



UNIVERSITAT AUTÒNOMA DE BARCELONA  
Escola de Postgrau  
Departament de Química

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**Materials híbrids orgànico-inorgànics  
derivats de biperidines i de sals d'imidazoli.  
Aplicacions en catàlisi.**

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MONTSERRAT TRILLA CASTAÑO

TESI DOCTORAL

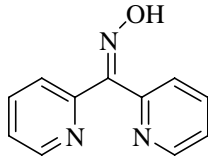
Juny 2008

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## **Annex: Col·lecció d'espectres**

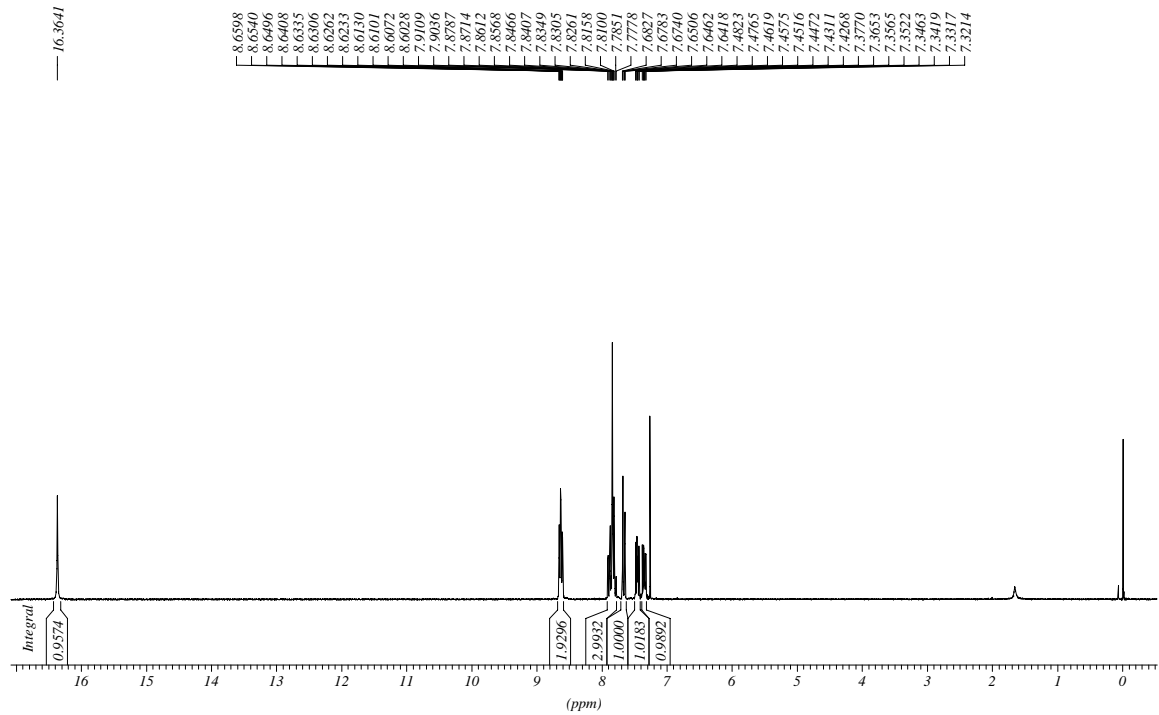
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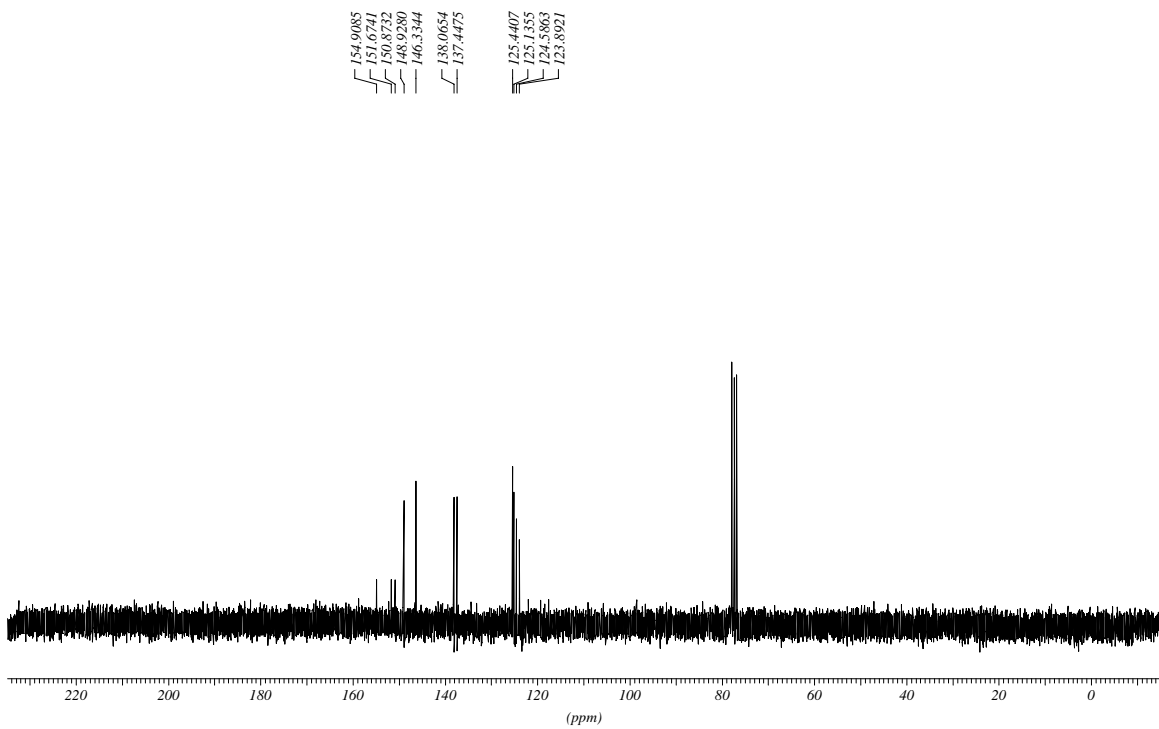


