

Synthesis and reactivity of 2-thionoester pyrroles: a route to 2-formyl pyrroles

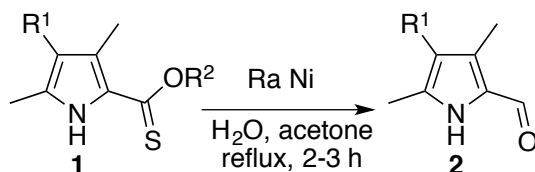
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Supplementary Information

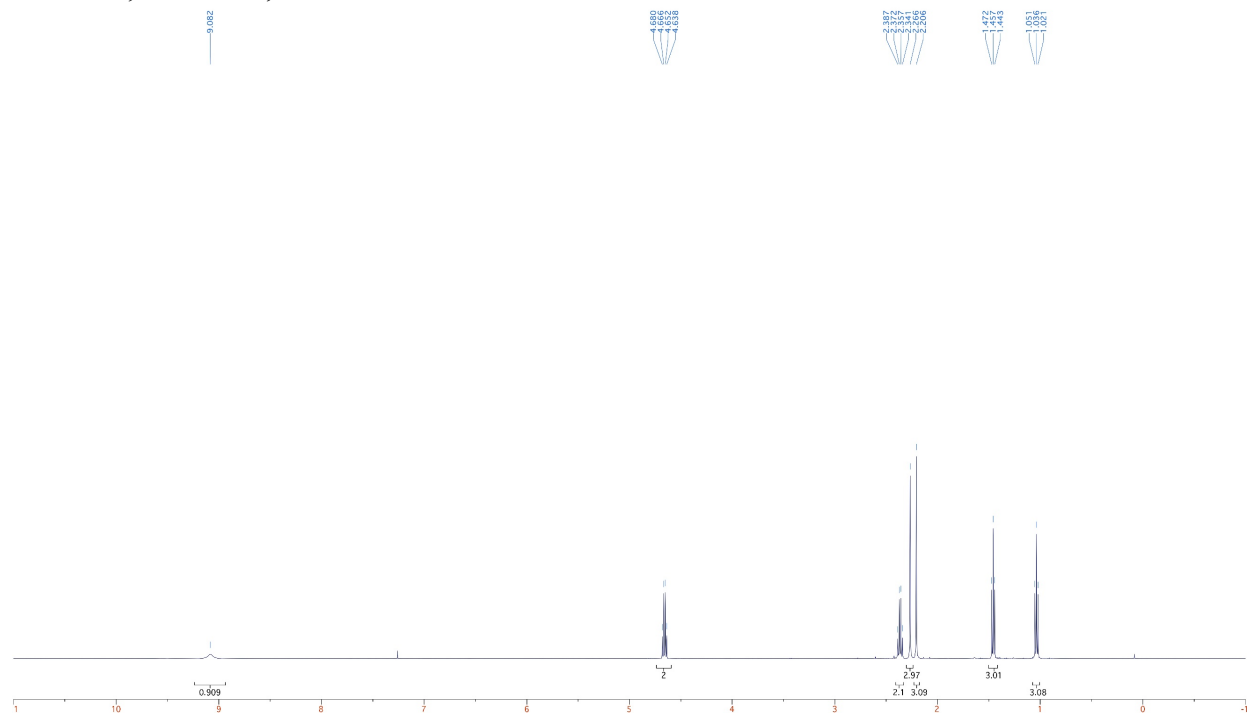
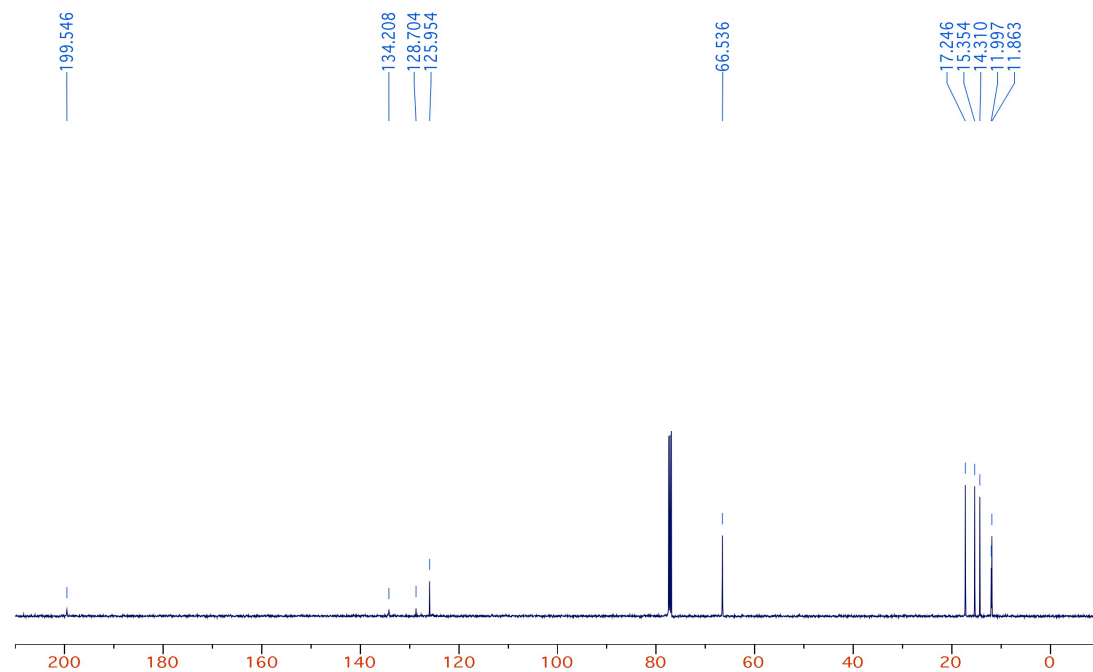
Evaluating stoichiometry of Raney nickel in reduction reaction**Table 1.** Stoichiometry of Raney nickel

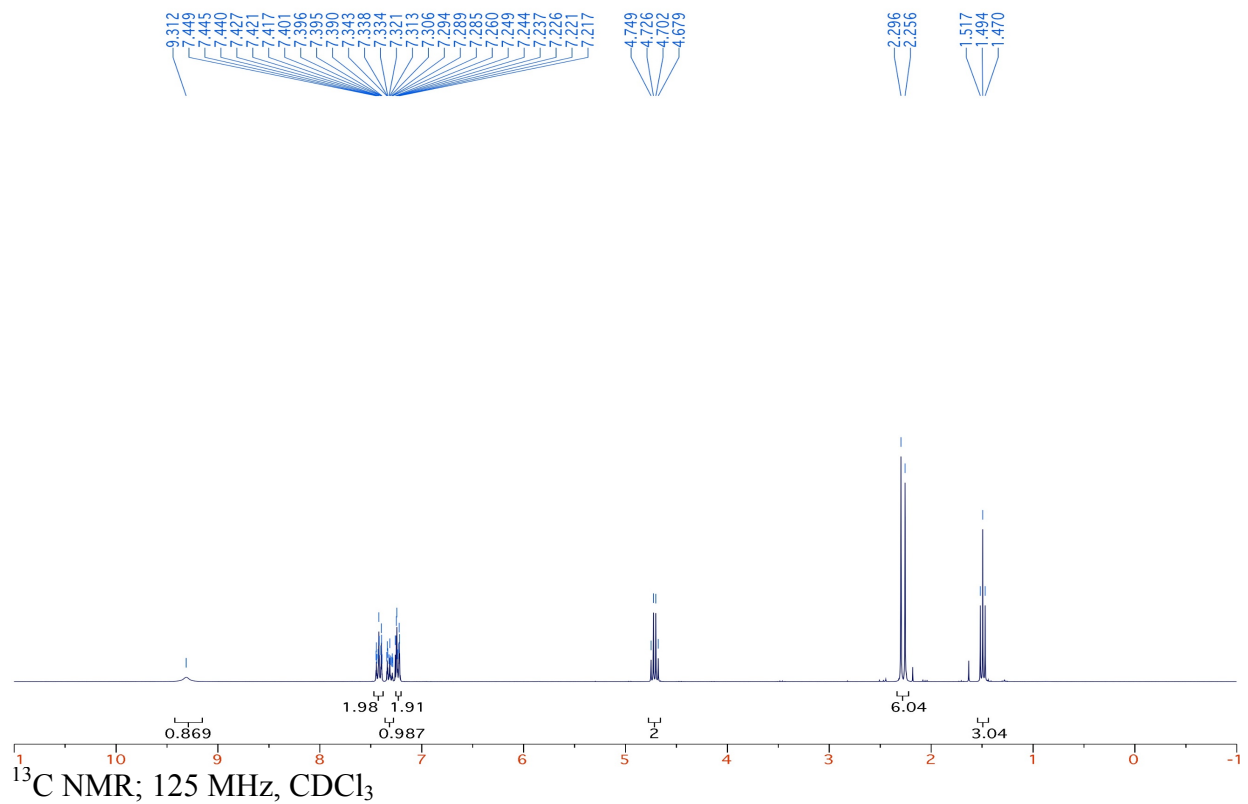
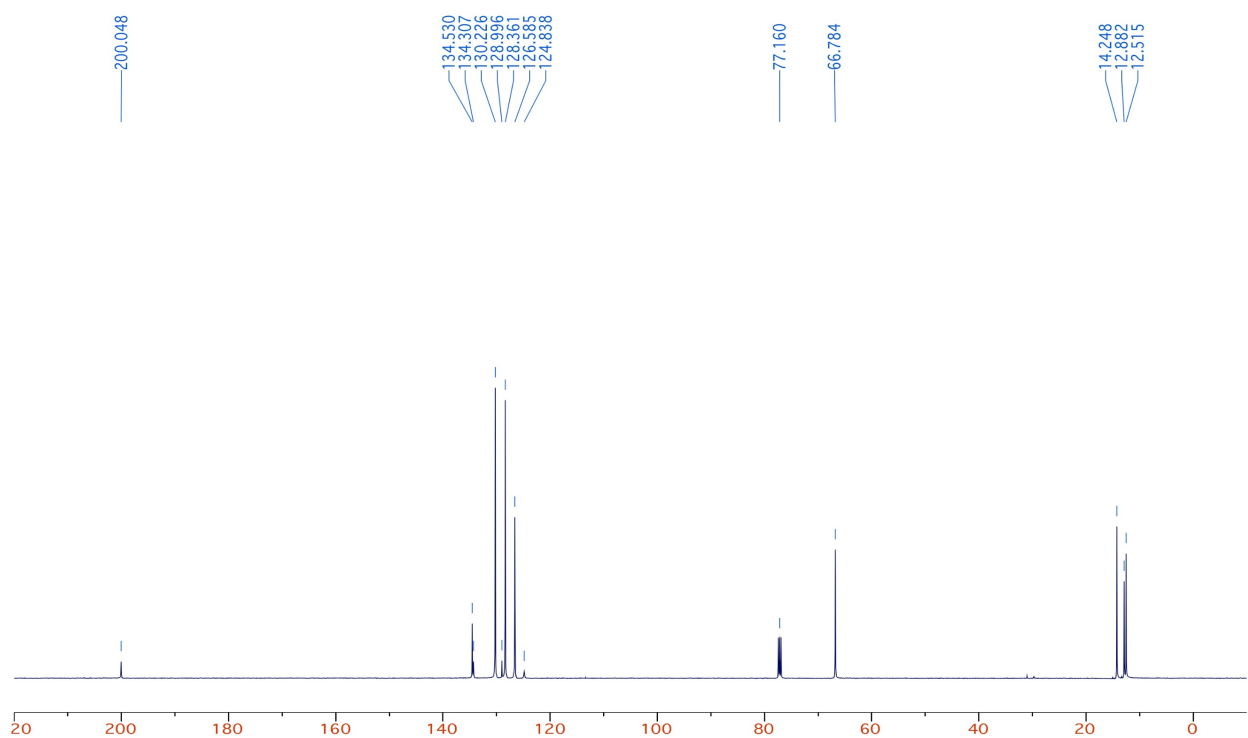
Entry	Reactant (mmol)	Amount of Raney Nickel (g)	Raney nickel (mmol)	Equiv. Raney Nickel	Yield (%)
1	1.1	2.4	28	25	67
2	1.0	3.4	39	39	53
3	0.88	1.3	15	17	43
4	0.40	0.17	2.0	5	17
5	0.47	2.0	23	49	50

