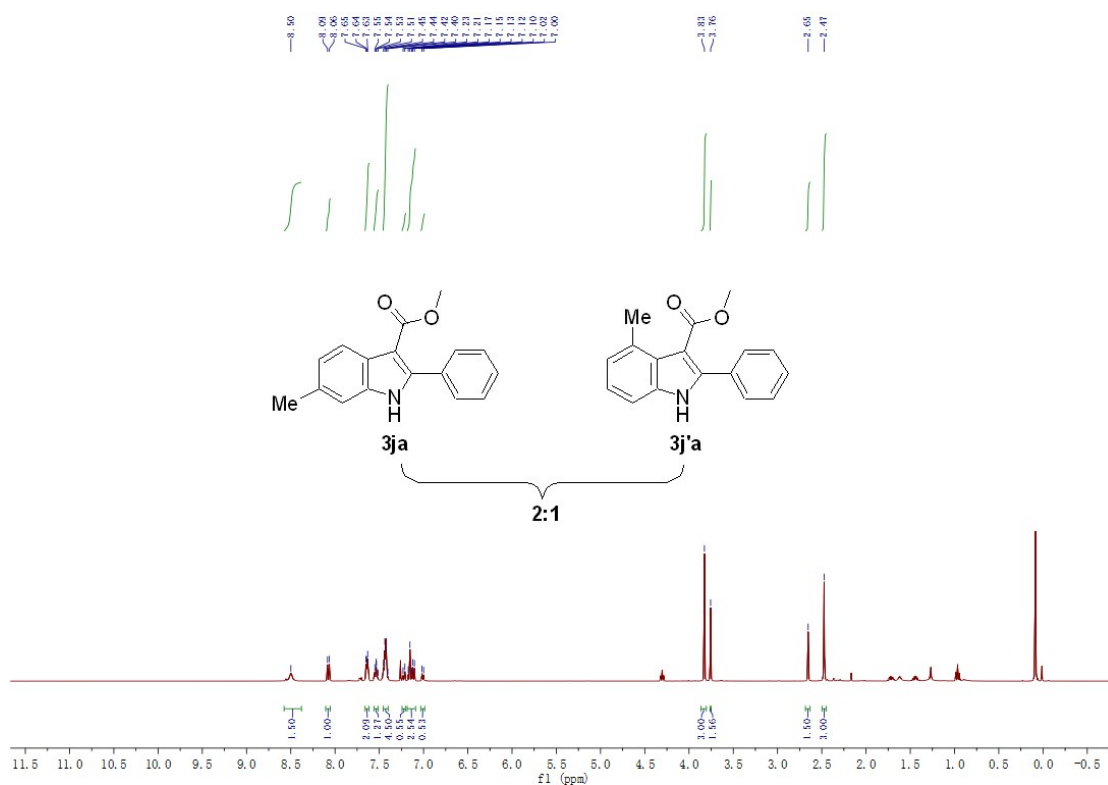


Methyl 2-phenyl-3*H*-benzo[*e*]indole-1-carboxylate (**3ia**)





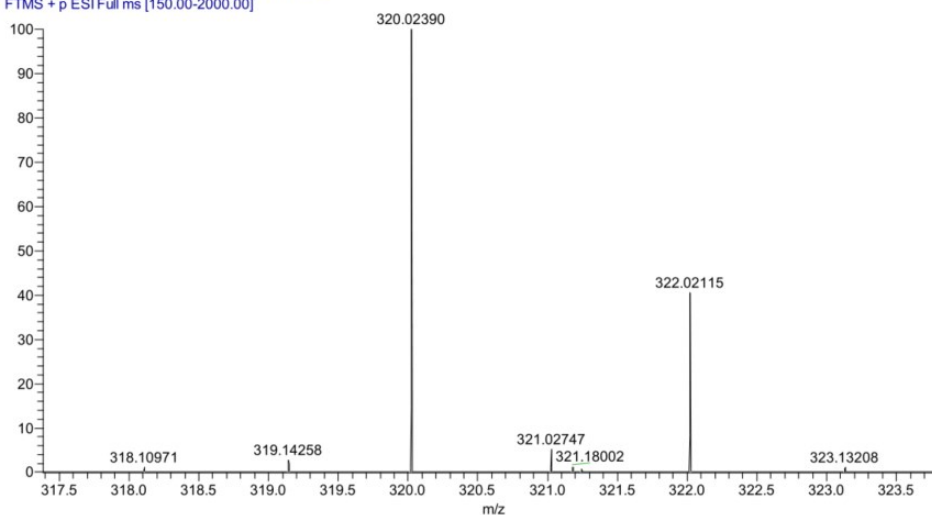
Mixture of methyl 6-methyl-2-phenyl-1*H*-indole-3-carboxylate (**3ja**) and methyl 4-methyl-2-phenyl-1*H*-indole-3-carboxylate (**3j'a**)



2. High-resolution mass spectra of new compounds

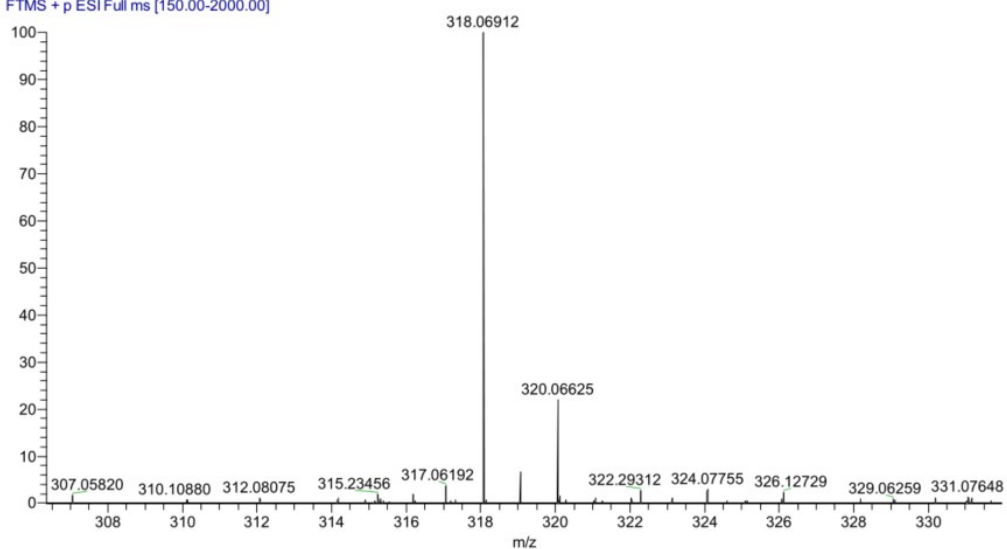
Methyl 5-chloro-2-(4-chlorophenyl)-1*H*-indole-3-carboxylate (3ab)

8_180118122621 #8 RT: 0.10 AV: 1 NL: 8.83E5
T: FTMS + p ESI Full ms [150.00-2000.00]

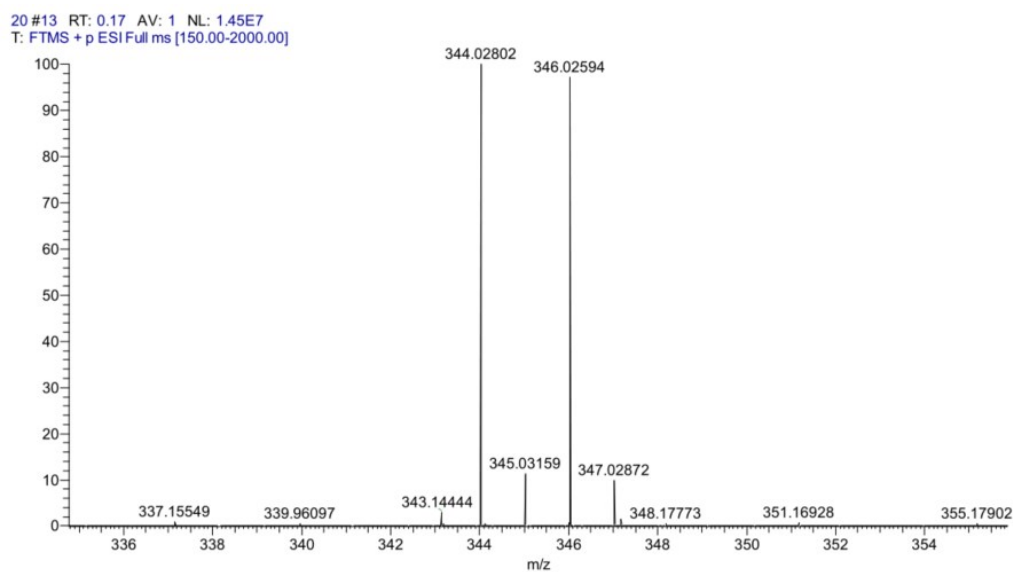


Ethyl 5-chloro-2-(4-fluorophenyl)-1*H*-indole-3-carboxylate (3ac)

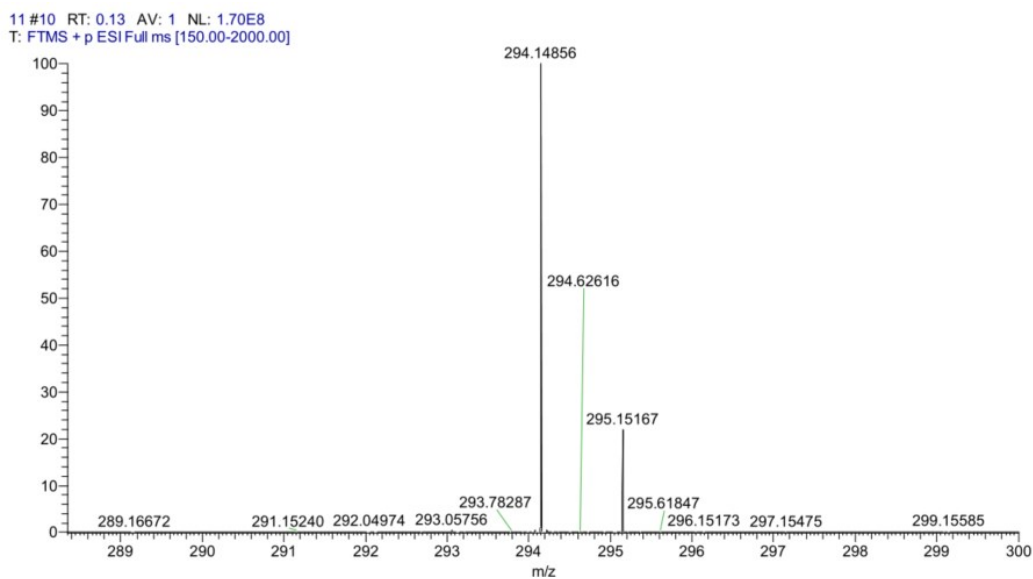
9 #11 RT: 0.14 AV: 1 NL: 5.75E6
T: FTMS + p ESI Full ms [150.00-2000.00]