### oxima de la di-2-piridilmetanona, 16

$^1\text{H}$ -RMN ( $\text{CDCl}_3$ , 250 MHz)

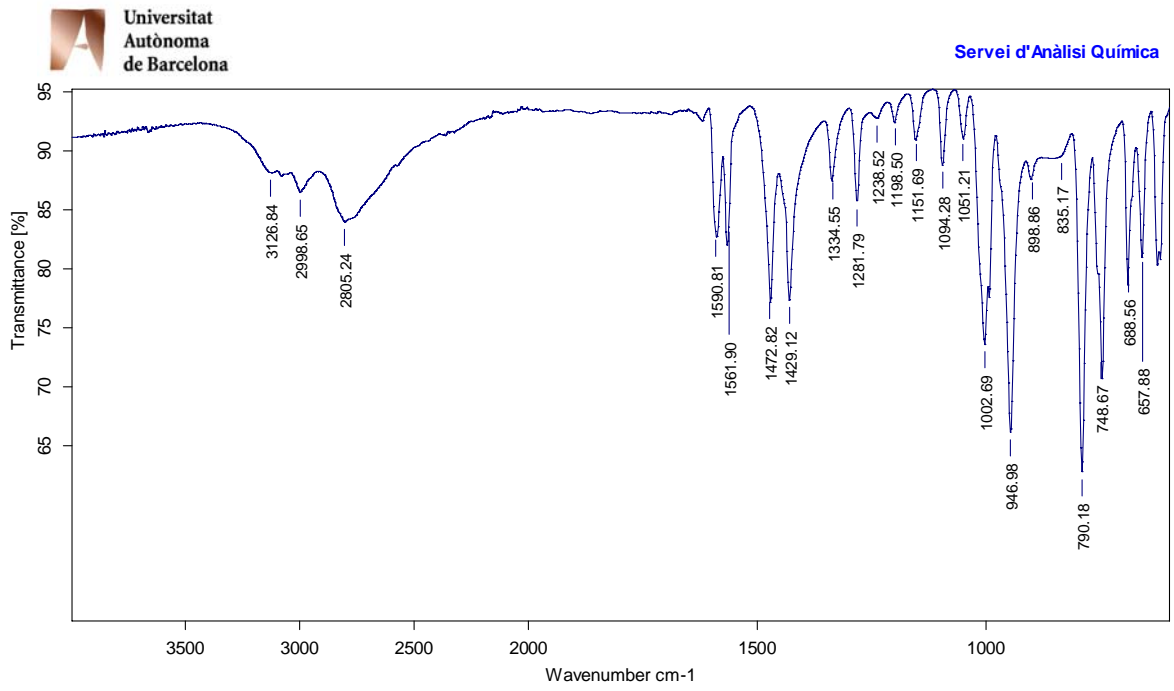


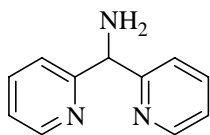
$^{13}\text{C}$ -RMN ( $\text{CDCl}_3$ , 62.5 MHz)



