

# The influence of polymerization approach on the catalytic performance of novel porous poly (ionic liquid) for green synthesis of pharmaceutical spiro-4-thiazolidinones

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## Part 1. Characterization of ionic monomer

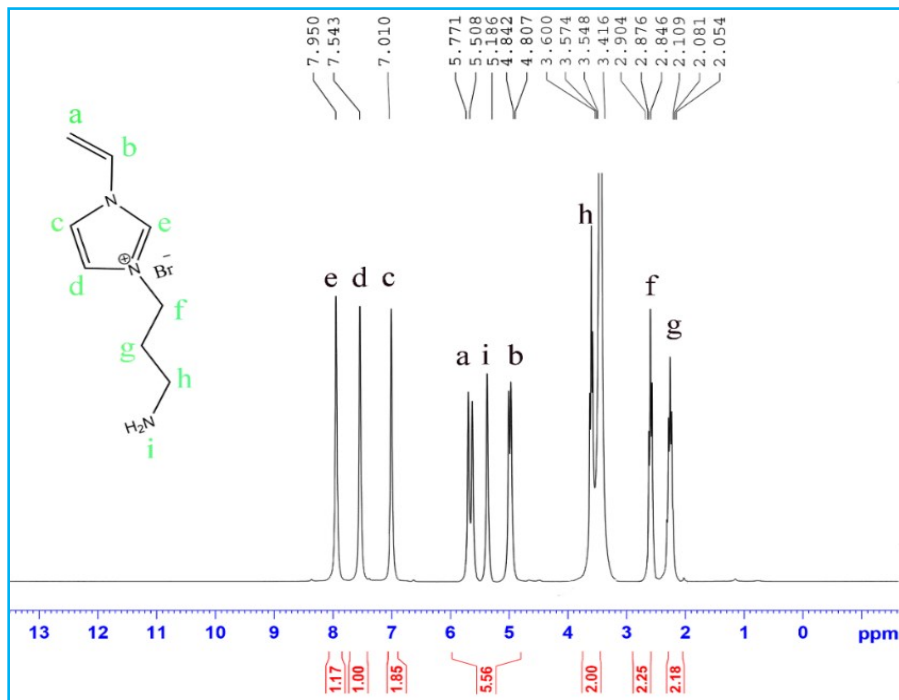


Figure S1. <sup>1</sup>H NMR spectra of ionic monomer

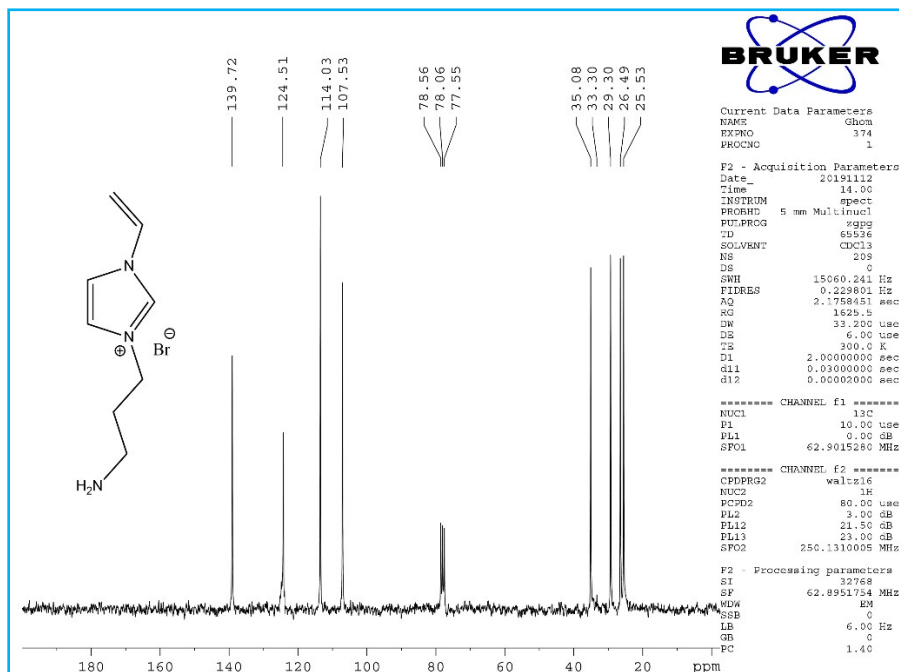
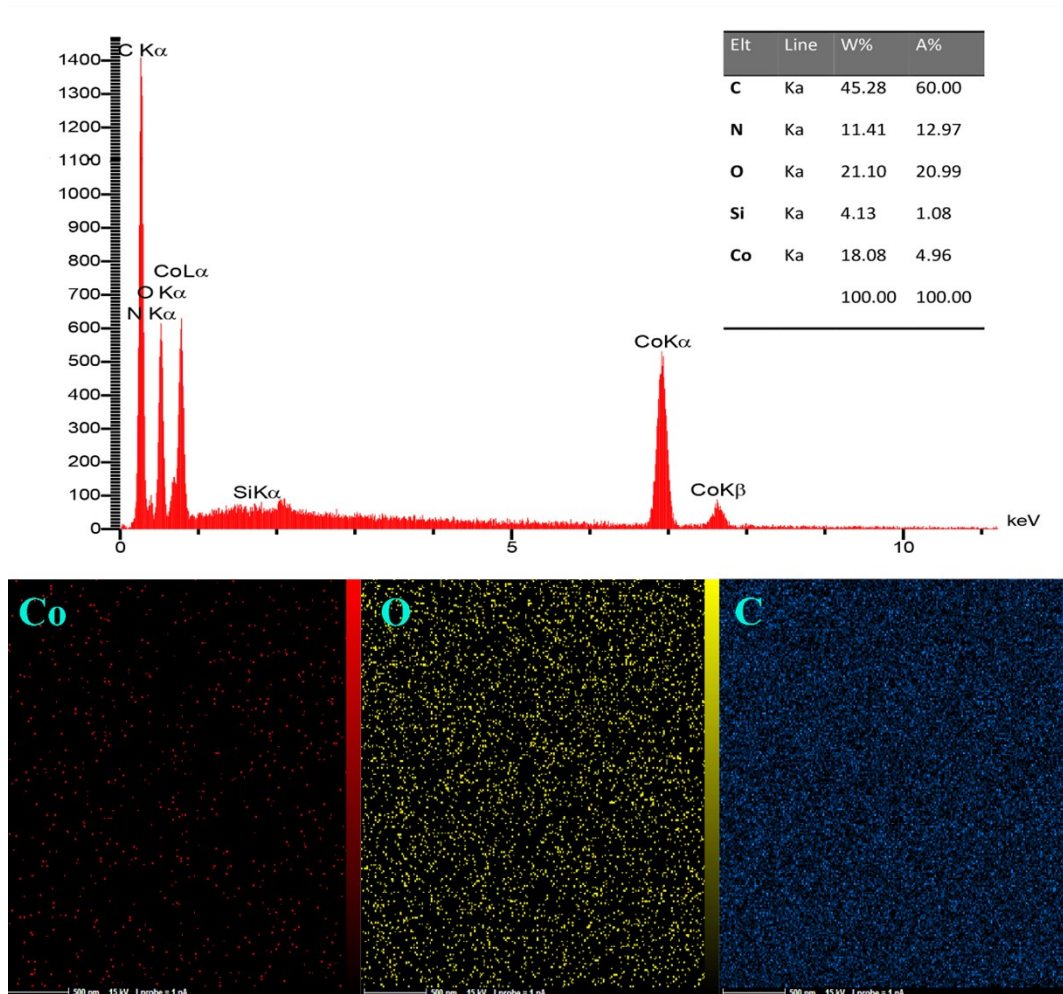
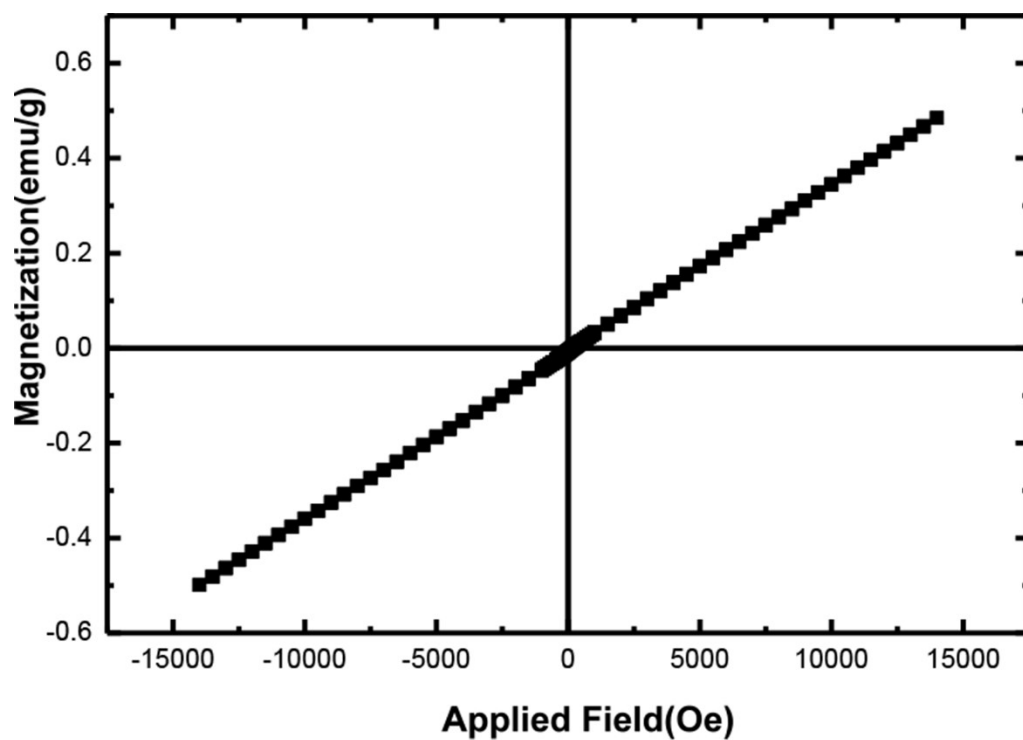


Figure S2. <sup>13</sup>C NMR spectra of ionic monomer

## Part 2. EDX analysis and elemental mapping images



**Part 2. VSM analysis**



**Figure S4.** VSM curve of sonocatalyst

### Part 3. Characterization of spiro-4-thiazolidinones

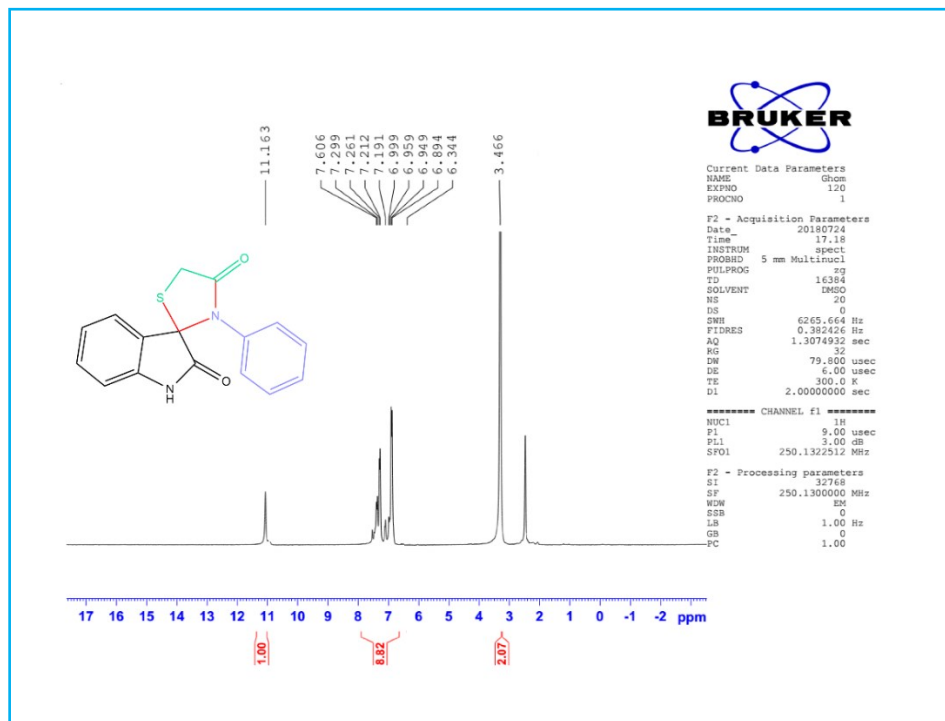


Figure S5. <sup>1</sup>H NMR spectrum of 3'-Phenyl-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4a**)

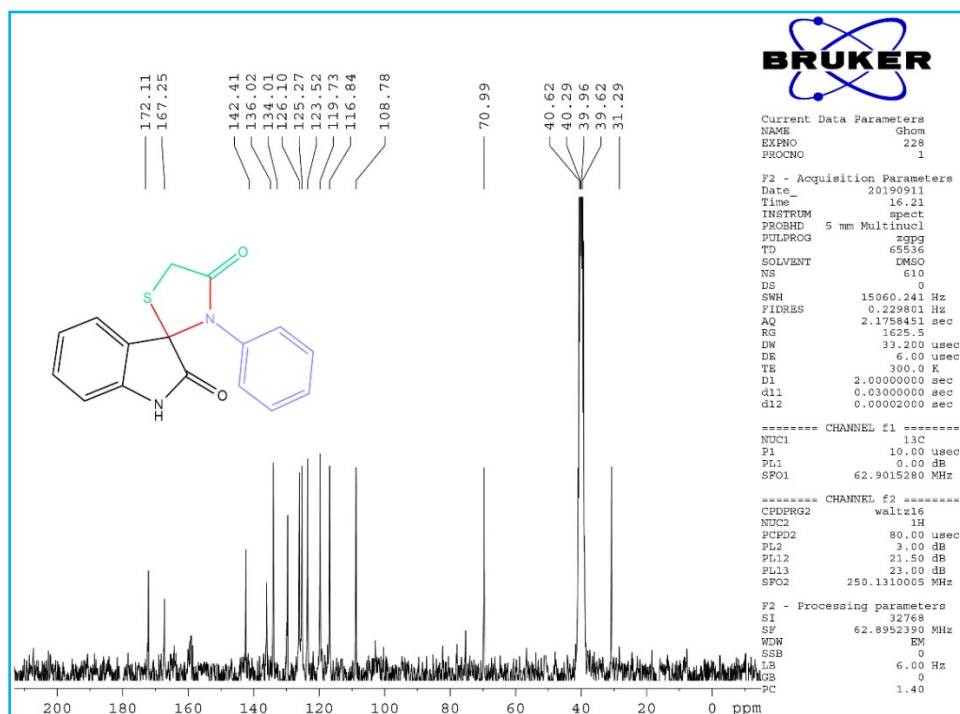


Figure S6. <sup>13</sup>C NMR spectrum of 3'-Phenyl-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4a**)

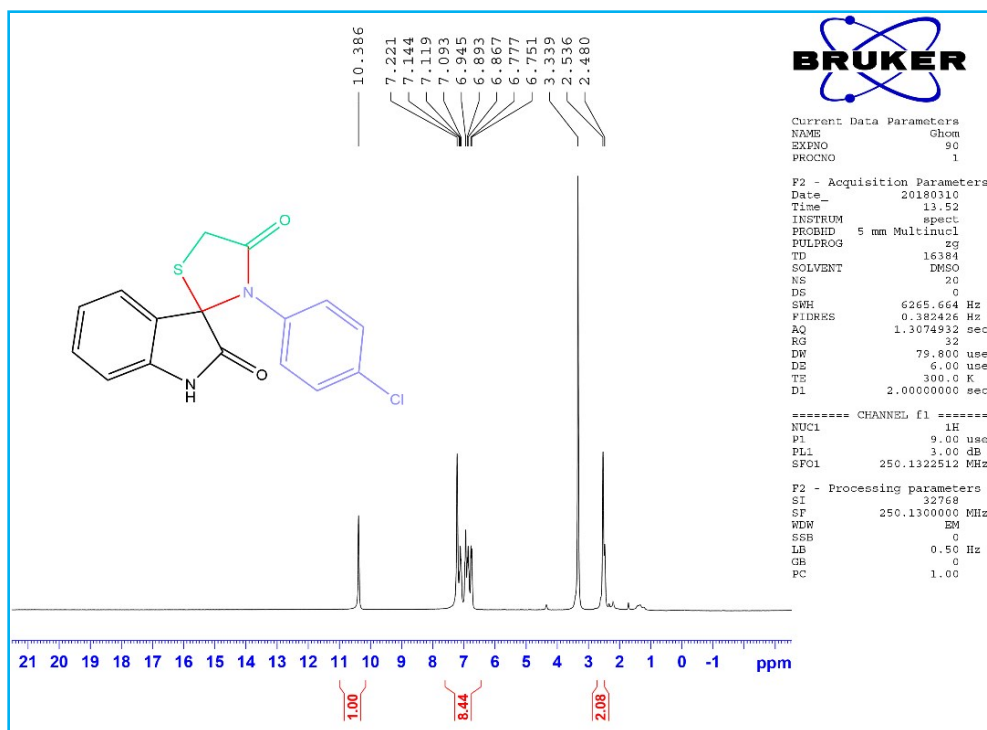


Figure S7. <sup>1</sup>H NMR spectrum of 3'-(4-Chlorophenyl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (4b)