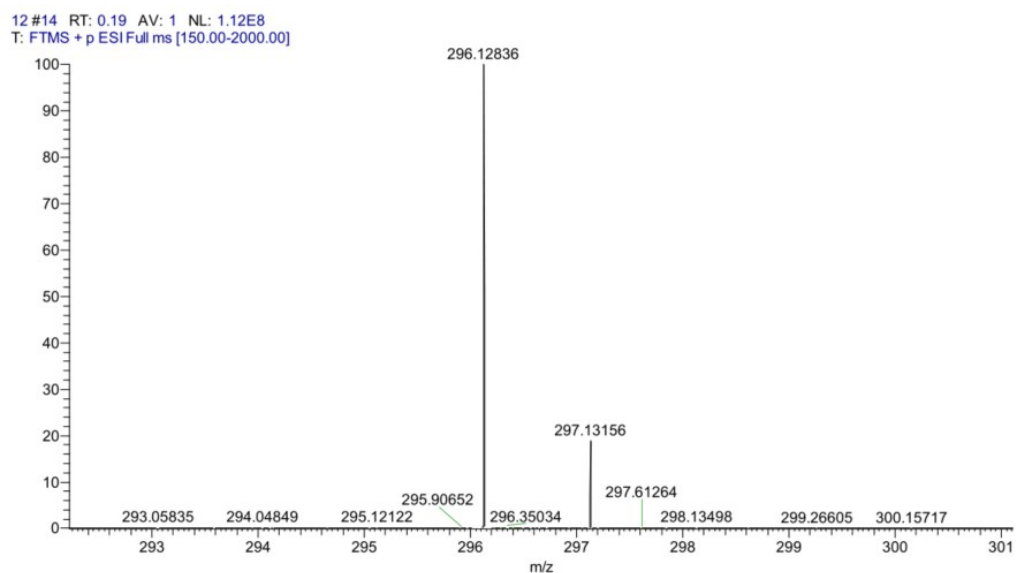
Methyl 2-(4-bromophenyl)-5-methyl-1*H*-indole-3-carboxylate (3ad)



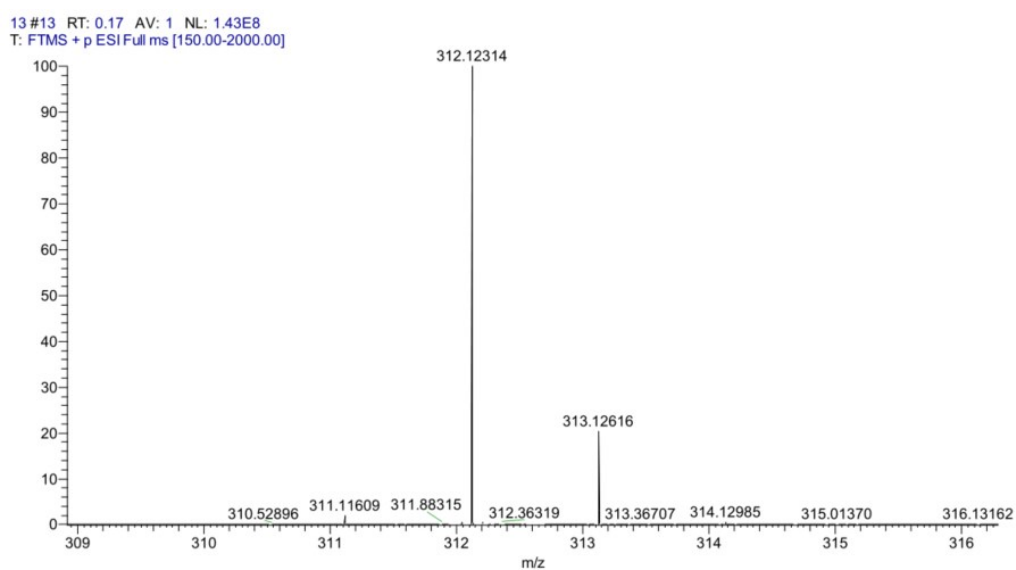
Ethyl 5-methyl-2-(*p*-tolyl)-1*H*-indole-3-carboxylate (3ae)



Methyl 2-(4-methoxyphenyl)-5-methyl-1*H*-indole-3-carboxylate (3af)

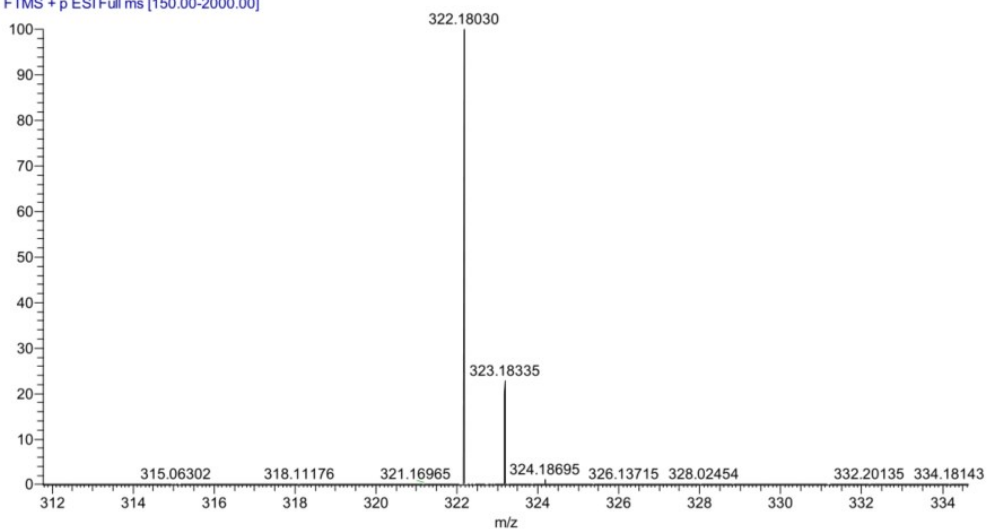


Methyl 5-methoxy-2-(4-methoxyphenyl)-1*H*-indole-3-carboxylate (3ag)



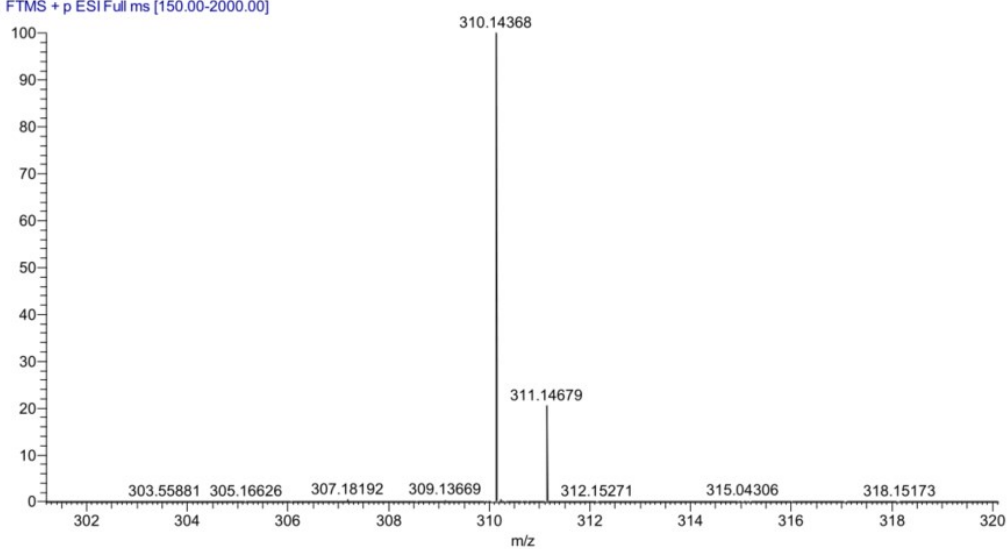
Methyl 2-[4-(tert-butyl) phenyl]-5-methyl-1H-indole-3-carboxylate (3ah)

19 #13 RT: 0.17 AV: 1 NL: 1.05E8
T: FTMS + p ESI Full ms [150.00-2000.00]



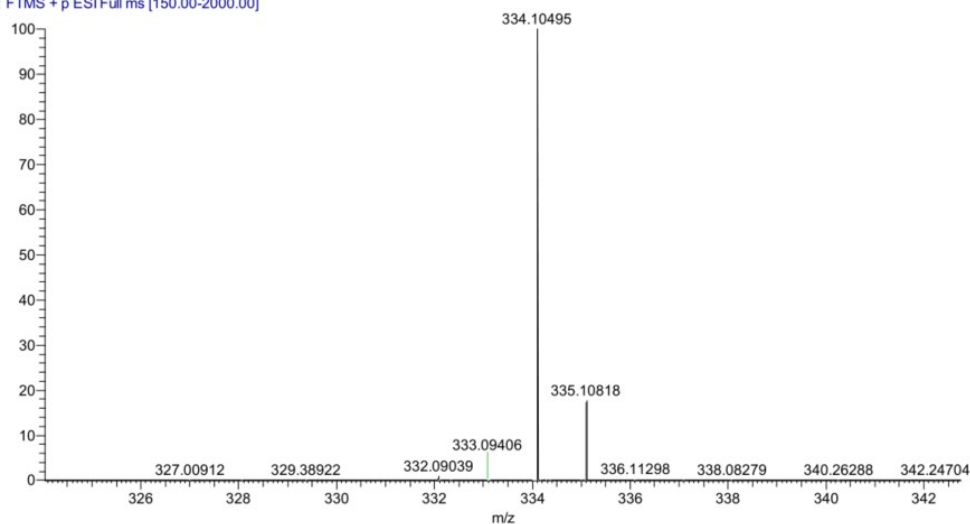
. Methyl 2-(4-ethoxyphenyl)-5-methyl-1H-indole-3-carboxylate (3ai)