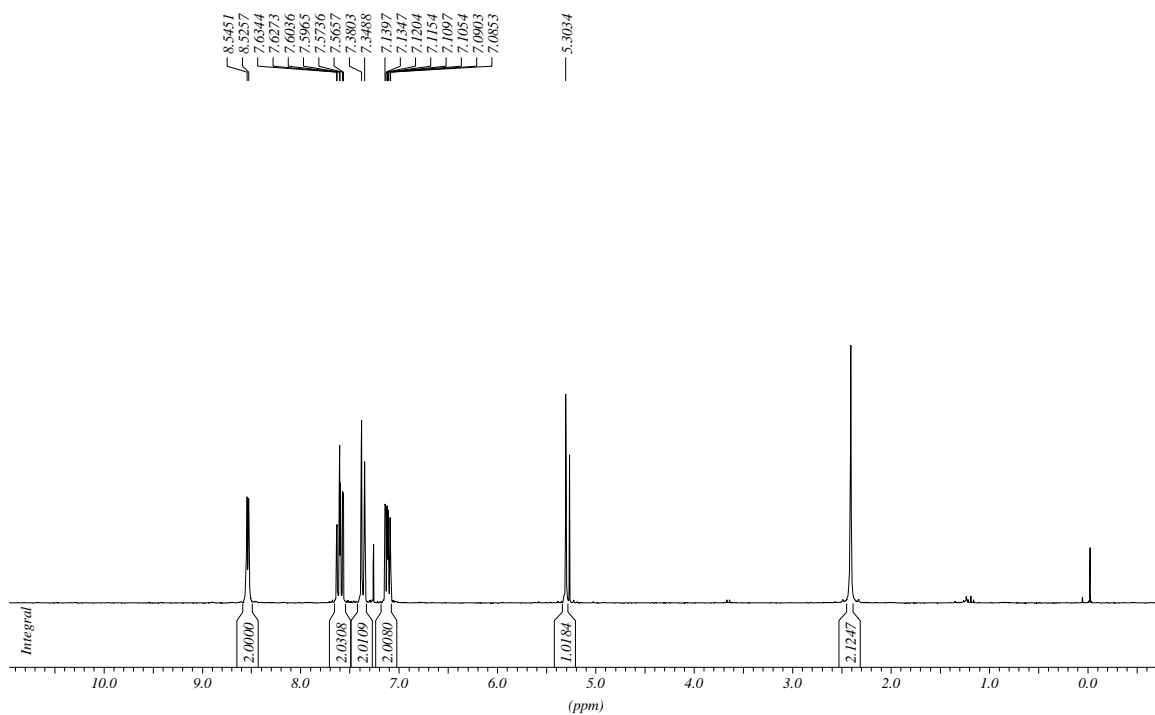
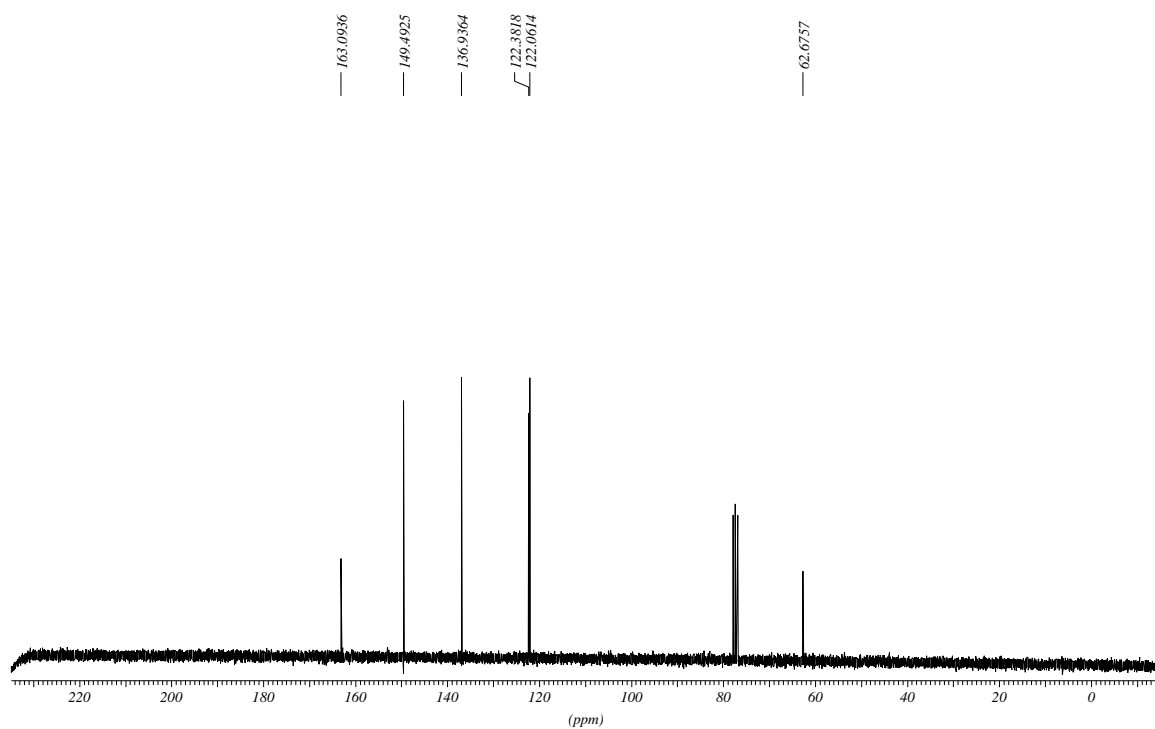


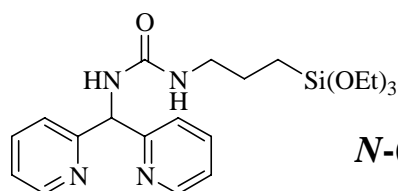
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)





