Supplementary information

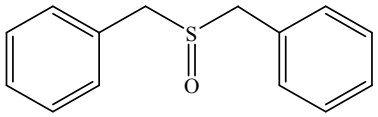
A nickel nanoparticle engineered $CoFe_2O_4/SiO_2$-NH_2@Carboxamide composite as a novel scaffold for the oxidation of sulfides and oxidative coupling of thiols

MINA ZOHREVANDI, ROYA MOZAFARI and MOHAMMAD GHADERMAZI*

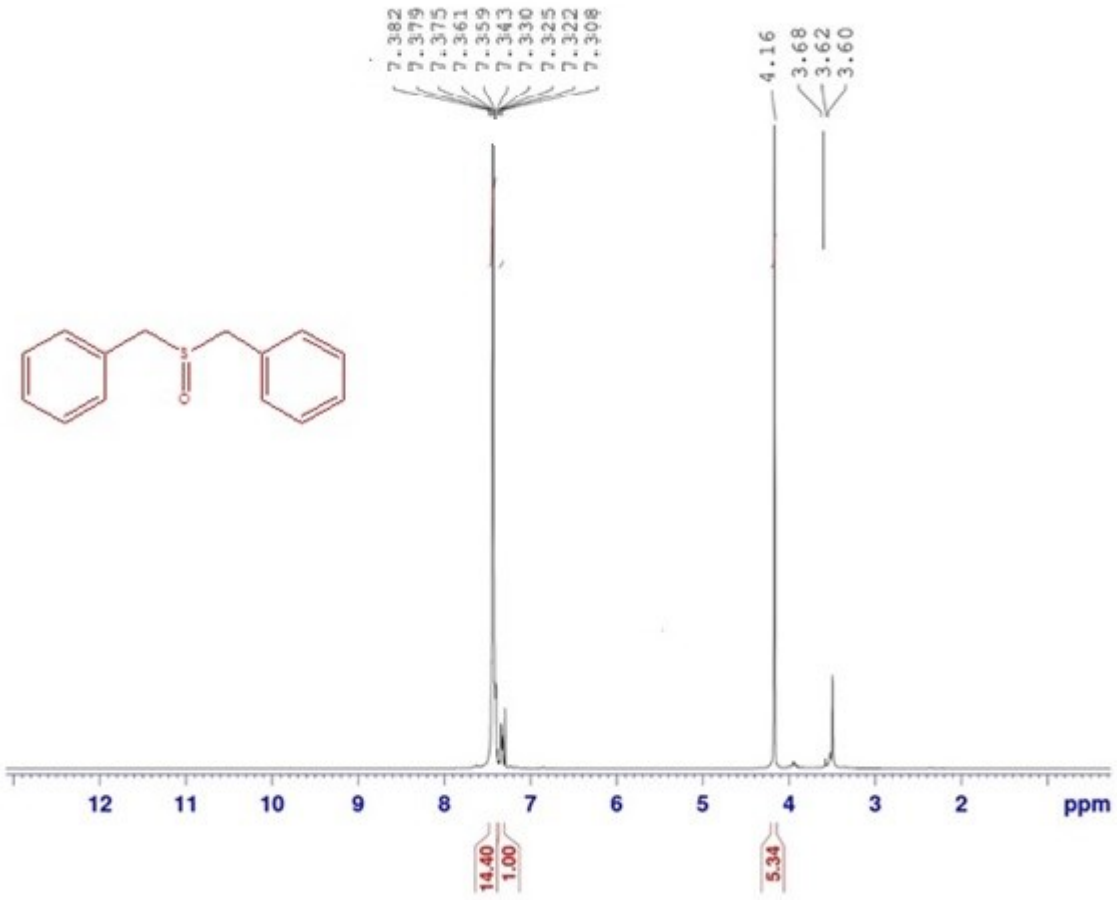
Department of Chemistry, University of Kurdistan, P.O. Box 66135-416, Sanandaj, Iran
Fax: +98 873324133; Tel: 98 87 33624133
* Email: mghadermazi@yahoo.com

Spectra data of sulfides from Table 2.

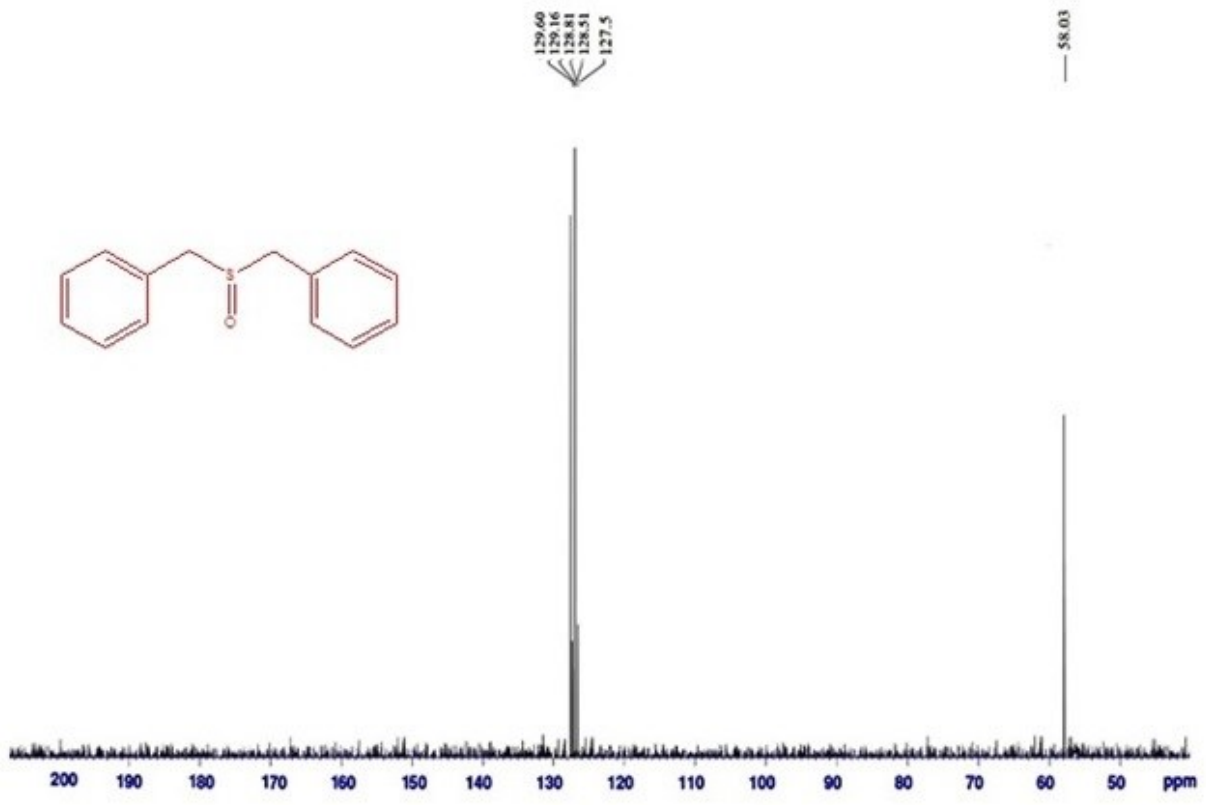
Methyl phenyl sulfoxide (Table 2, entry 1)



Melting point: 137-140°C. ^{1}HNMR (400 MHz, $CDCl_3$, ppm): δ 4.16 (S, 4H), 7.38-7.30 (m, 10H); ^{13}CNMR (75 MHz, $CDCl_3$, ppm): δ 58.03 , 129.6, 129.16, 128.81, 128.51, 127.5. IR (KBr) (cm^{-1}): ν (S═O): 1016–1072.