21 #13 RT: 0.17 AV: 1 NL: 9.82E7
T: FTMS + p ESI Full ms [150.00-2000.00]



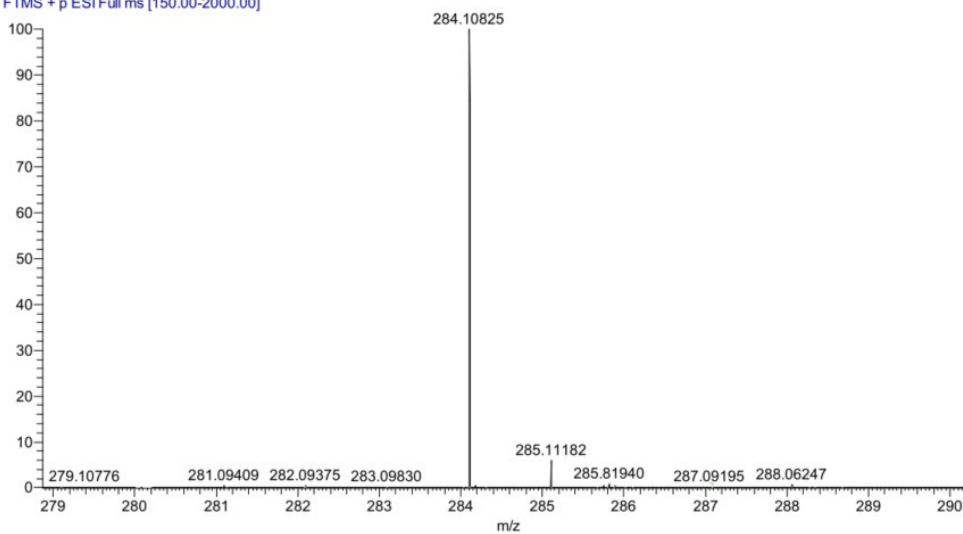
Methyl 5-methyl-2-[4-(trifluoromethyl)phenyl]-1H-indole-3-carboxylate (3aj)

22 #7 RT: 0.08 AV: 1 NL: 3.26E7
T: FTMS + p ESI Full ms [150.00-2000.00]



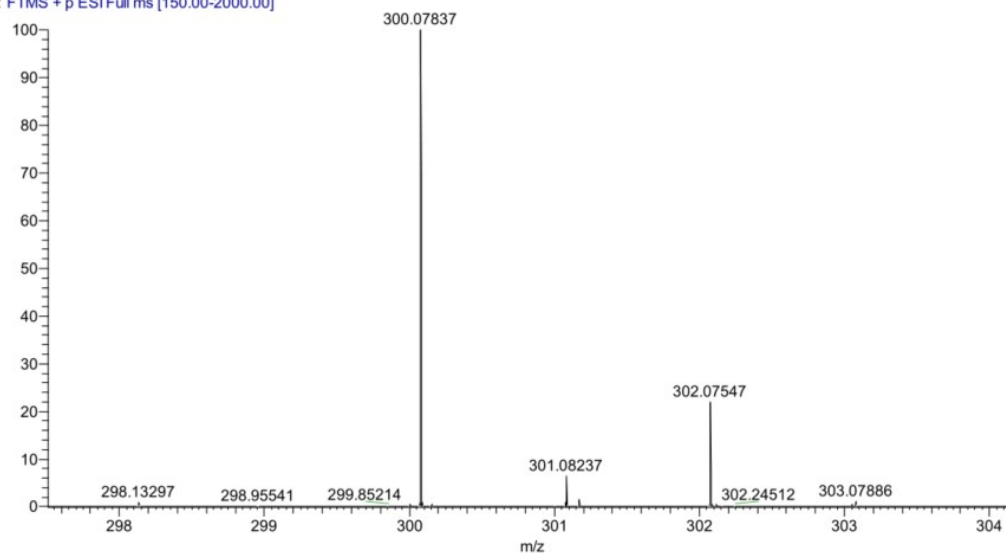
Methyl 2-(3-fluorophenyl)-5-methyl-1H-indole-3-carboxylate (3ak)

18 #17 RT: 0.23 AV: 1 NL: 2.13E7
T: FTMS + p ESI Full ms [150.00-2000.00]



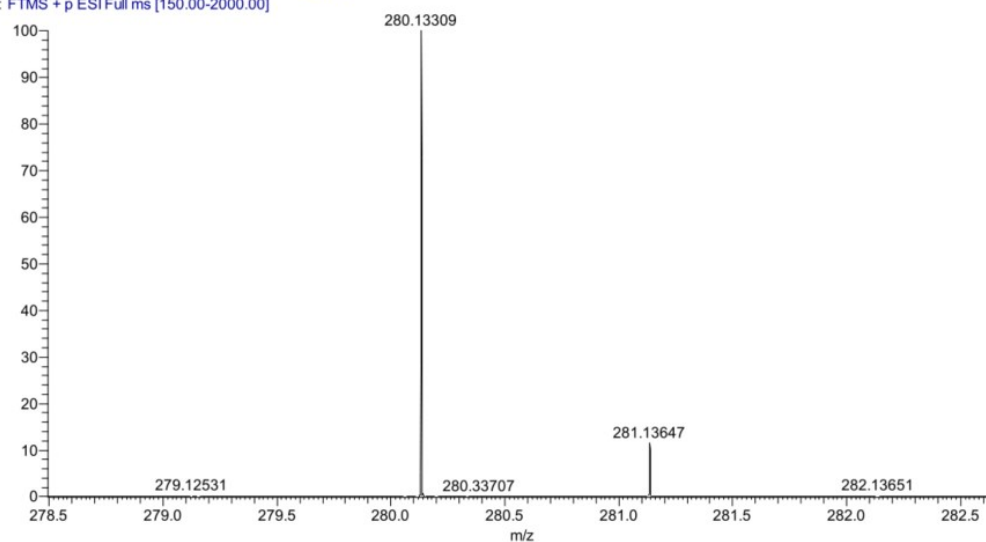
Methyl 2-(3-chlorophenyl)-5-methyl-1*H*-indole-3-carboxylate (3aI)

17 #14 RT: 0.18 AV: 1 NL: 1.39E7
T: FTMS + p ESI Full ms [150.00-2000.00]



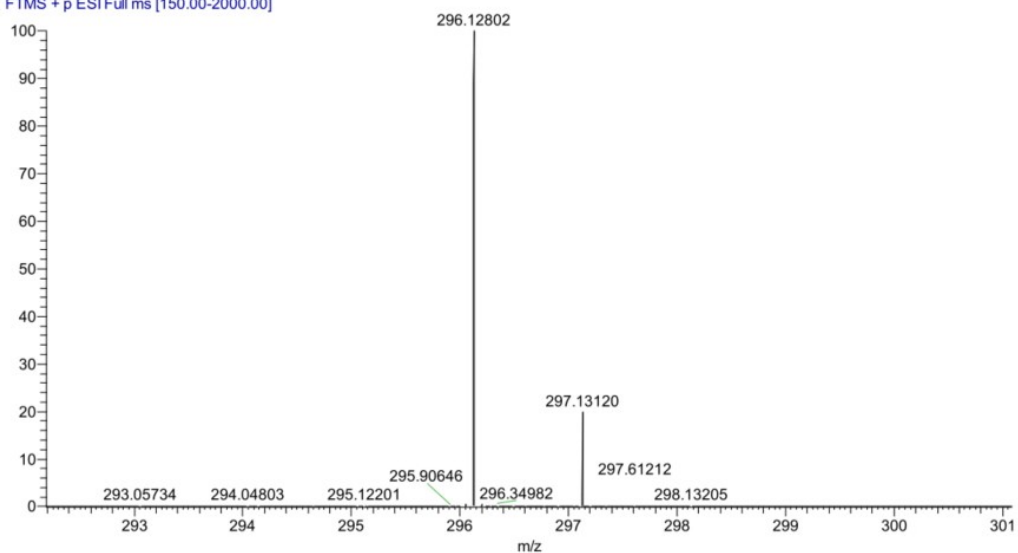
Methyl 5-methyl-2-(*m*-tolyl)-1*H*-indole-3-carboxylate (3aM)

14_180118151210 #32 RT: 0.48 AV: 1 NL: 2.08E7
T: FTMS + p ESI Full ms [150.00-2000.00]



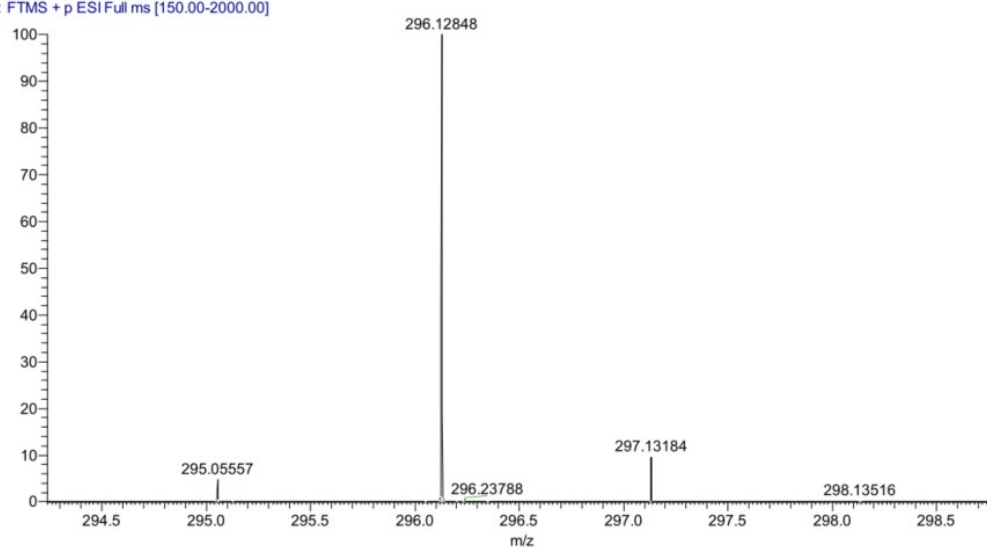
Methyl 5-methoxy-2-(*m*-tolyl)-1*H*-indole-3-carboxylate (3an)