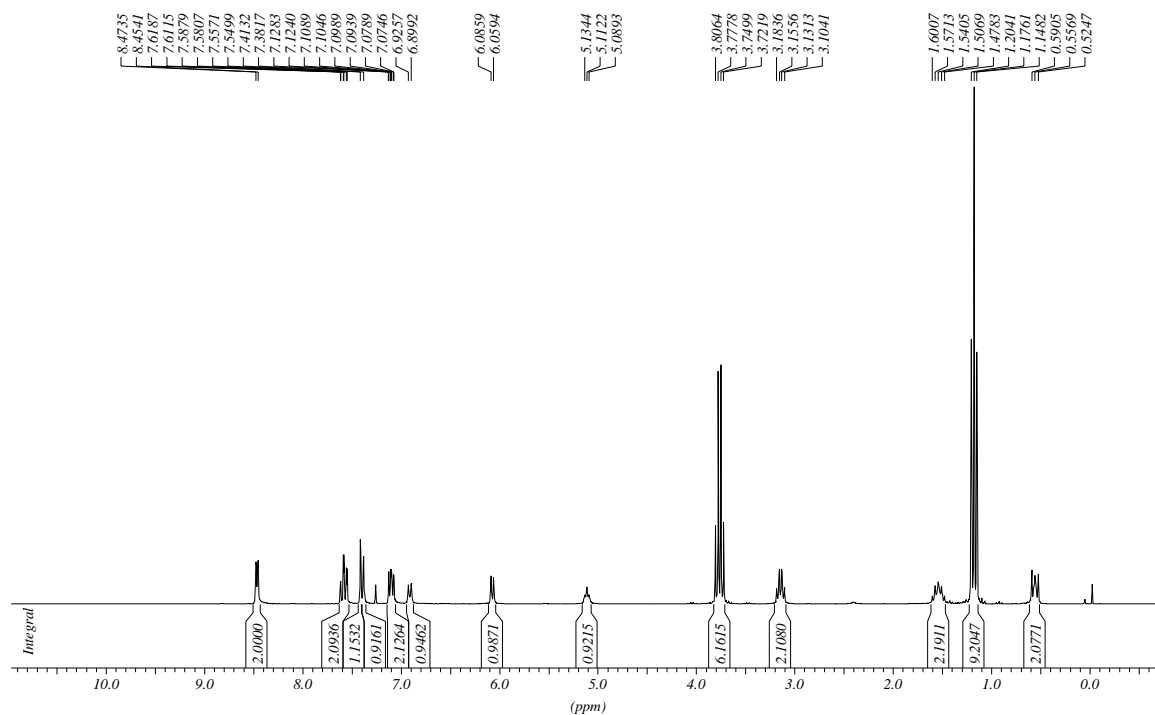
di-2-piridilmetanamina, 17

 $^1\text{H}$ -RMN ( $\text{CDCl}_3$ , 250 MHz) $^{13}\text{C}$ -RMN ( $\text{CDCl}_3$ , 62.5 MHz)