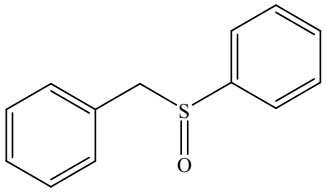


S1. [1]HNMR spectrum of methyl phenyl sulfoxide in $CDCl_3$ (Table 2, entry 1)

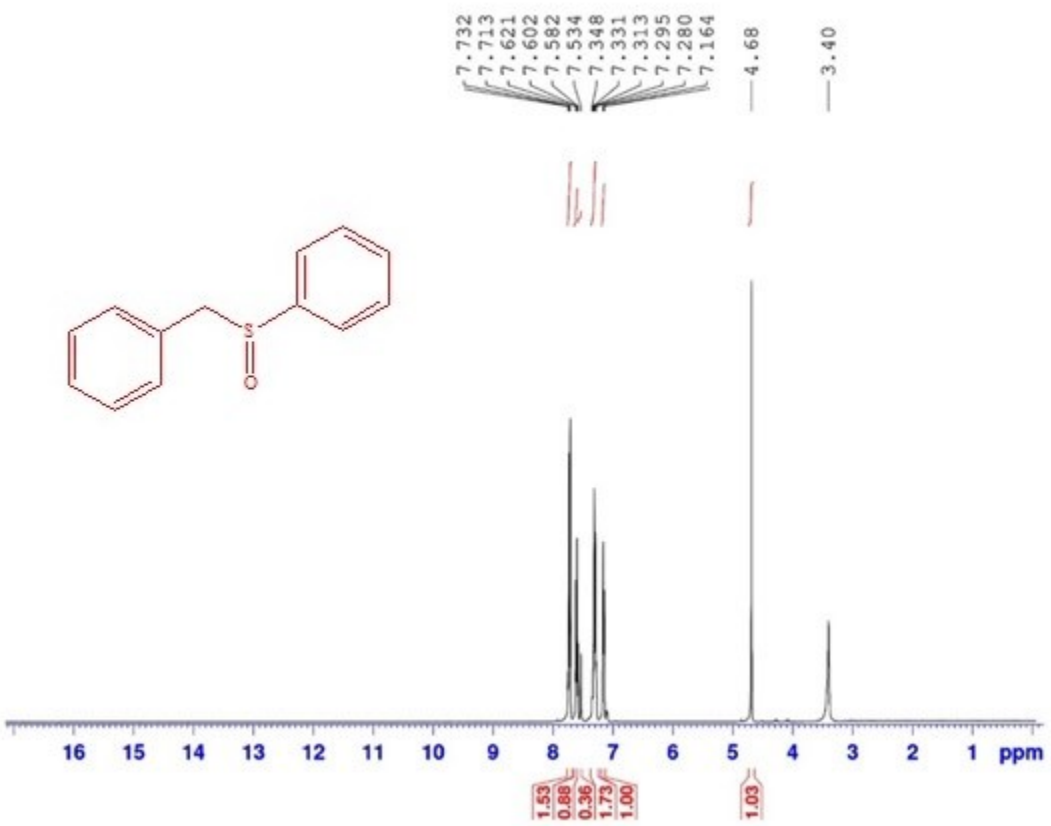


S2. ^{13}CNMR spectrum of methyl phenyl sulfoxide in $CDCl_3$ (Table 2, entry 1)

Benzyl phenyl sulfoxide (Table 2, entry 2)

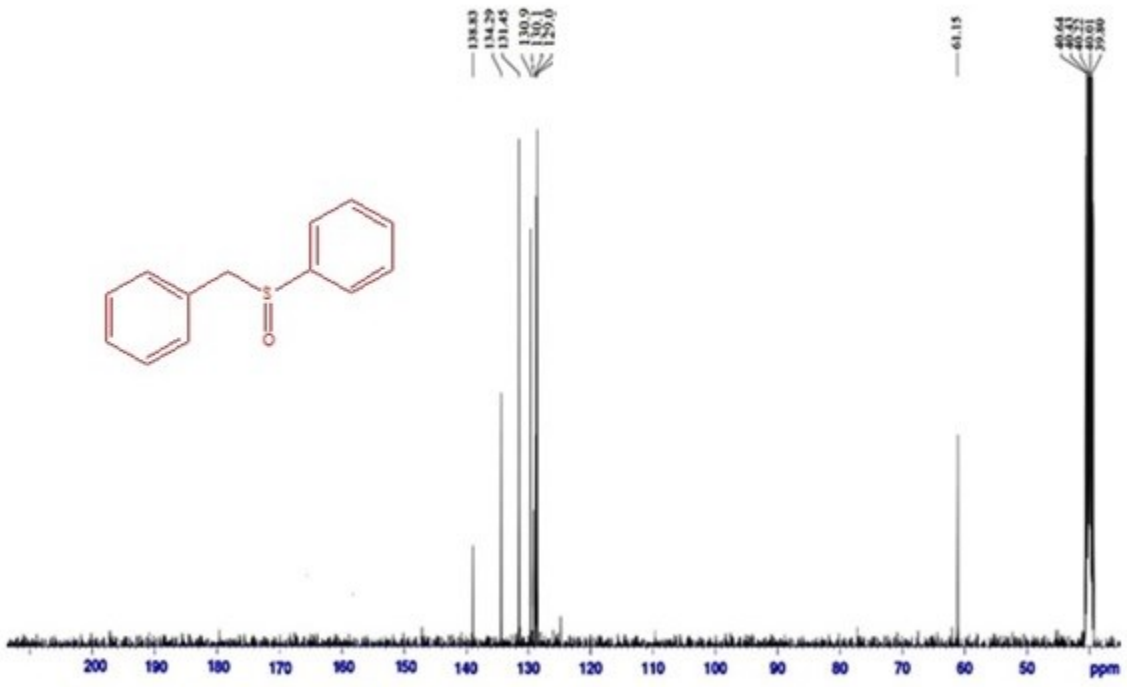


Melting point: 124-128 °C. ^{1}HNMR (400 MHz, $CDCl_3$, ppm): δ 4.68 (s, 2H), 7.48-7.16 (m, 4H), 7.73-7.53 (m, 4H). ^{13}CNMR (75 MHz, $CDCl_3$, ppm): δ 61.15, 138.83-134.29, 1131.45, 130.9, 131.1, 129.0. IR (KBr) (cm^{-1}): ν (S═O): 1065.



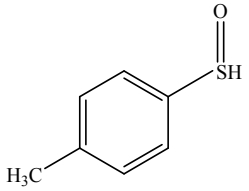
S3.^{1}HN

MR spectrum of benzyl phenyl sulfoxide in $CDCl_3$ (Table 2, entry 2)

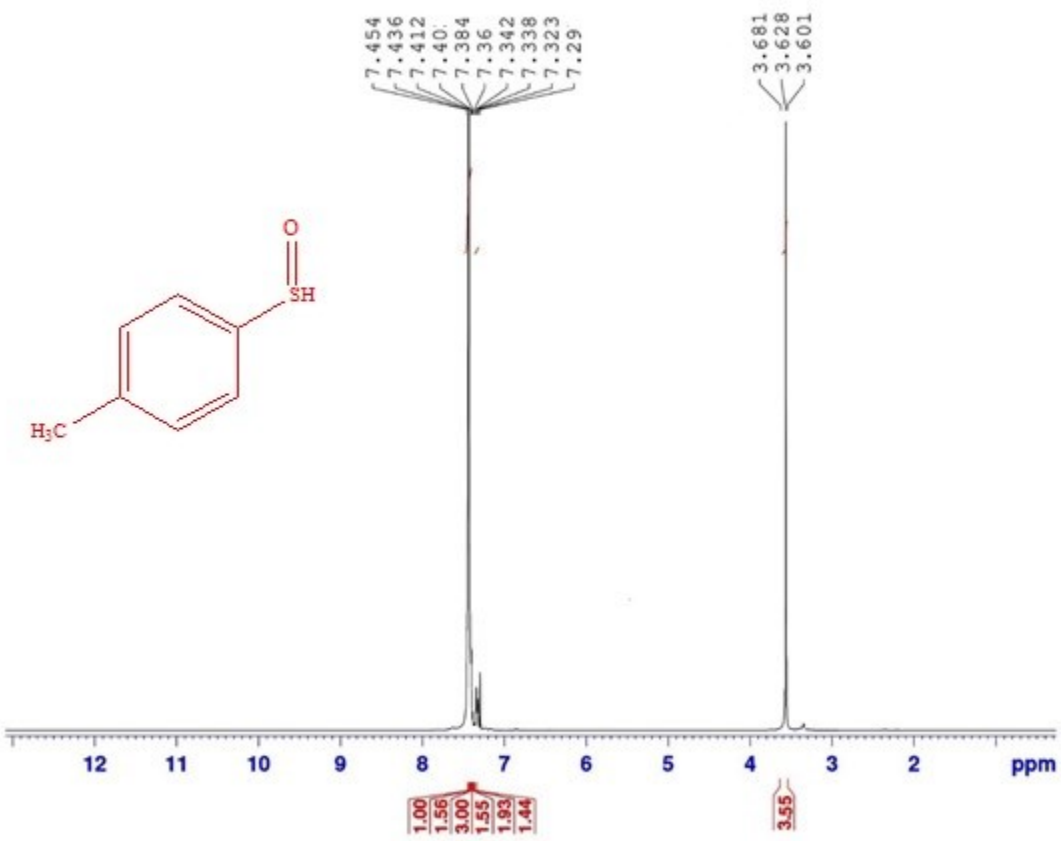


S4. ^{13}CNMR spectrum of benzyl phenyl sulfoxide in $CDCl_3$ (Table 2, entry 2)