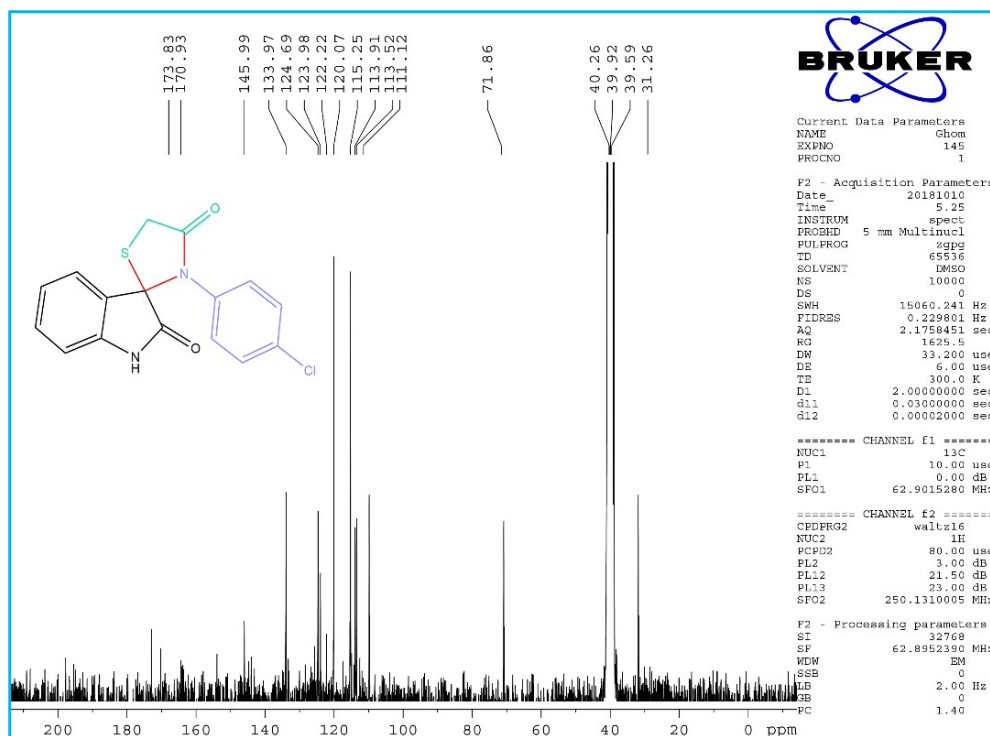
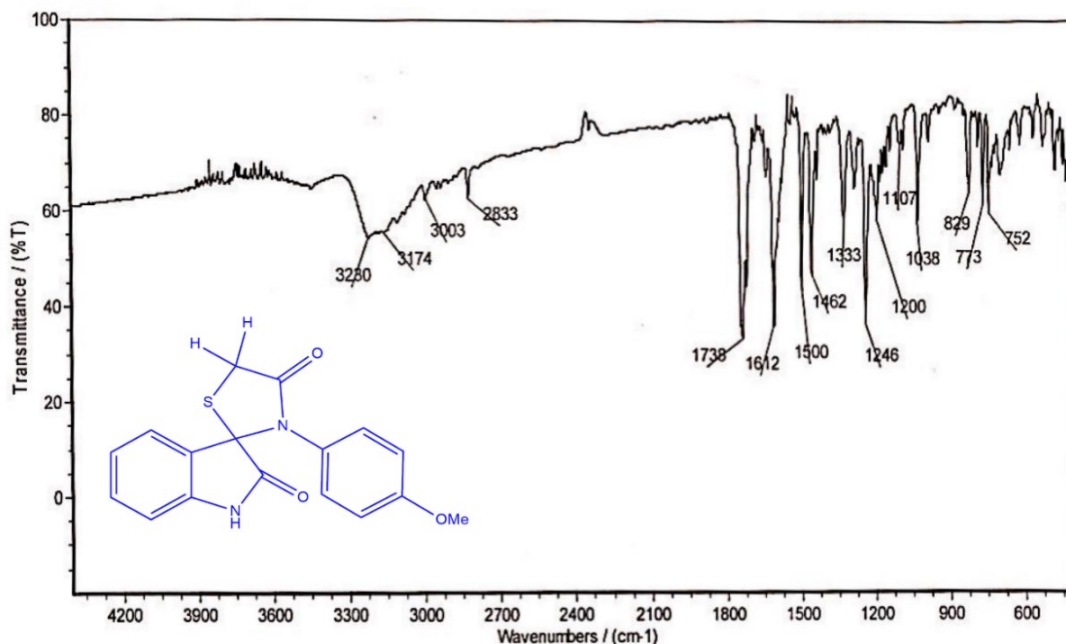
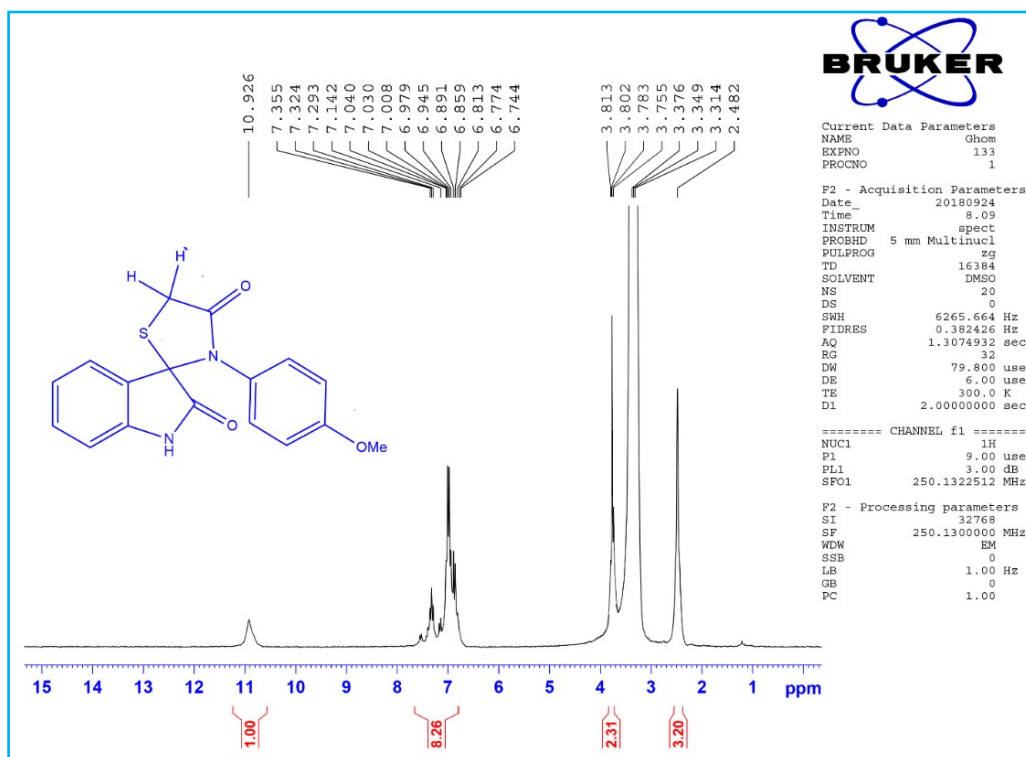


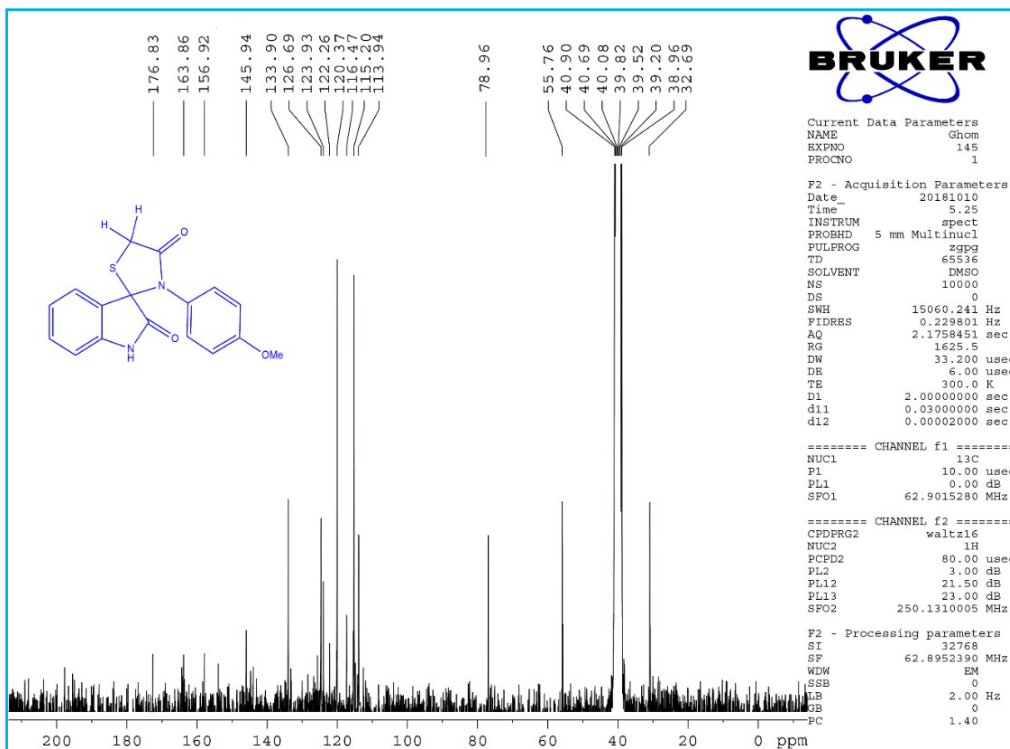
Figure S8. <sup>13</sup>C NMR spectrum of 3'-(4-Chlorophenyl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (4b)



New compound, Figure S9: FT-IR (KBr) spectrum of 3'-(4-Methoxyphenyl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4c**)



New compound, Figure S10: <sup>1</sup>H NMR spectrum of 3'-(4-Methoxyphenyl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4c**)



New compound, **Figure S11**:  $^{13}\text{C}$  NMR spectrum of 3'-(4-Methoxyphenyl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4c**)



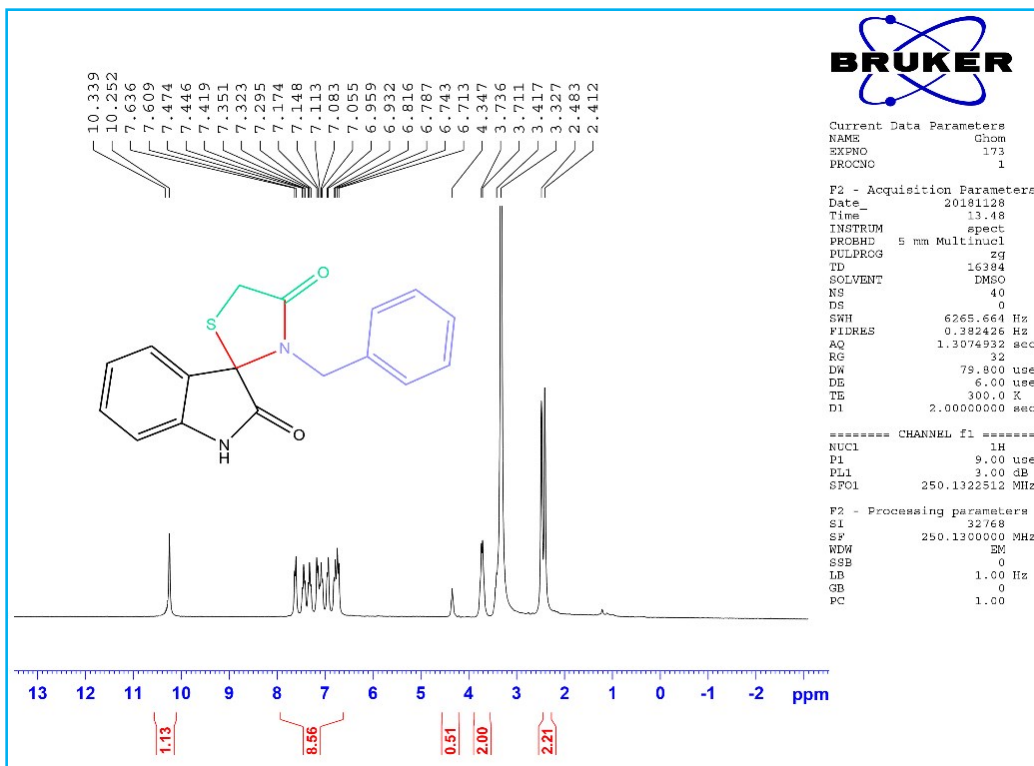


Figure S12:  $^1\text{H}$  NMR spectrum of 3'-Benzyl-spiro[indoline-3,2'-thiazolidine]-2,4'-dione (**4d**)

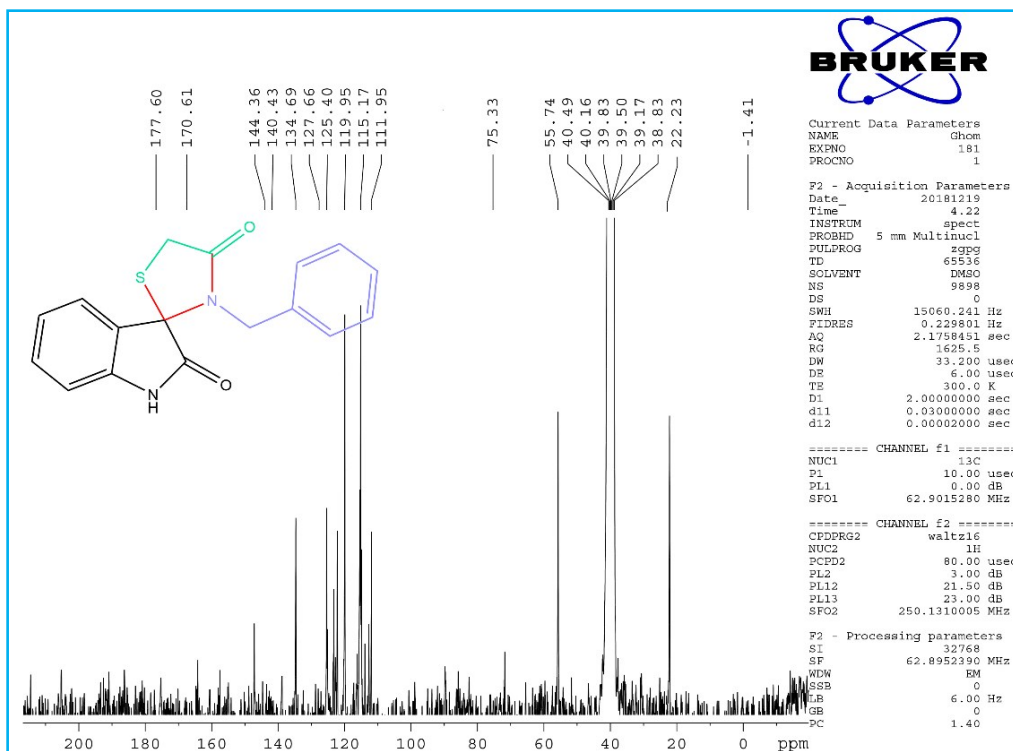
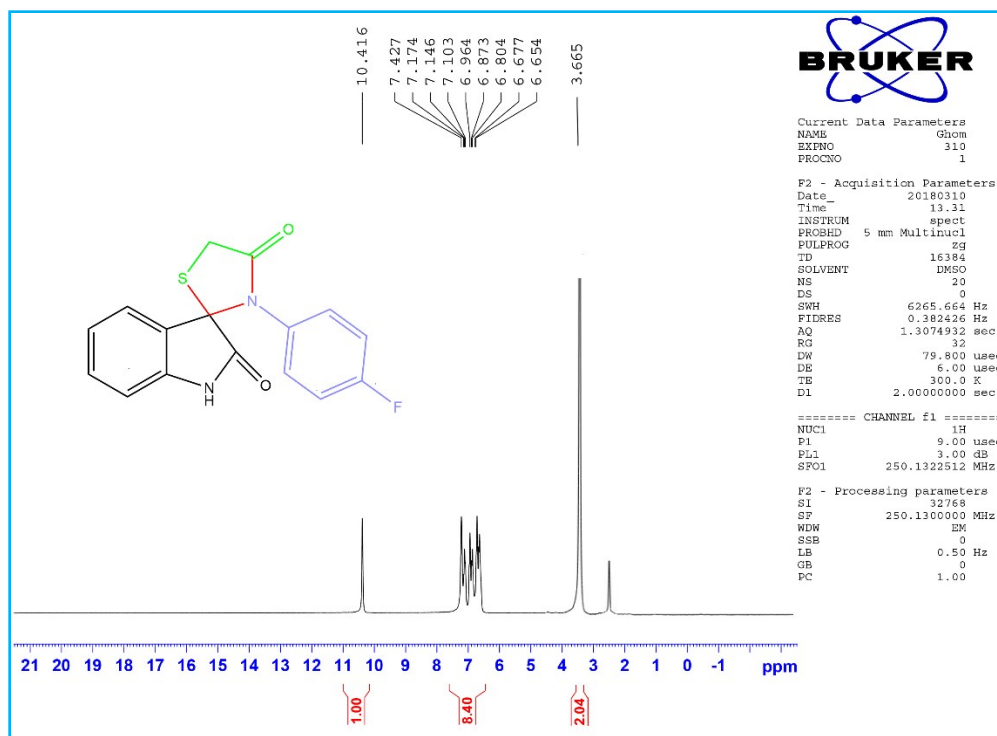
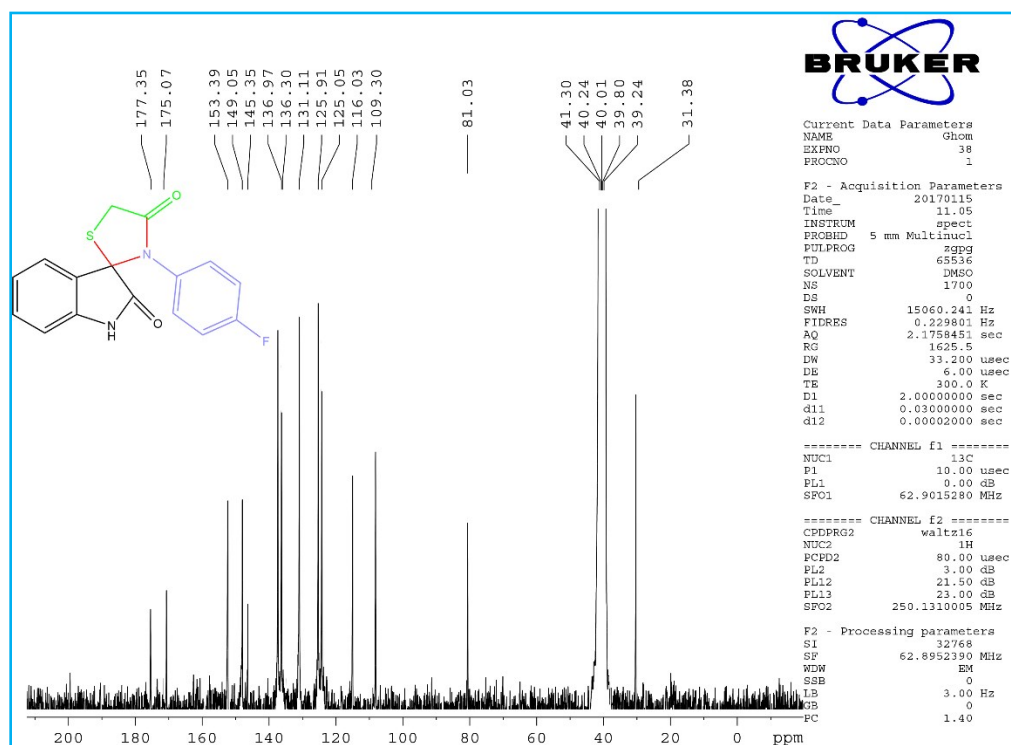