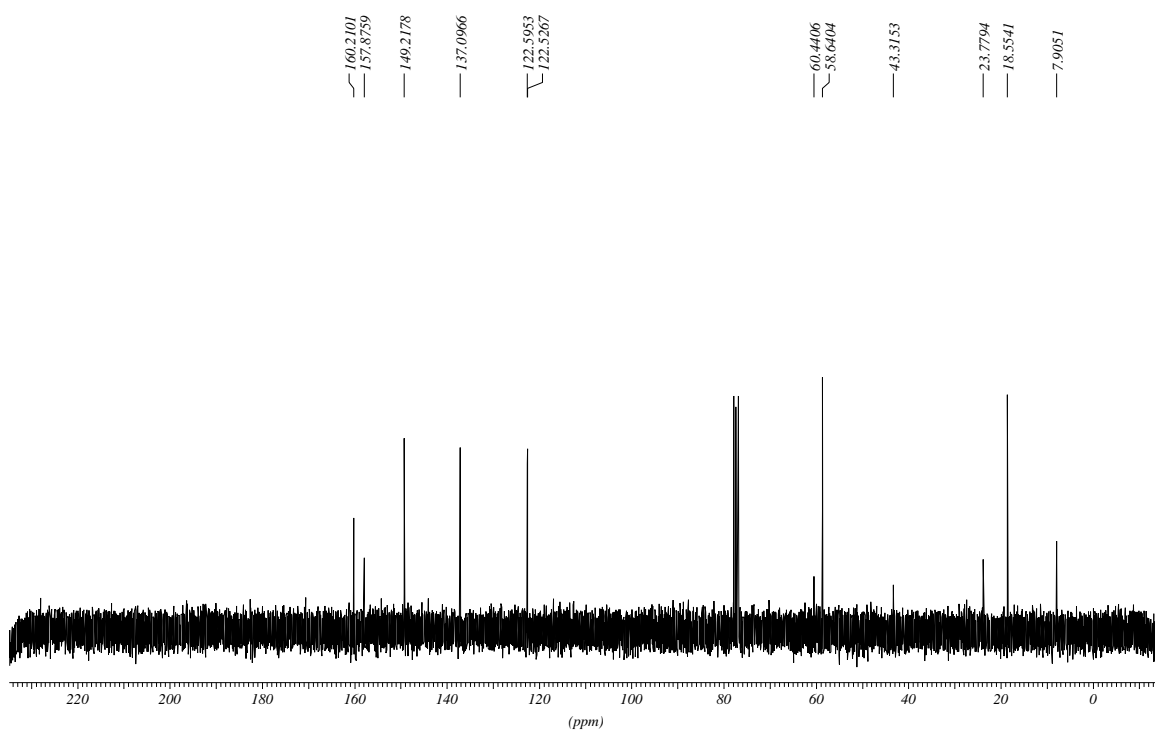


***N*-(di-2-piridilmetil)-*N'*-(3-(triethoxisilil)propil)urea, 5**

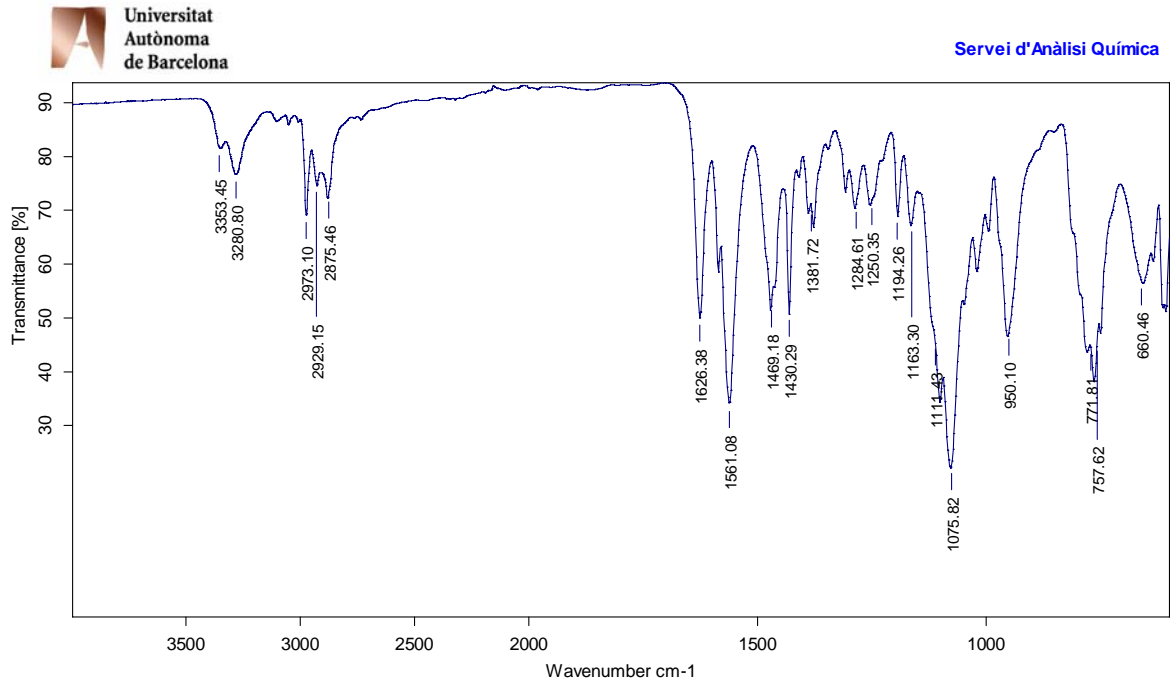
**<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)**