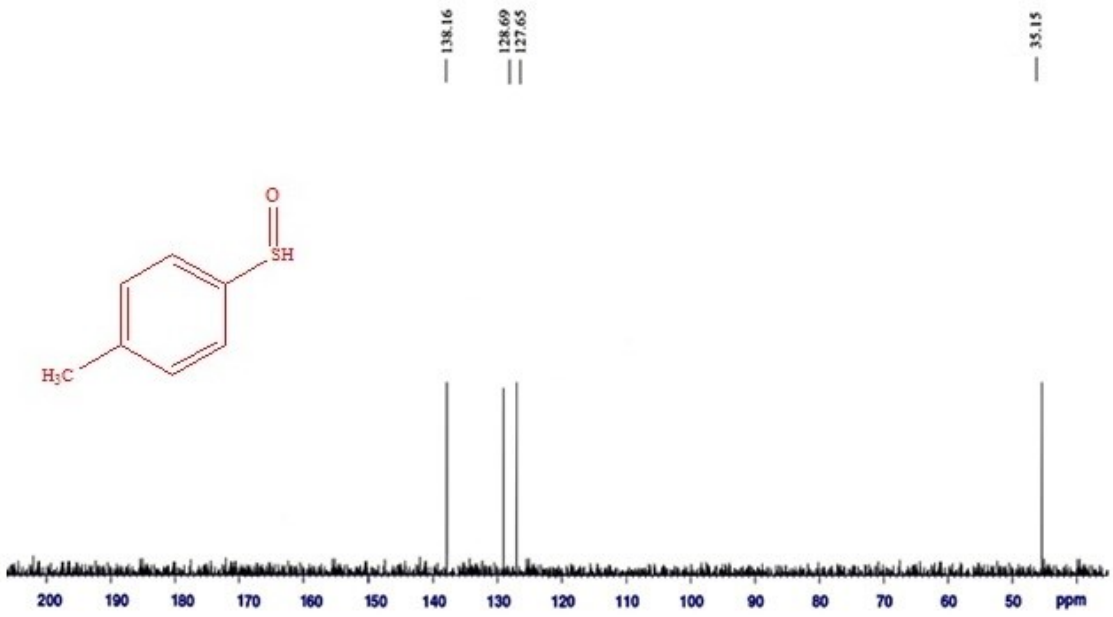
Methyl p-tolyl sulfoxide (Table 2, entry 4)



Melting point: 69-72. ^{1}HNMR (300 MHz, $CDCl_3$, ppm): δ 3.60-368- (m, 3H), 7.29–7.45 (m, 5H); ^{13}CNMR (75 MHz, $CDCl_3$, ppm): δ 35.15, 127.65, 128.69, 138.16. IR (KBr) (cm^{-1}): ν (S═O): 1082.

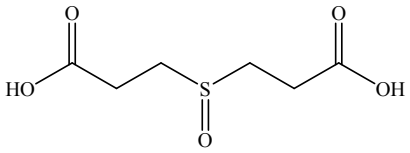


S5. ^{1}HNMR spectrum of Methyl p-tolyl sulfoxide in $CDCl_3$ (Table 2, entry 4)

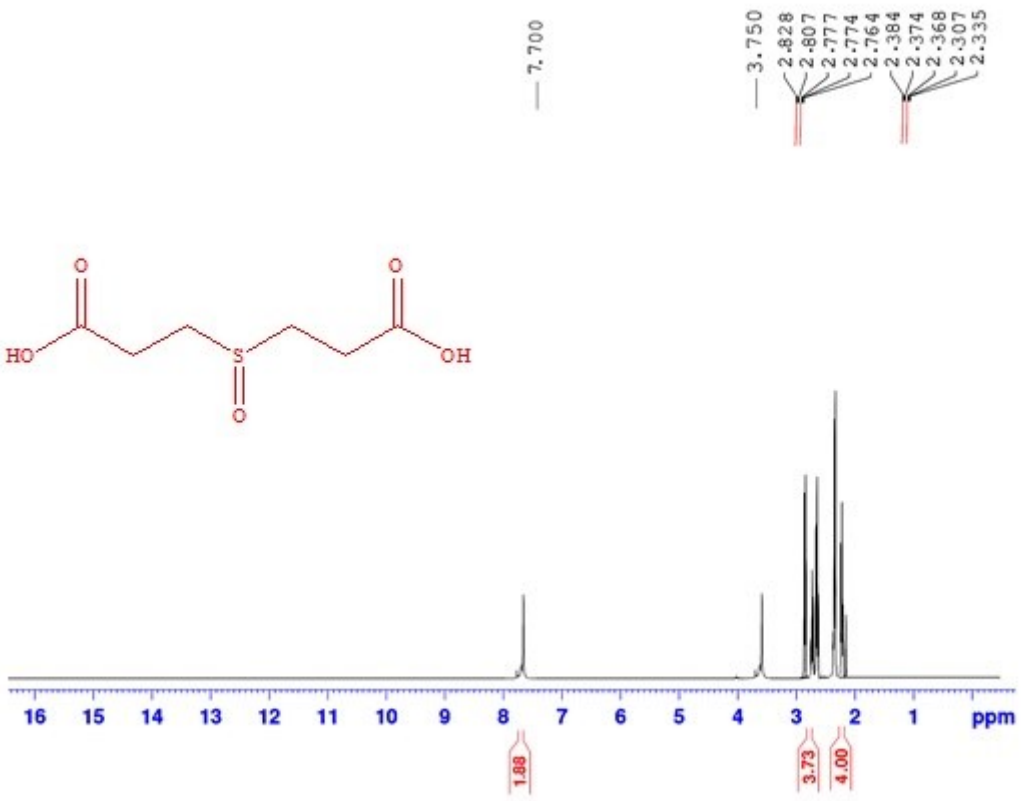


S6. ^{13}CNMR spectrum of Methyl p-tolyl sulfoxide in $CDCl_3$ (Table 2, entry 4)