15 #25 RT: 0.37 AV: 1 NL: 1.86E8
T: FTMS + p ESI Full ms [150.00-2000.00]



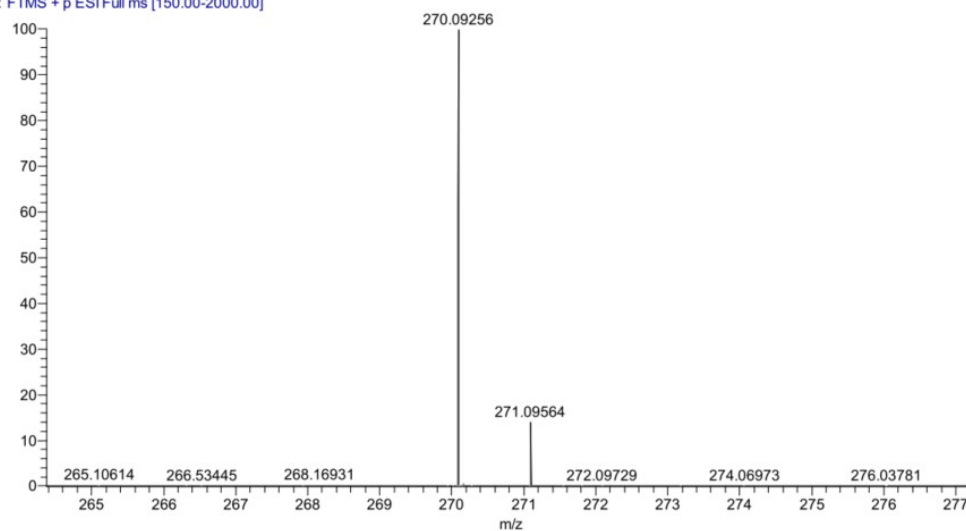
Methyl 2-(3-methoxyphenyl)-5-methyl-1*H*-indole-3-carboxylate (3ao)

16 #14 RT: 0.19 AV: 1 NL: 1.24E7
T: FTMS + p ESI Full ms [150.00-2000.00]



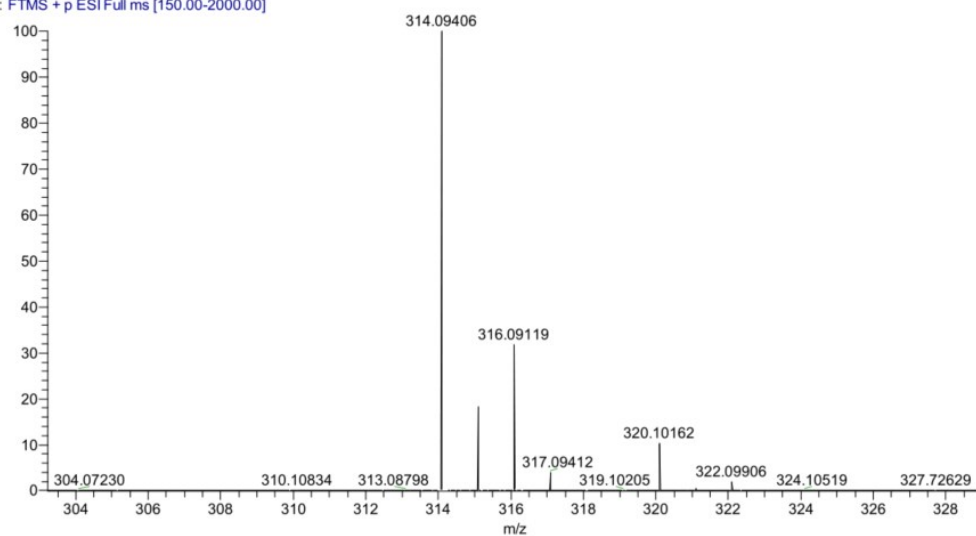
Methyl 5-fluoro-2-phenyl-1*H*-indole-3-carboxylate (3da)

23 #11 RT: 0.14 AV: 1 NL: 2.60E7
T: FTMS + p ESI Full ms [150.00-2000.00]



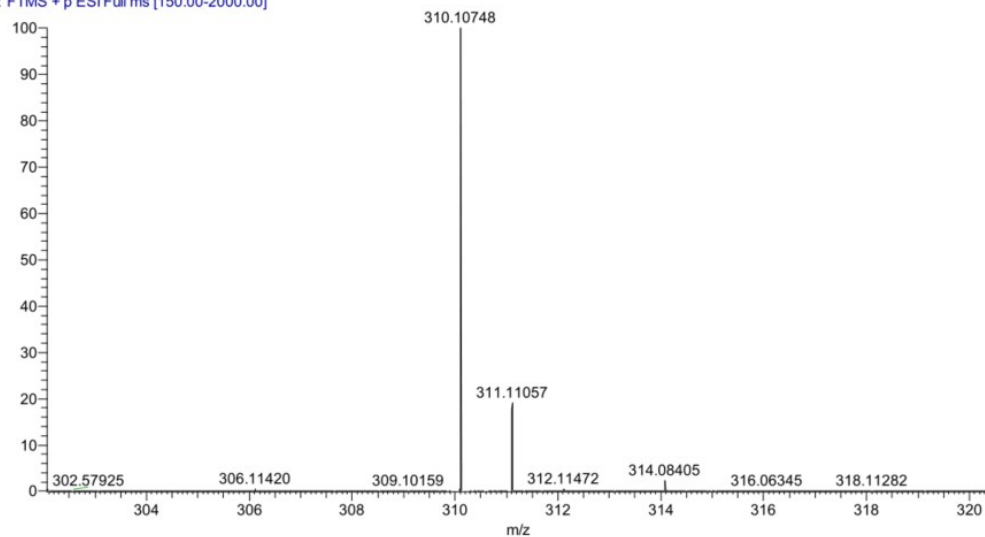
Ethyl 5-chloro-2-(*p*-tolyl)-1*H*-indole-3-carboxylate (3ea)

10 #11 RT: 0.14 AV: 1 NL: 6.74E7
T: FTMS + p ESI Full ms [150.00-2000.00]



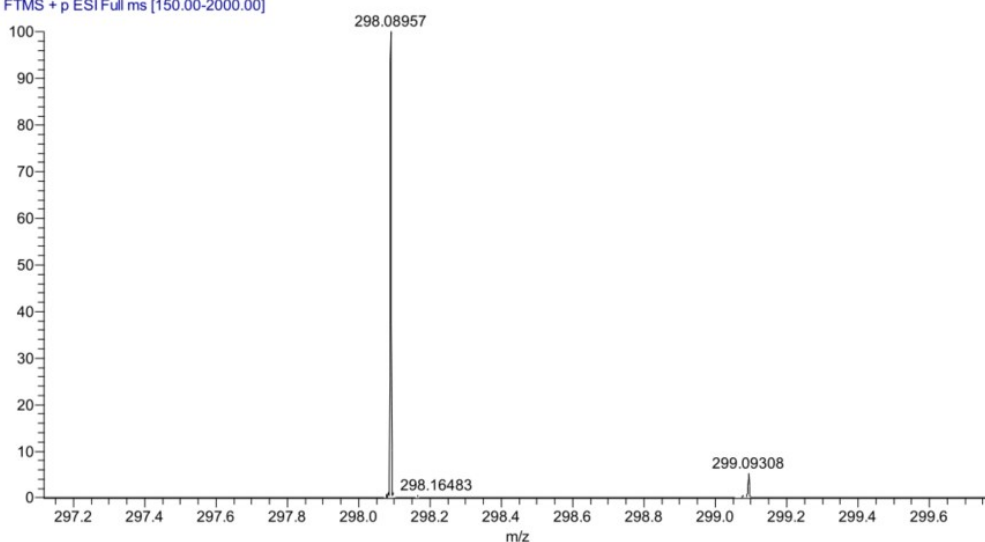
Dimethyl 2-phenyl-1*H*-indole-3,5-dicarboxylate (3fa)

27 #13 RT: 0.17 AV: 1 NL: 1.19E8
T: FTMS + p ESI Full ms [150.00-2000.00]



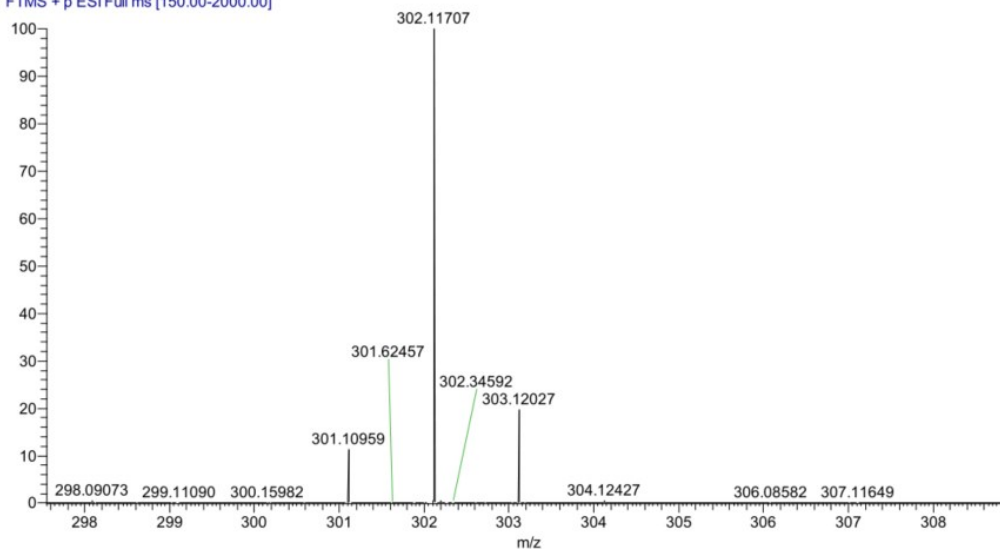
Methyl 5-(methylthio)-2-phenyl-1*H*-indole-3-carboxylate (3ga)