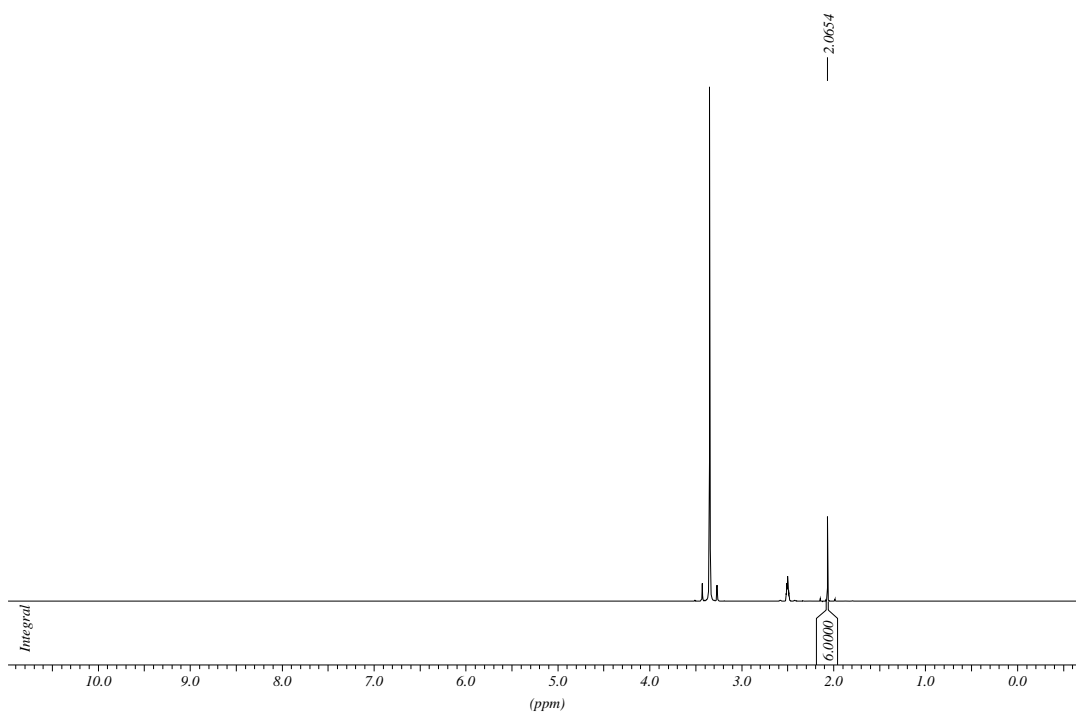


**<sup>13</sup>C-RMN (CDCl<sub>3</sub>, 62.5 MHz)**

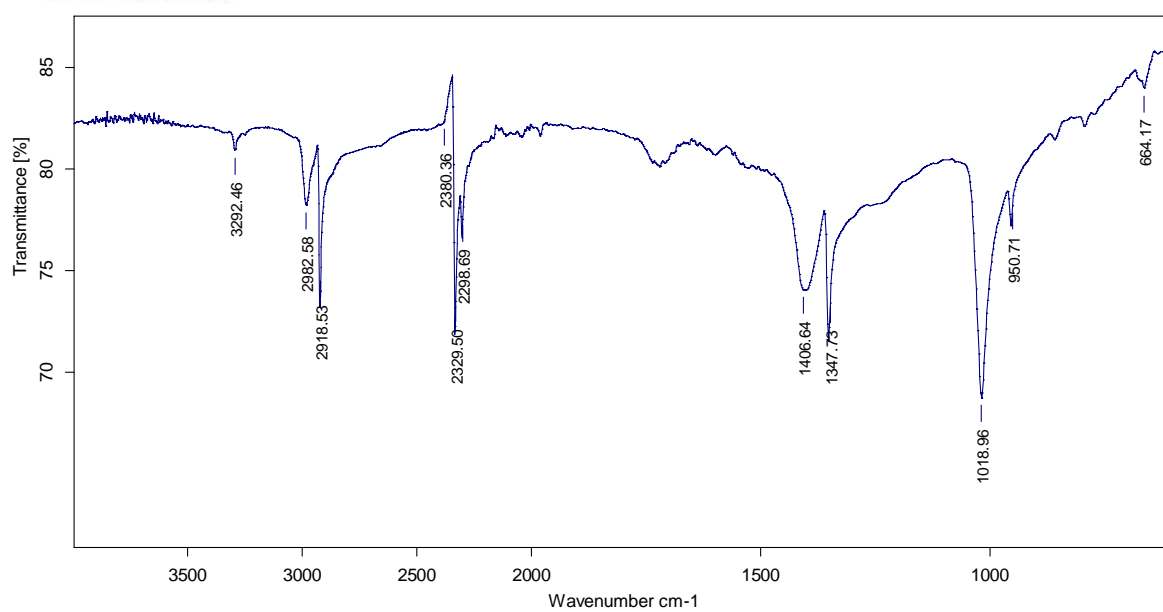


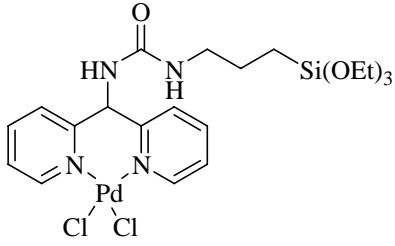
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)



**bis(acetonitril)dicloropal·ladi(II)** **$^1\text{H}$ -RMN (DMSO- $d_6$ , 250 MHz)****IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)**Universitat  
Autònoma  
de Barcelona