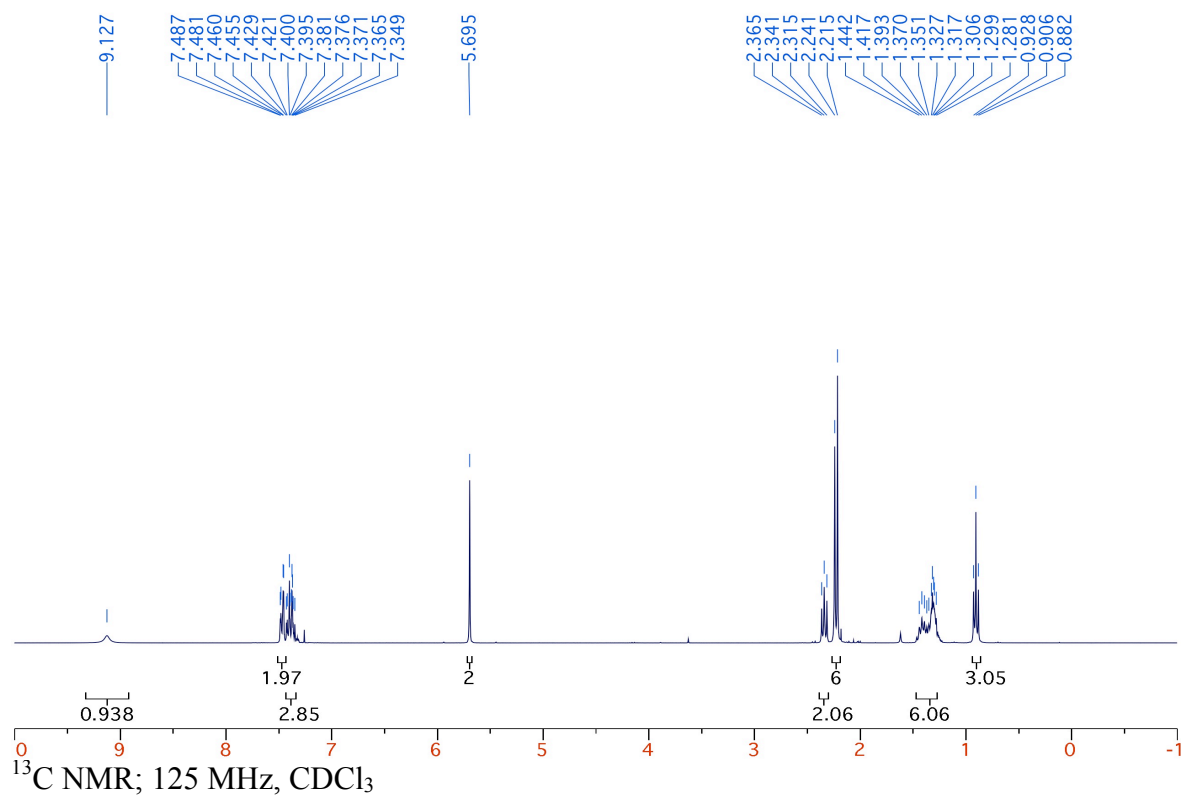
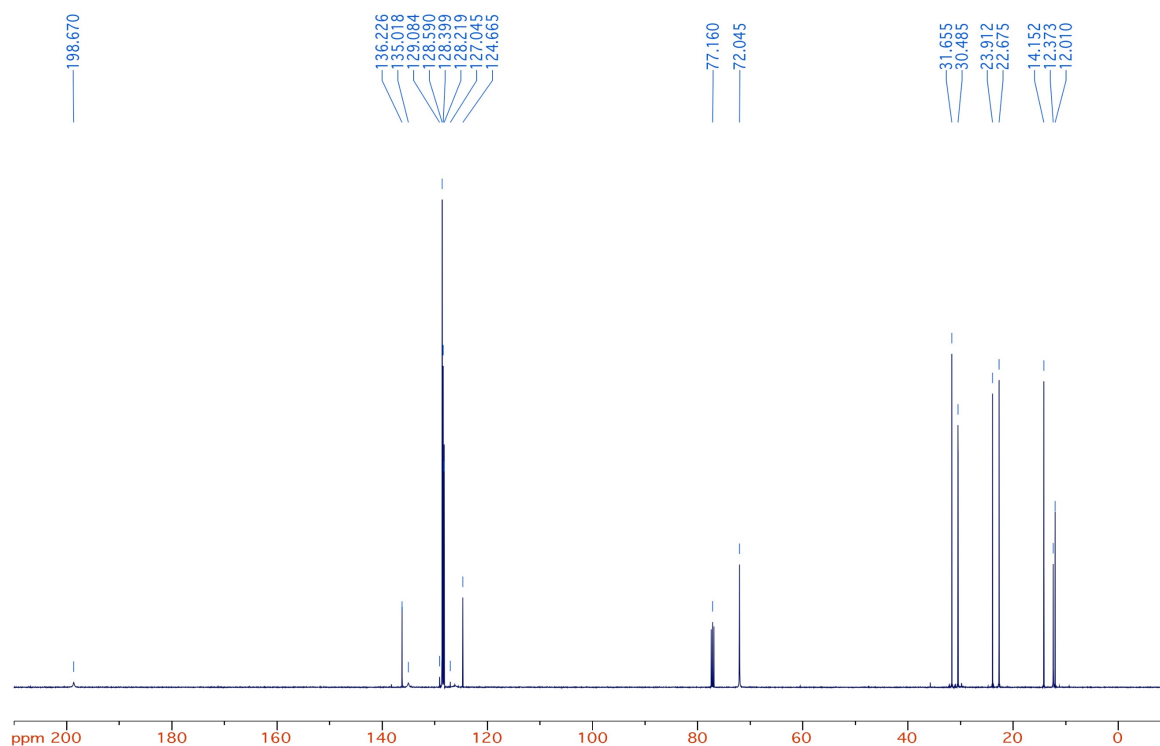
Quantifying Raney nickel slurry

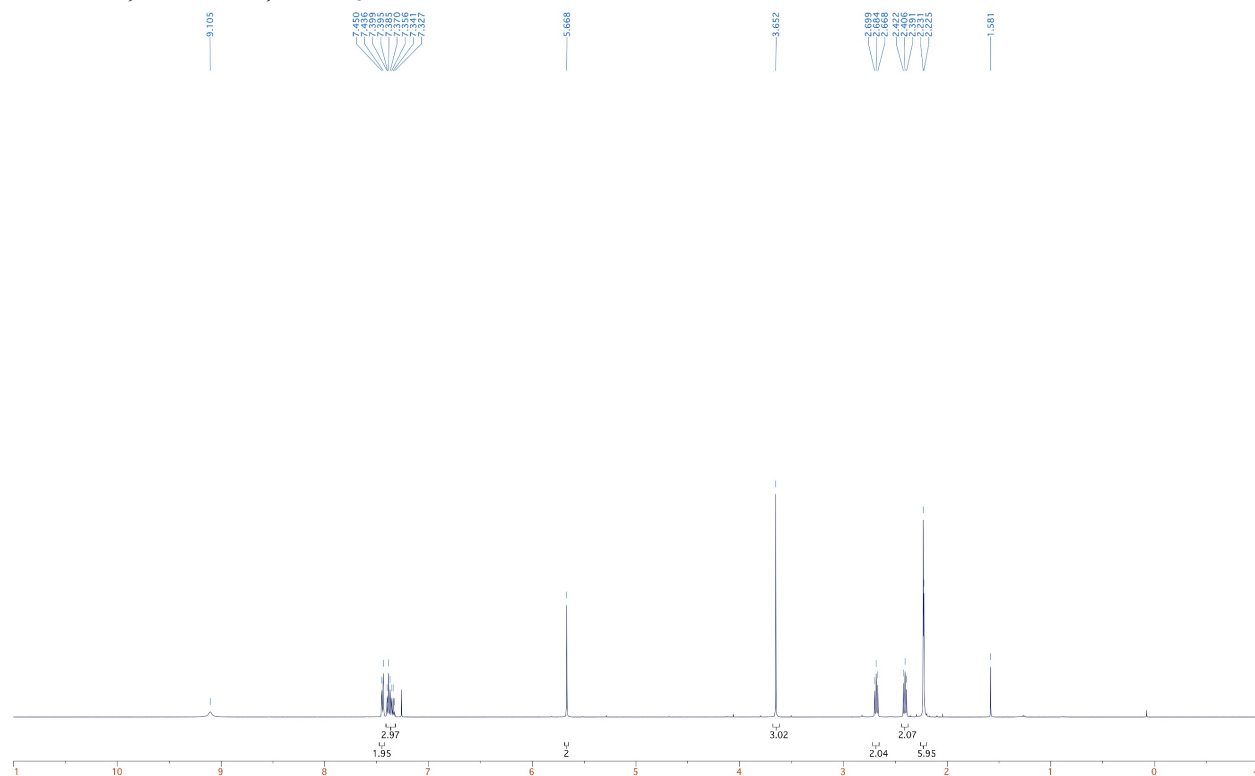
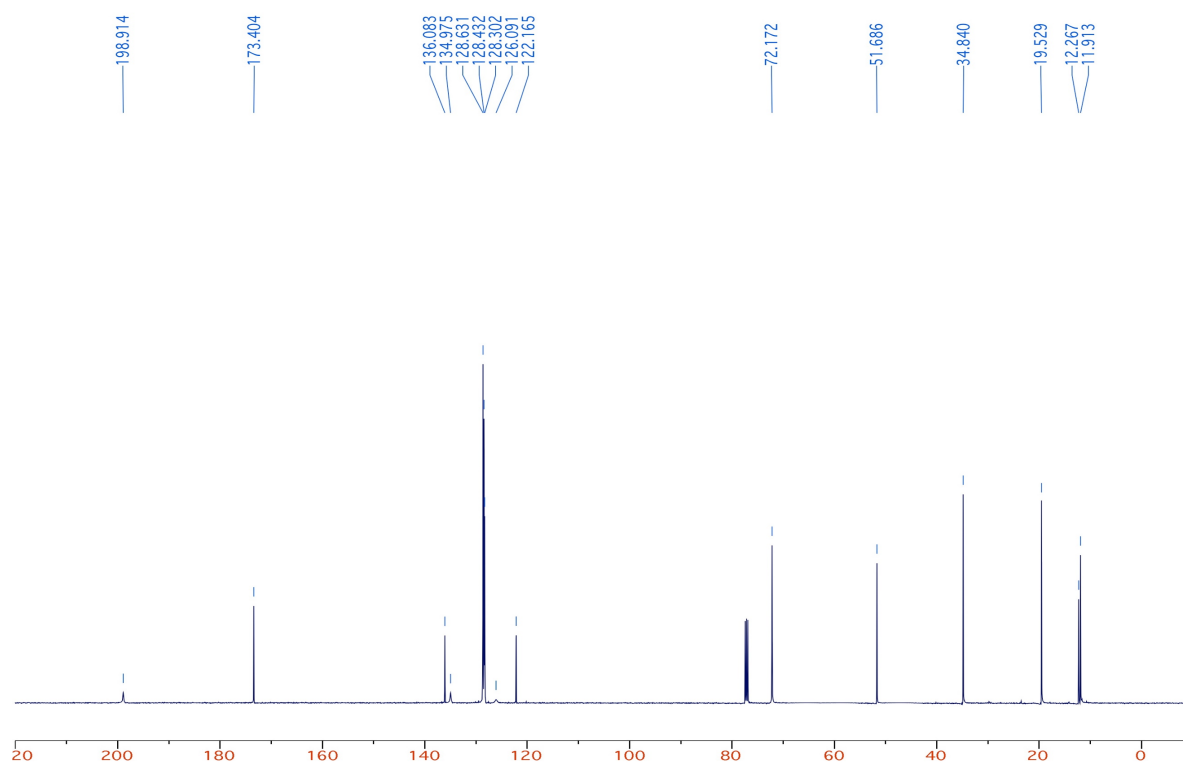
Since Raney nickel is available as a slurry in water, and transfer of a known amount to a reaction vessel can be challenging. The fact that the slurry settles (Raney nickel sinks) during transfer is especially problematic. Moreover, due to its pyrophoricity, we chose not to use dry material. To efficiently calculate the stoichiometry of Raney nickel, the mass was calculated following the method provided by the supplier. We first measured out a certain volume of the Raney nickel slurry, quickly and after shaking, and measured its mass. Then, the mass of water, as expected for that volume, was subtracted. The corrected mass ratio thus calculated accounts for the density difference of water and Raney nickel within the volume taken in the beginning: (weight of slurry reagent – weight of water of the same volume) * density factor (1.2). From this calculation, we found that 2 mL of slurry is approximately equal to 2.4-2.5 g of Raney nickel which is equivalent to about 25 mmol. The masses of Raney nickel in **Table 1** in the accompanying manuscript were calculated using this method.