25 #18 RT: 0.26 AV: 1 NL: 9.70E6
T: FTMS + p ESI Full ms [150.00-2000.00]



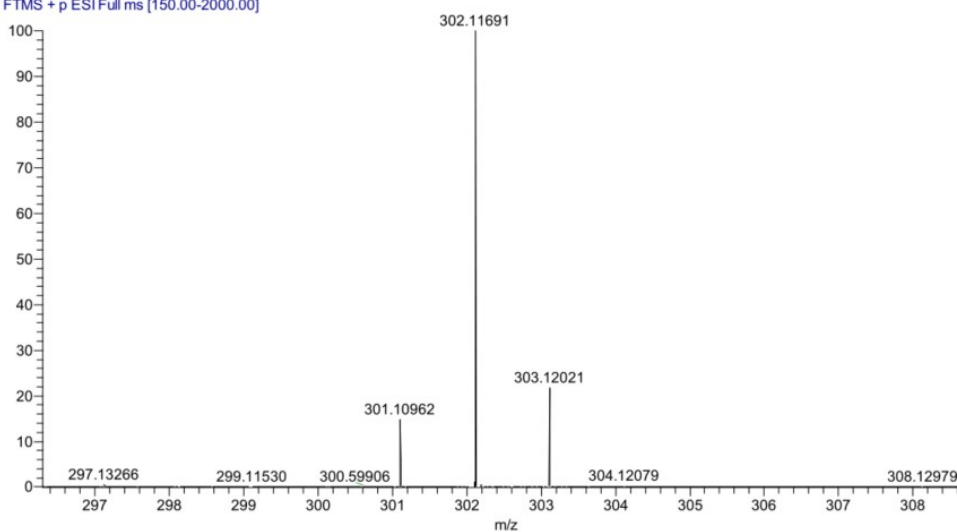
Methyl 2-phenyl-1*H*-benzo[*g*]indole-3-carboxylate (3ha)

26 #23 RT: 0.31 AV: 1 NL: 3.21E7
T: FTMS + p ESI Full ms [150.00-2000.00]



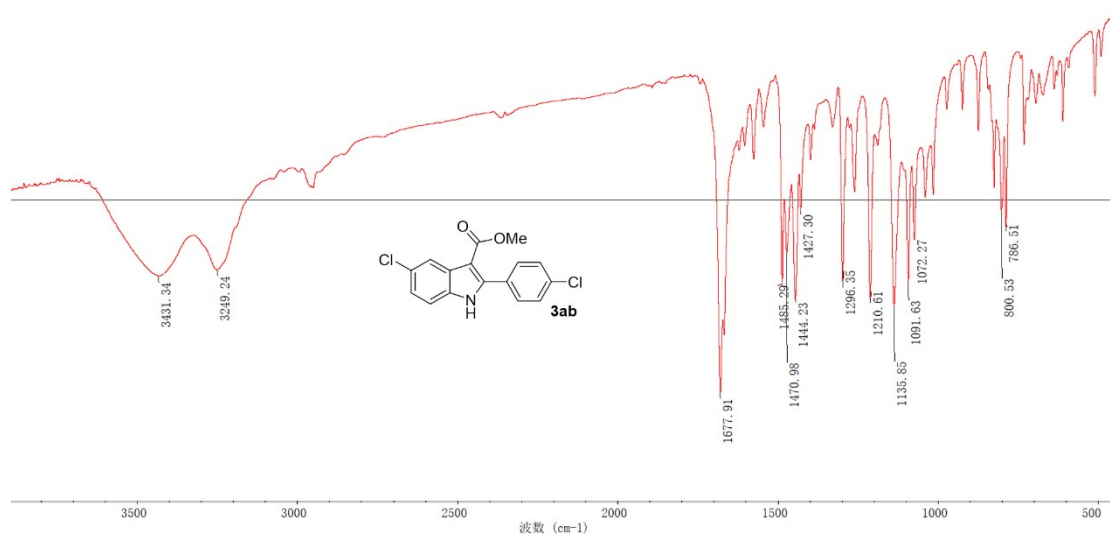
Methyl 2-phenyl-3*H*-benzo[*e*]indole-1-carboxylate (3ia)

24 #8 RT: 0.10 AV: 1 NL: 4.47E7
T: FTMS + p ESI Full ms [150.00-2000.00]