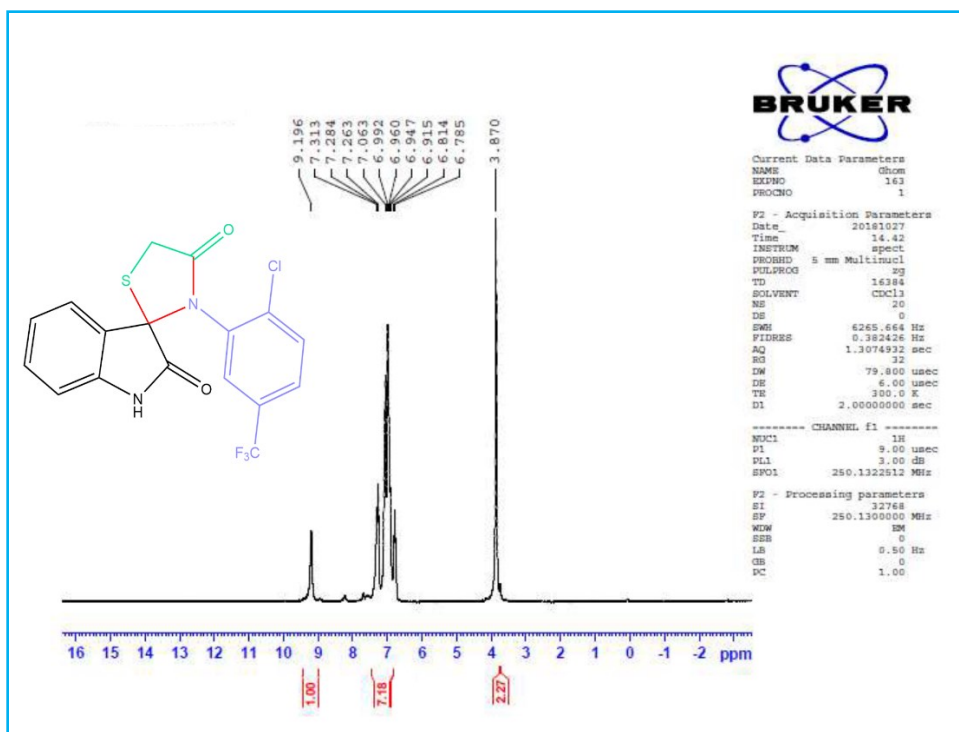
Figure S13:  $^{13}\text{C}$  NMR spectrum of 3'-Benzyl-spiro[indoline-3,2'-thiazolidine]-2,4'-dione (**4d**)



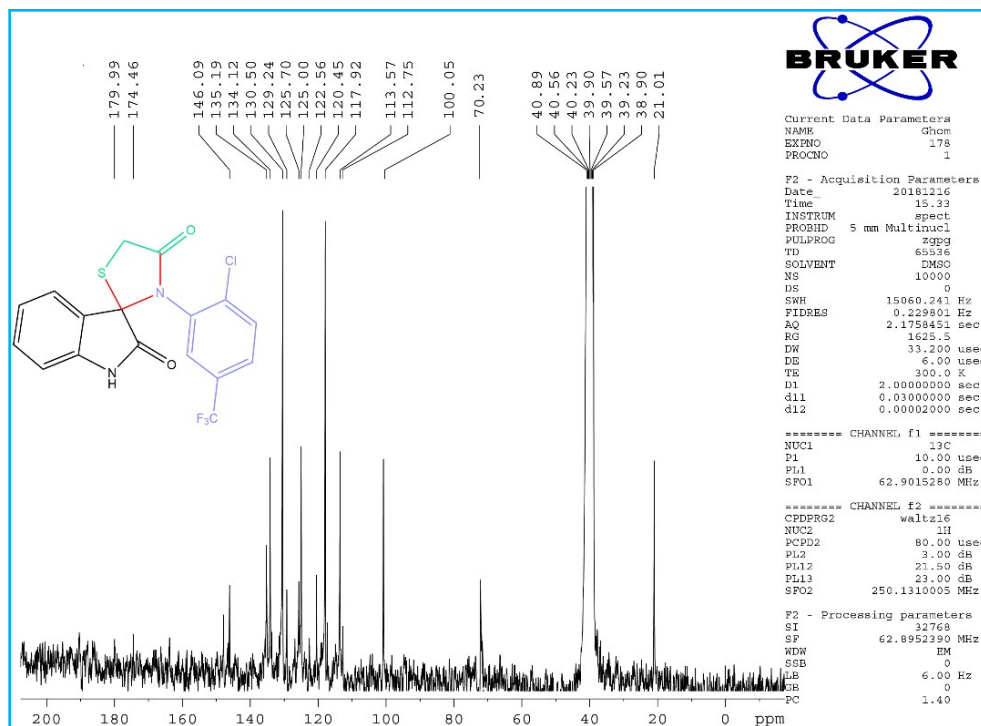
**Figure S14:**  $^1\text{H}$  NMR spectrum of 3'-(4-Fluorophenyl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H) dione (**4e**)



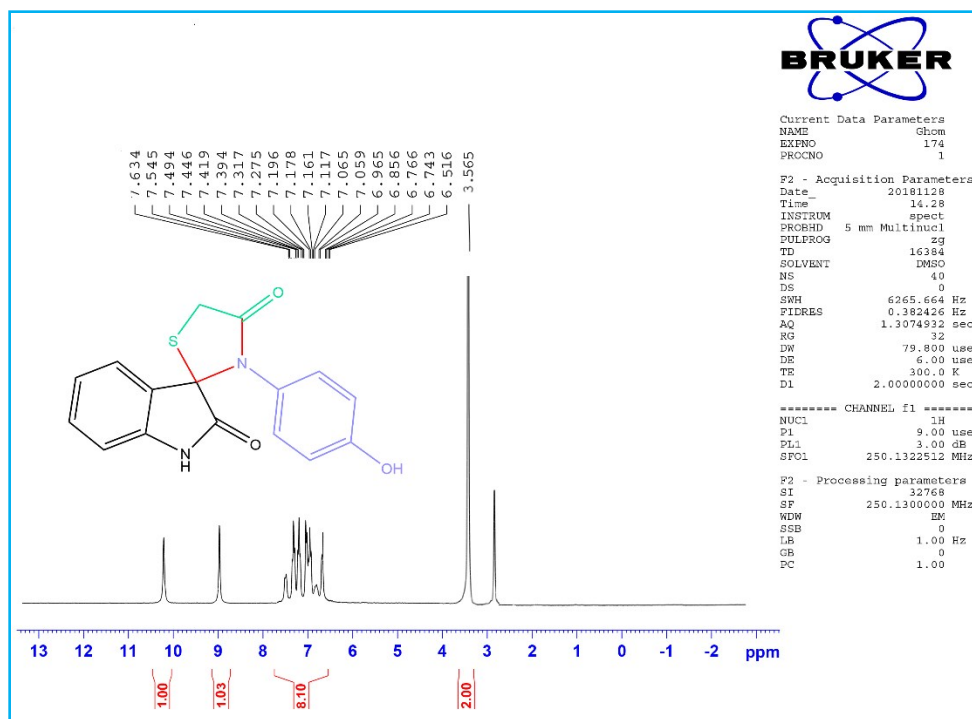
**Figure S15:**  $^{13}\text{C}$  NMR spectrum of 3'-(4-Fluorophenyl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H) dione (**4e**)



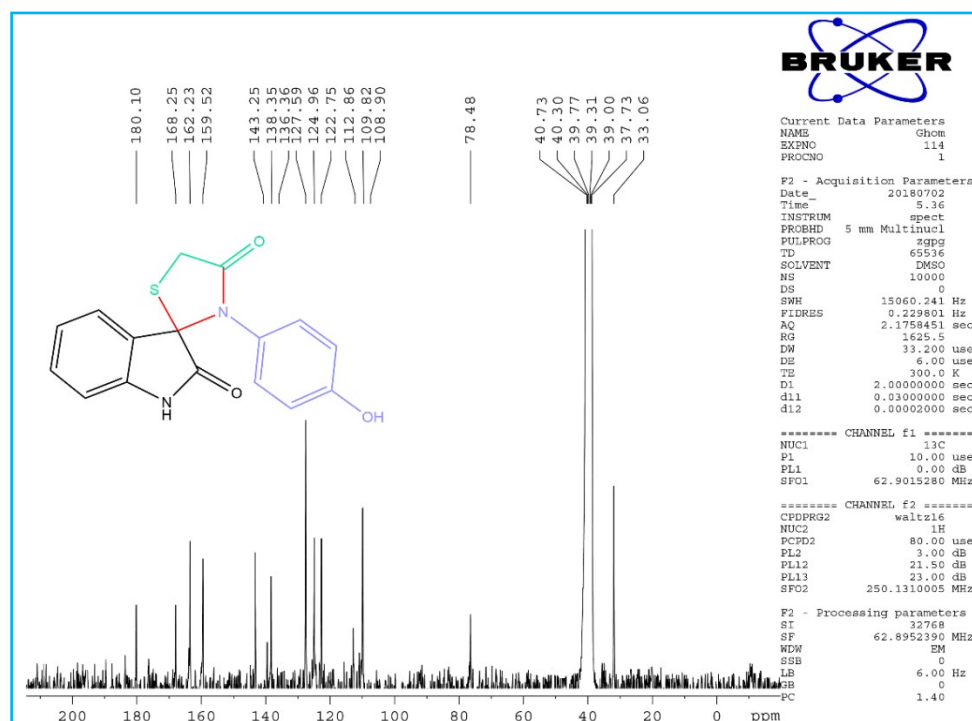
**Figure S16:**  $^1\text{H}$  NMR spectrum of 3'-(5-Trifluoromethyl-2-chlorophenyl)-spiro-[3H-indole3,2'-thiazolidine]-2,4'(1H)-dione (**4f**)



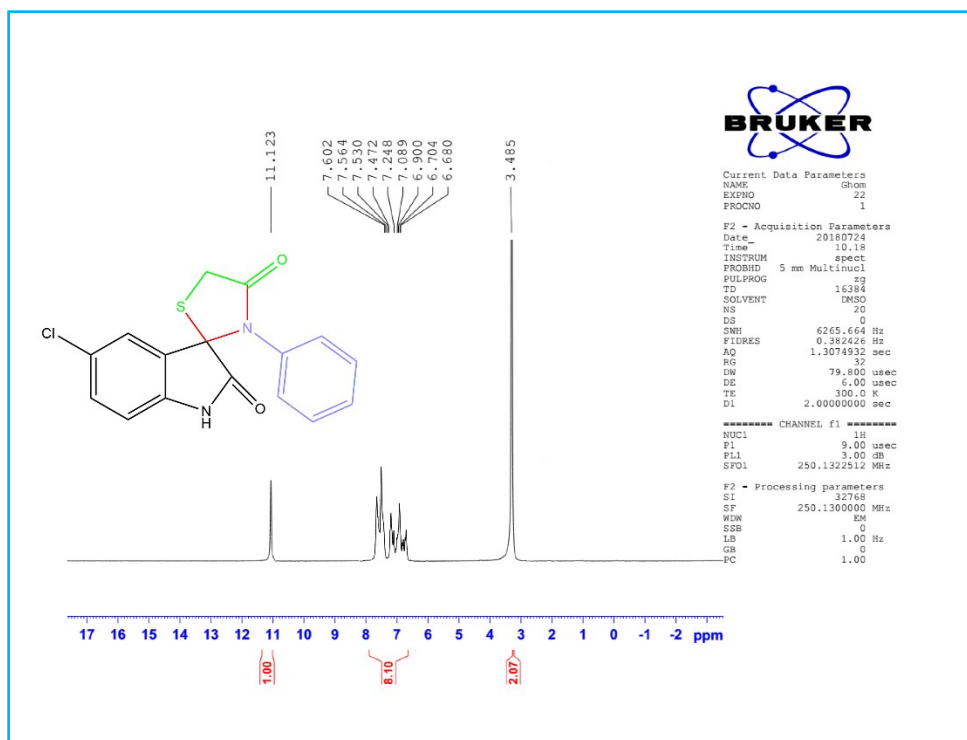
**Figure S17:**  $^{13}\text{C}$  NMR spectrum of 3'-(5-Trifluoromethyl-2-chlorophenyl)-spiro-[3H-indole3,2'-thiazolidine]-2,4'(1H)-dione (**4f**)



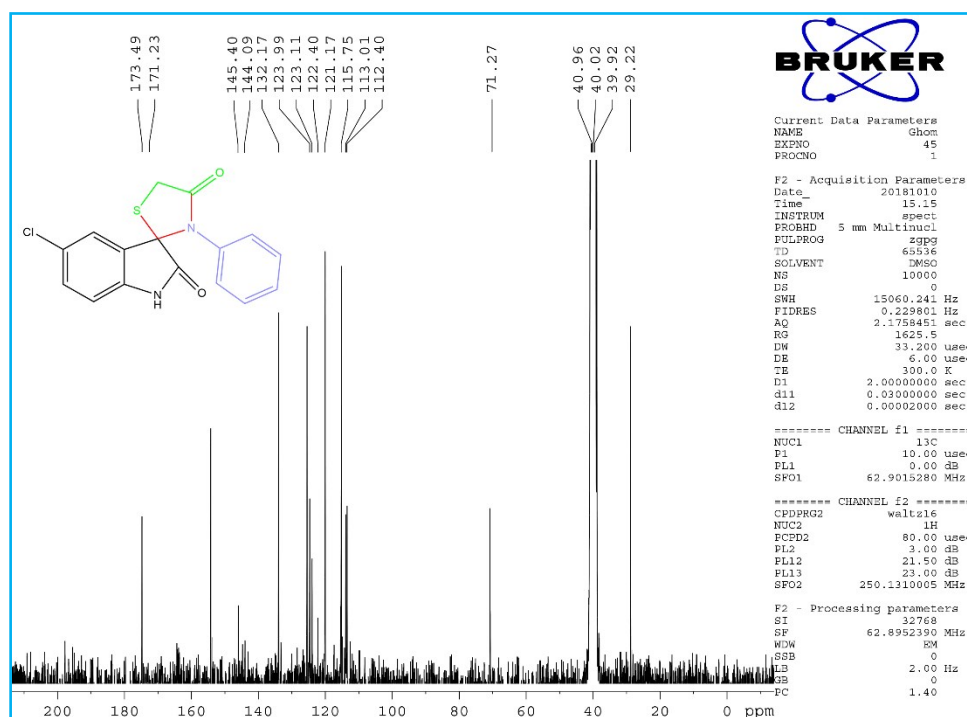
**Figure S18:**  $^1\text{H}$  NMR spectrum of 3'-(4-Hydroxyphenyl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4g**)



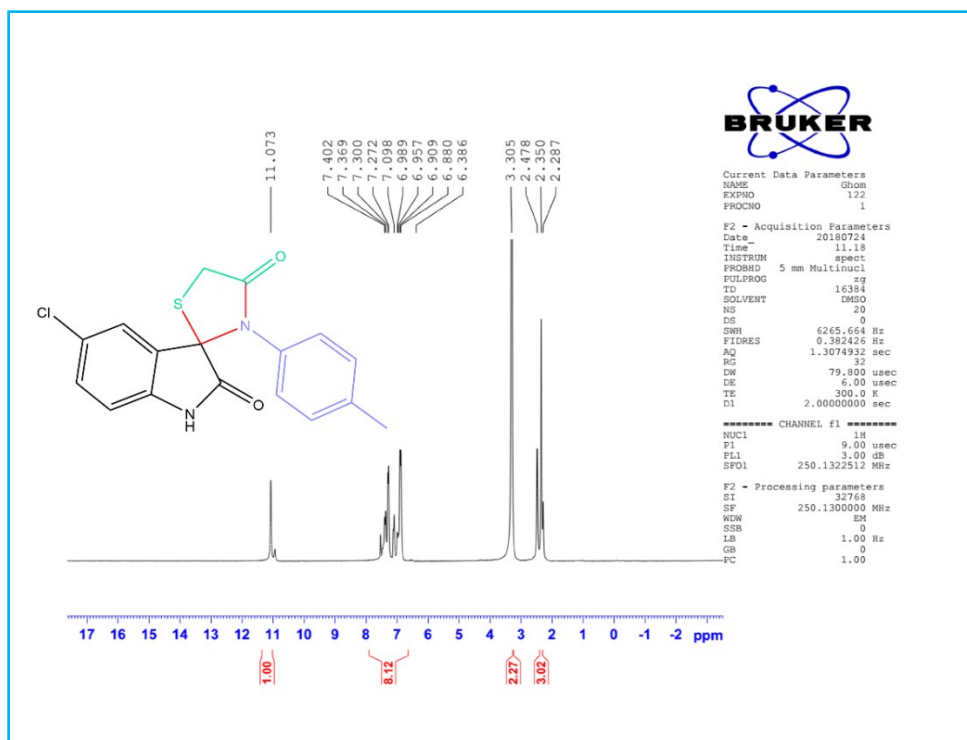
**Figure S19:**  $^{13}\text{C}$  NMR spectrum of 3'-(4-Hydroxyphenyl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4g**)



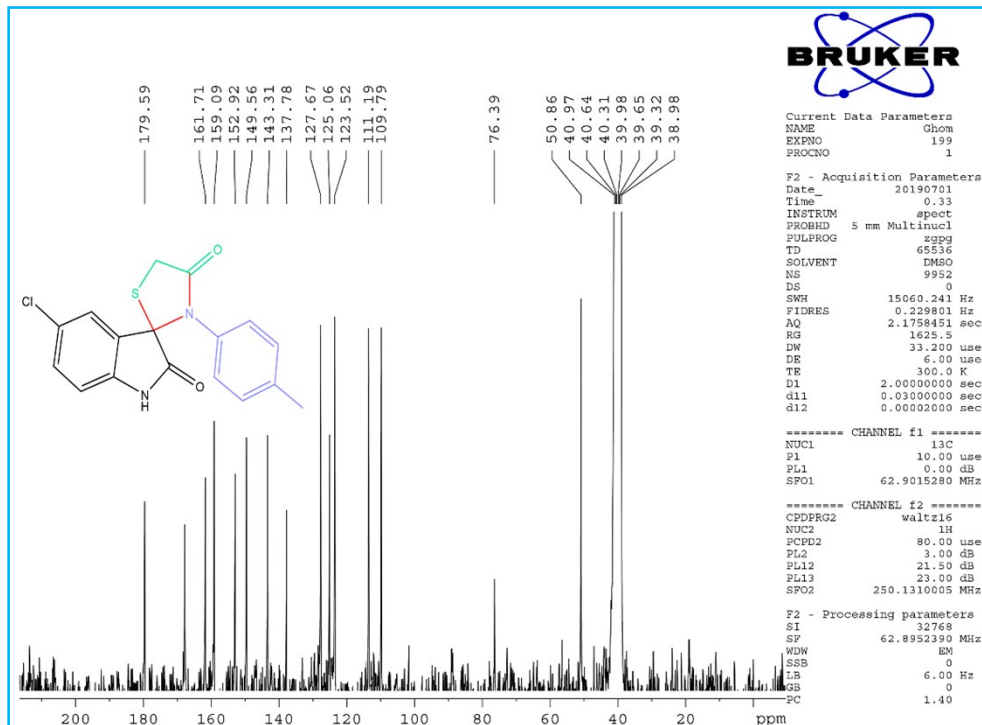
**Figure S20:**  $^1\text{H}$  NMR spectrum of 5-Chloro-3'-phenylspiro[indoline-3,2'-thiazolidine]-2,4'-dione (4h)