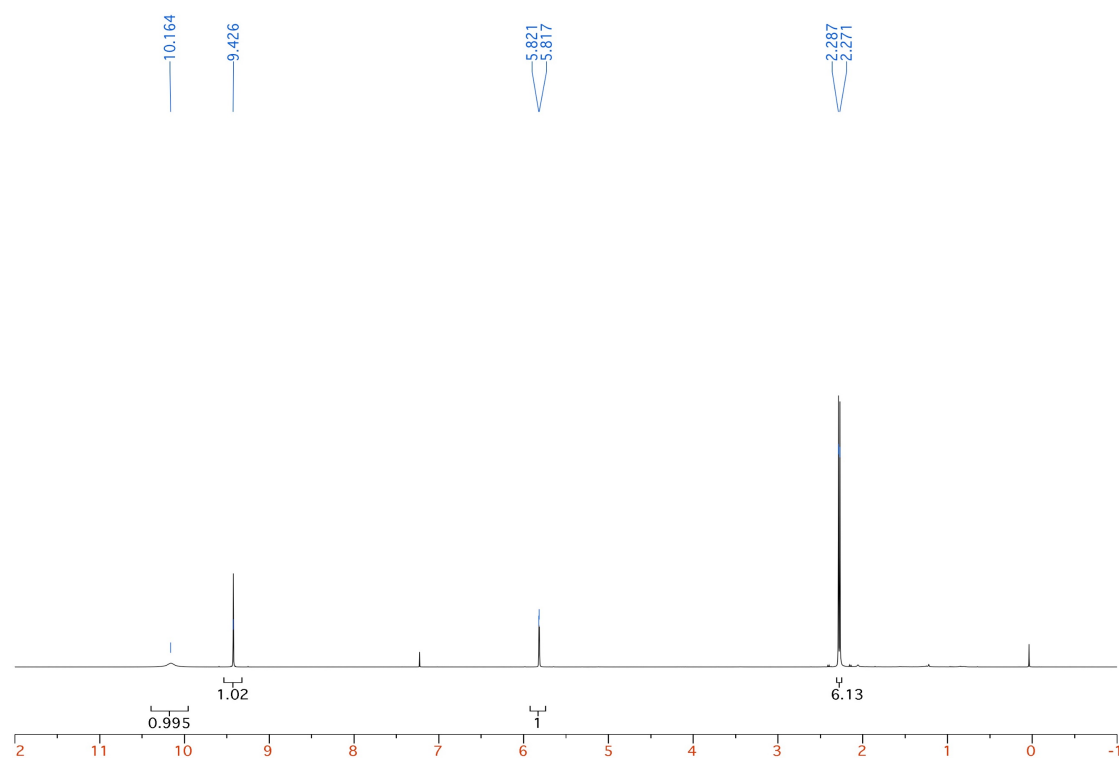
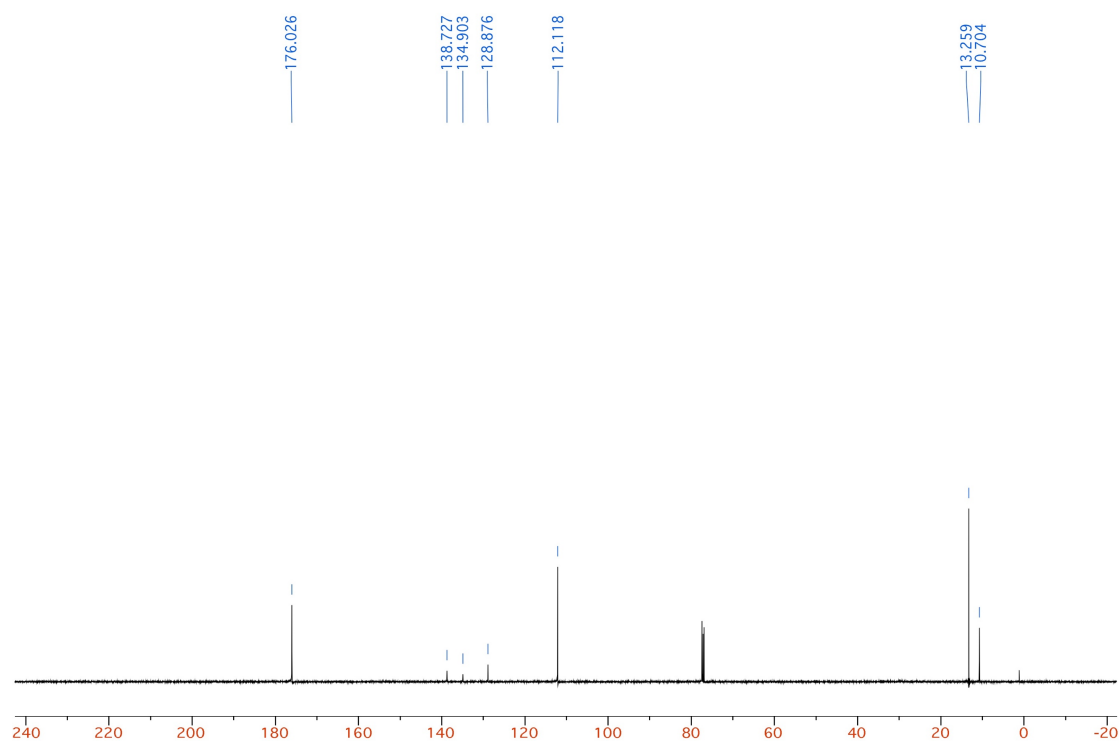
NMR Spectra

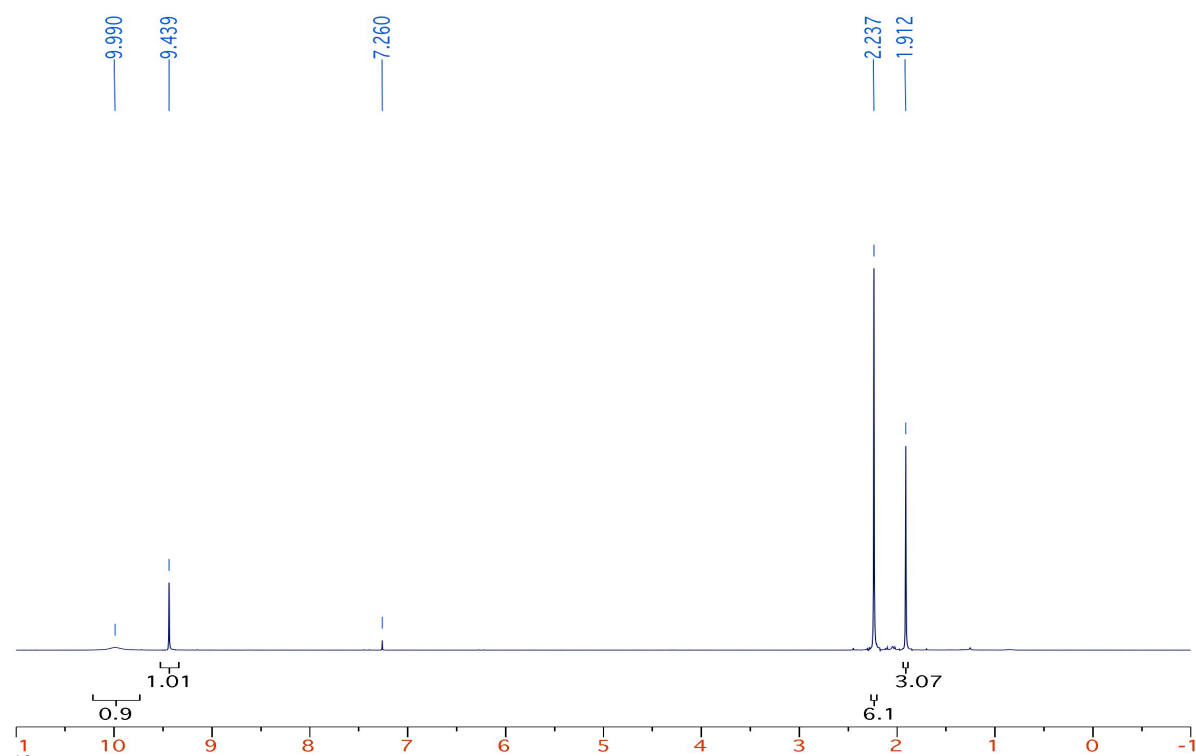
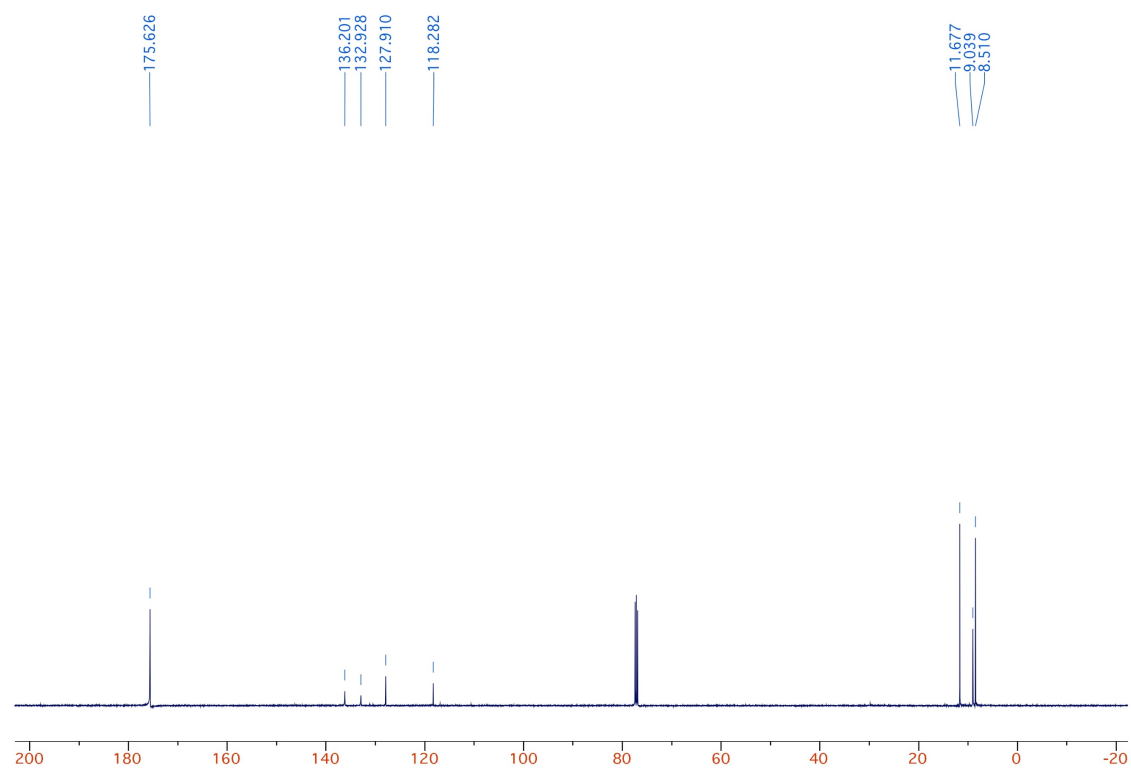
O-Ethyl-4-ethyl-3,5-dimethyl-1*H*-pyrrole-2-carbothioate (1c) ^1H NMR; 500 MHz, CDCl_3  ^{13}C NMR; 125 MHz, CDCl_3 

***O*-Ethyl-3,5-dimethyl-4-phenyl-1*H*-pyrrole-2-carbothioate (1d)**¹H NMR; 300 MHz, CDCl₃¹³C NMR; 125 MHz, CDCl₃

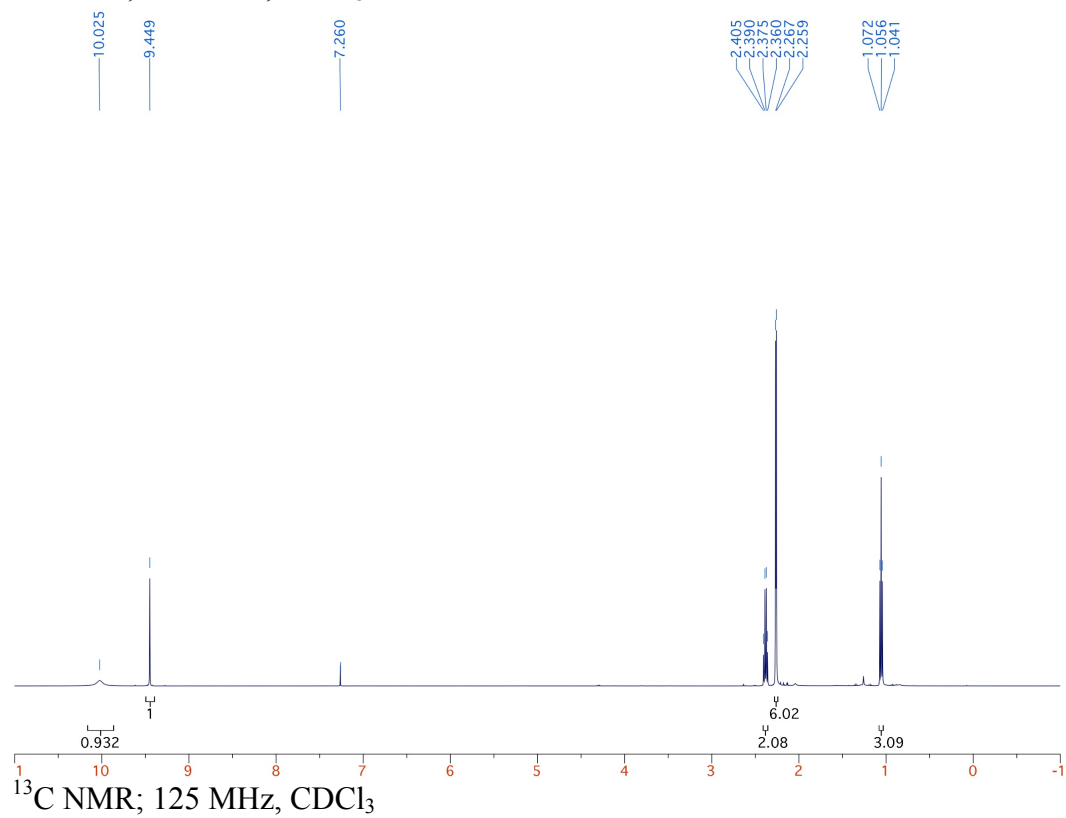
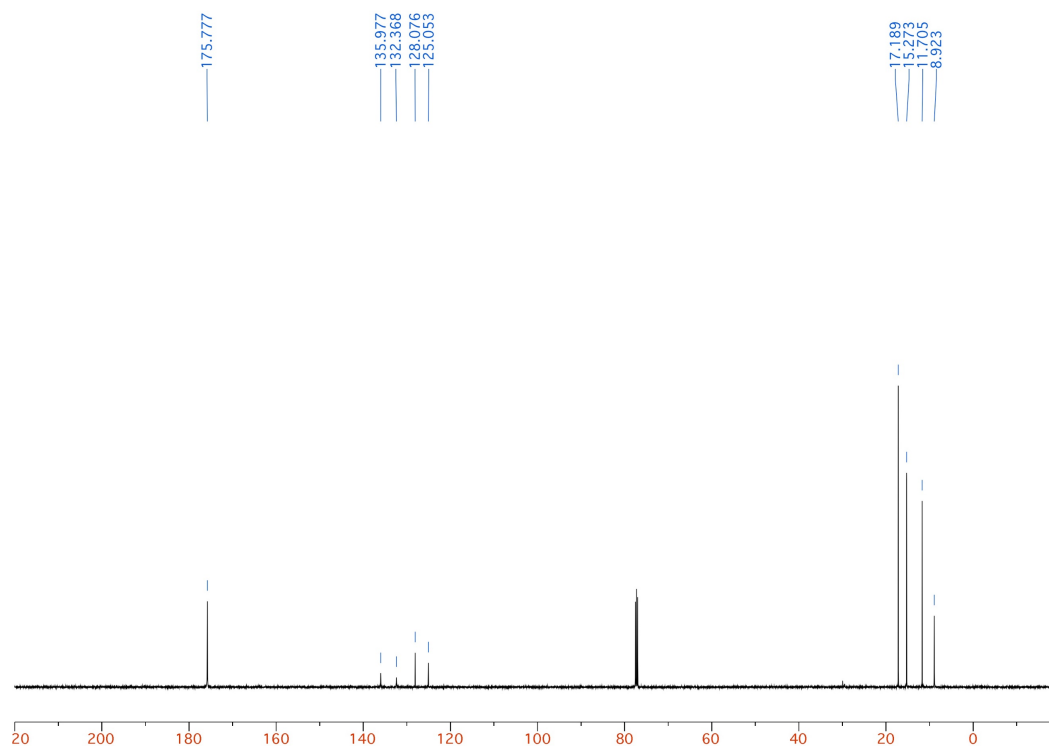
***O*-Benzyl-3,5-dimethyl-4-pentyl-1*H*-pyrrole-2-carbothioate (1g)**¹H NMR; 300 MHz, CDCl₃¹³C NMR; 125 MHz, CDCl₃