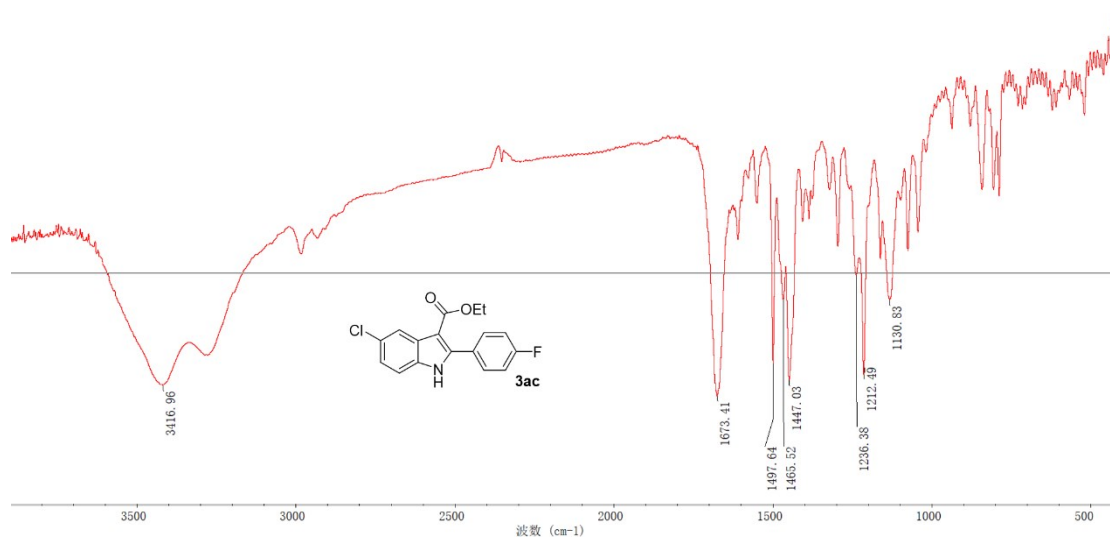


3. IR spectra of new compounds

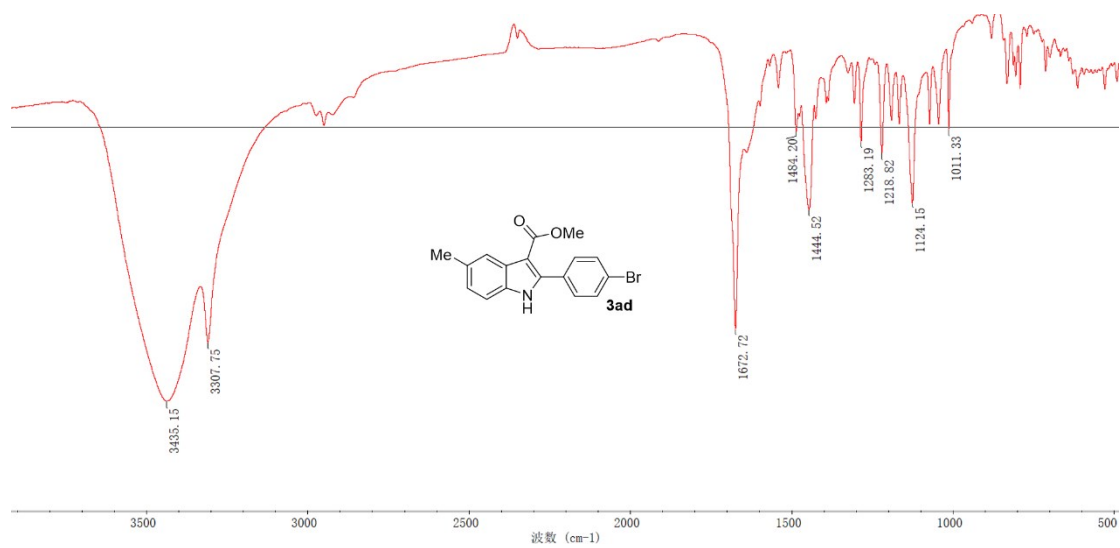
IR spectra of 3ab



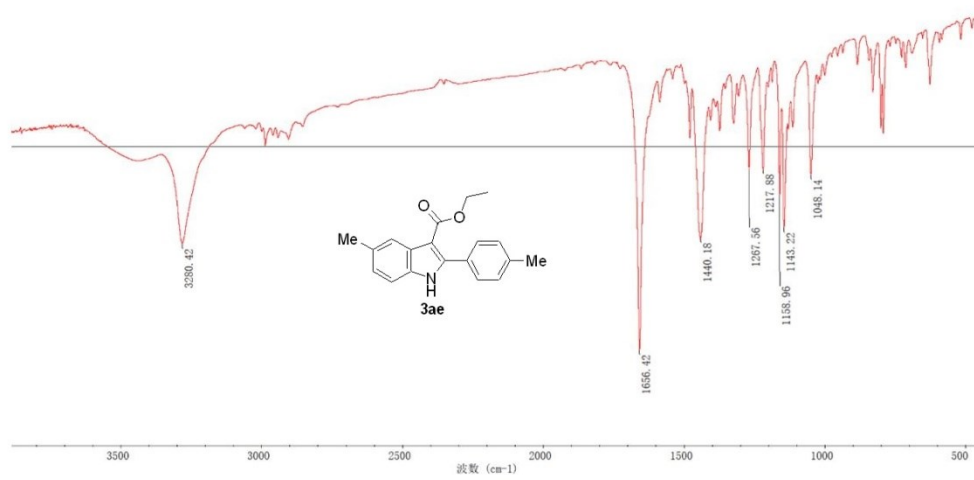
IR spectra of 3ac



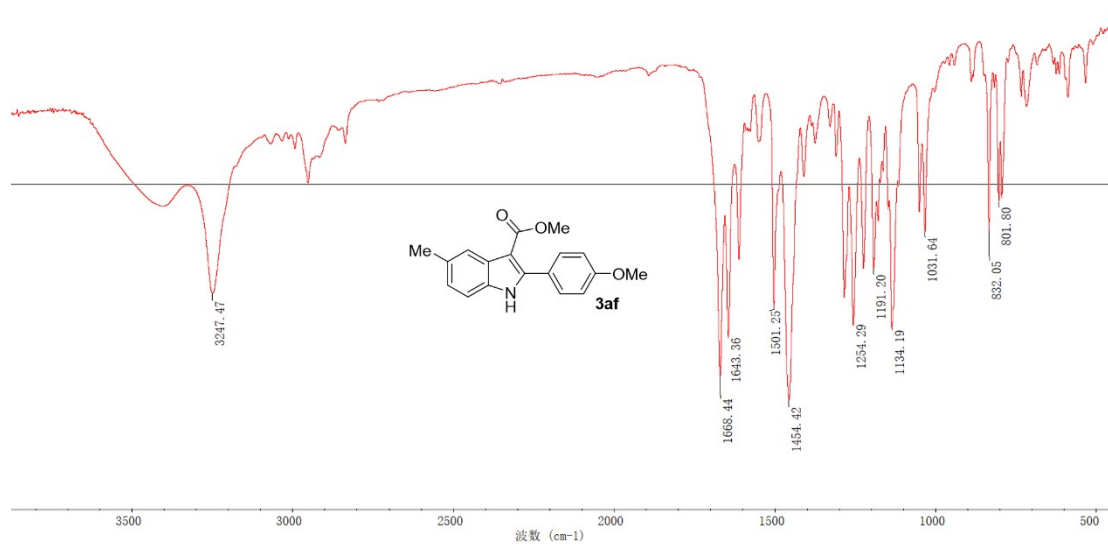
IR spectra of 3ad



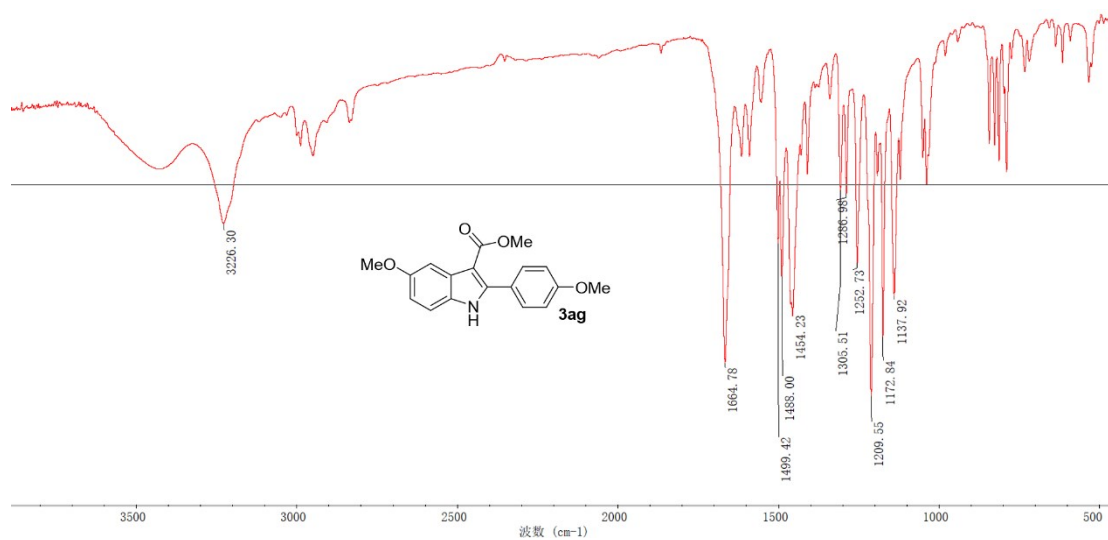
IR spectra of 3ae



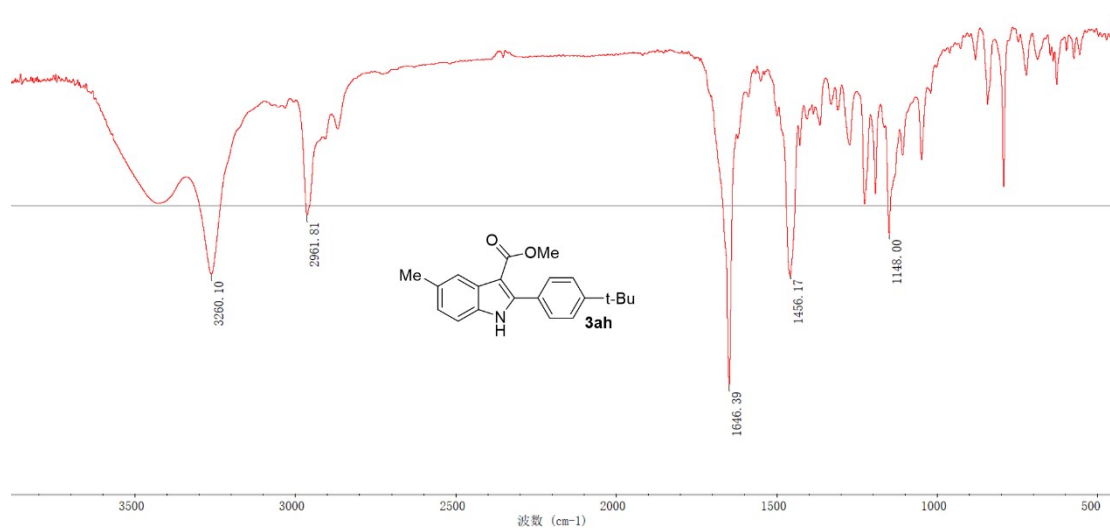
IR spectra of 3af