**Figure S21:**  $^{13}\text{C}$  NMR spectrum of 5-Chloro-3'-phenylspiro[indoline-3,2'-thiazolidine]-2,4'-dione (4h)

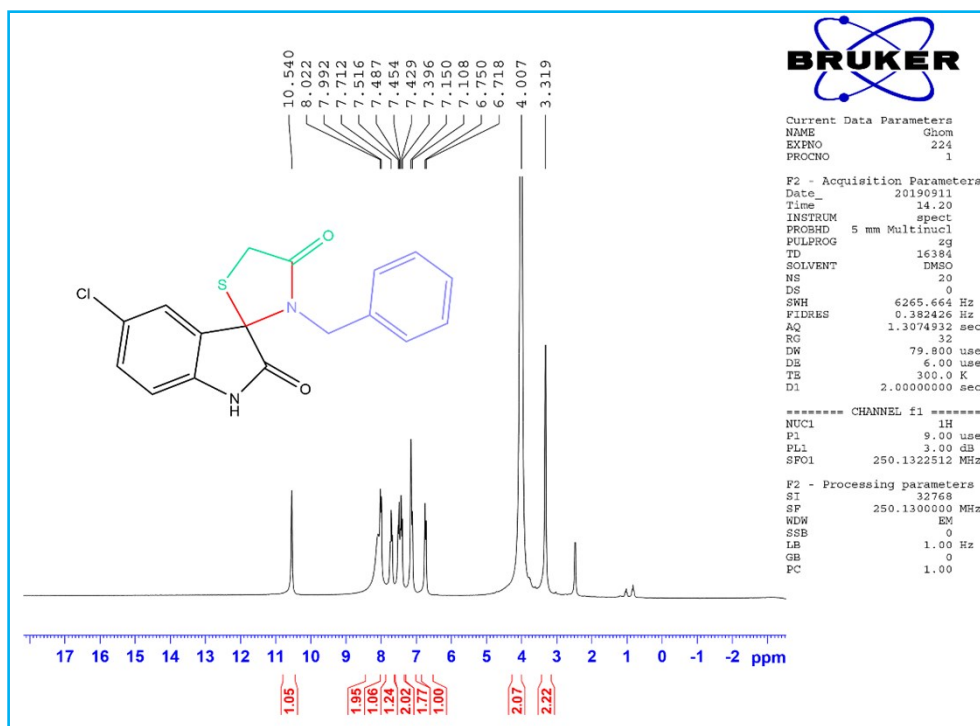


**Figure S22:**  $^1\text{H}$  NMR spectrum of 3'-(4-Methyl)- 5-chlorospiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4i**)

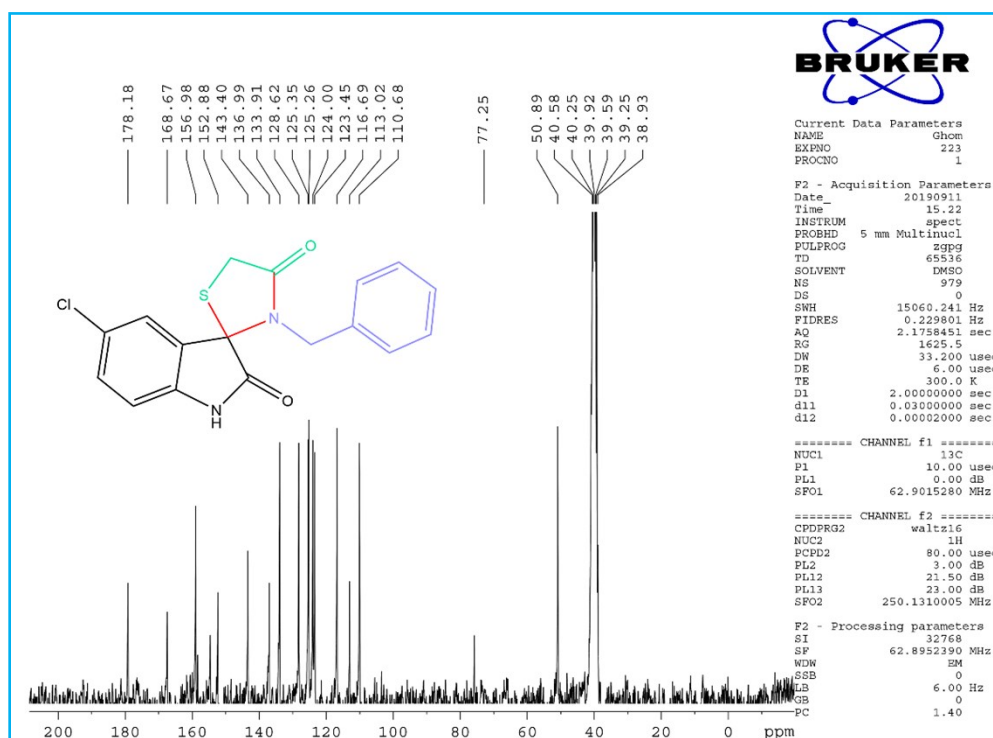


**Figure S23:**  $^{13}\text{C}$  NMR spectrum of 3'-(4-Methyl)- 5-chlorospiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4i**)

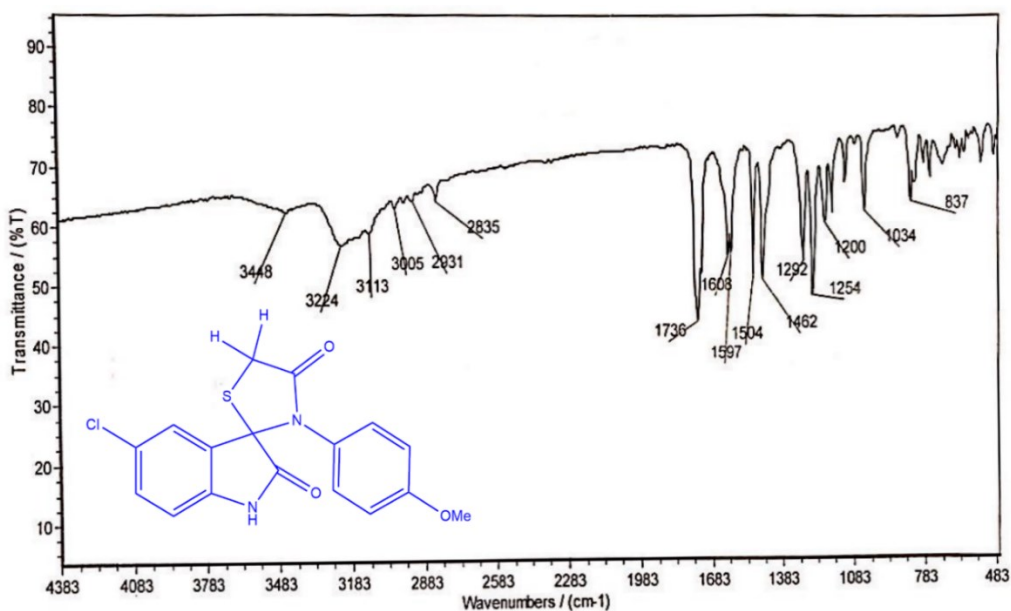




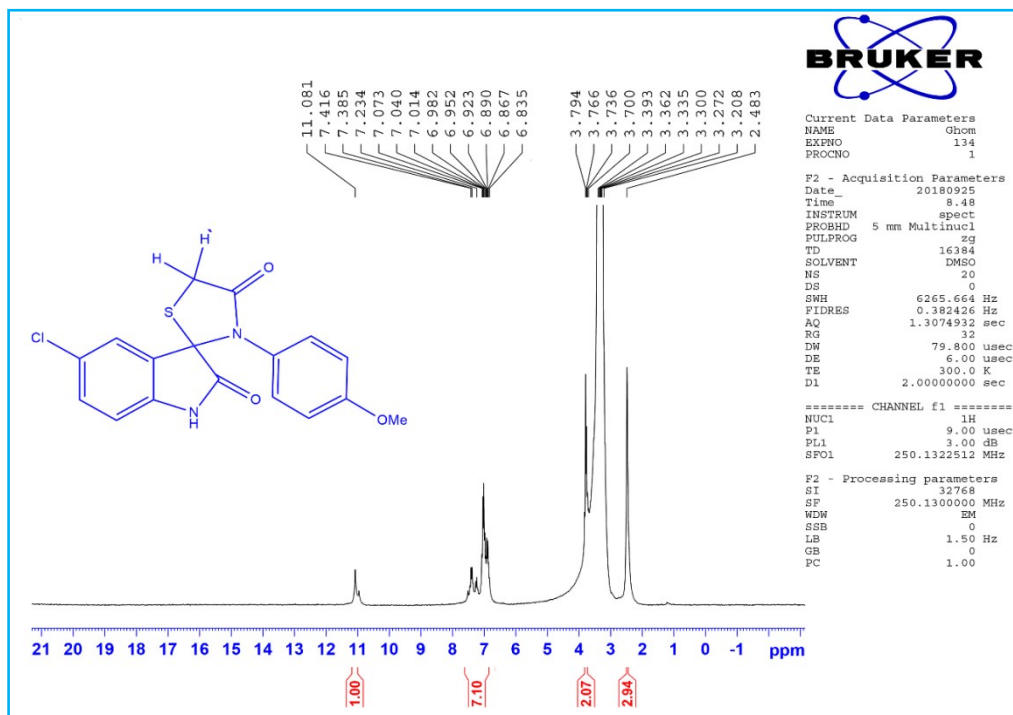
**Figure S24:**  $^1\text{H}$  NMR spectrum of 3'-Benzyl-5-chlorospiro[indoline-3,2'-thiazolidine]-2,4'-dione (4j)



**Figure S25:**  $^{13}\text{C}$  NMR spectrum of 3'-Benzyl-5-chlorospiro[indoline-3,2'-thiazolidine]-2,4'-dione (4j)

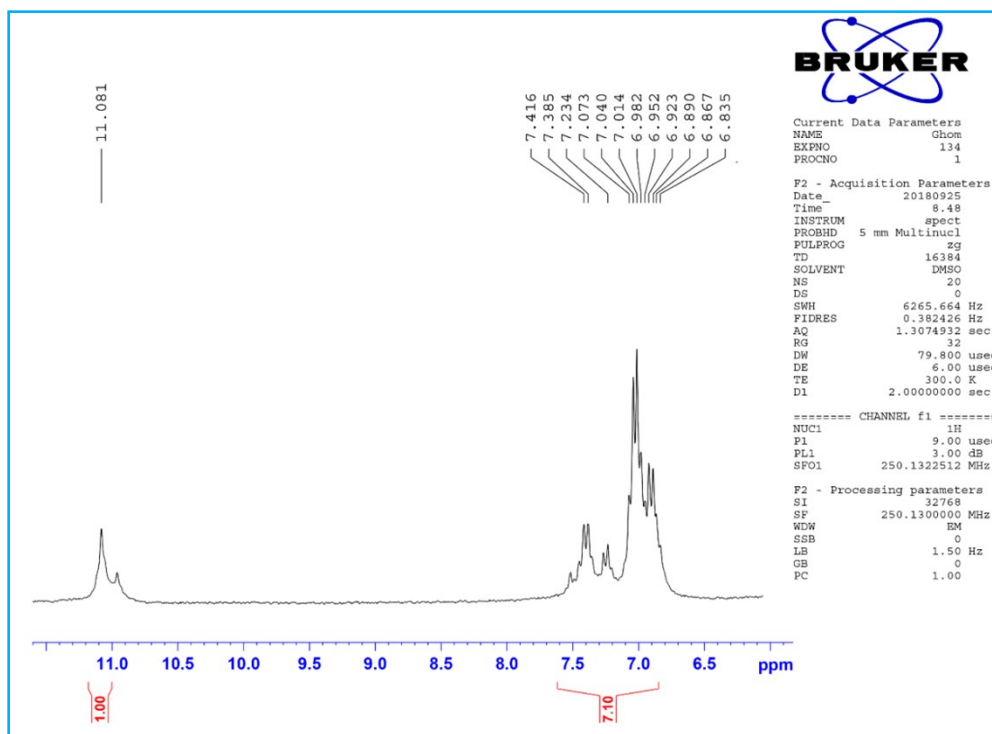


New compound, Figure S26: FT-IR (KBr) spectrum of 3'-(4-Methoxyphenyl)- 5-Chloro-3'-phenylspiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4k**)

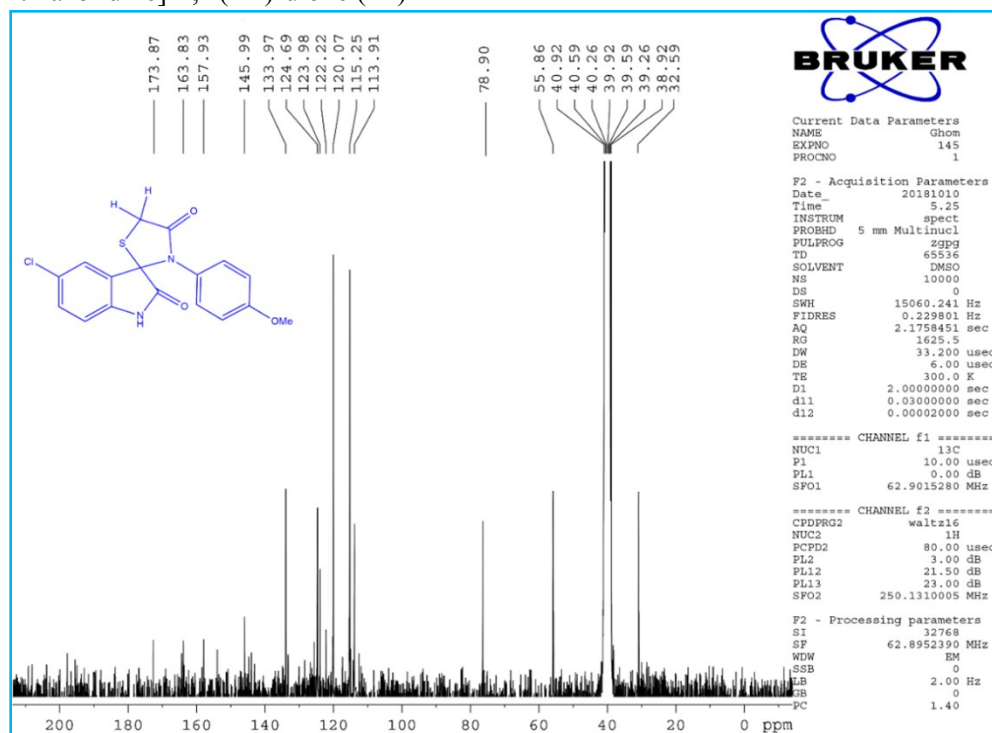


New compound, Figure S27: <sup>1</sup>H NMR spectrum of 3'-(4-Methoxyphenyl)- 5-Chloro-3'-phenylspiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4k**)

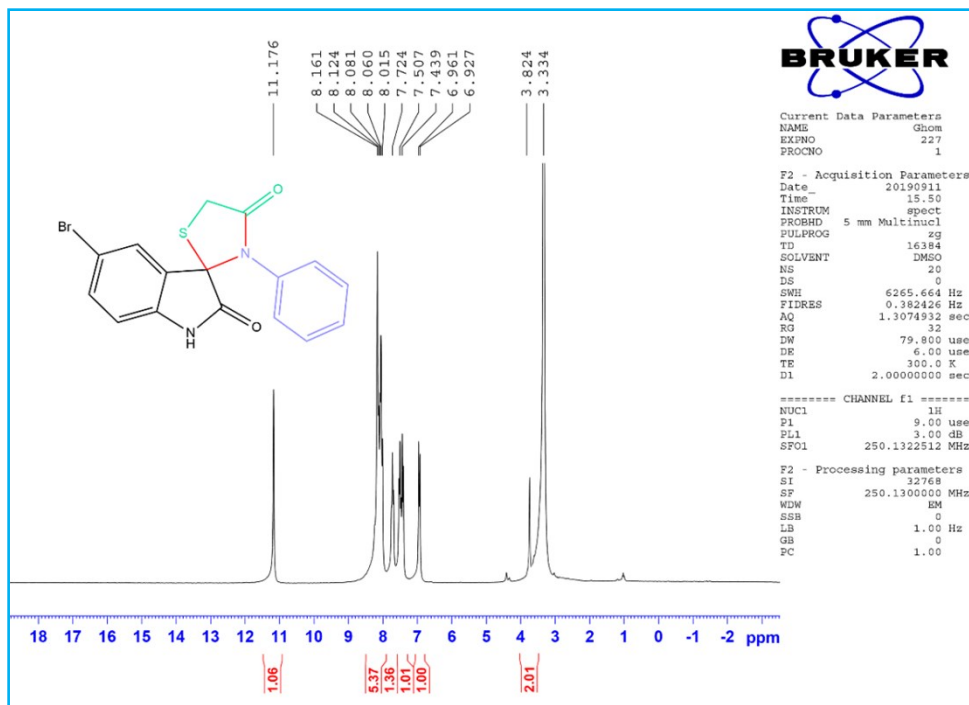




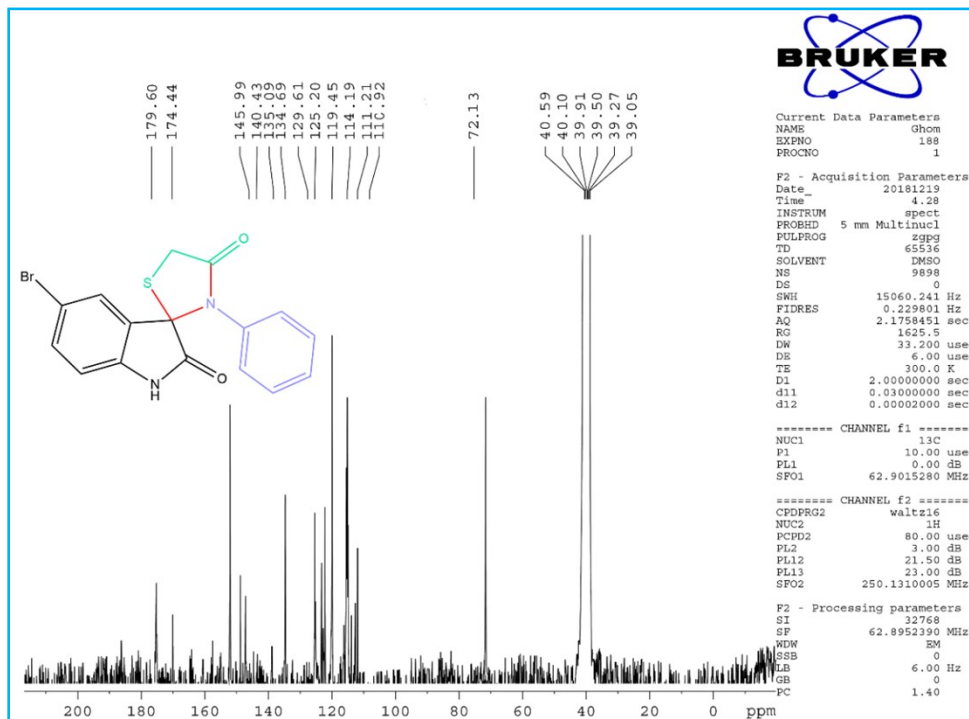
New compound, Figure S28:  $^1\text{H}$  NMR spectrum of 3'-(4-Methoxyphenyl)- 5-Chloro-3'-phenylspiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4k**)