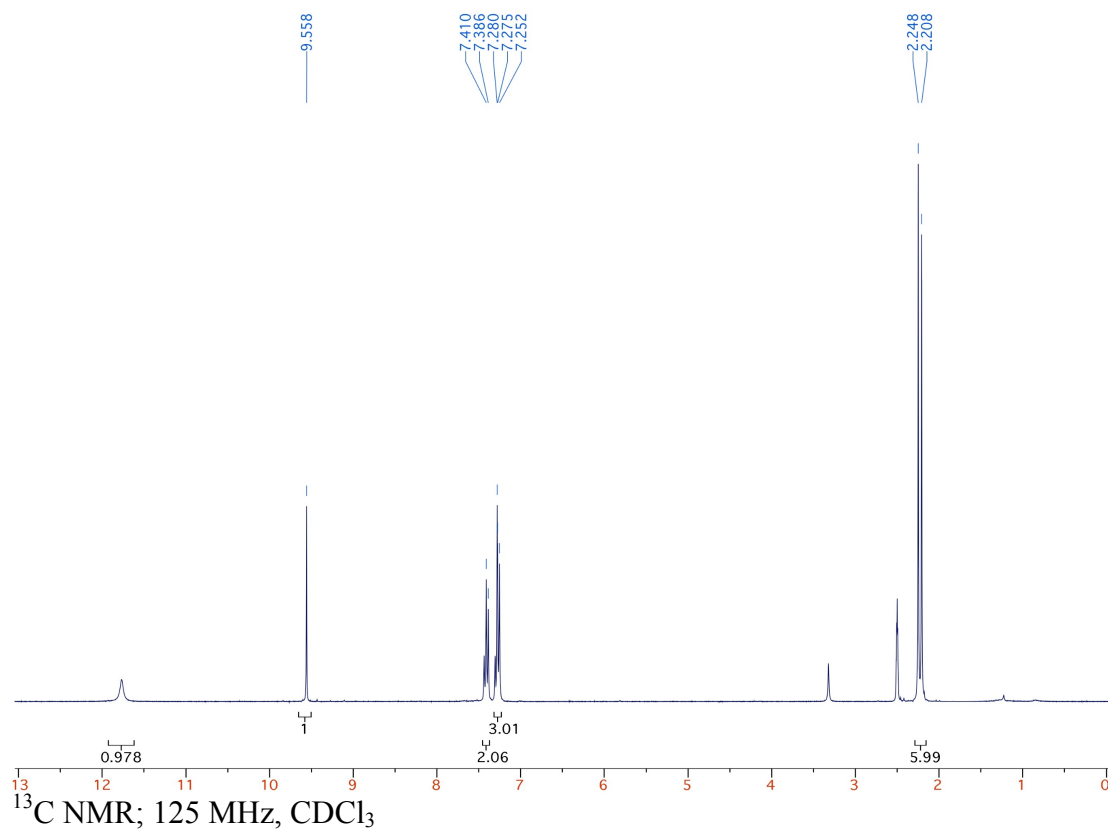
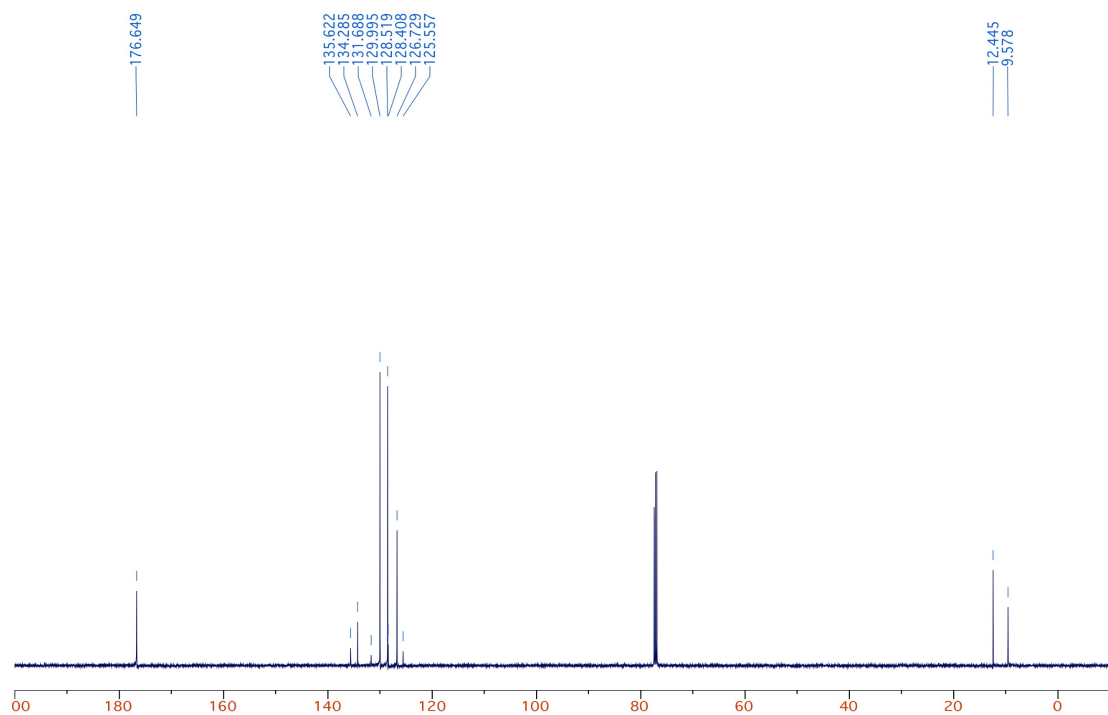
***O*-Benzyl-3,5-dimethyl-4-methylpropionic-1*H*-pyrrole-2-carbothioate (1h)**¹H NMR; 500 MHz, CDCl₃¹³C NMR; 125 MHz, CDCl₃

2-Formyl-3,5-dimethylpyrrole (2a) ^1H NMR; 300 MHz, CDCl_3  ^{13}C NMR; 125 MHz, CDCl_3 

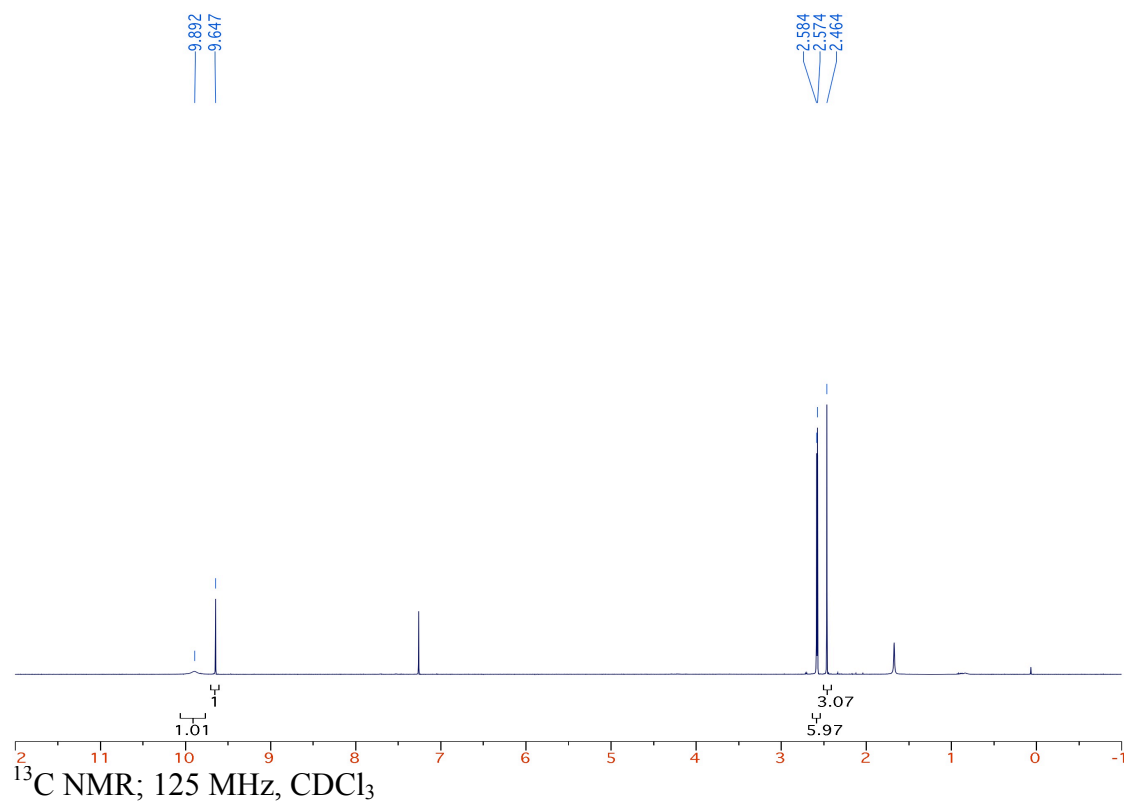
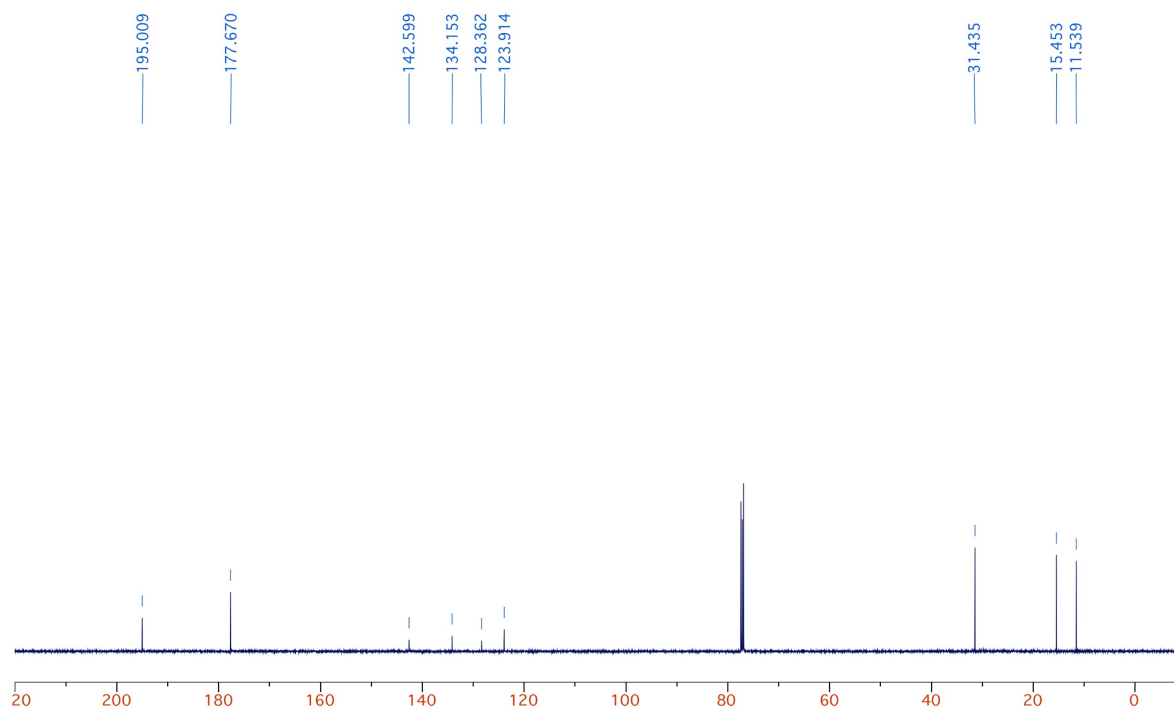
2-Formyl-3,4,5-trimethylpyrrole (2b) ^1H NMR; 300 MHz, CDCl_3  ^{13}C NMR; 125 MHz, CDCl_3 