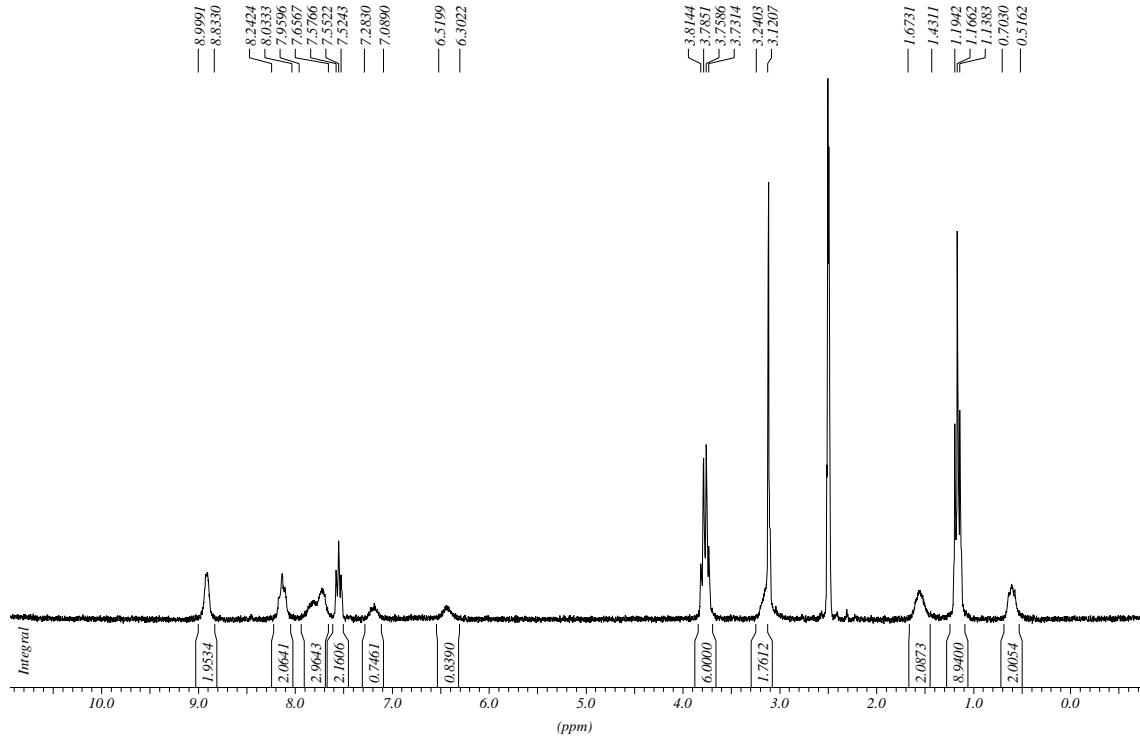
Servei d'Anàlisi Química



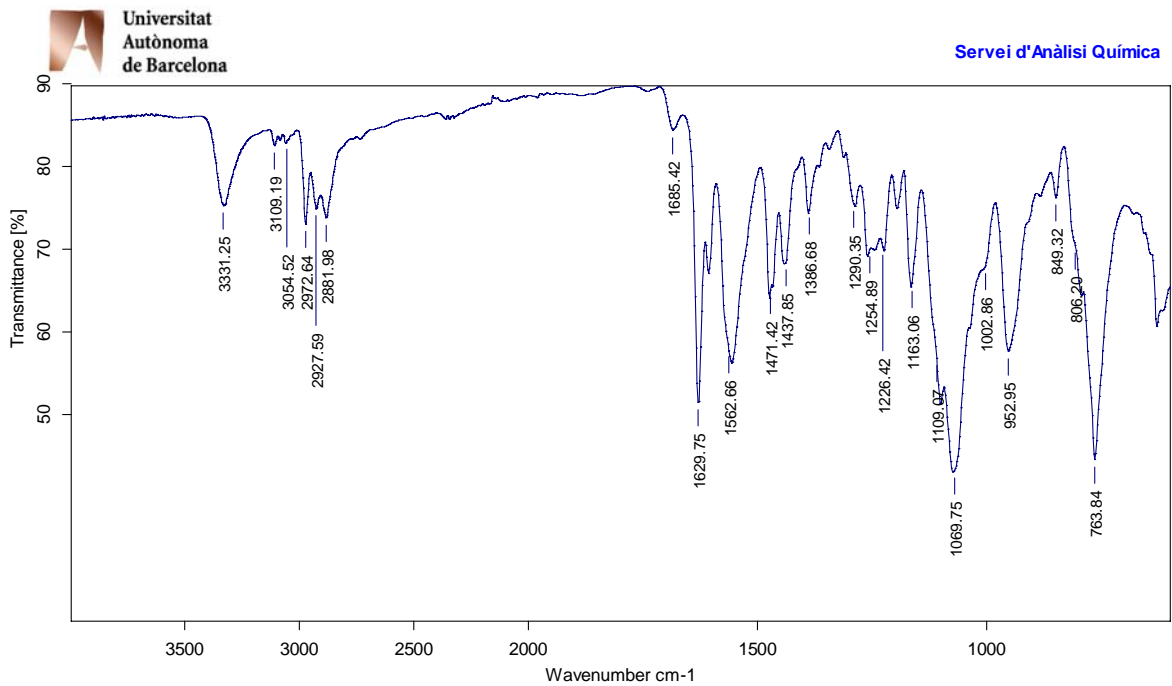


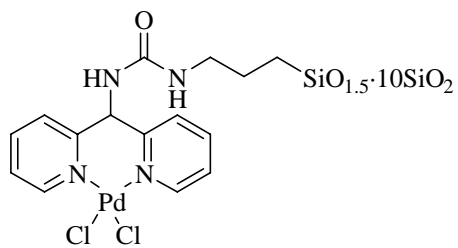
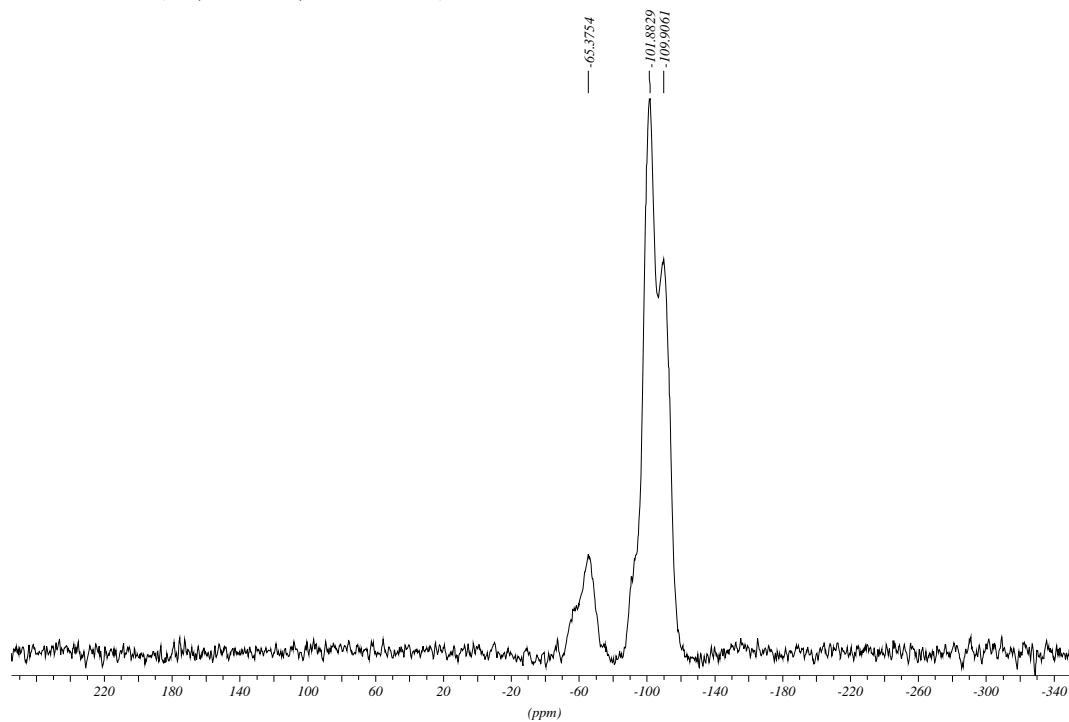