New compound, Figure S29:  $^{13}\text{C}$  NMR spectrum of 3'-(4-Methoxyphenyl)- 5-Chloro-3'-phenylspiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4k**)



**Figure S30:**  $^1\text{H}$  NMR spectrum of 5-Bromo-3'-phenylspiro[indoline-3,2'-thiazolidine]-2,4'-dione (41)



**Figure S31:**  $^{13}\text{C}$  NMR spectrum of 5-Bromo-3'-phenylspiro[indoline-3,2'-thiazolidine]-2,4'-dione (41)

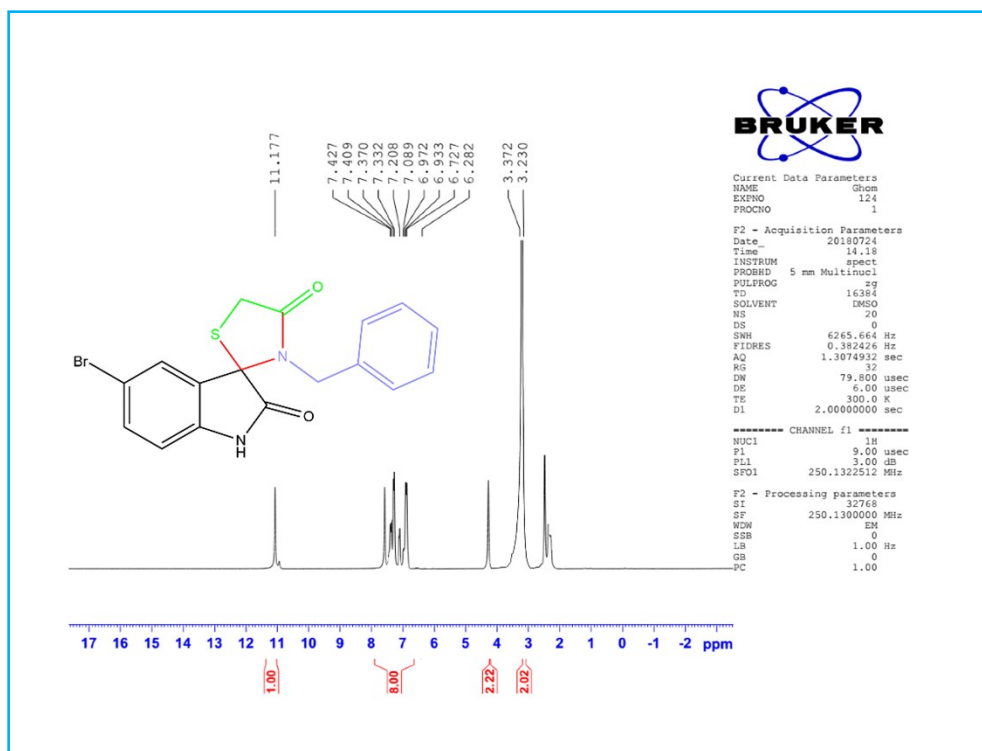


Figure S32:  $^1\text{H}$  NMR spectrum of 3'-Benzyl-5-bromospiro[indoline-3,2'-thiazolidine]-2,4'-dione (**4m**)

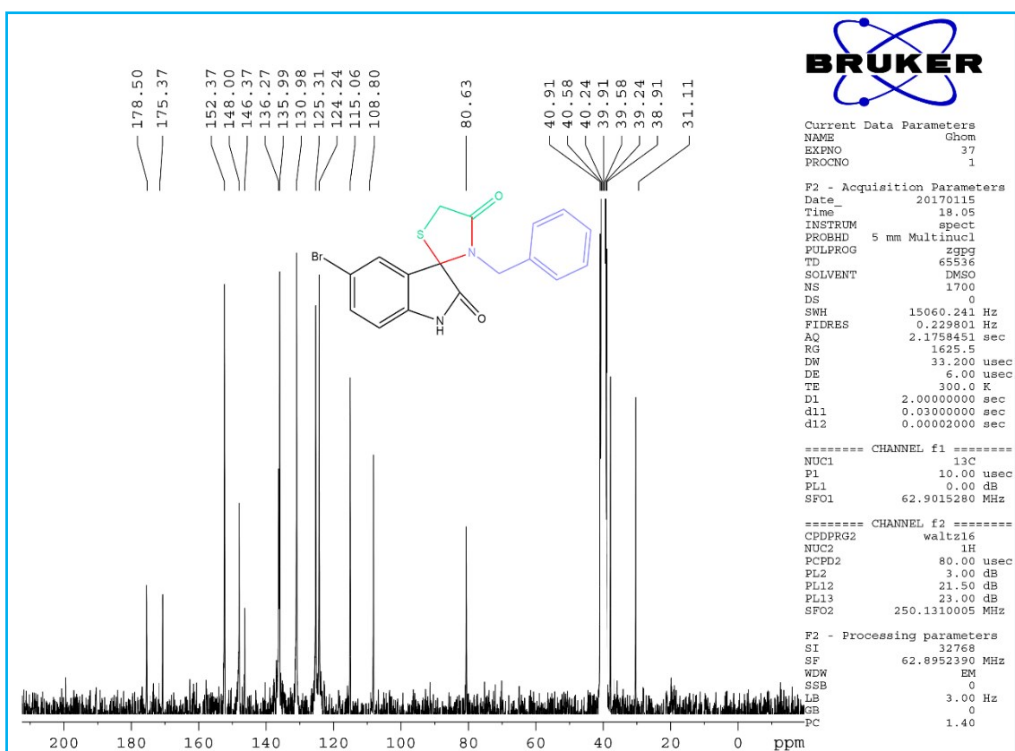
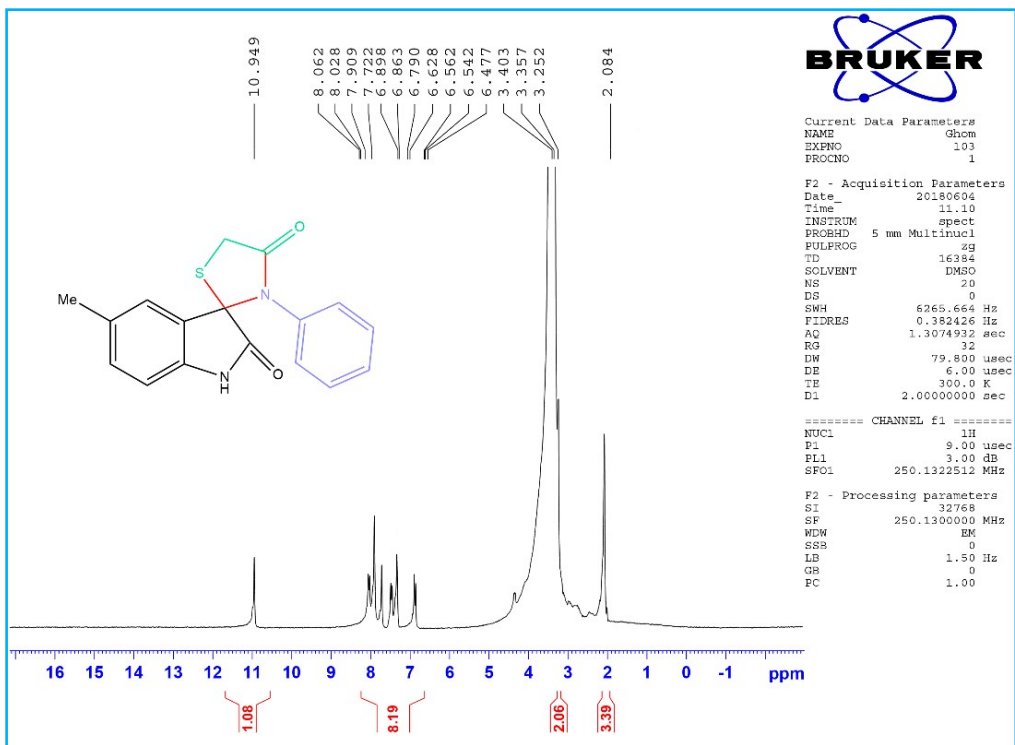
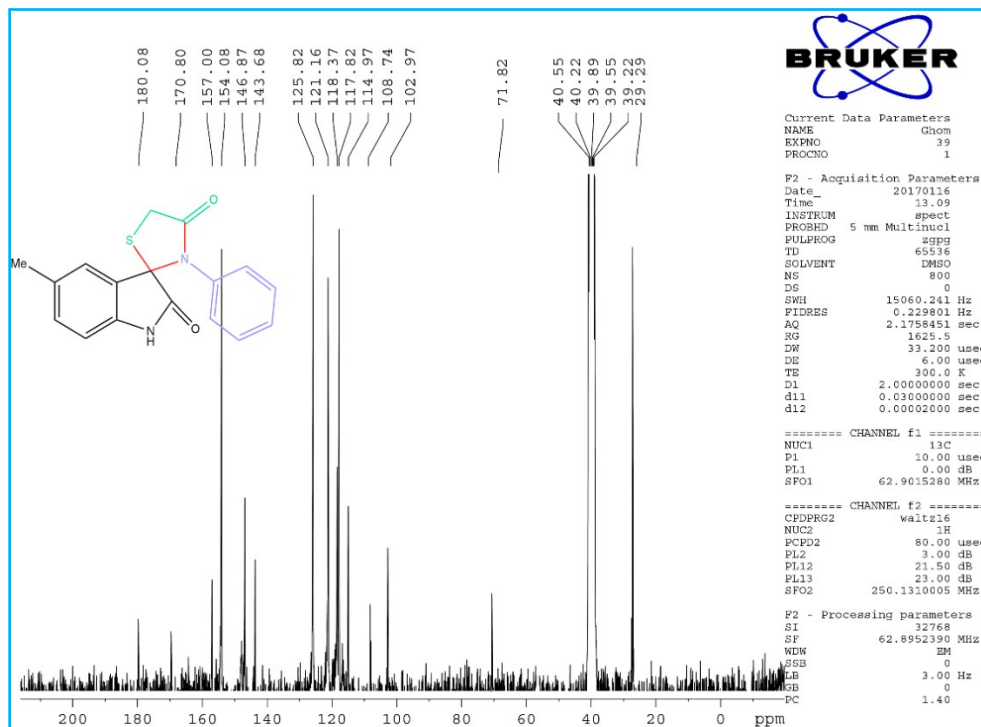


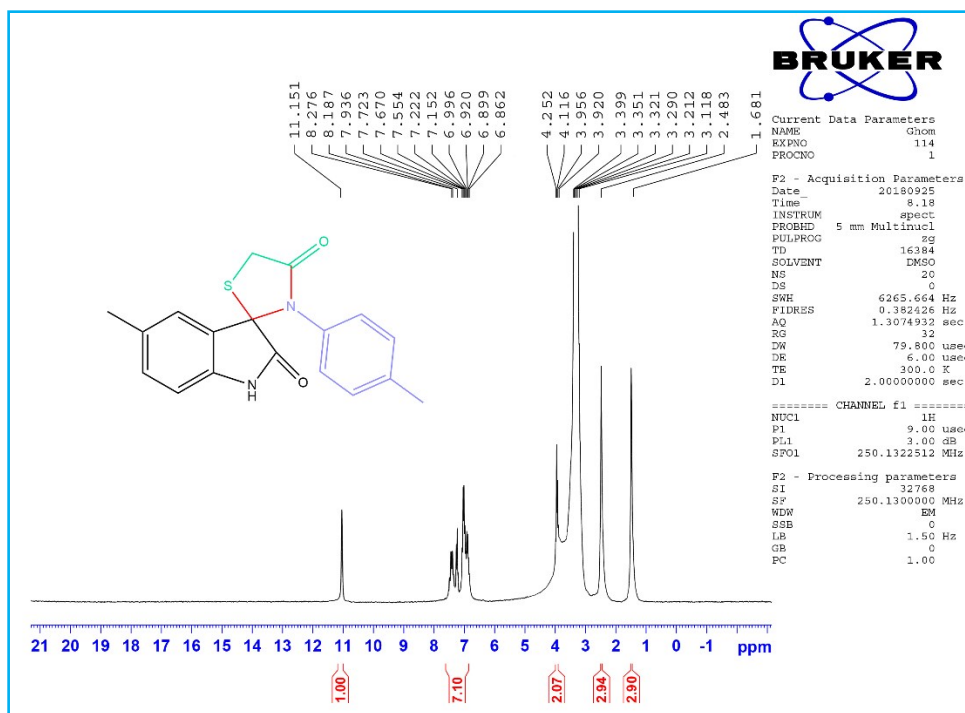
Figure S33:  $^{13}\text{C}$  NMR spectrum of 3'-Benzyl-5-bromospiro[indoline-3,2'-thiazolidine]-2,4'-dione (**4m**)



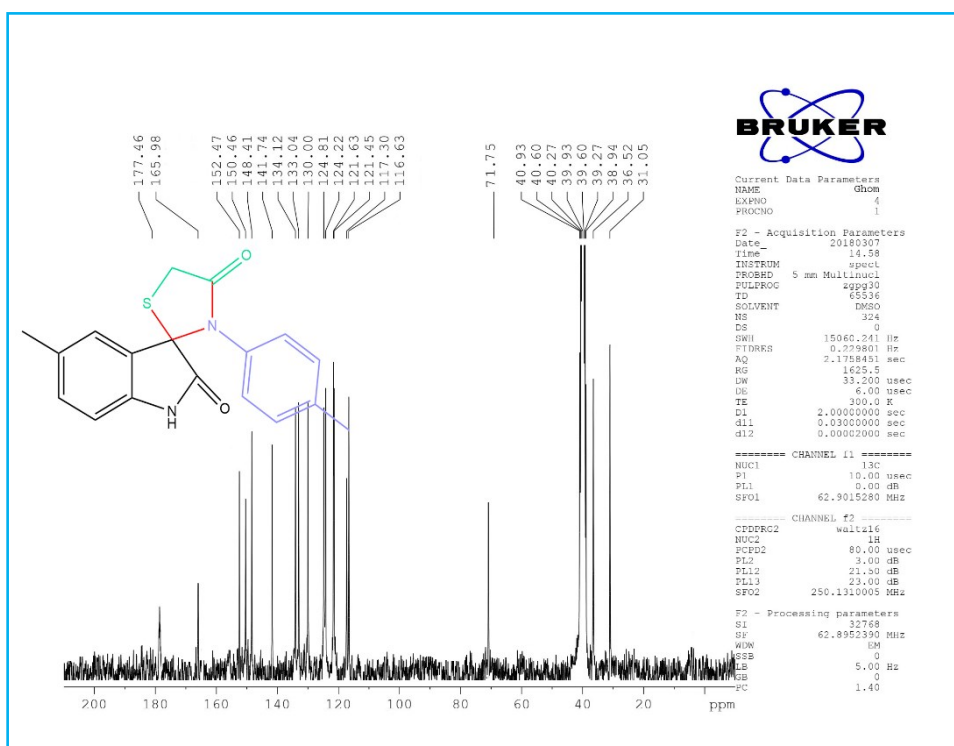
**Figure S34:**  $^1\text{H}$  NMR spectrum of 5-Methyl-3'-phenylspiro[indoline-3,2'-thiazolidine]-2,4'-dione (4n)



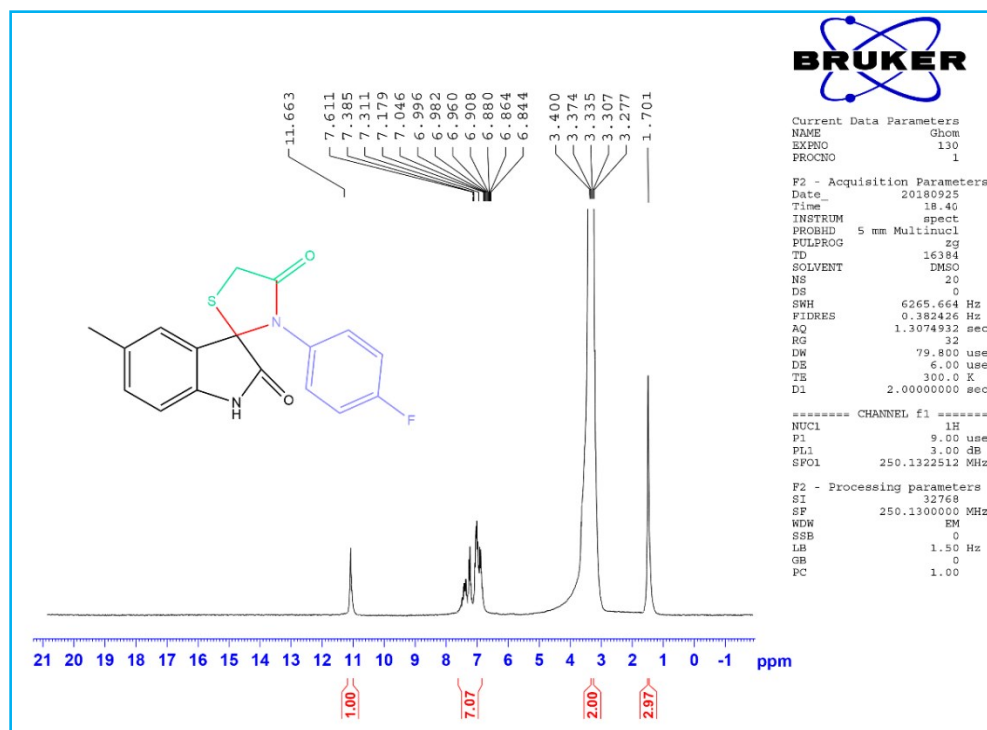
**Figure S35:**  $^{13}\text{C}$  NMR spectrum of 5-Methyl-3'-phenylspiro[indoline-3,2'-thiazolidine]-2,4'-dione (4n)