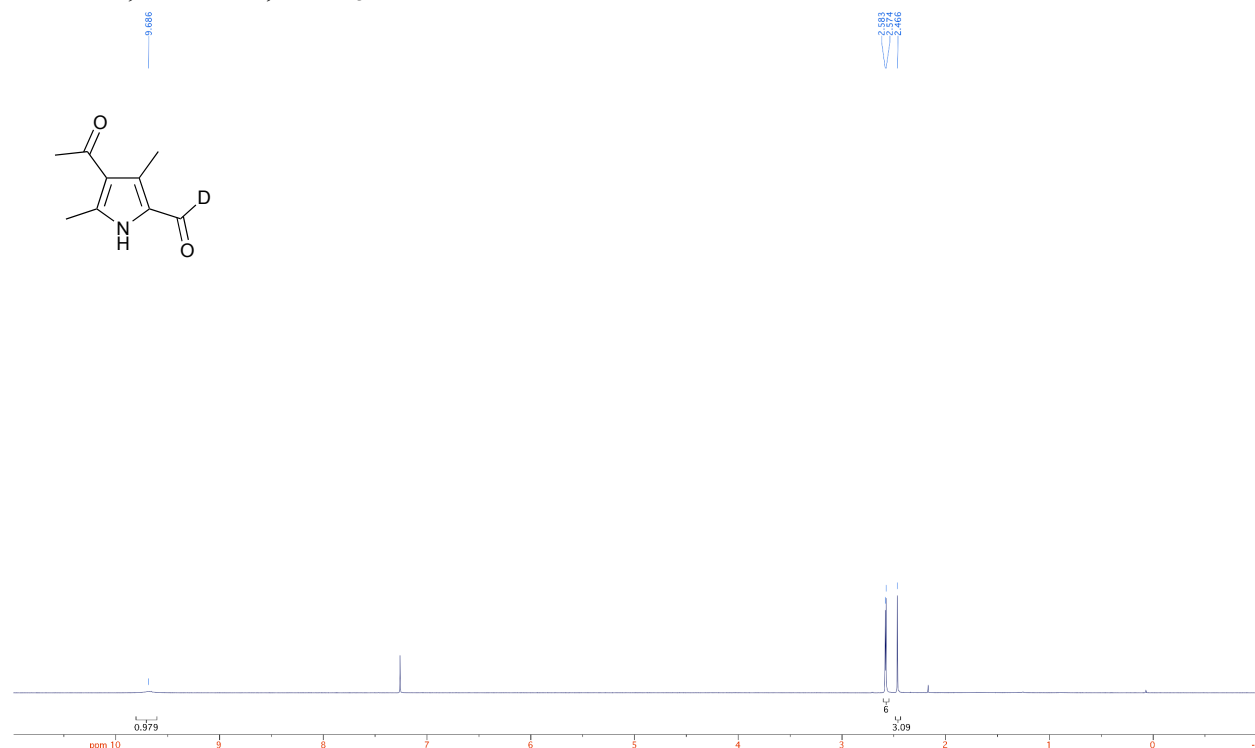
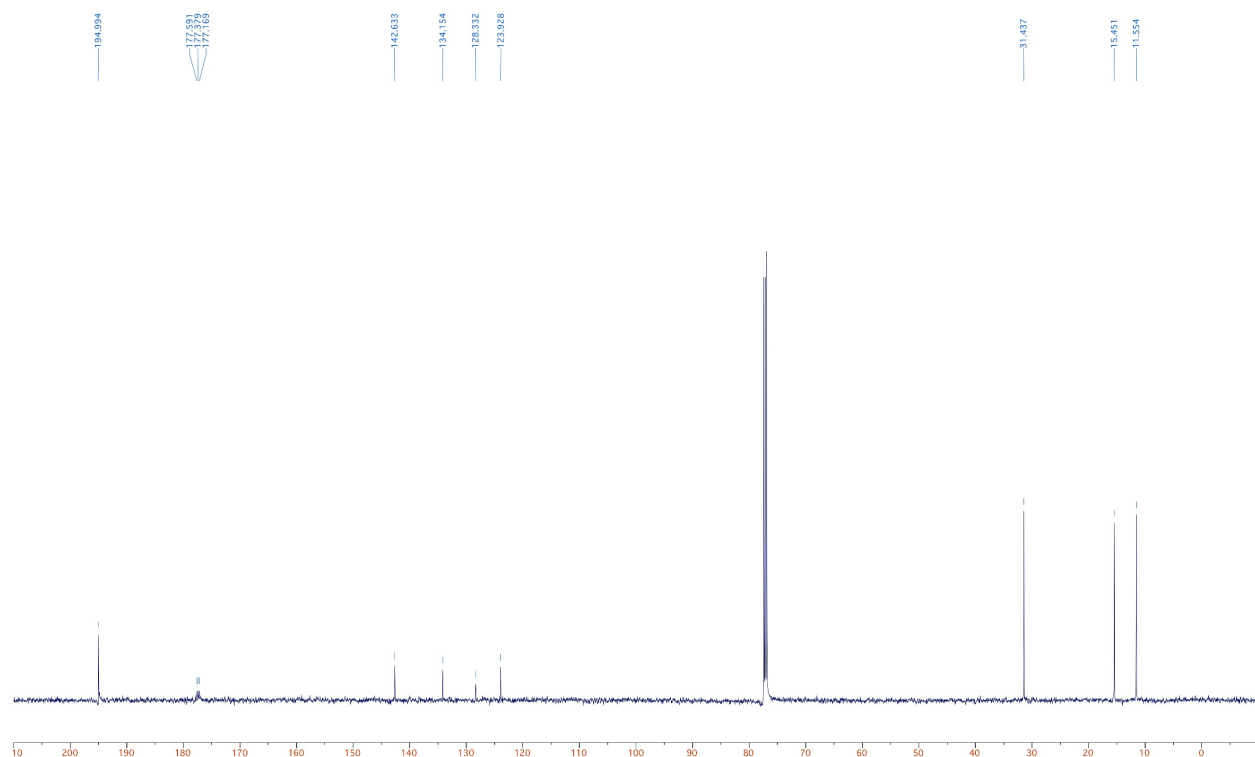
4-Ethyl-2-formyl-3,5-dimethylpyrrole (2c)

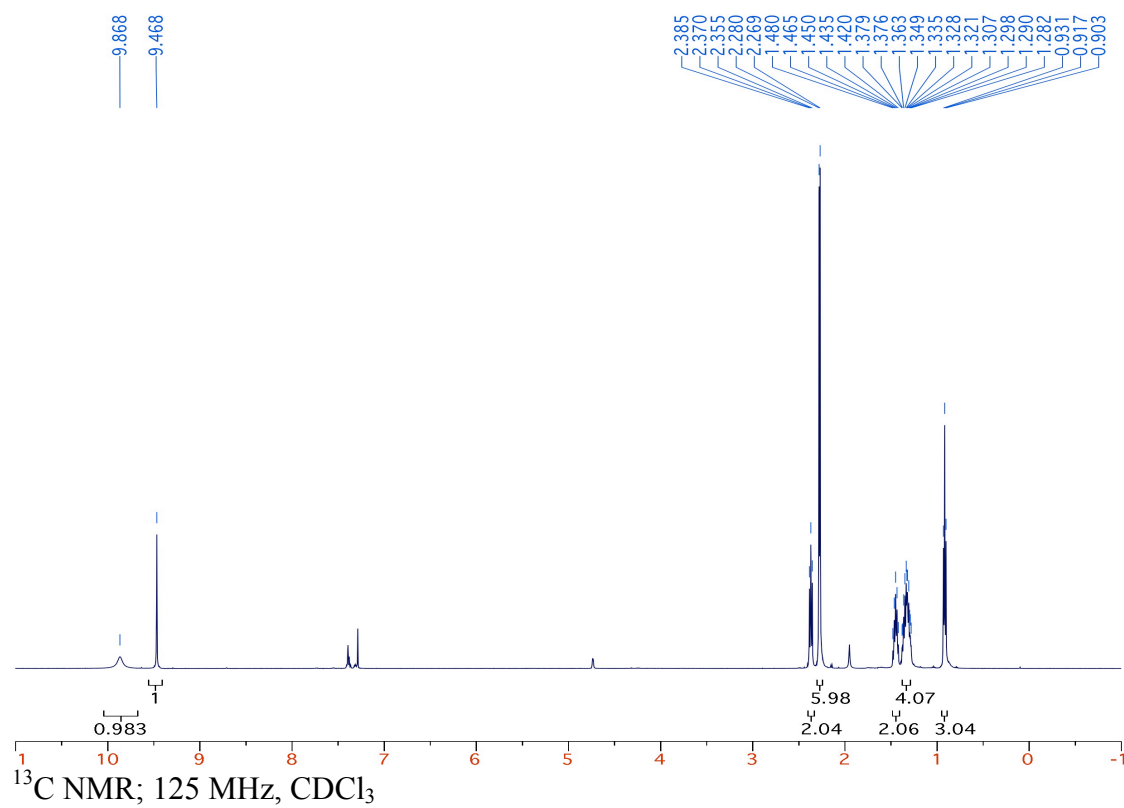
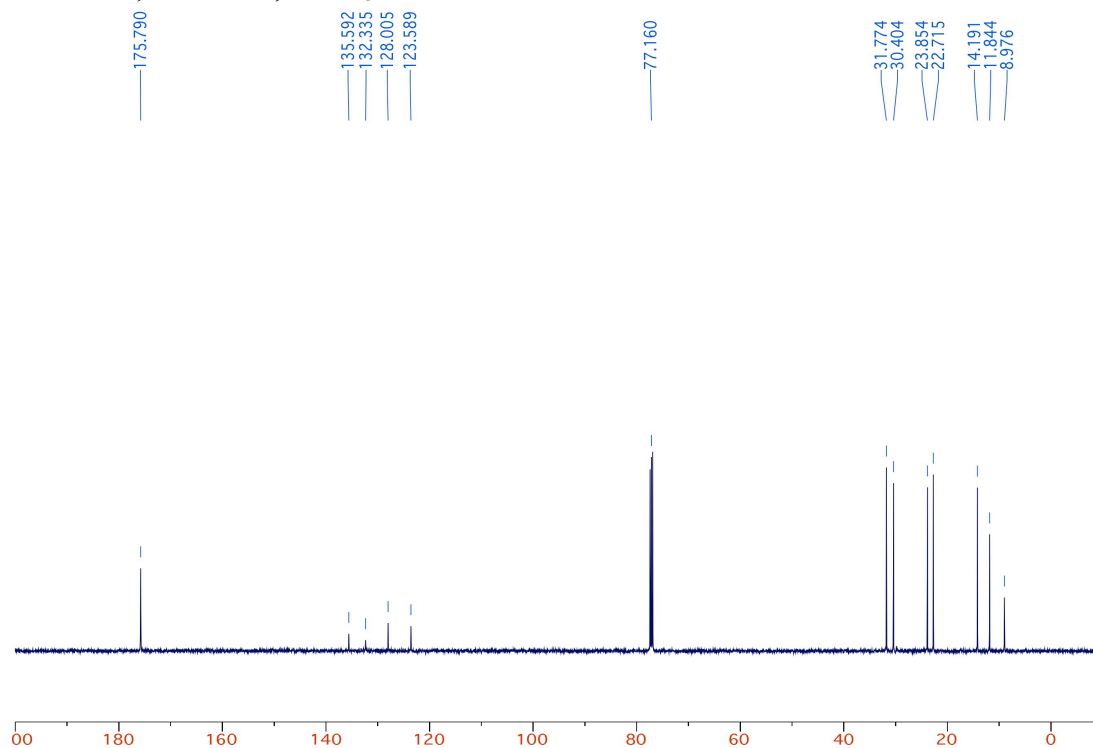
 ^1H NMR; 300 MHz, CDCl_3  ^{13}C NMR; 125 MHz, CDCl_3 