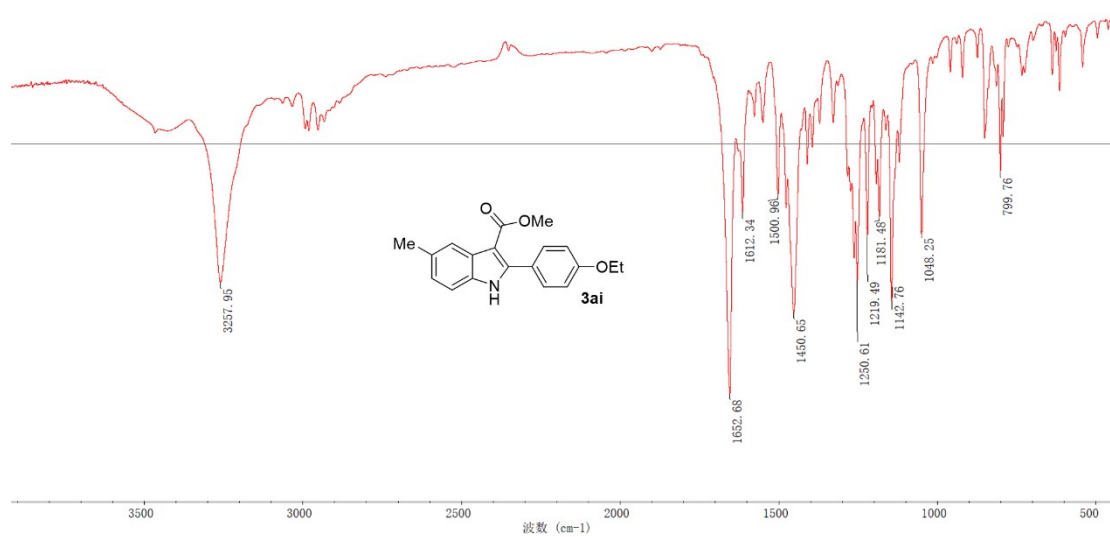
IR spectra of 3ag



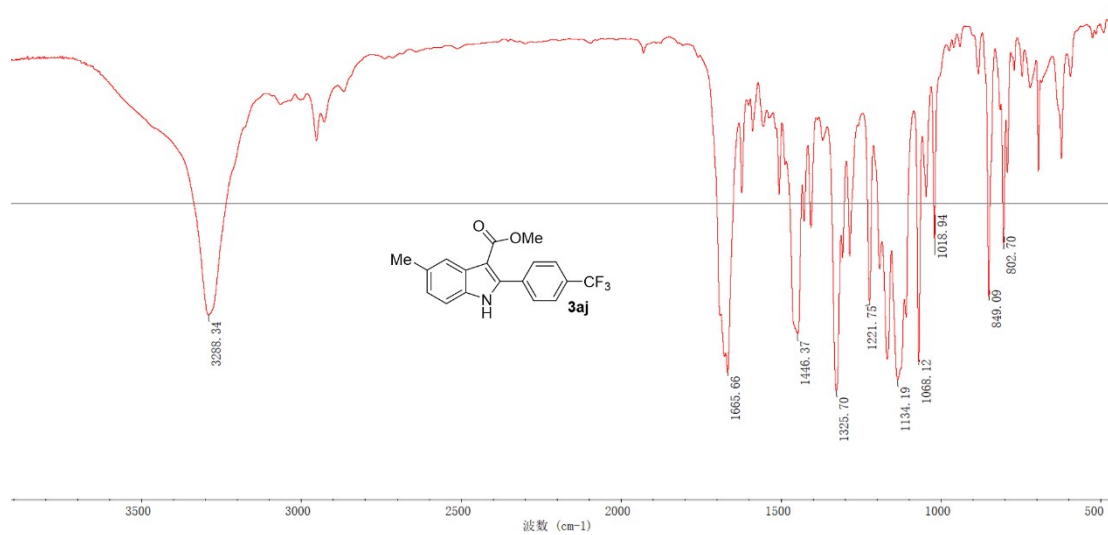
IR spectra of 3ah



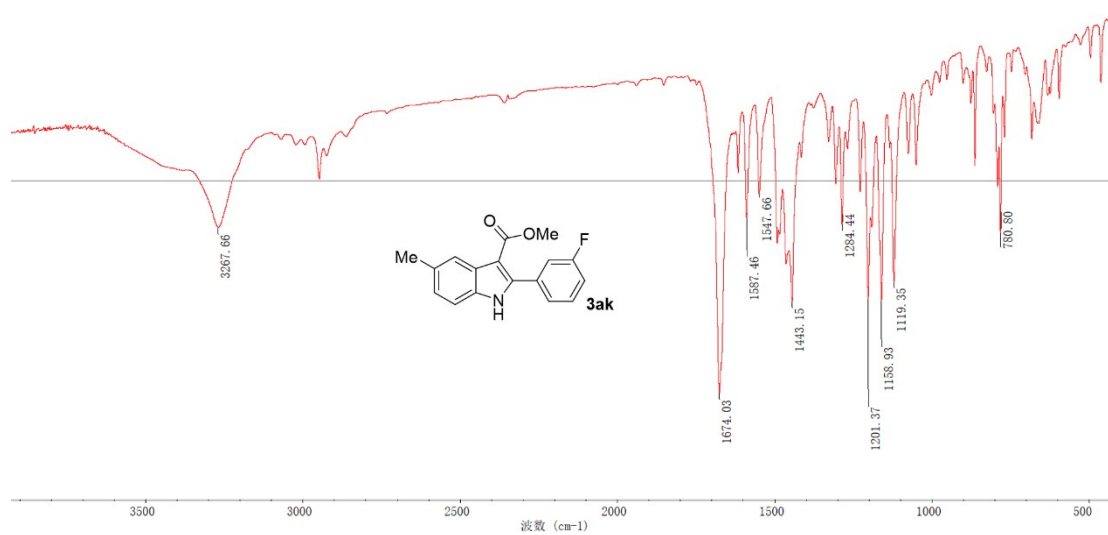
IR spectra of 3ai



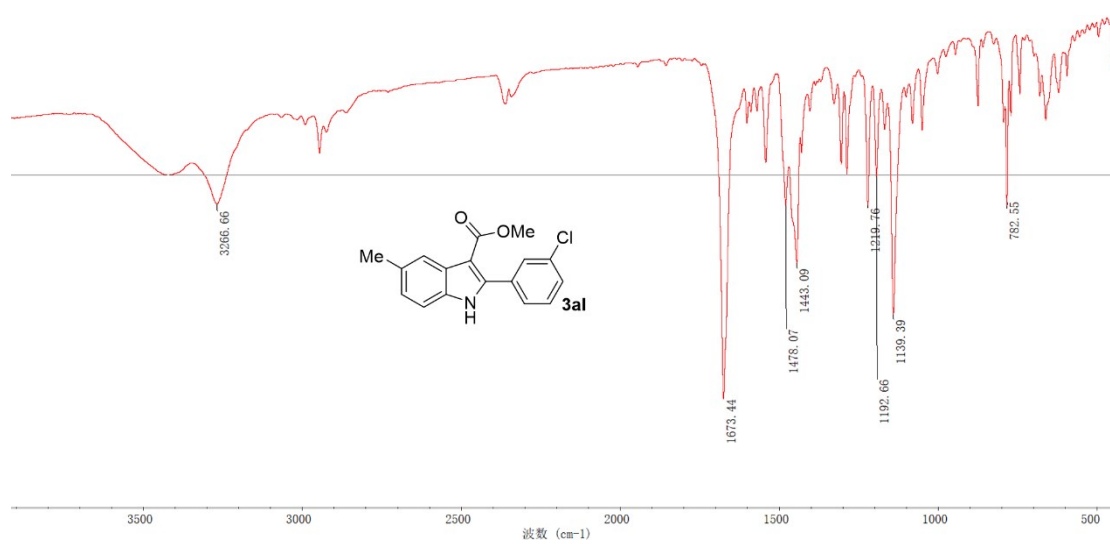
IR spectra of 3aj



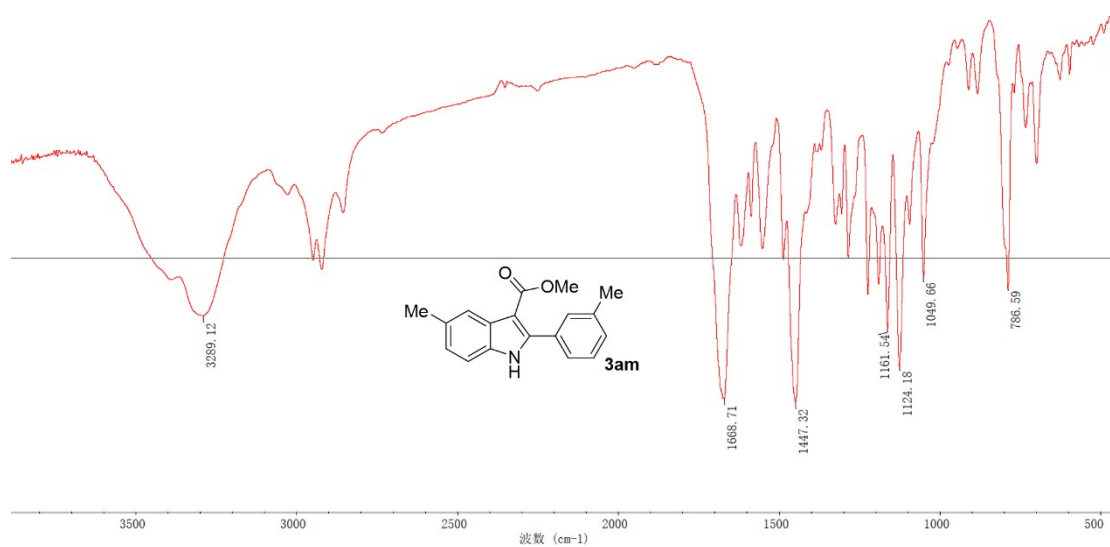
IR spectra of 3ak



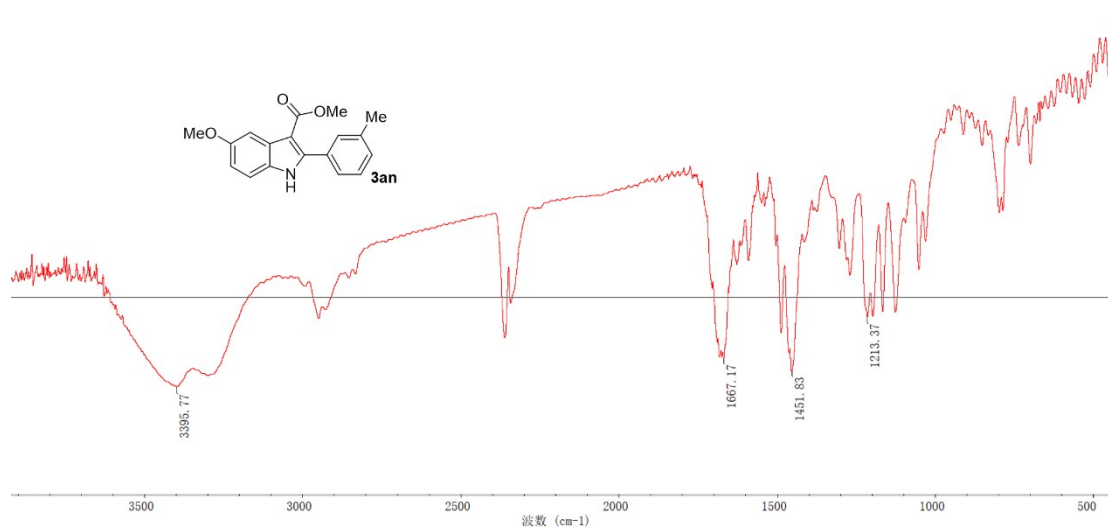
IR spectra of 3al



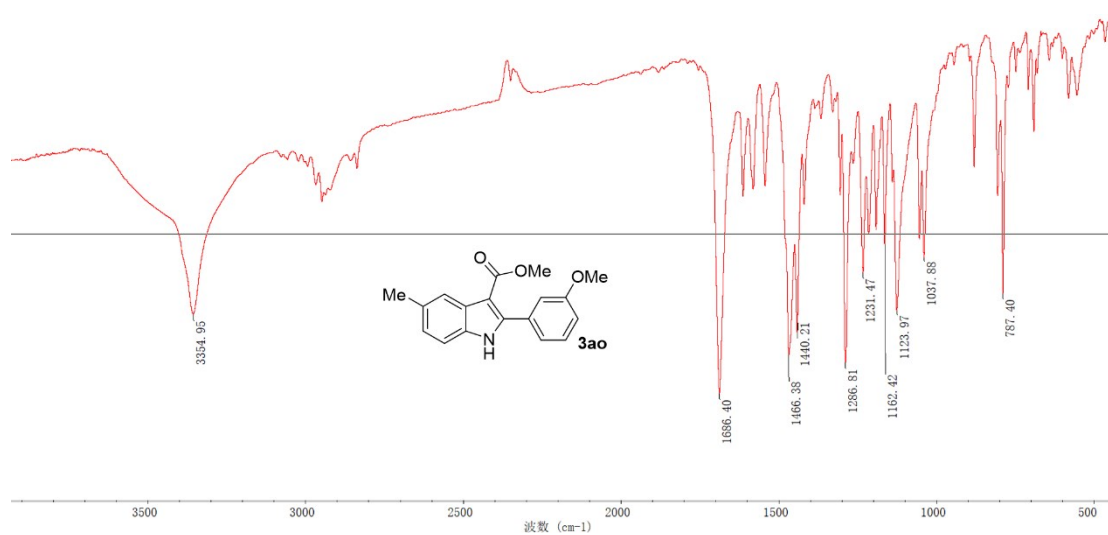