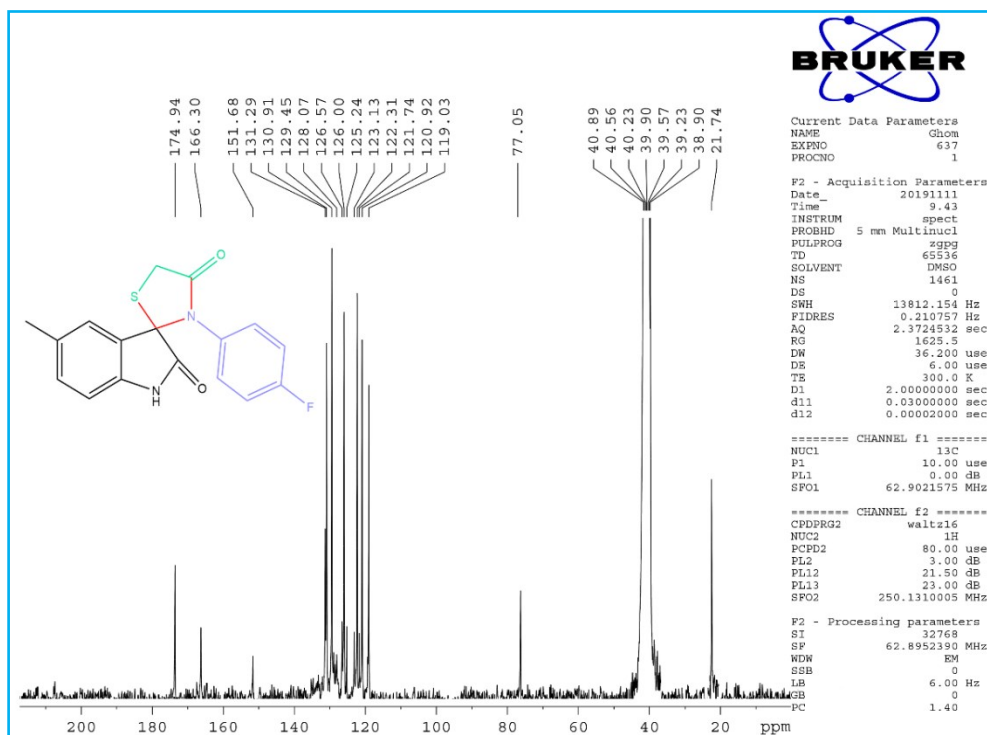
**Figure S36:**  $^1\text{H}$  NMR spectrum of 3'-(4-Methyl)- 5-methylspiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**40**)



**Figure S37:**  $^{13}\text{C}$  NMR spectrum of 3'-(4-Methyl)- 5-methylspiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**40**)

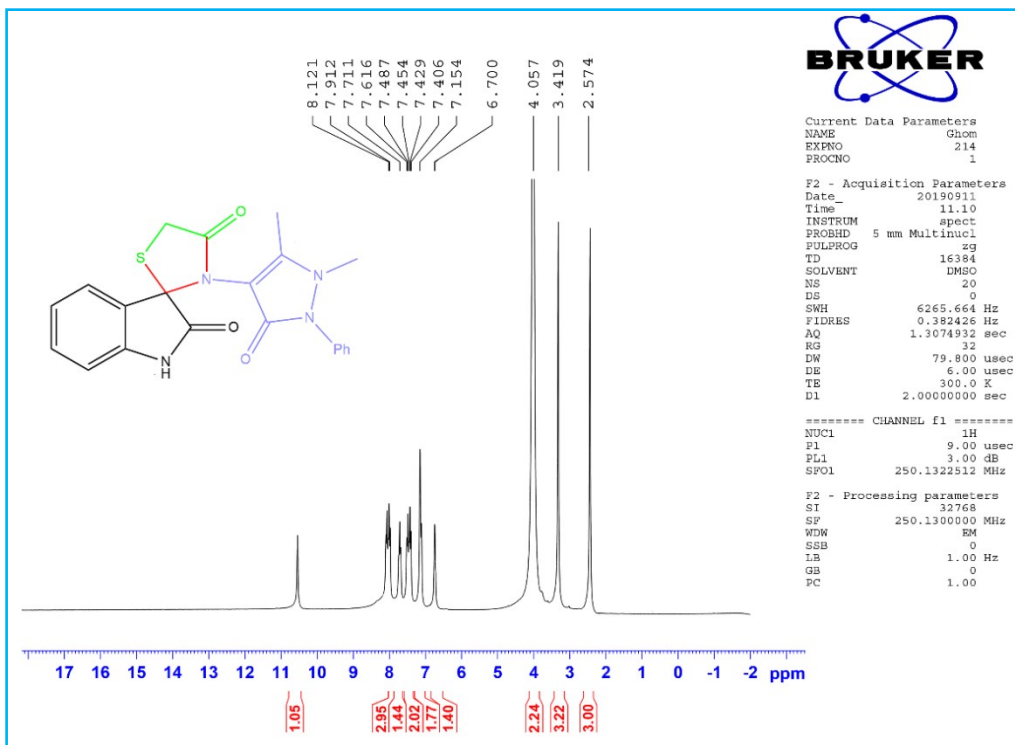


**Figure S38:**  $^1\text{H}$  NMR spectrum of 3'-(4-Fluorophenyl)- 5-methylspiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4p**)

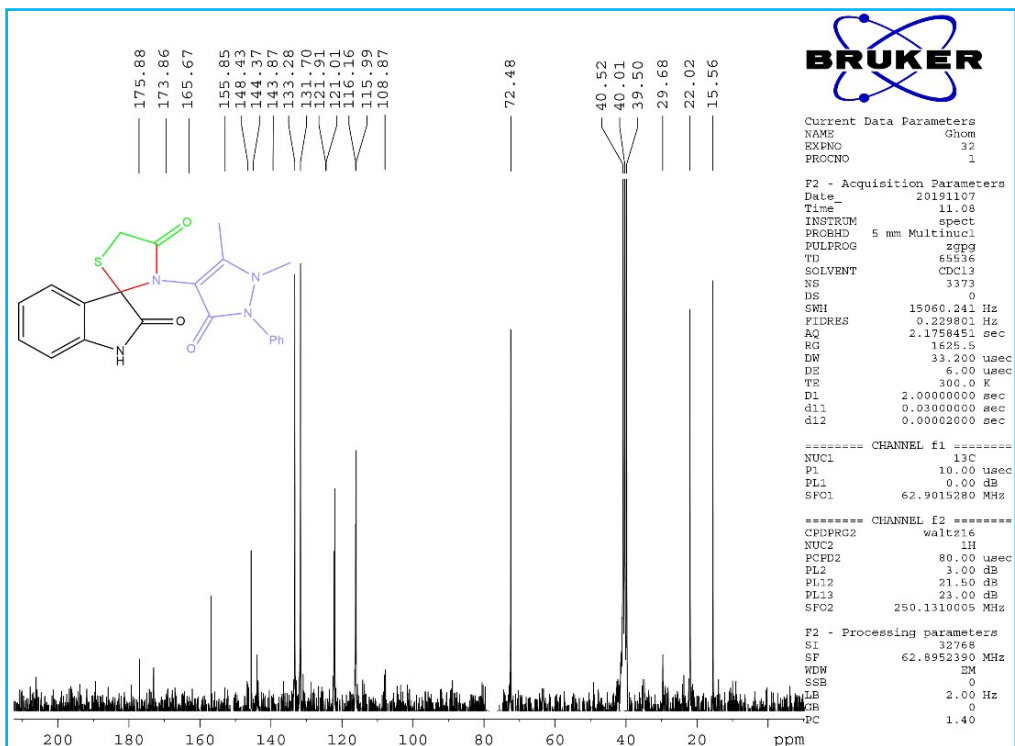


**Figure S39:**  $^{13}\text{C}$  NMR spectrum of 3'-(4-Fluorophenyl)- 5-methylspiro[3H-indole-3,2'-thiazolidine]-2,4'(1H)-dione (**4p**)

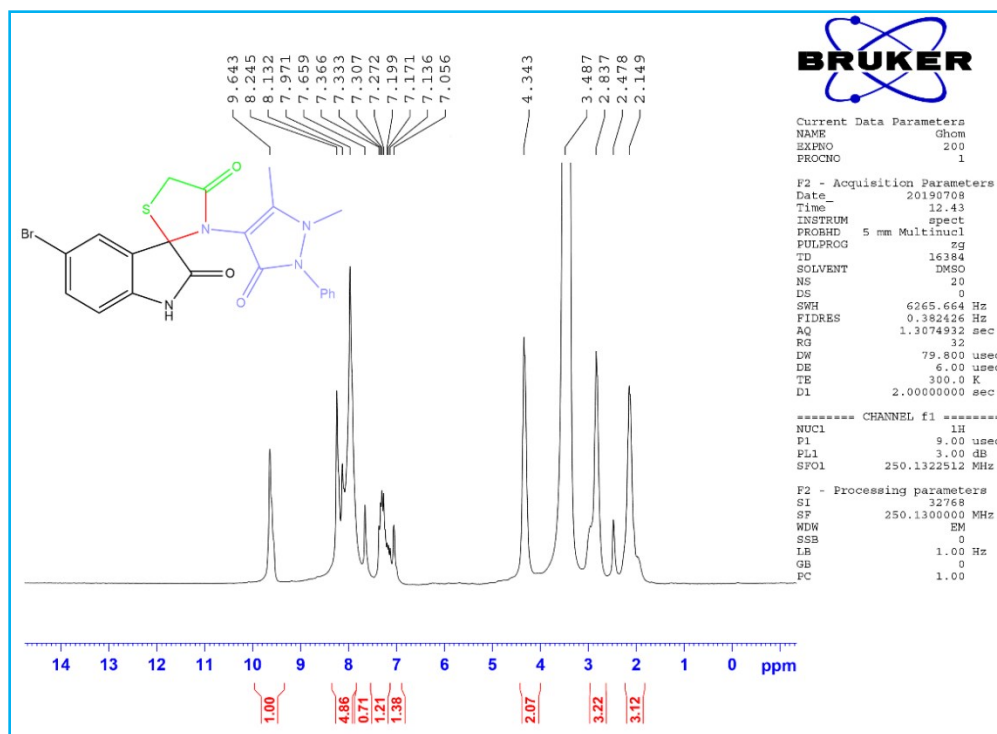




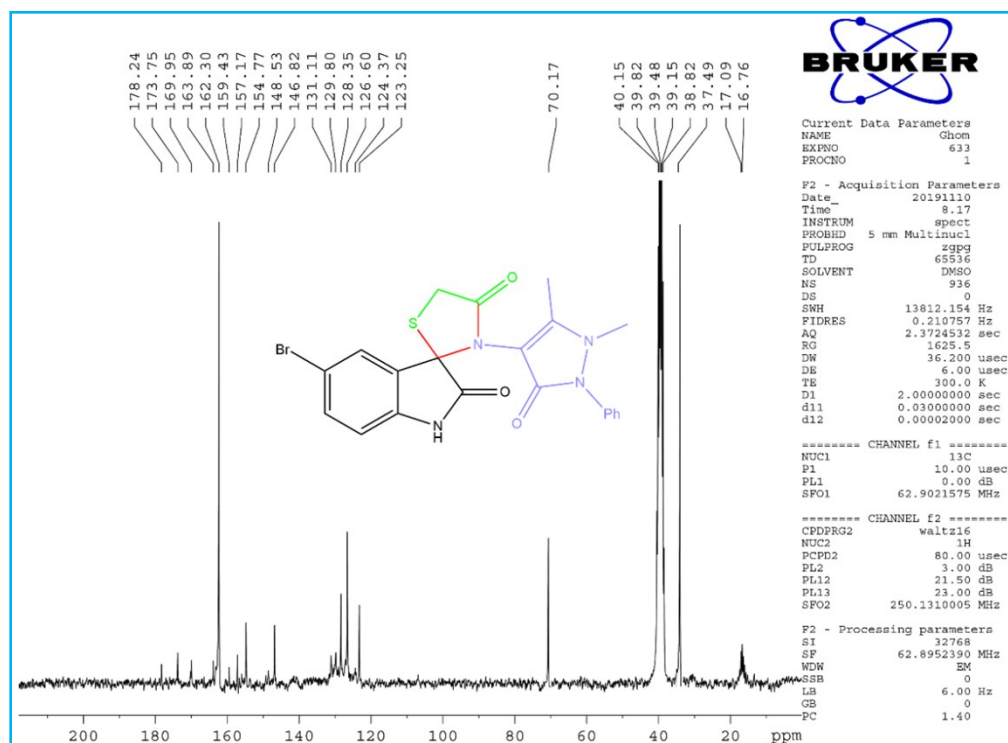
**Figure S40:**  $^1\text{H}$  NMR spectrum of 3'-(2,3-dihydro-1,5-dimethyl-3-oxo-2-phenyl-1Hpyrazol-4-yl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H) dione (**4q**)



**Figure S41:**  $^{13}\text{C}$  NMR spectrum of 3'-(2,3-dihydro-1,5-dimethyl-3-oxo-2-phenyl-1Hpyrazol-4-yl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H) dione (**4q**)

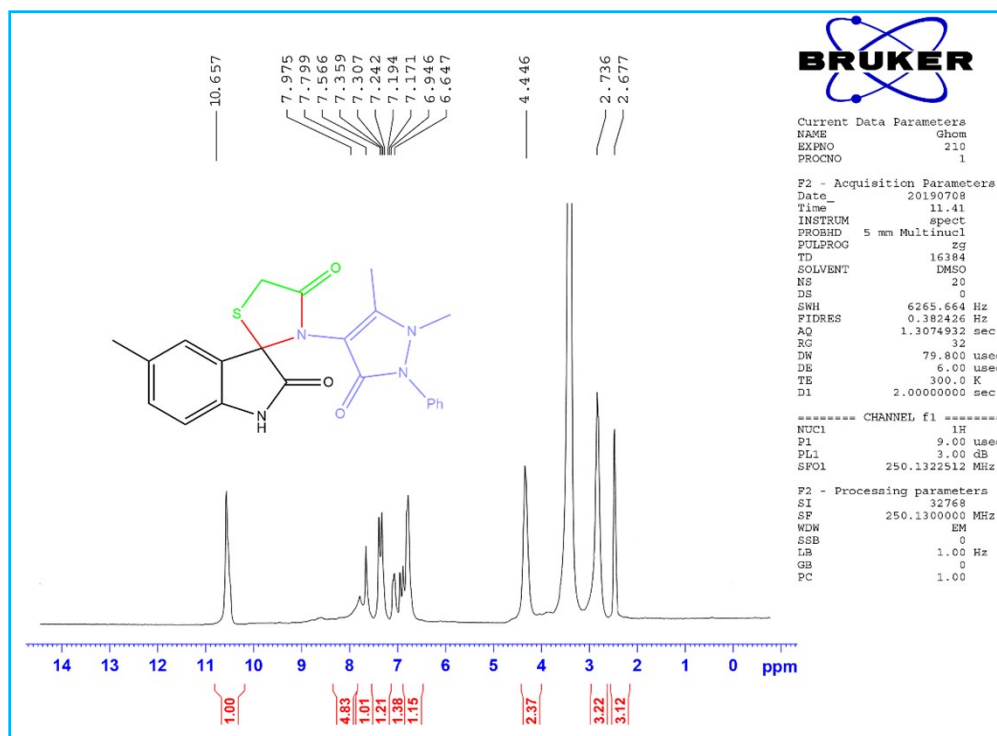


**Figure S42:**  $^1\text{H}$  NMR spectrum of 5-Bromo-3'-(2,3-dihydro-1,5-dimethyl-3-oxo-2-phenyl-1Hpyrazol-4-yl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H) dione (**4r**)

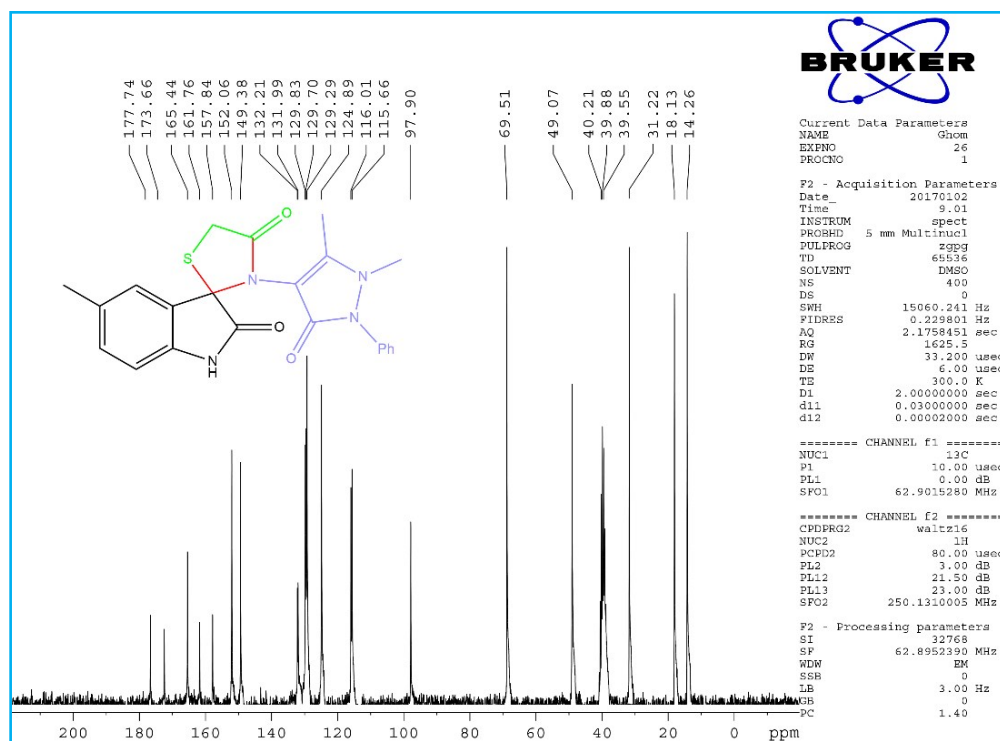


**Figure S43:**  $^{13}\text{C}$  NMR spectrum of 5-Bromo-3'-(2,3-dihydro-1,5-dimethyl-3-oxo-2-phenyl-1Hpyrazol-4-yl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H) dione (**4r**)