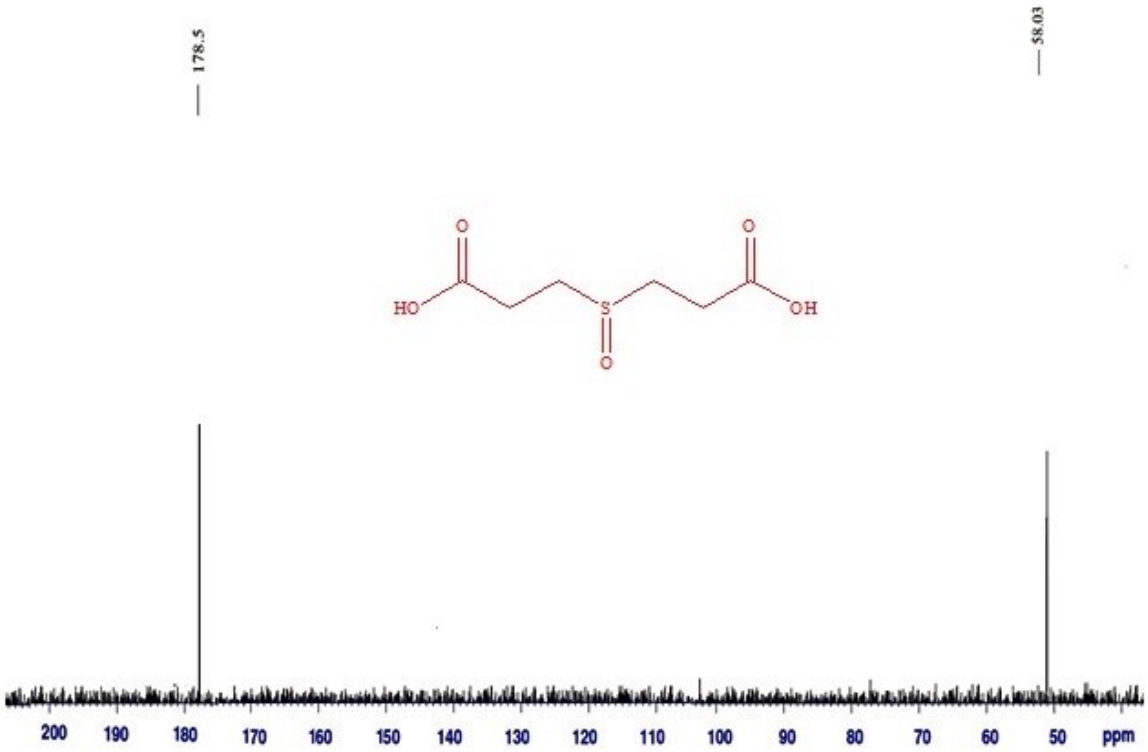
3, 3′-Sulfinyldipropionic acid (Table 2, entry 5)



Melting point: 112-114 °C. ^{1}HNMR (400 MHz, $CDCl_3$, ppm): δ 2.33-2.38 (s, 4H), 2.76– 2.82 (m, 4H), 7.70 (s, 2H); ^{13}CNMR (75 MHz, $CDCl_3$, ppm): δ 53.03, 178.5. IR (KBr) (cm^{-1}): ν (S═O): 1109.

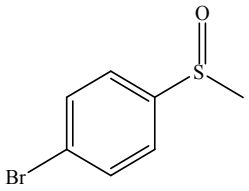


S7. [1]HNMR spectrum of 3, 3′-Sulfinyldipropionic acid in $CDCl_3$ (Table 2, entry 5)

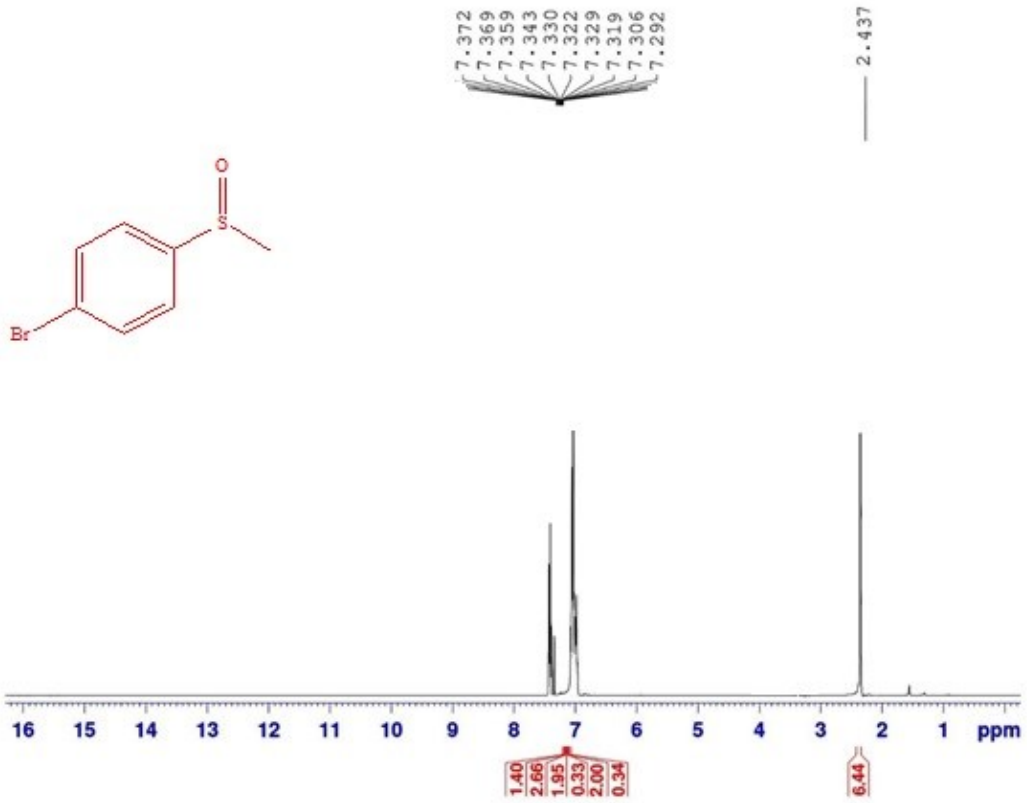


S8. ^{13}CNMR spectrum of 3, 3′-Sulfinyldipropionic acid in $CDCl_3$ (Table 2, entry 5)

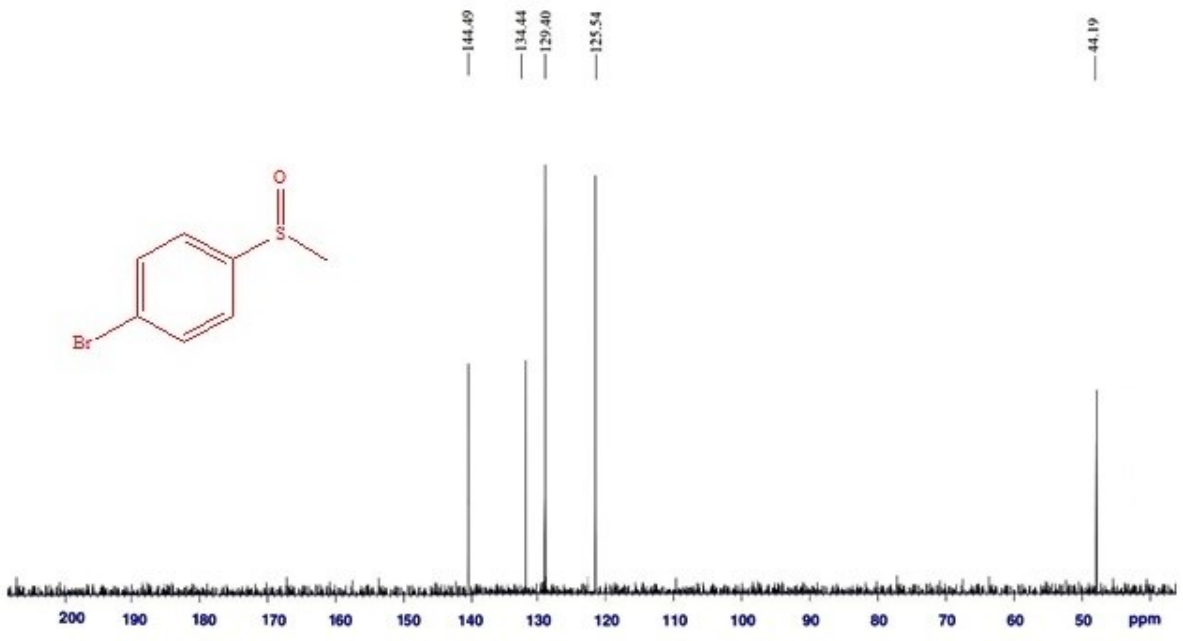
1-bromo-4-(methylsulfinyl) benzene (Table 2, entry 12)



Melting point: 60-64. ^{1}HNMR (400 MHz, $CDCl_3$, ppm): δ 2.43 (s, 3H), 7.29-7.37 (m, 4H). ^{13}CNMR (75 MHz, $CDCl_3$, ppm): δ 44.19, 125.54, 129.4, 134.44, 144.49. IR (KBr) (cm^{-1}): ν (S═O): 1028.