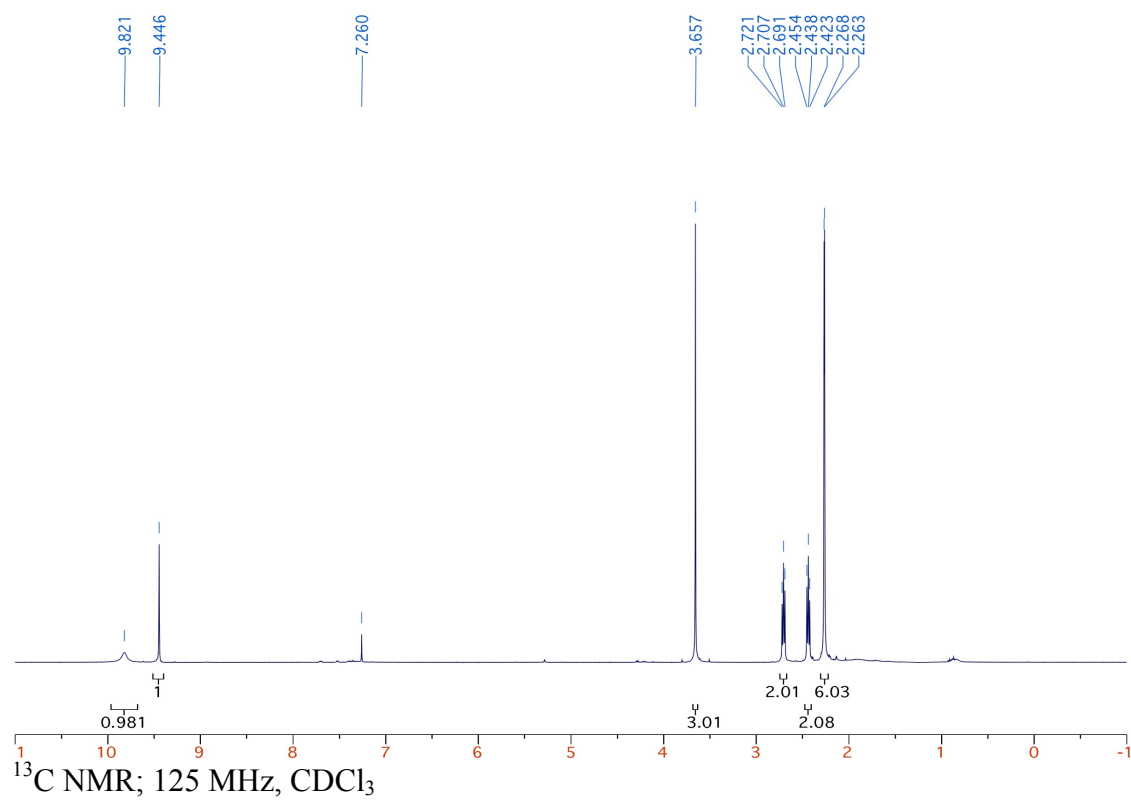
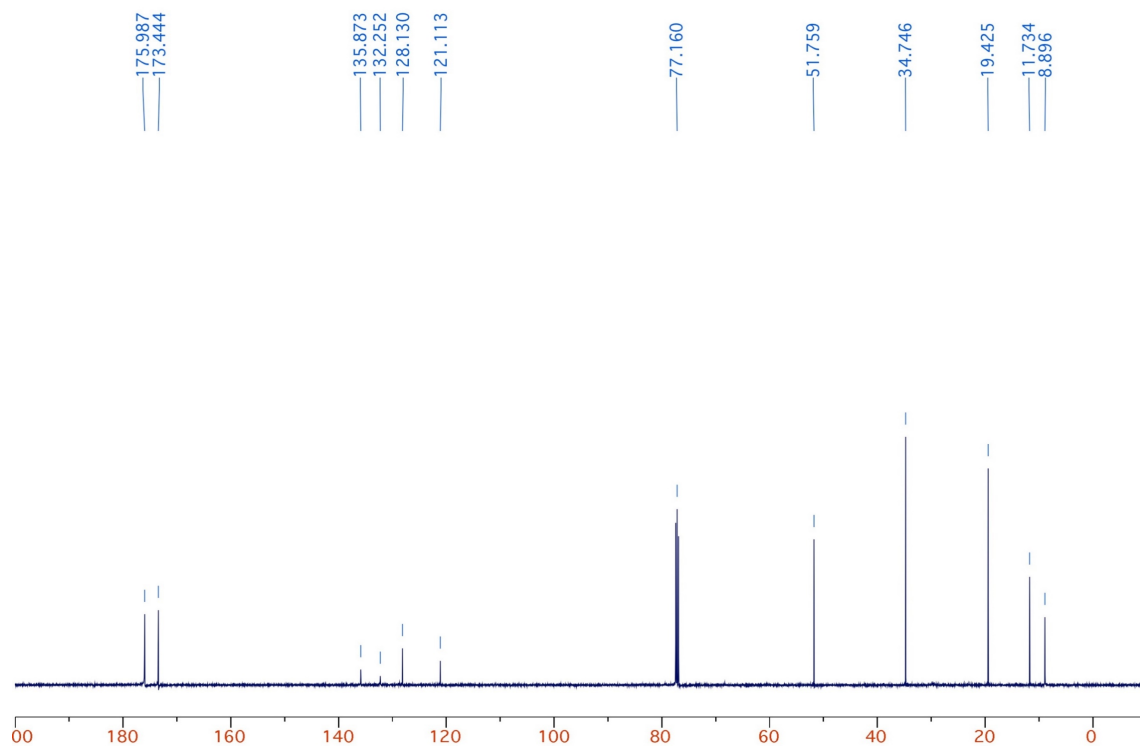
2-Formyl-3,5,-dimethyl-4-phenylpyrrole (2d) ^1H NMR; 300 MHz, DMSO- d_6  ^{13}C NMR; 125 MHz, CDCl_3 

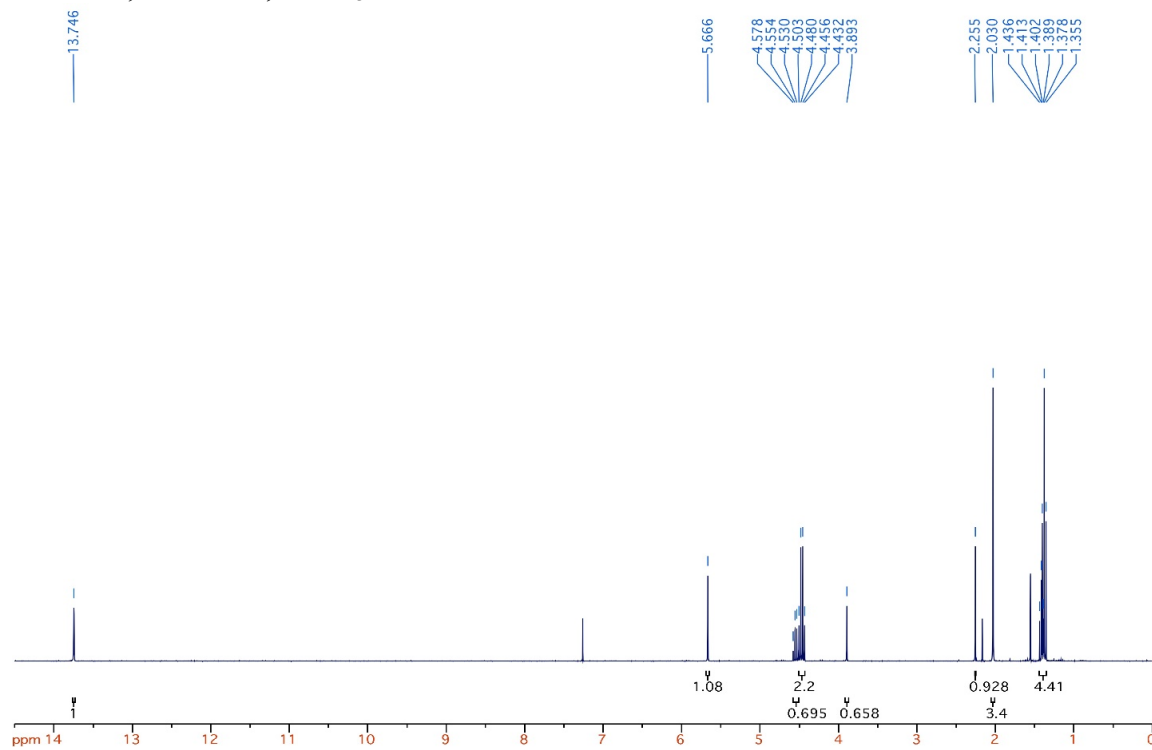
4-Acetyl-2-formyl-3,5-dimethylpyrrole (2e)

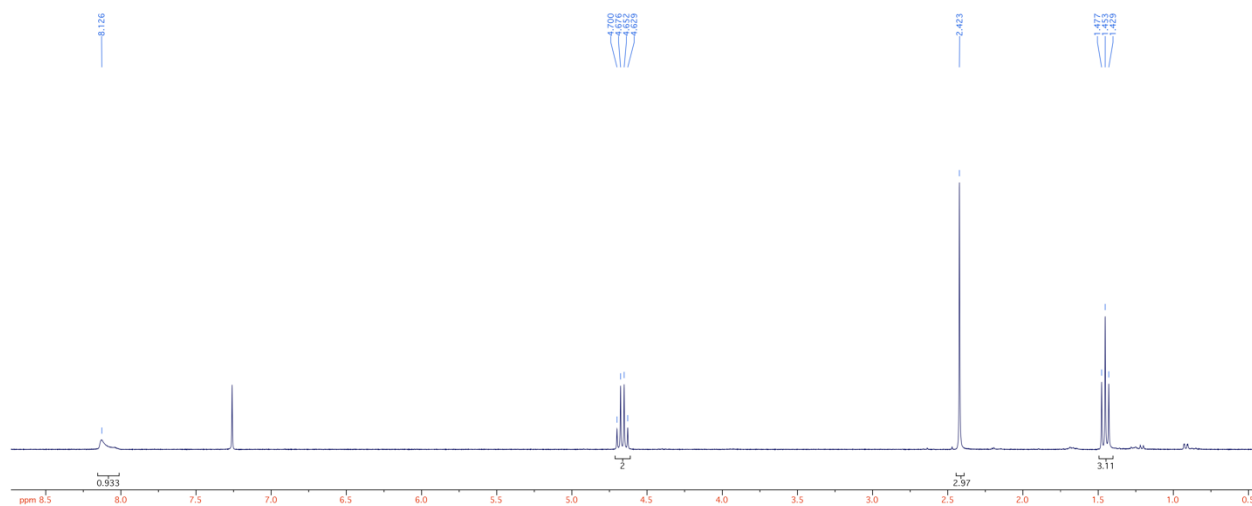
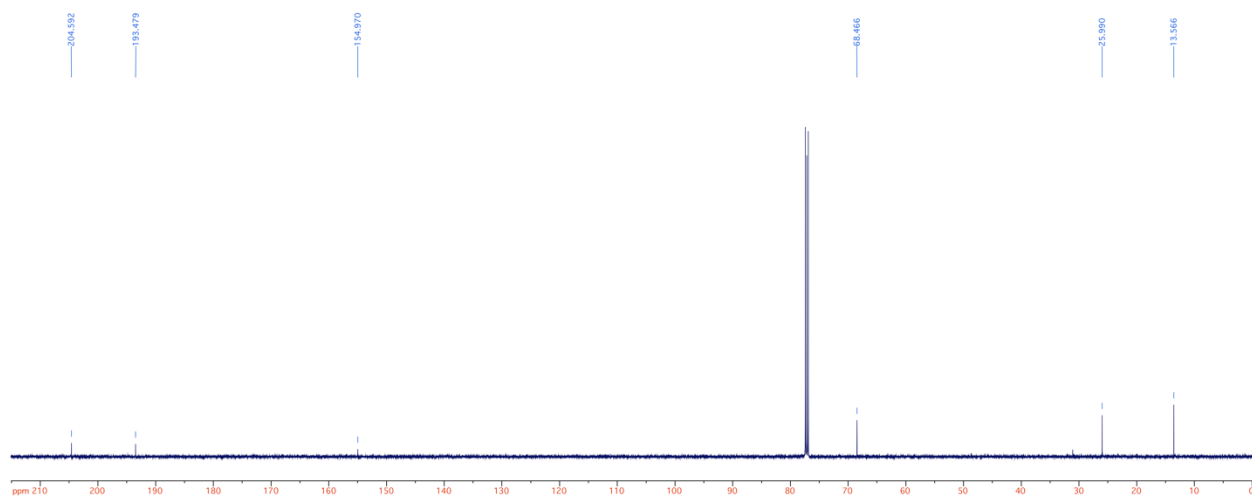
 ^1H NMR; 300 MHz, CDCl_3  ^{13}C NMR; 125 MHz, CDCl_3 