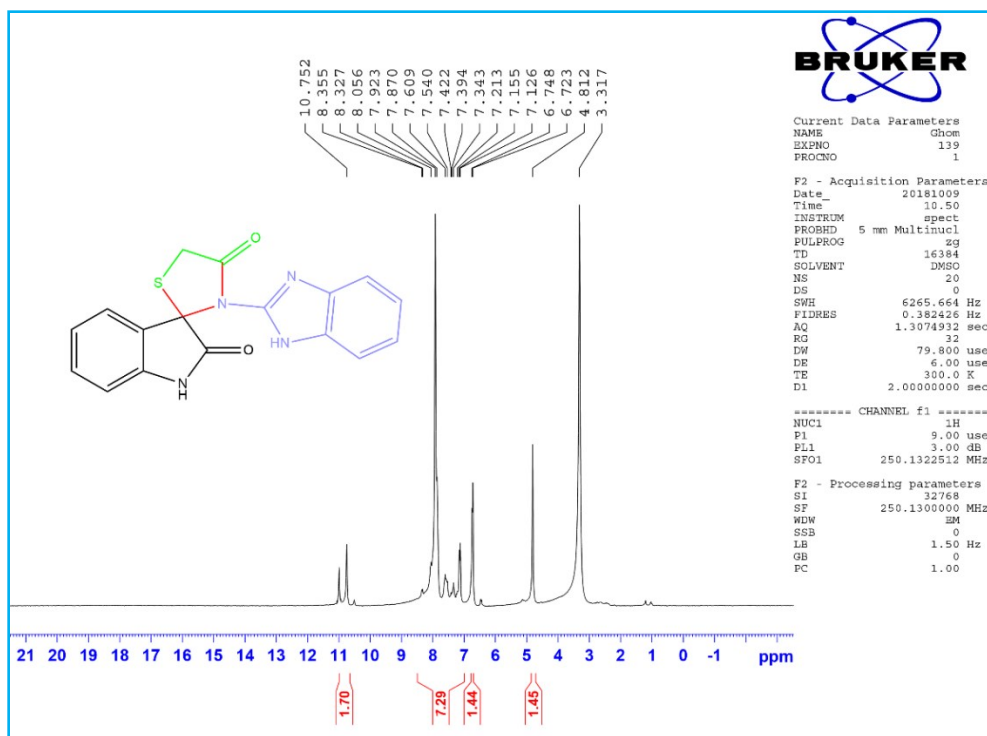




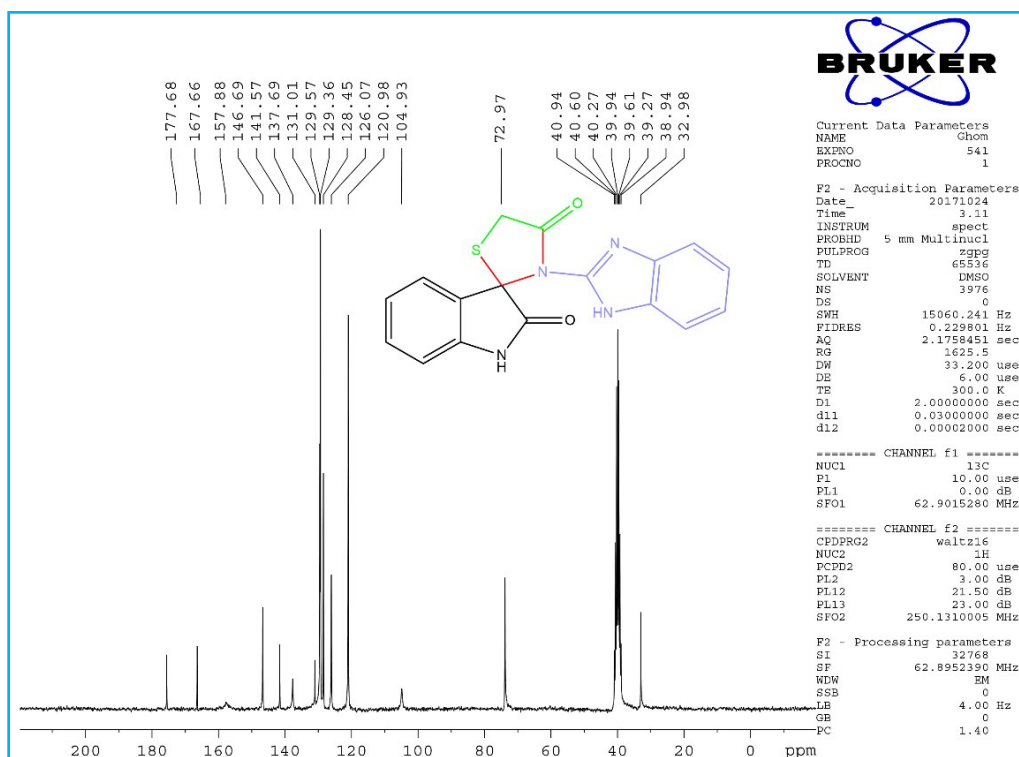
**Figure S44:**  $^1\text{H}$  NMR spectrum of 5-Methyl-3'-(2,3-dihydro-1,5-dimethyl-3-oxo-2-phenyl-1Hpyrazol-4-yl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H) dione (**4s**)



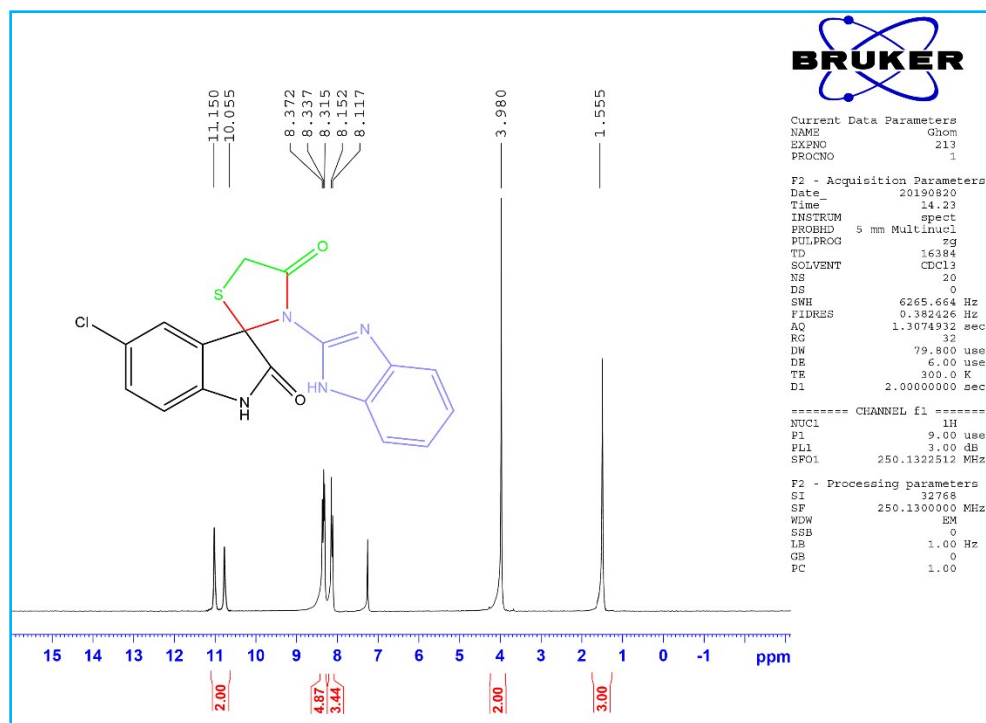
**Figure S45:**  $^{13}\text{C}$  NMR spectrum of 5-Methyl-3'-(2,3-dihydro-1,5-dimethyl-3-oxo-2-phenyl-1Hpyrazol-4-yl)-spiro[3H-indole-3,2'-thiazolidine]-2,4'(1H) dione (**4s**)



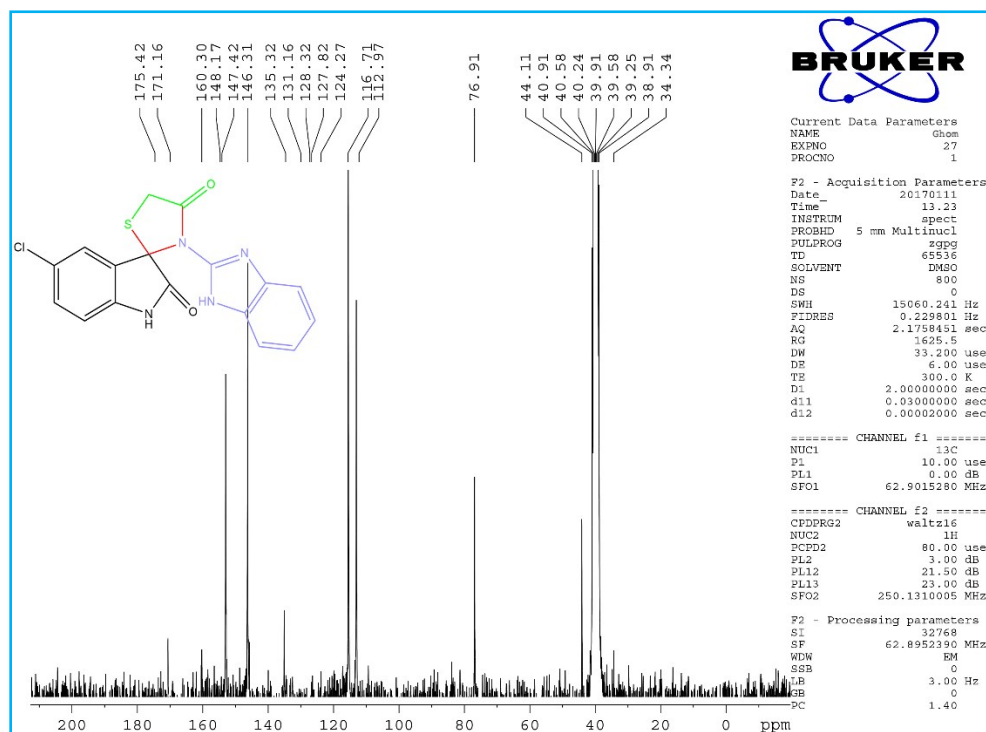
**Figure S46:**  $^1\text{H}$  NMR spectrum of 3'-(1H-benzimidazol-2-yl)-spiro-[3H-indole-3,2' thiazolidine]-2,4'(1H)-dione (**4t**)



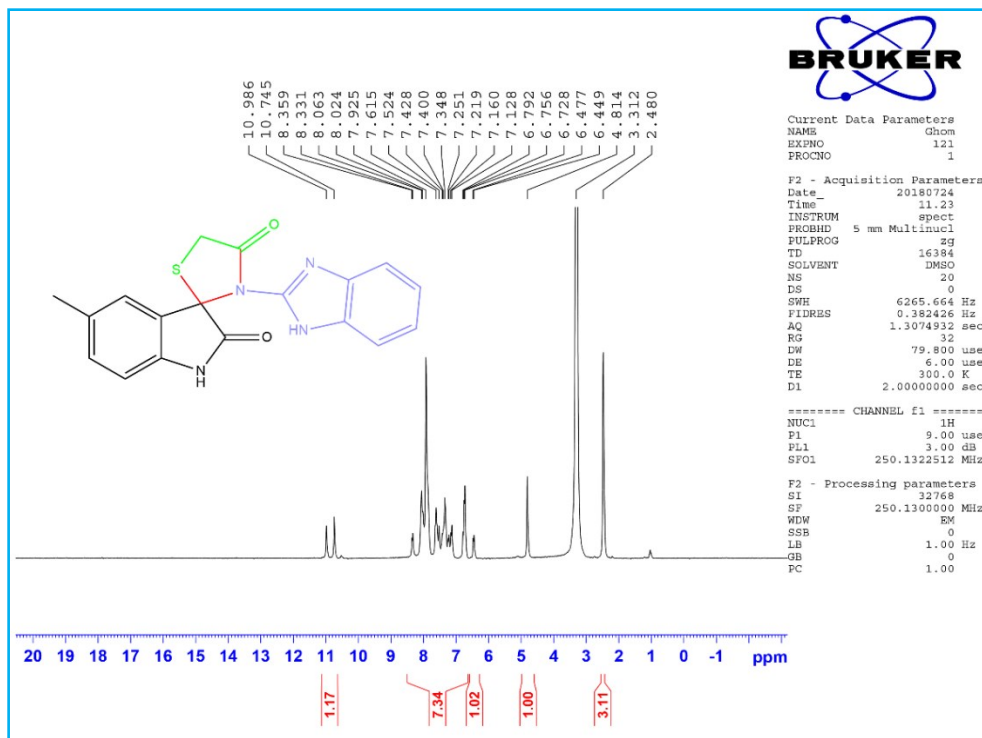
**Figure S47:**  $^{13}\text{C}$  NMR spectrum of 3'-(1H-benzimidazol-2-yl)-spiro-[3H-indole-3,2' thiazolidine]-2,4'(1H)-dione (**4t**)



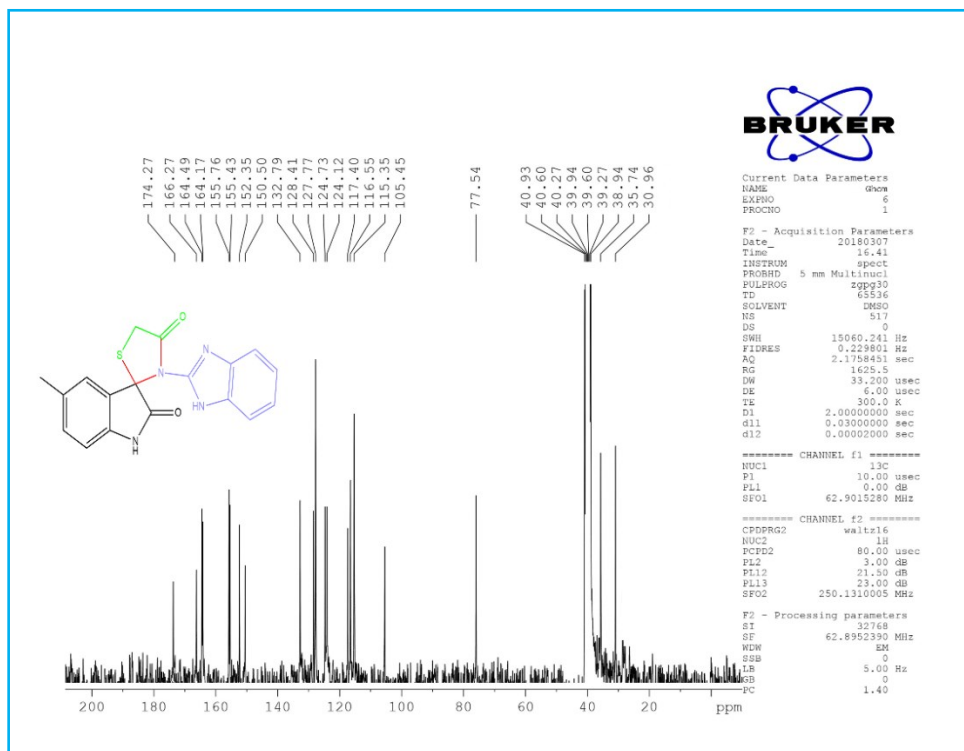
**Figure S48:**  $^1\text{H}$  NMR spectrum of 5-Chloro-3'-(1H-benzimidazol-2-yl)-spiro-[3H-indole 3,2'-thiazolidine]-2,4'(1H)-dione (**4u**)



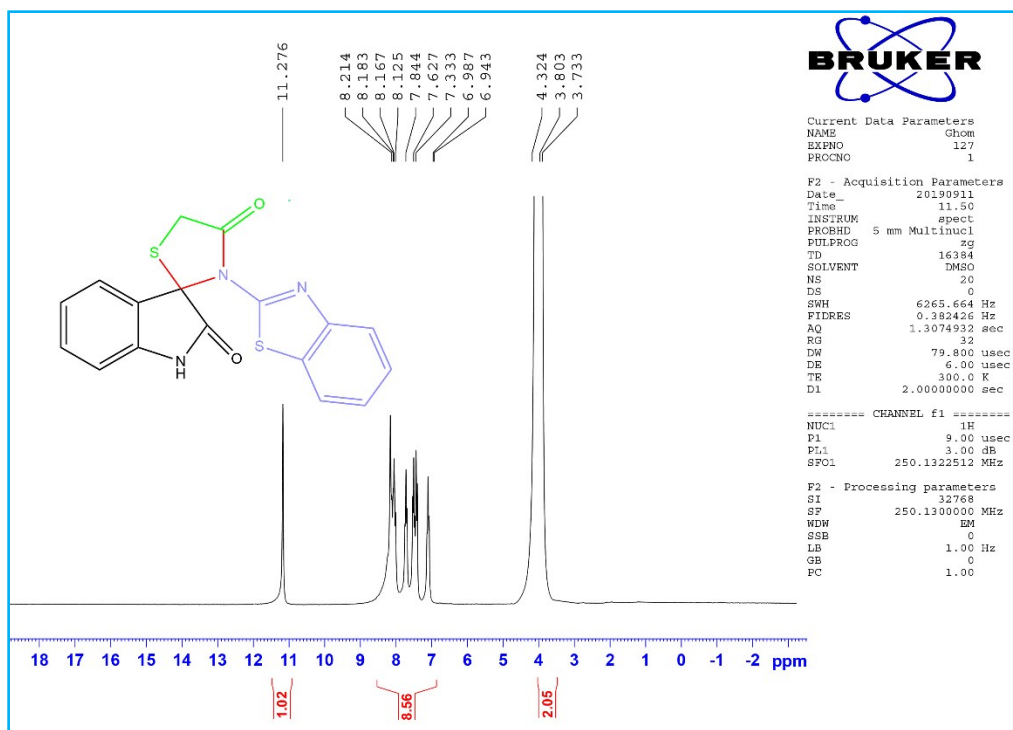
**Figure S49:**  $^{13}\text{C}$  NMR spectrum of 5-Chloro-3'-(1H-benzimidazol-2-yl)-spiro-[3H-indole 3,2'-thiazolidine]-2,4'(1H)-dione (**4u**)