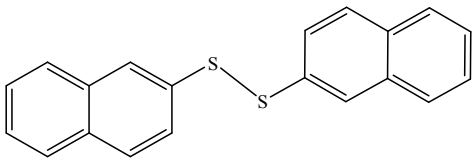
S9. ^{1}HNMR spectrum of 1-bromo-4-(methylsulfinyl) benzene in $CDCl_3$ (Table 2, entry 12)



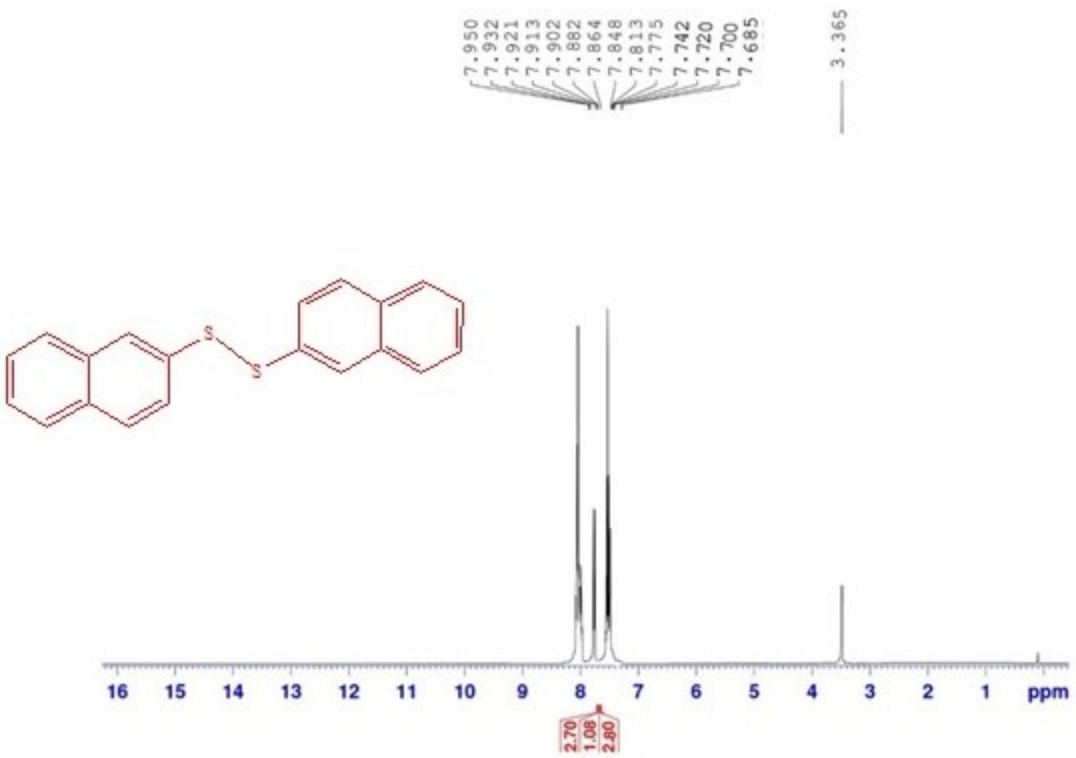
S10. ^{13}CNMR spectrum of 1-bromo-4-(methylsulfinyl) benzene in $CDCl_3$ (Table 2, entry 12)

Spectra data of disulfides from Table 4.

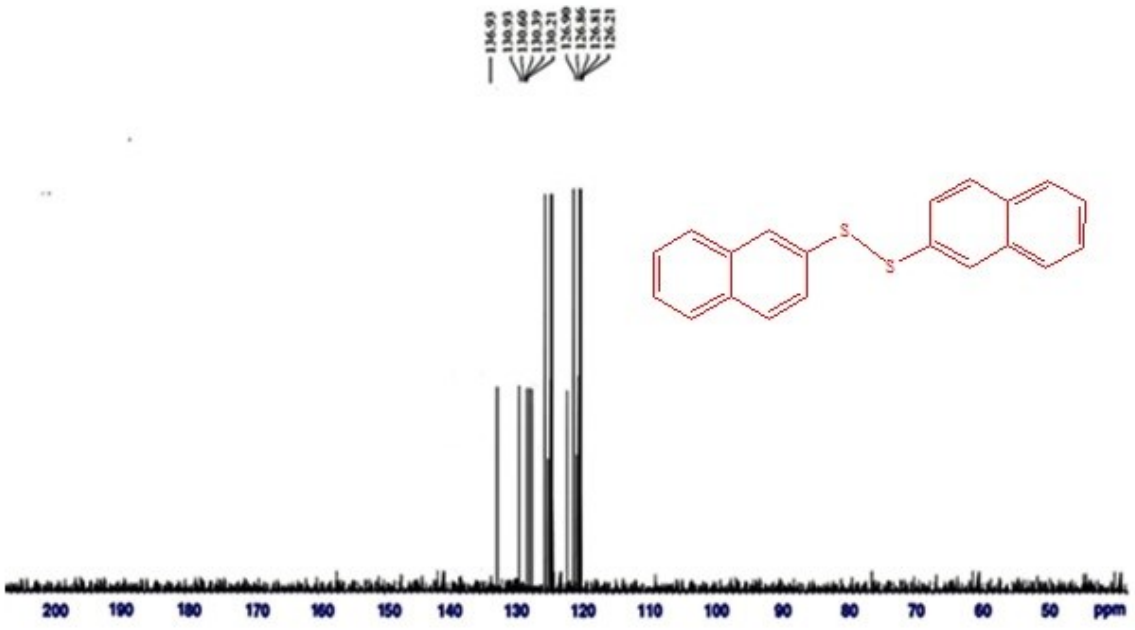
1, 2-di(naphthalen-2-yl)disulfane (Table 4, entry 3)



Melting point: 132-136°C. ^{1}HNMR (400 MHz, DMSO, ppm): δ 7.68-7.74 (m, 6H) ,7.77-7.88 (m, 2H), 7.90– 7.95 (m, 6H); ^{13}CNMR (100 MHz, DMSO, ppm): δ 126.21-126.81, 126.86-126.90, 130.21-130.39, 130.60-130.93. IR (KBr) (cm^{-1}): IR (KBr) (cm^{-1}): ν (S-S): 1036.

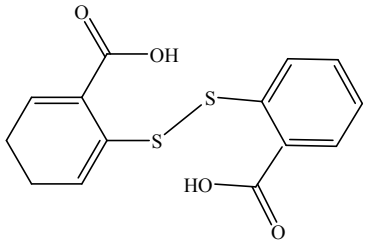


S11. [1]H-NMR spectrum of 1, 2-di(naphthalen-2-yl)disulfane in DMSO (Table 4, entry 3)