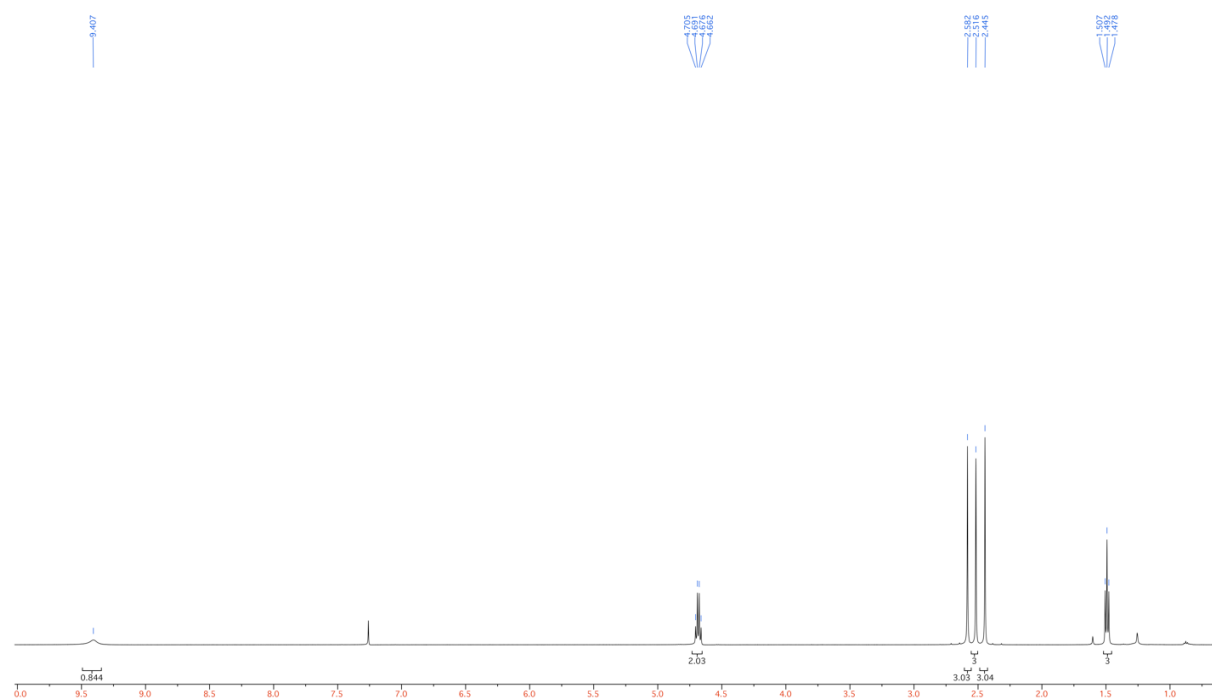
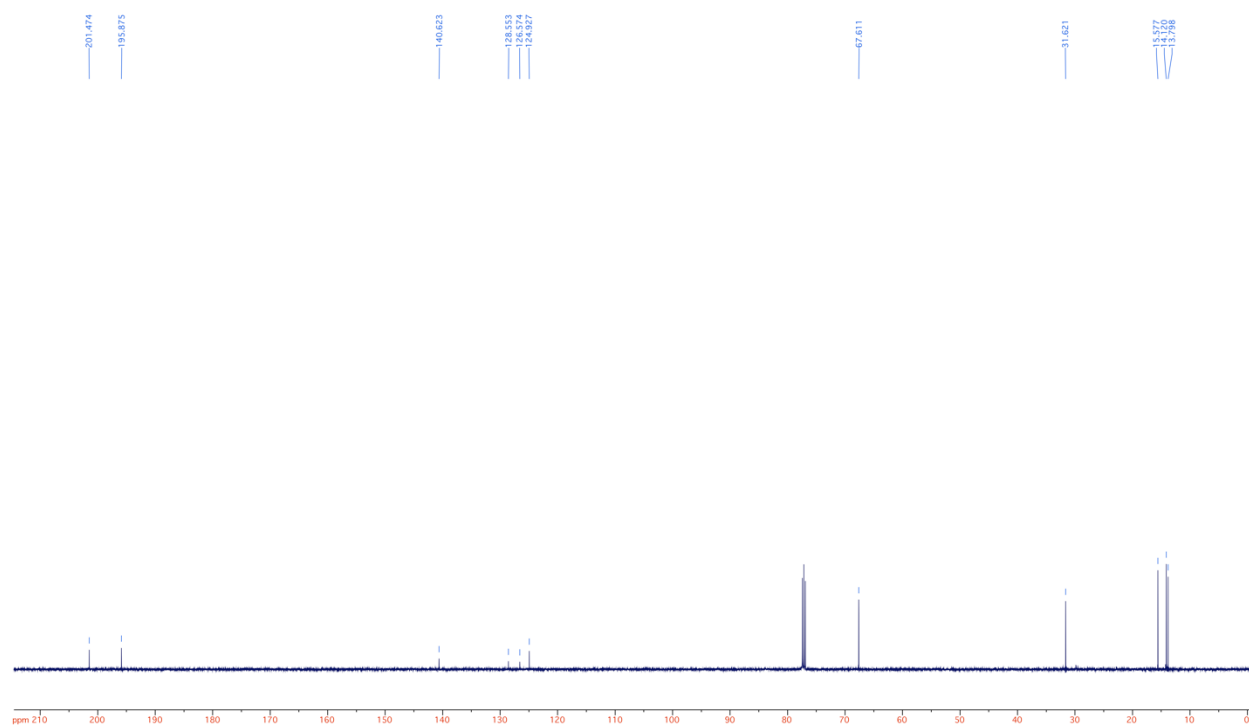
4-Acetyl-2-formyl-*d*-3,5-dimethylpyrrole (2e') ^1H NMR; 300 MHz, CDCl_3  ^{13}C NMR; 125 MHz, CDCl_3 

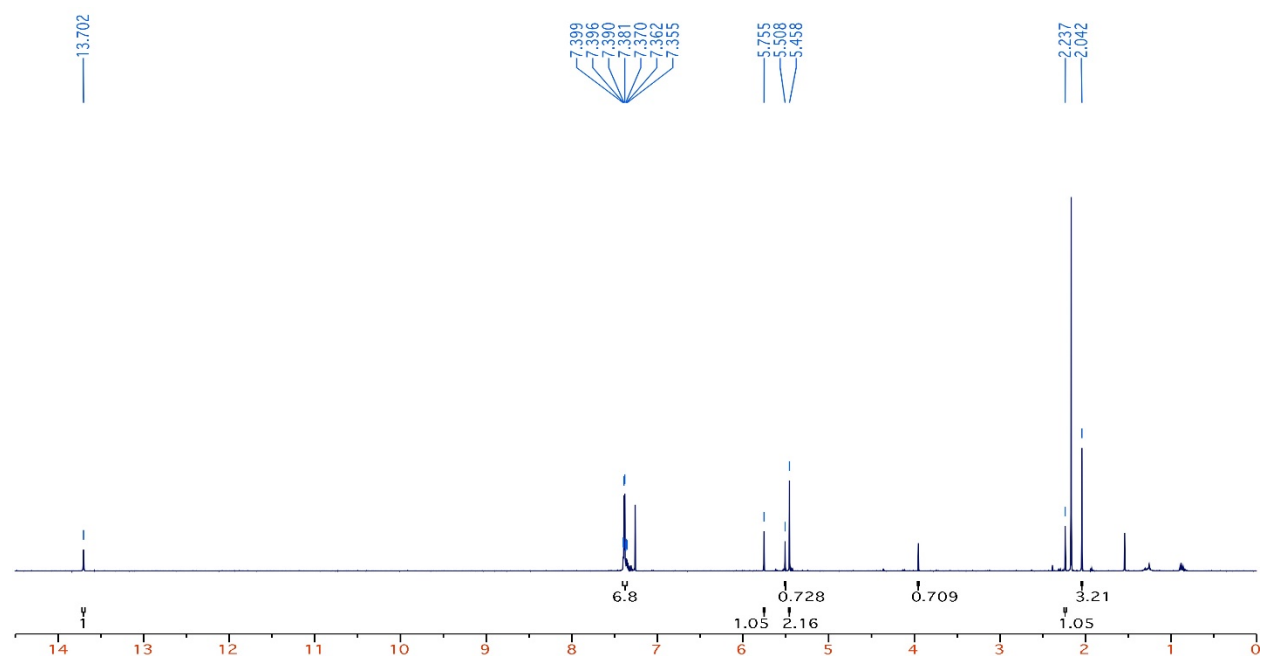
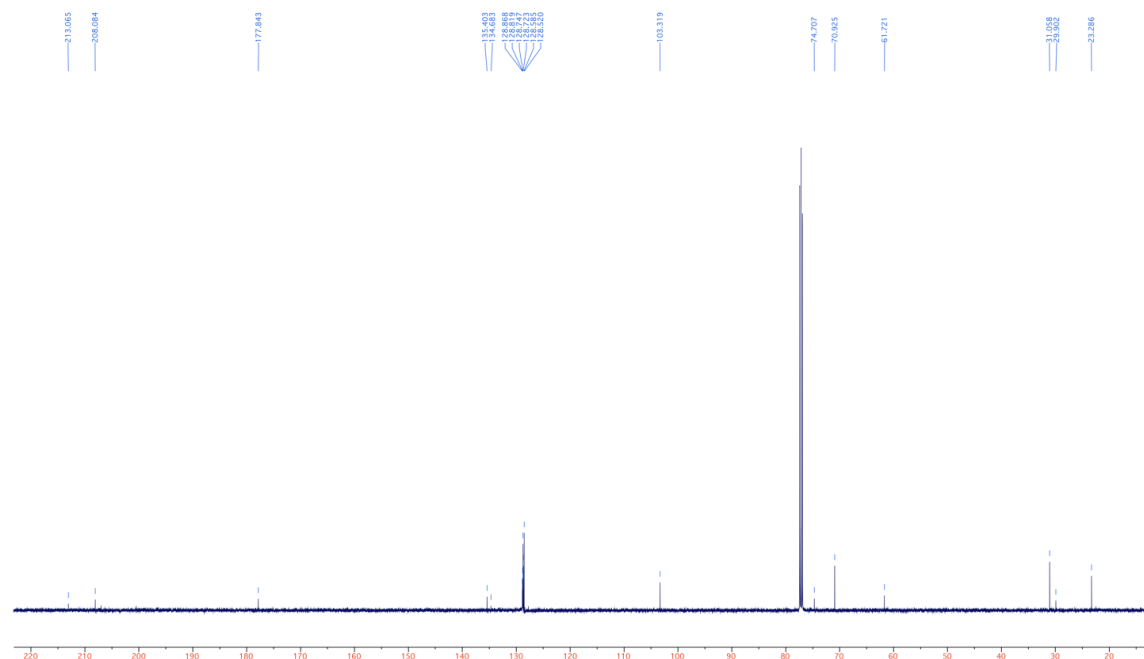
2-Formyl-3,5-dimethyl-4-pentylpyrrole (2g) ^1H NMR; 300 MHz, CDCl_3  ^{13}C NMR; 125 MHz, CDCl_3 

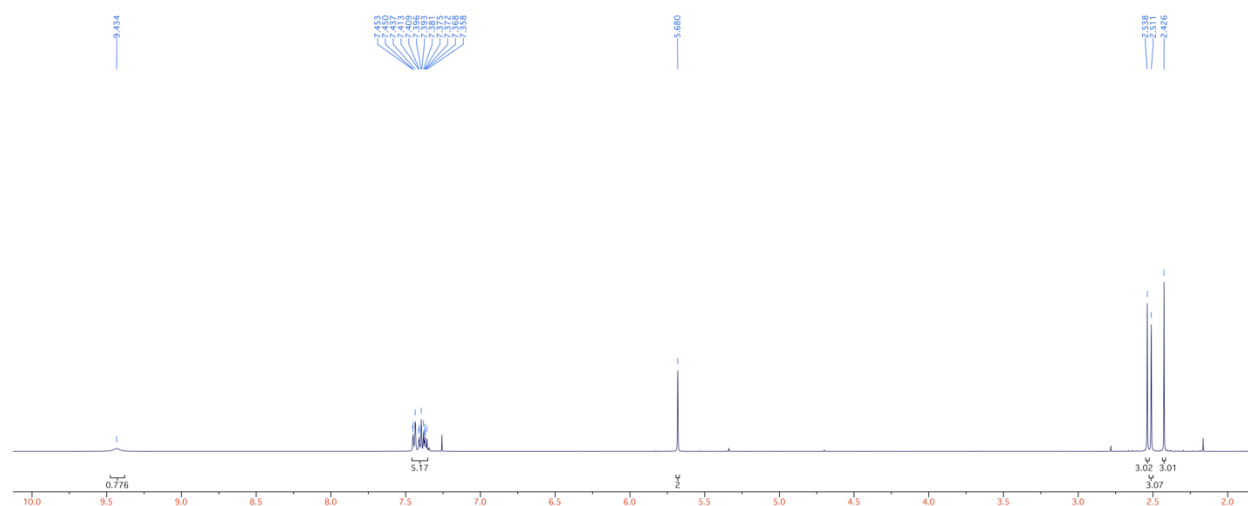
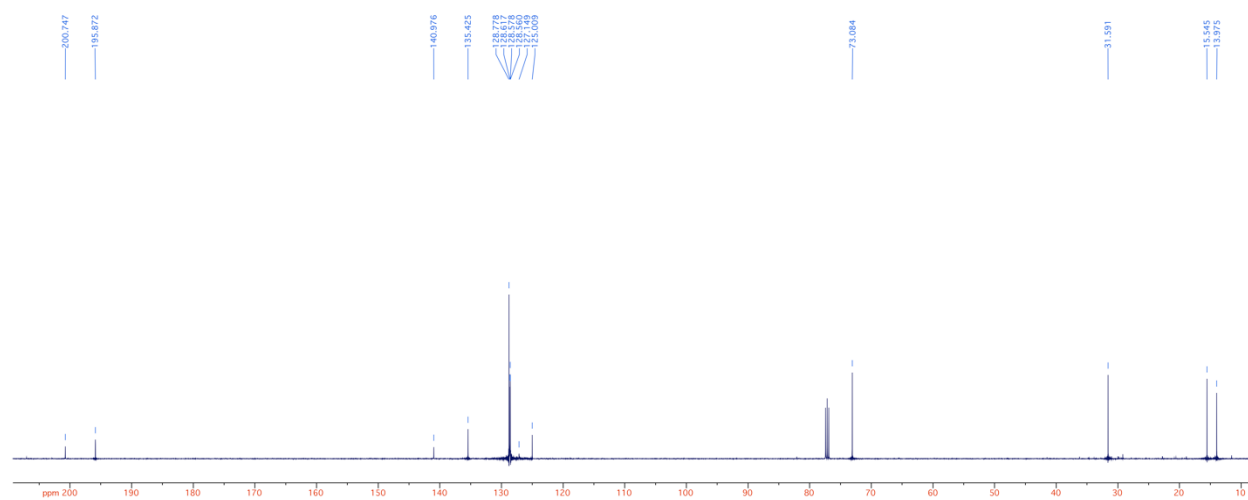
2-Formyl-3,5-dimethyl-4-methylpropionic pyrrole (2h) ^1H NMR; 500 MHz, CDCl_3  ^{13}C NMR; 125 MHz, CDCl_3 