IR spectra of 3am



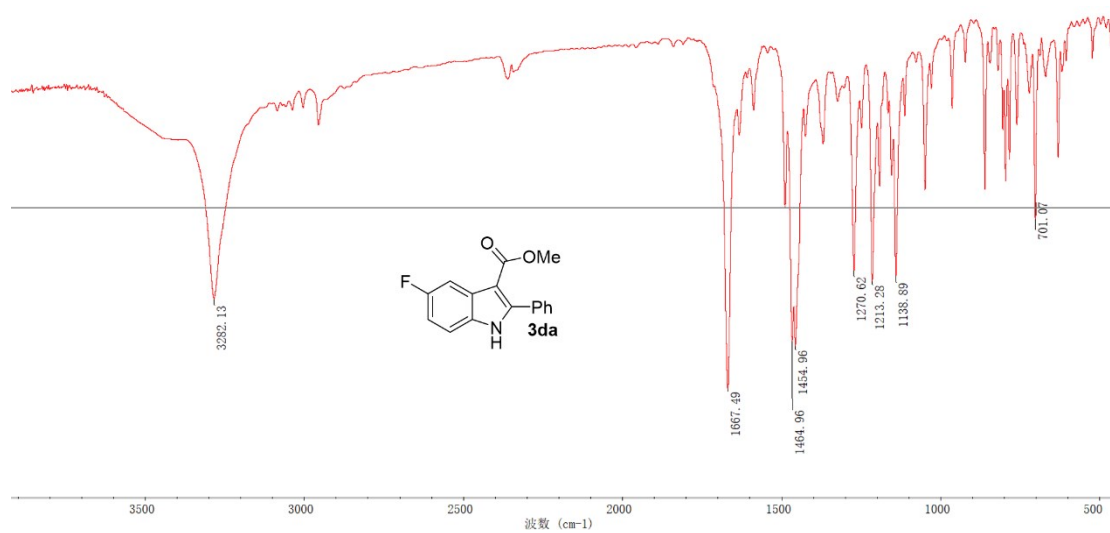
IR spectra of 3an



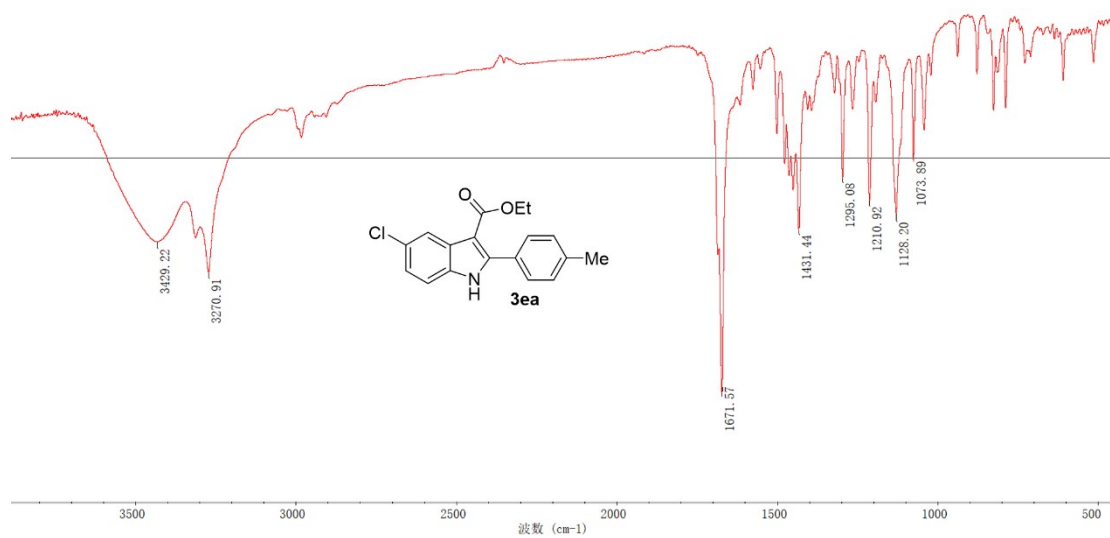
IR spectra of 3ao



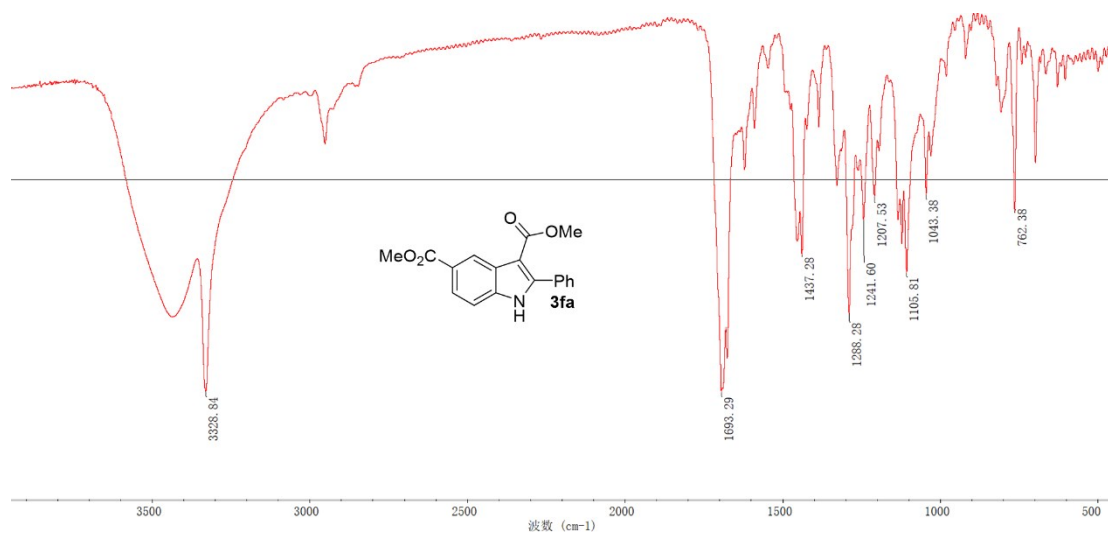
IR spectra of 3da



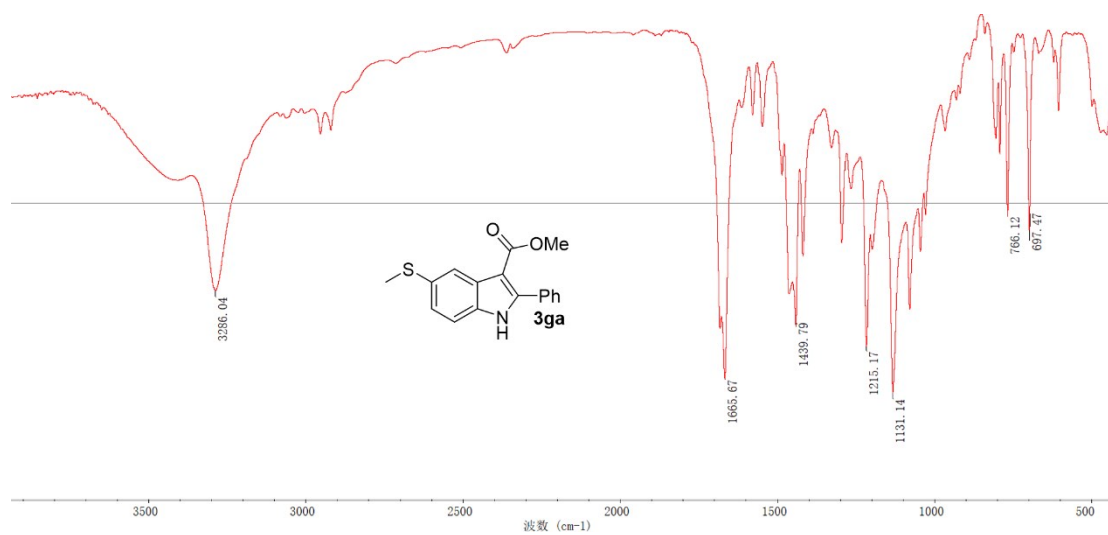
IR spectra of 3ea



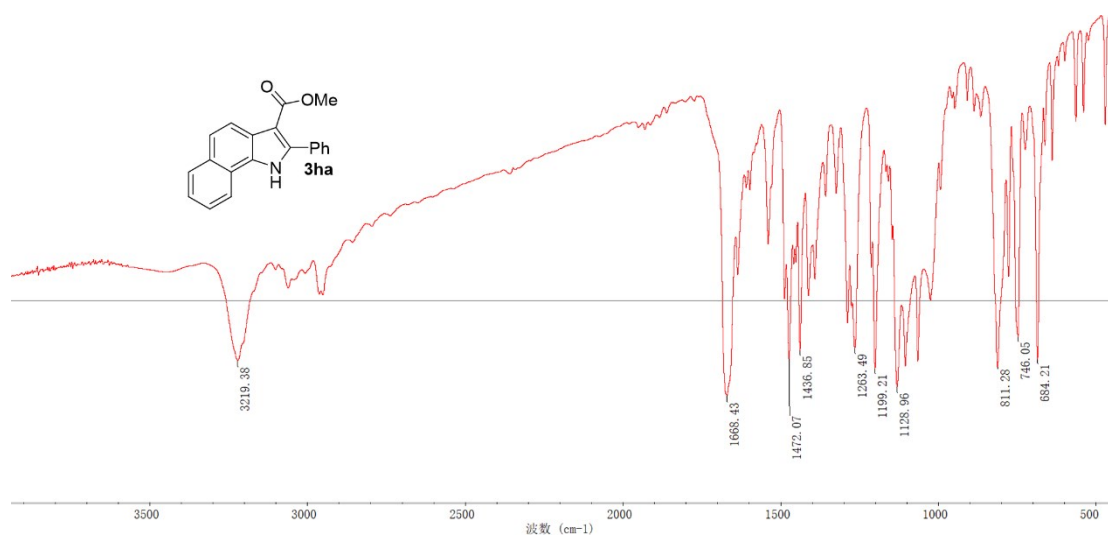
IR spectra of 3fa



IR spectra of 3ga



IR spectra of 3ha



IR spectra of 3ia