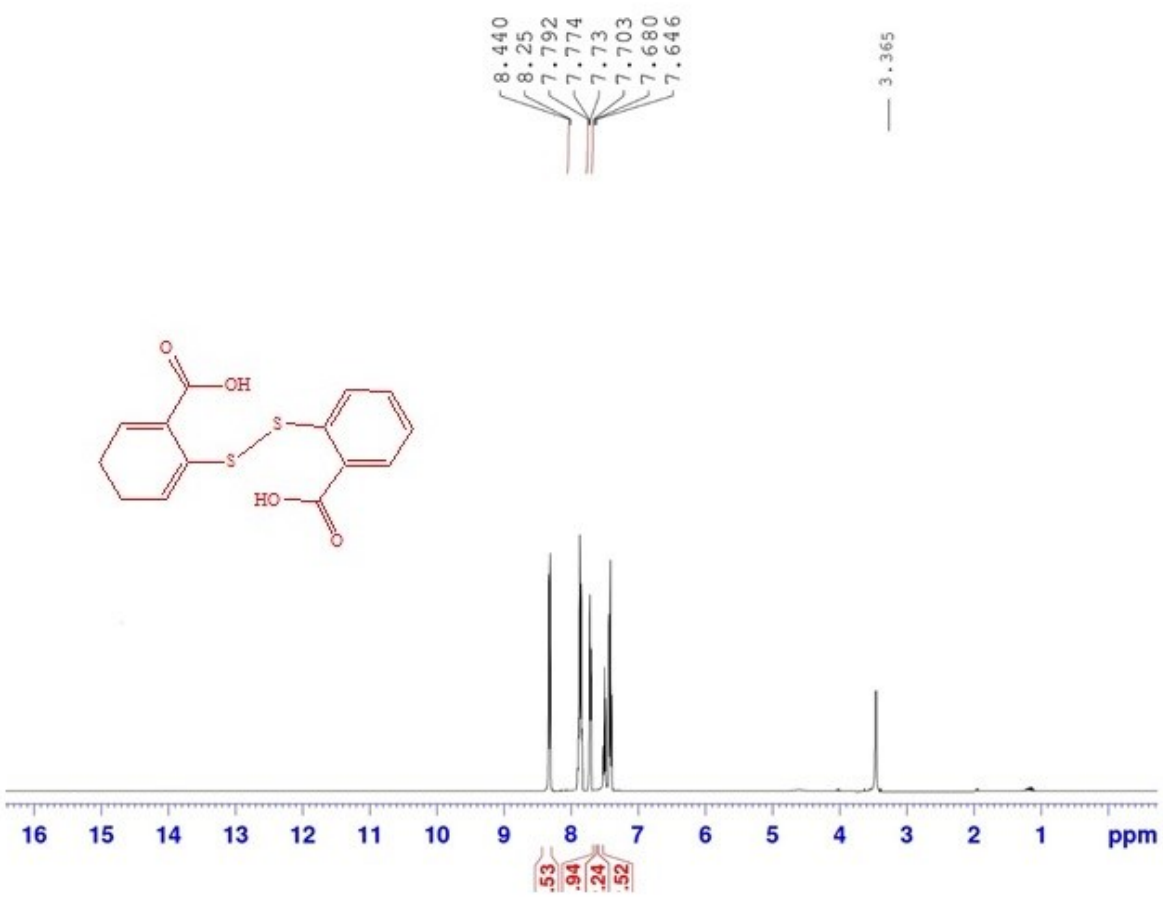


S12. ^{13}CNMR spectrum of 1, 2-di(naphthalen-2-yl)disulfane in DMSO (Table 4, entry 3)

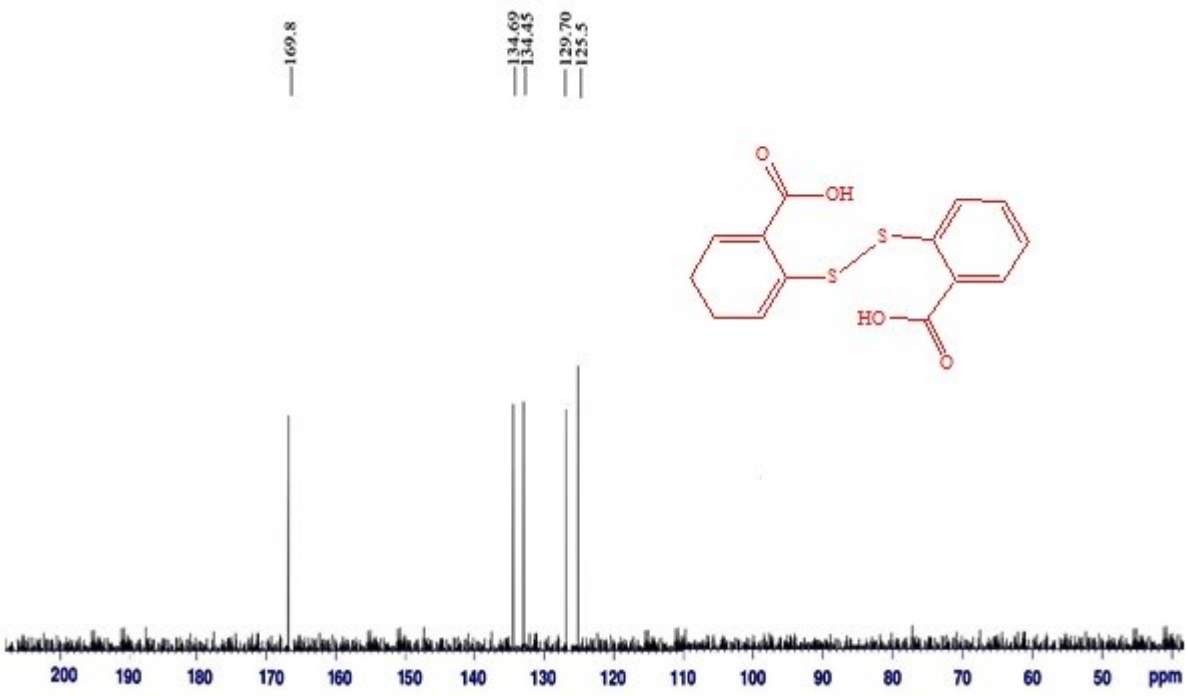
2, 2′- disulfanediyldibenzoic acid (Table 4, entry 4)



Melting point: 280-283 °C. ^{1}HNMR (400 MHz, DMSO, ppm): δ 7.64-7.68 (m, 4H) ,7.70-7.79 (m, 4H), 8.82– 8.44 (m, 2H); ^{13}CNMR (100 MHz, $CDCl_3$, ppm): δ 125.50, 129.70, 134.45,134.69, 169.83. IR (KBr) (cm^{-1}): ν (S-S): 1029.

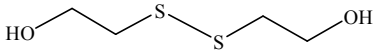


S13. [1]H-NMR spectrum of 2, 2′- disulfanediyldibenzoic acid in DMSO (Table 4, entry 4)

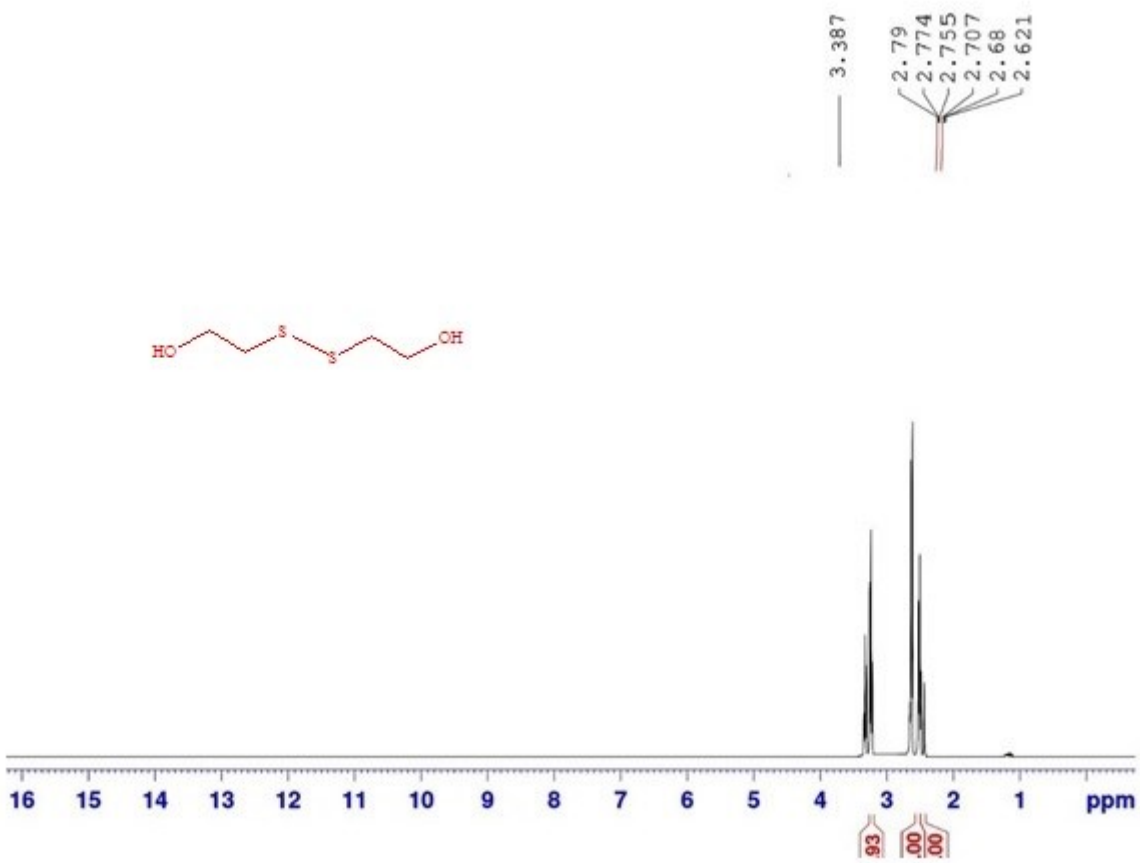


S14. ^{13}CNMR spectrum of 2, 2′- disulfanediyldibenzoic acid in DMSO (Table 4, entry 4)