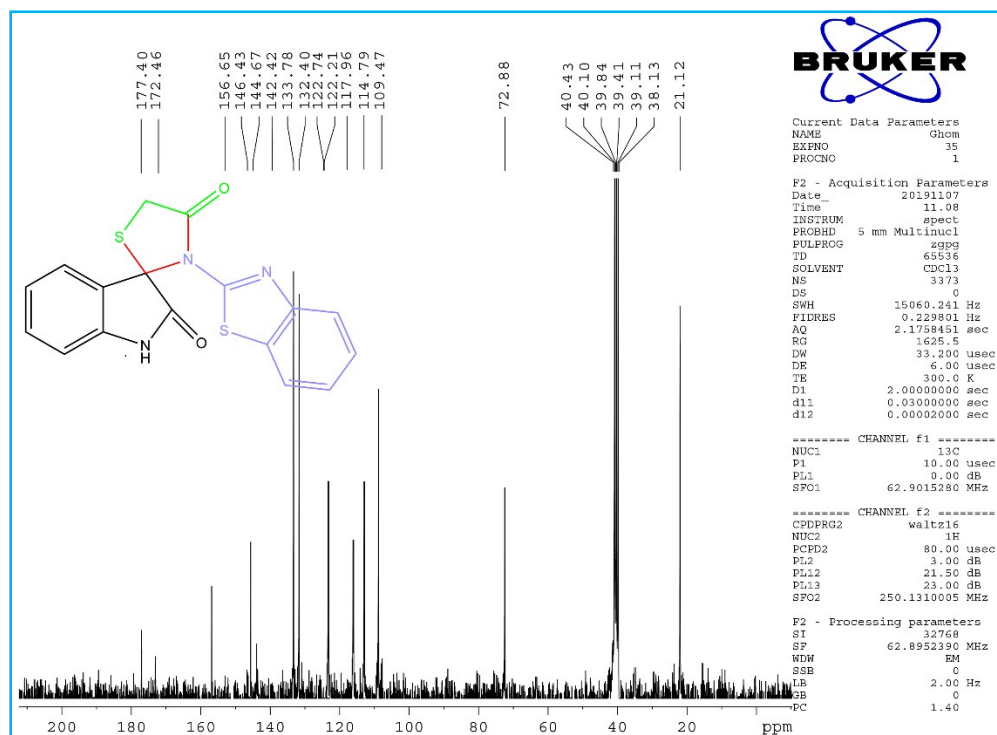
**Figure S50:**  $^1\text{H}$  NMR spectrum of 5-Methyl-3'-(1H-benzimidazol-2-yl)-spiro-[3H-indole3,2`thiazolidine]-2,4'(1H)-dione (**4v**)



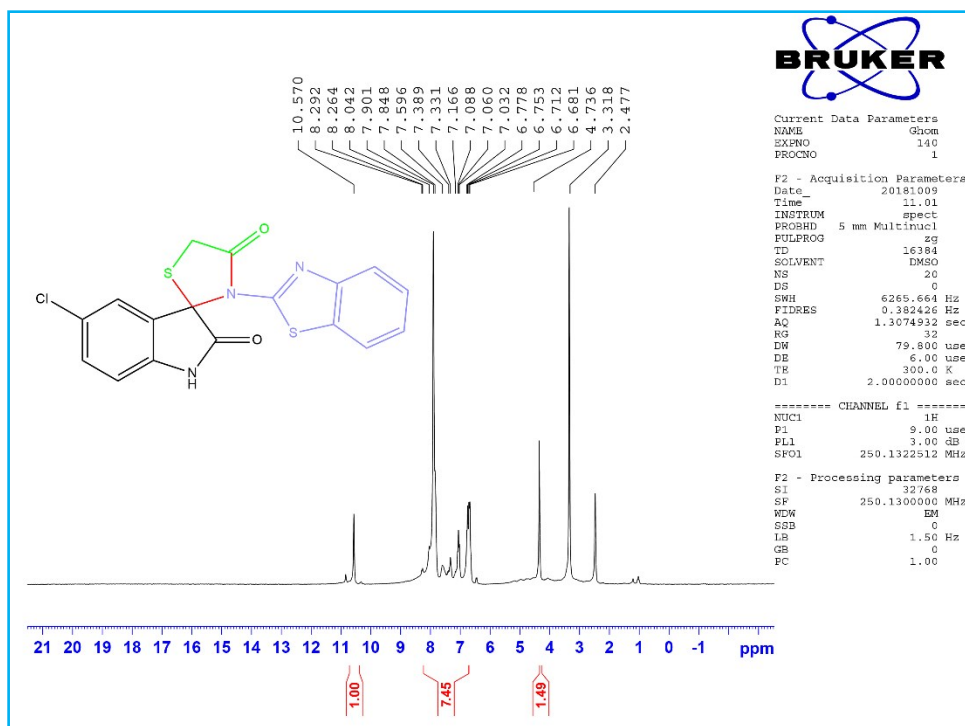
**Figure S51:**  $^{13}\text{C}$  NMR spectrum of 5-Methyl-3'-(1H-benzimidazol-2-yl)-spiro-[3H-indole3,2`thiazolidine]-2,4'(1H)-dione (**4v**)



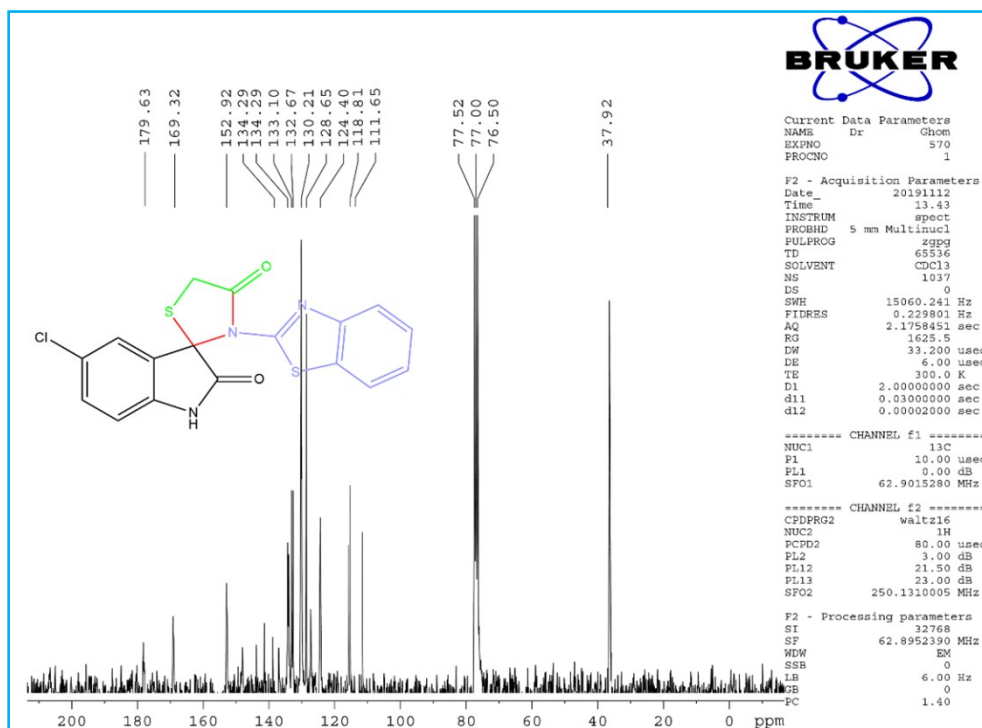
**Figure S52:**  $^1\text{H}$  NMR spectrum of 3'-(1,3-Benzothiazol-2-yl)-spiro-[3H-indole-3,2' thiazolidine]2,4'-(1H)-dione (**4w**)



**Figure S53:**  $^{13}\text{C}$  NMR spectrum of 3'-(1,3-Benzothiazol-2-yl)-spiro-[3H-indole-3,2' thiazolidine]2,4'-(1H)-dione (**4w**)

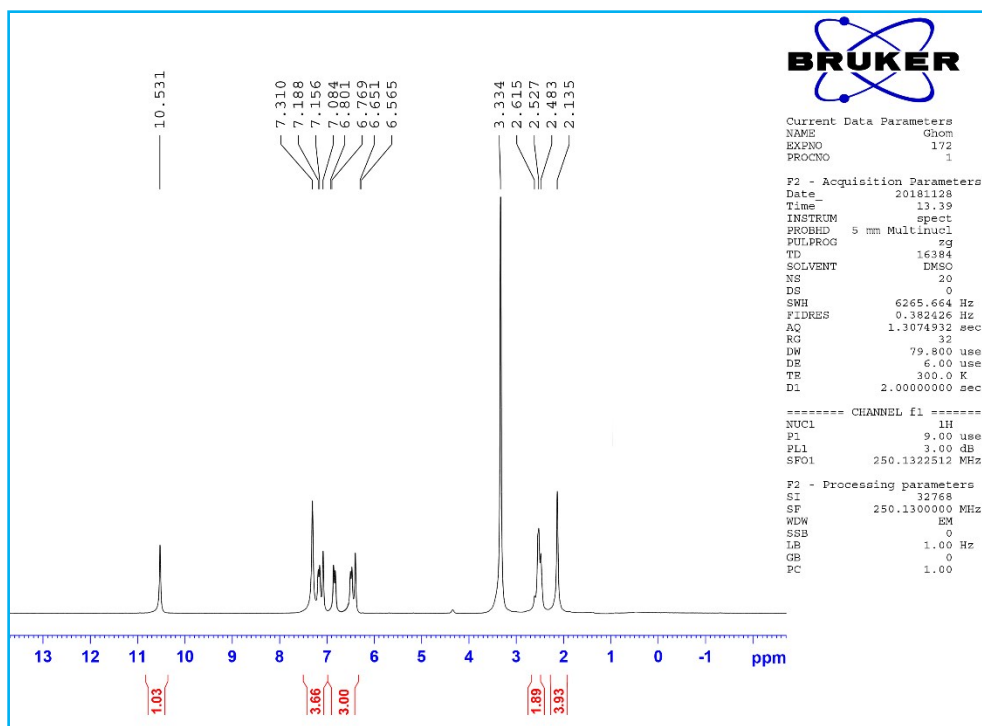


**Figure S54:**  $^1\text{H}$  NMR spectrum of 5-Chloro-3'-(1,3-benzothiazol-2-yl)-spiro-[3H-indole-3,2'thiazolidine]-2,4'(1H)-dione (**4x**)

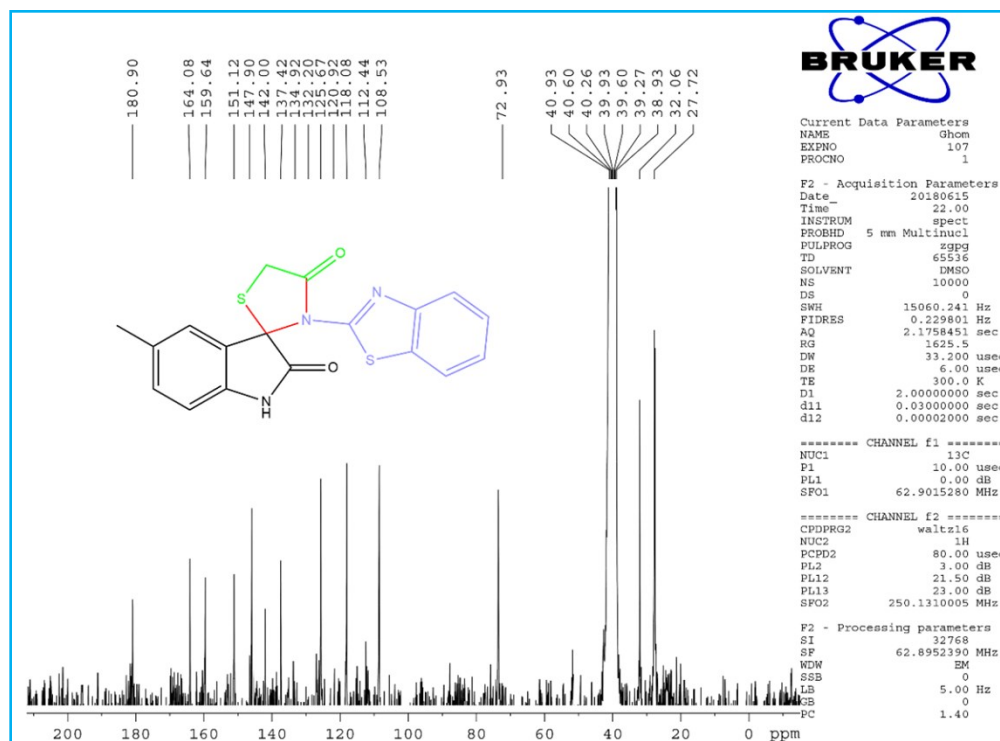


**Figure S55:**  $^{13}\text{C}$  NMR spectrum of 5-Chloro-3'-(1,3-benzothiazol-2-yl)-spiro-[3H-indole-3,2'thiazolidine]-2,4'(1H)-dione (**4x**)

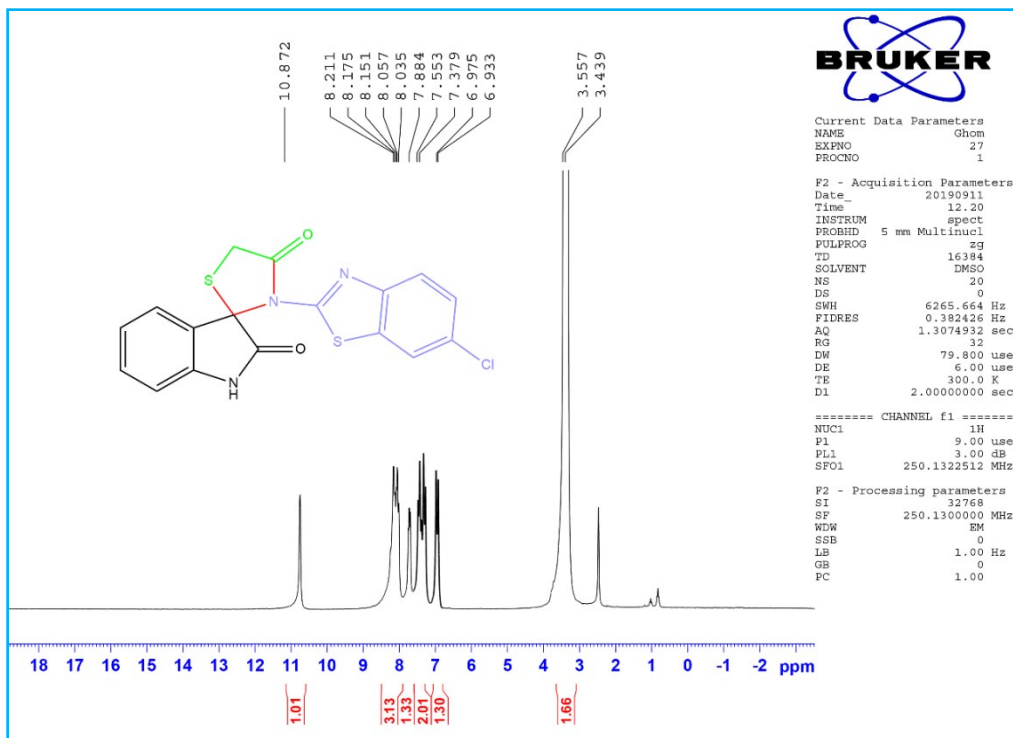




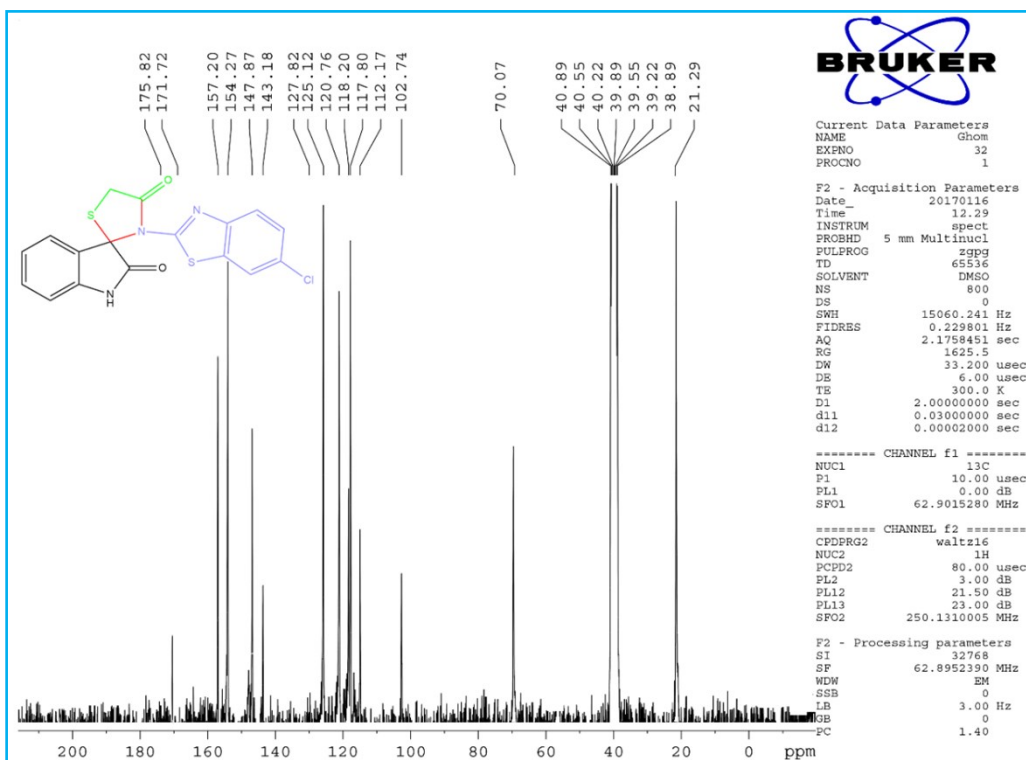
**Figure S56:**  $^1\text{H}$  NMR spectrum of 5-Methyl-3'-(1,3-benzothiazol-2-yl)-spiro-[3H-indole3,2'-thiazolidine]-2,4'(1H)-dione (**4y**)



**Figure S57:**  $^{13}\text{C}$  NMR spectrum of 5-Methyl-3'-(1,3-benzothiazol-2-yl)-spiro-[3H-indole3,2'-thiazolidine]-2,4'(1H)-dione (**4y**)



**Figure S58:**  $^1\text{H}$  NMR spectrum of 3'-(6-chloro-1,3-benzothiazol-2-yl)-spiro-[3H-indole3,2'-thiazolidine]-2,4'(1H)-dione (**4z**)



**Figure S59:**  $^{13}\text{C}$  NMR spectrum of 3'-(6-chloro-1,3-benzothiazol-2-yl)-spiro-[3H-indole3,2'-thiazolidine]-2,4'(1H)-dione (**4z**)