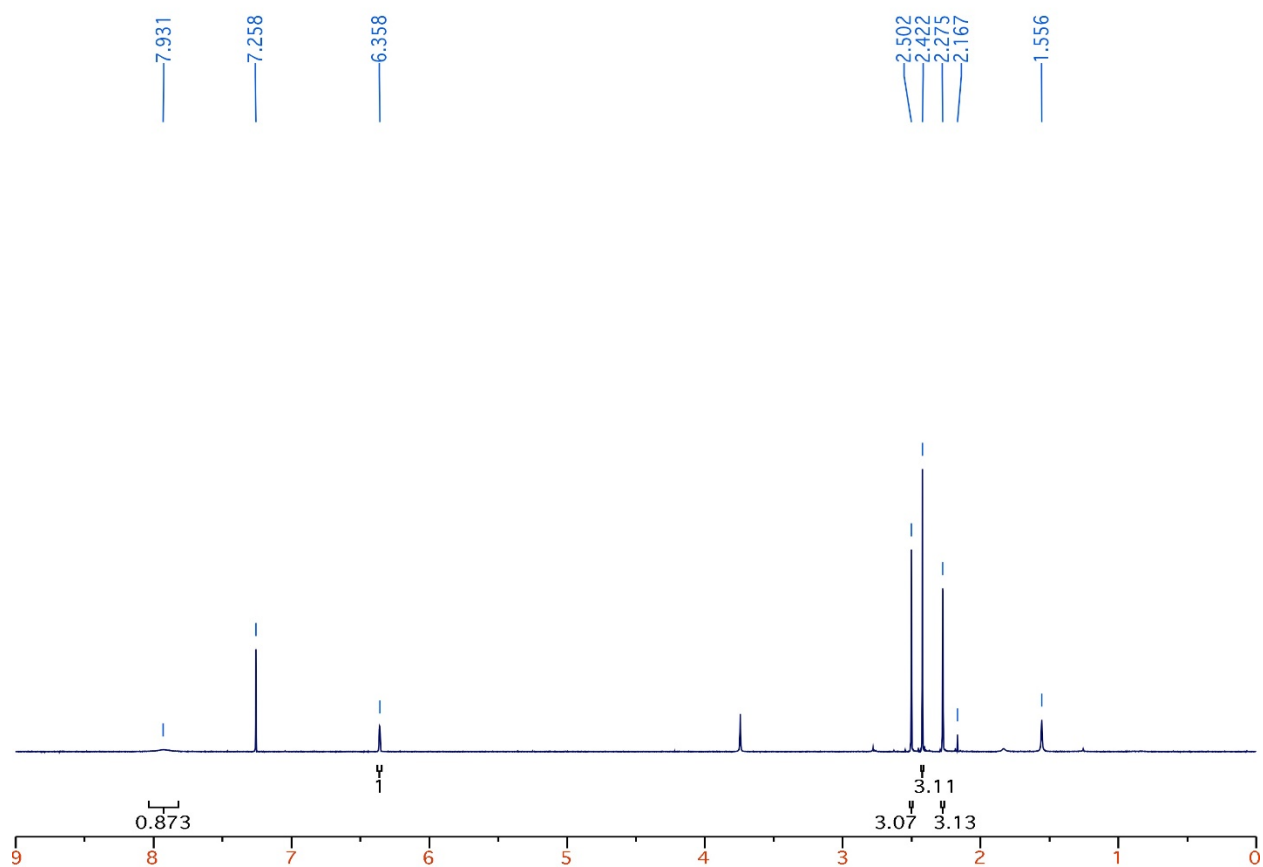
***O*-Ethyl acetothioacetate (4)**¹H NMR; 300 MHz, CDCl₃

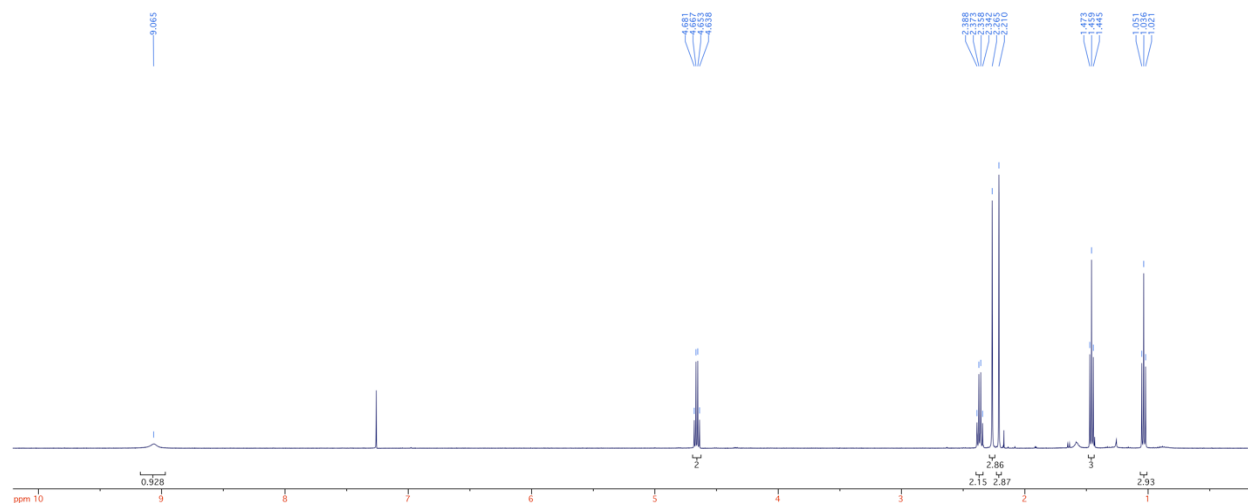
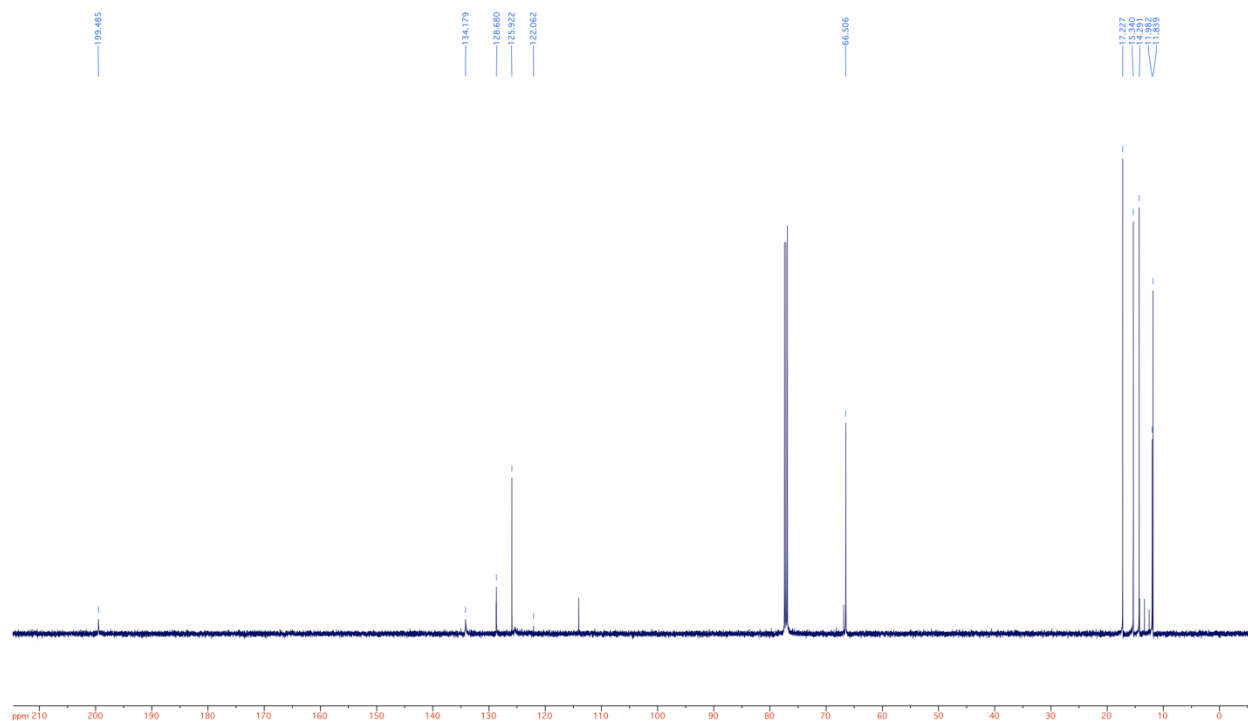
***O*-Ethyl 2-oximinoacetothioacetate (5)** ^1H NMR; 300 MHz, CDCl_3  ^{13}C NMR; 125 MHz, CDCl_3 

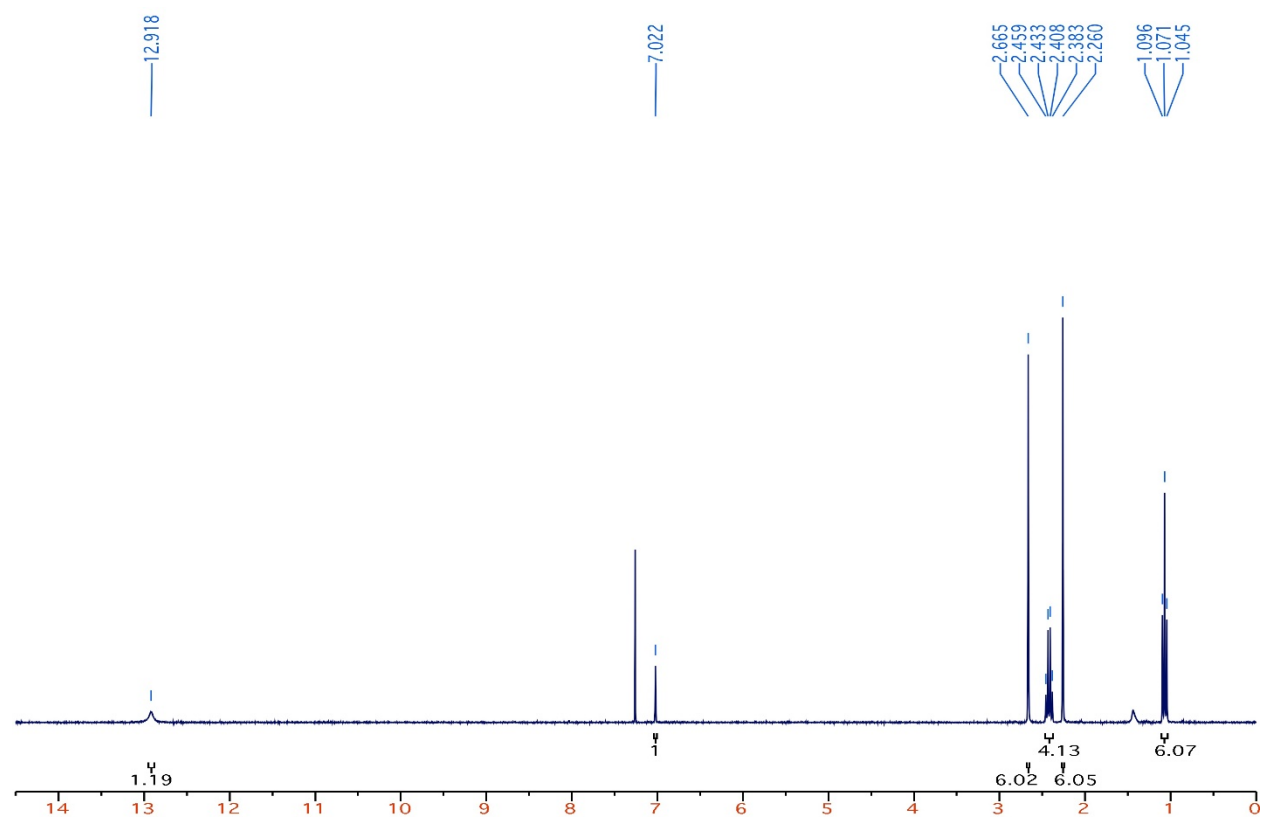
***O*-Ethyl 4-acetyl-3,5-dimethyl-1*H*-pyrrole-2-carbothioate (1e)**¹H NMR; 300 MHz, CDCl₃¹³C NMR; 125 MHz, CDCl₃

¹H NMR; 500 MHz, CDCl₃ ^{13}C NMR; 125 MHz, CDCl_3 

***O*-Benzyl 4-acetyl-3,5-dimethyl-1*H*-pyrrole-2-carbothioate**¹H NMR; 500 MHz, CDCl₃¹³C NMR; 125 MHz, CDCl₃

3-Acetyl-2,4-dimethyl-1*H*-pyrrole (8)¹H NMR; 300 MHz, CDCl₃

***O*-Ethyl 4-ethyl-3,5-dimethyl-1*H*-pyrrole-2-carbothioate (1c)**¹H NMR; 500 MHz, CDCl₃¹³C NMR; 125 MHz, CDCl₃

1,3,7,9-Tetramethyl-2,8-diethyl-5-*H*-4,6-dipyrryn hydrobromide (7)¹H NMR; 300 MHz, CDCl₃

***O*-Ethyl 3,5-dimethyl-1*H*-pyrrole-2-carbothioate (1a)**¹H NMR; 300 MHz, CDCl₃