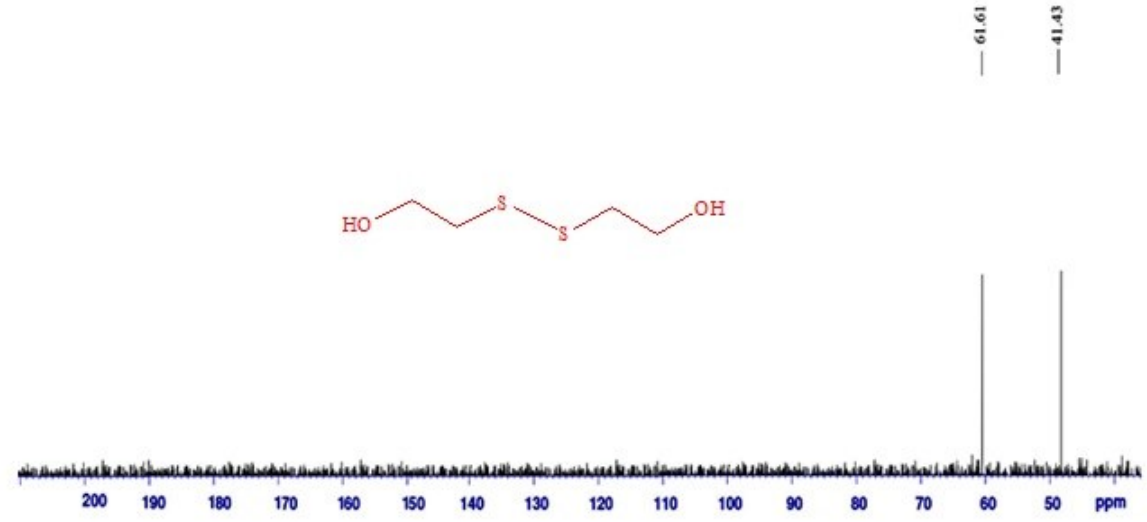
2, 2′- disulfanediyldiethanol (Table 4, entry 6)



Melting point: Oil. ^{1}HNMR (400 MHz, DMSO, ppm): δ 2.262-2.798 (m, 4H), 3.38 (m, 4H); ^{13}CNMR (100 MHz, DMSO, ppm): δ 41.43, 61.61. IR (KBr) (cm^{-1}): ν (S-S): 1047.



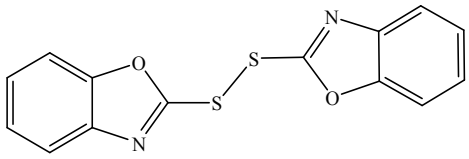
S15. ^{1}H-NMR spectrum of 2, 2′- disulfanediyldiethanol in DMSO (Table 4, entry 6)

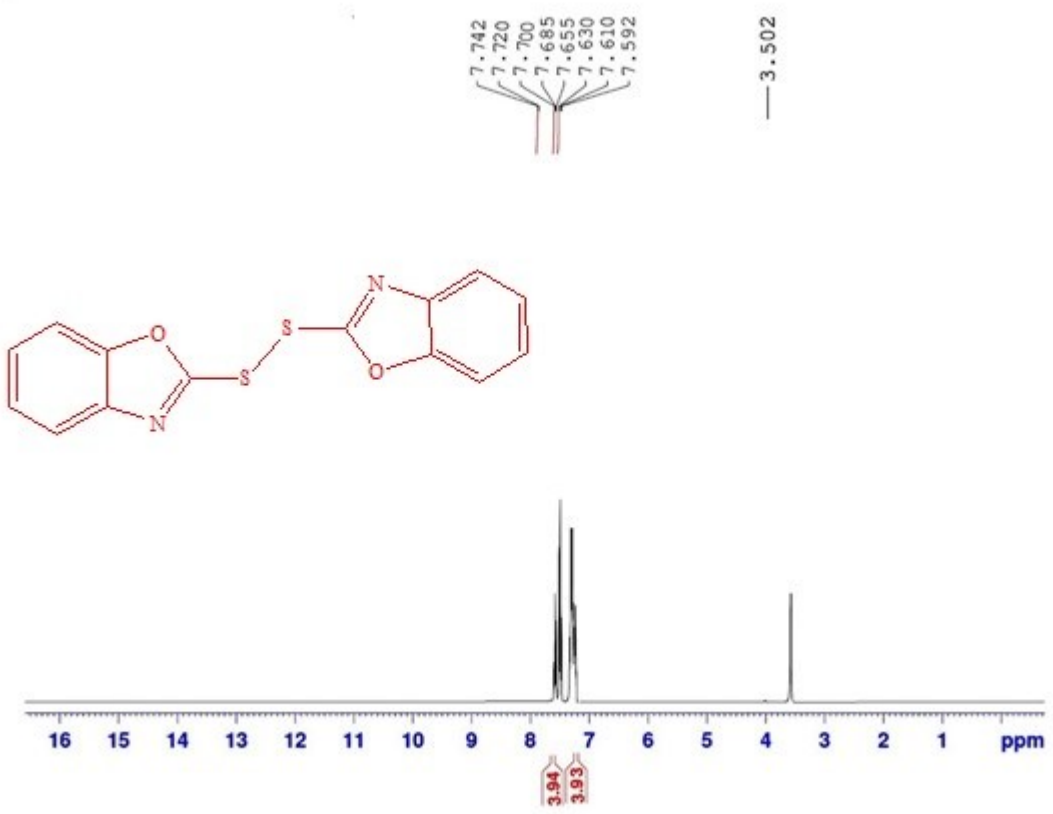


S16. ^{13}CNMR spectrum of 2, 2′- disulfanediyldiethanol in DMSO (Table 4, entry 6)

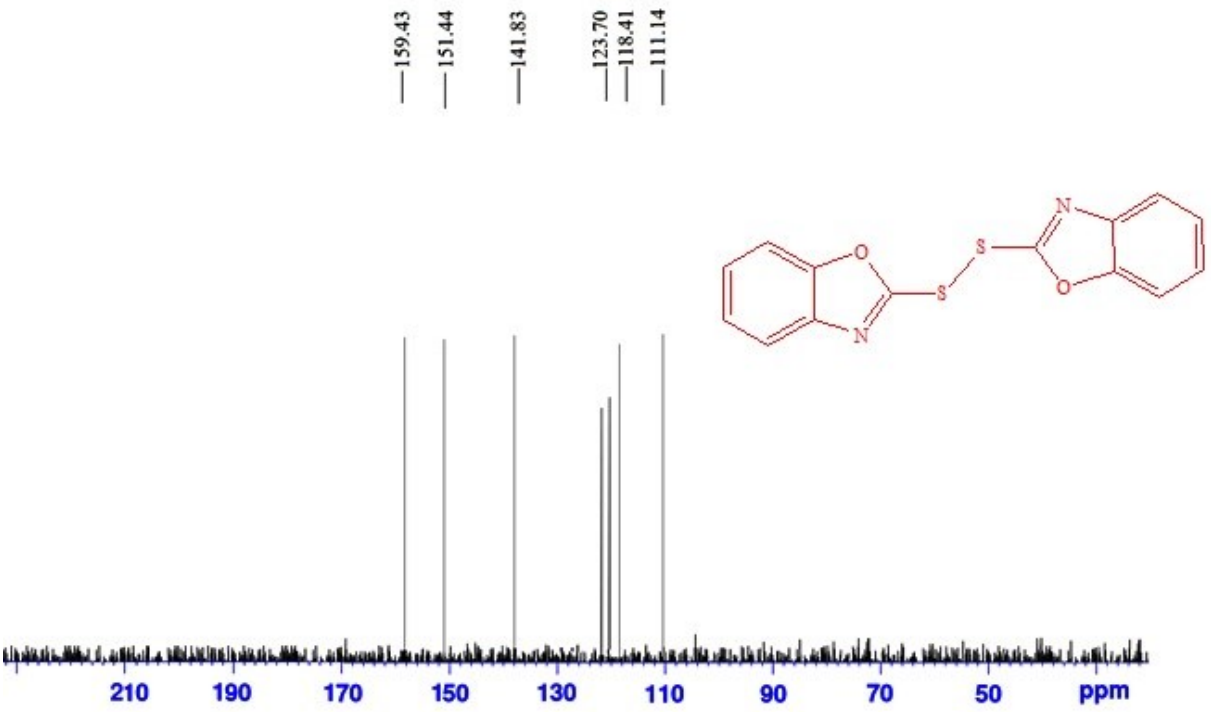
1, 2-bis(benzo[d]oxazol-2-yl)disulfane (Table 2, entry 8)

Melting point: 95-98 °C. ^{1}HNMR (400 MHz, $CDCl_3$, ppm): δ 7.59-7.68 (m, 4H), 7.70– 7. 74 (m, 4H); ^{13}CNMR (75 MHz, $CDCl_3$, ppm): δ 111.14, 118.41, 123.70 , 141.83, 151.44, 159.43. IR (KBr) (cm^{-1}): ν (S-S): 1042.



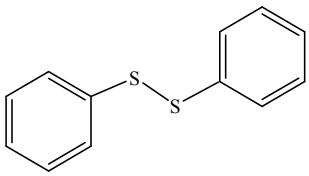


S17. ^{1}H-NMR spectrum of 1, 2-bis(benzo[d]oxazol-2-yl)disulfane in $CDCl_3$ (Table 2, entry 8)

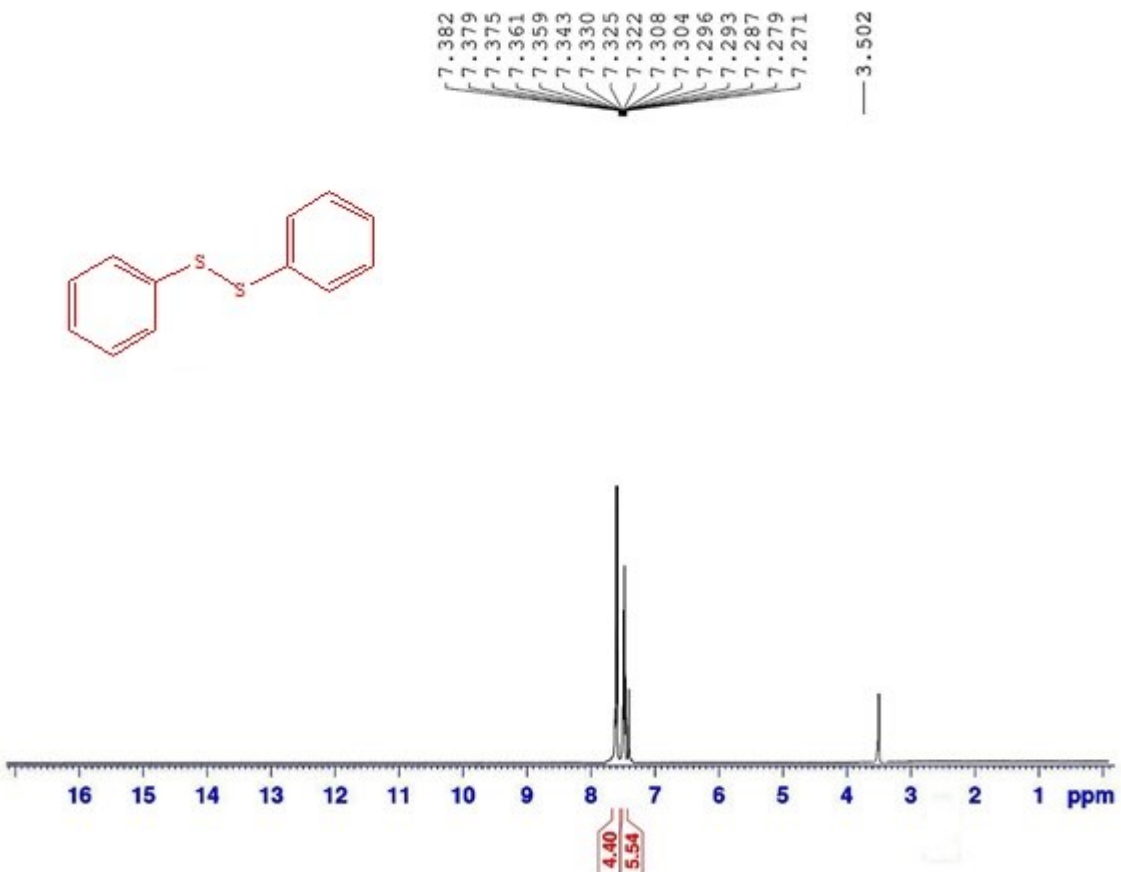


S18. ^{13}CNMR spectrum of 1, 2-bis(benzo[d]oxazol-2-yl)disulfane in $CDCl_3$ (Table 2, entry 8)

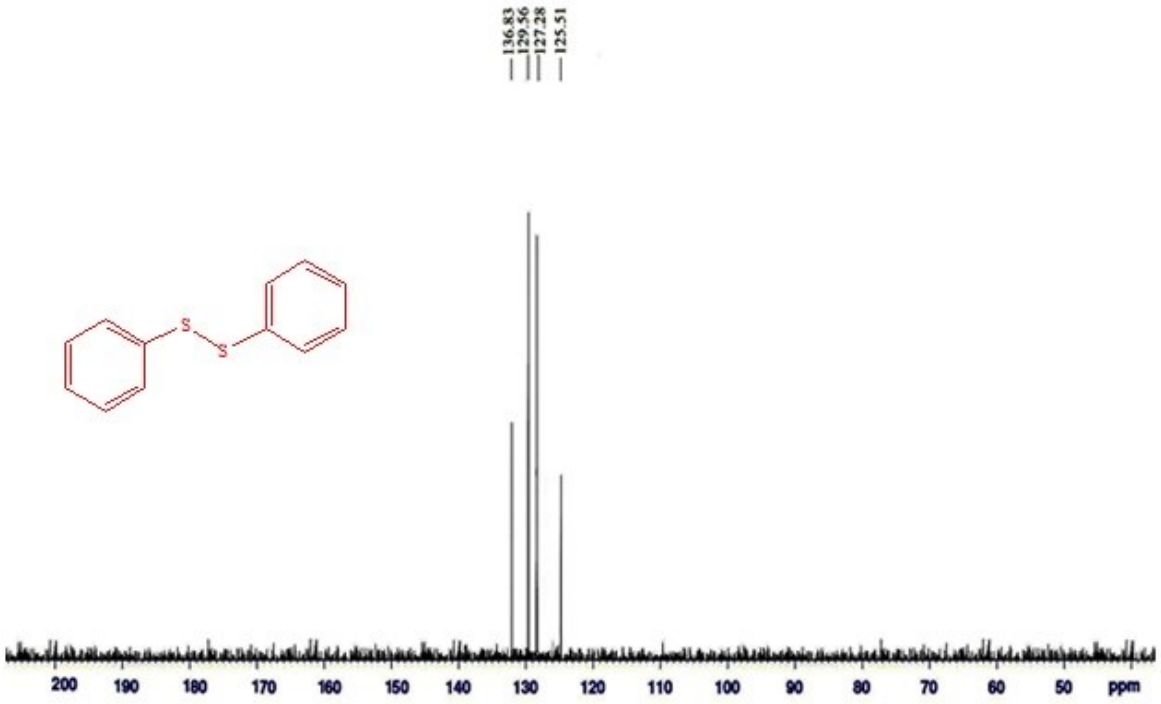
1, 2- diphenyldisulfane (Table 4, entry 9)



Melting point: 98-101 °C. ^{1}HNMR (300 MHz, $CDCl_3$, ppm): δ 7.271-7.322 (m, 6H) ,7.325-7.382 (m, 4H); ^{13}CNMR (100 MHz, $CDCl_3$, ppm): δ 125.51, 127.28, 129.56 , 136.83. IR (KBr) (cm^{-1}): ν (S-S): 1043.



S19. ^{1}H-NMR spectrum of 1, 2- diphenyldisulfane in $CDCl_3$ (Table 4, entry 9)



S20. ^{13}CNMR spectrum of 1, 2- diphenyldisulfane in $CDCl_3$ (Table 4, entry 9)