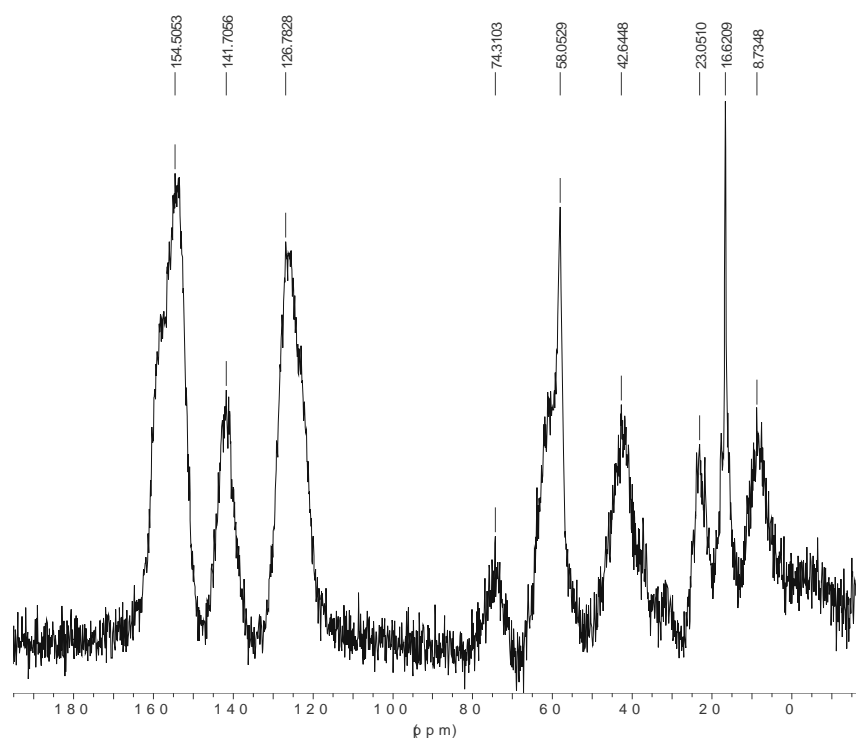
complex de pal·ladi derivat de *N*-(di-2-piridilmetil)-*N'*-(3-(triethoxisilil)propil)urea, 18

$^1\text{H}$ -RMN (DMSO- $d_6$ , 250 MHz, 56 °C)

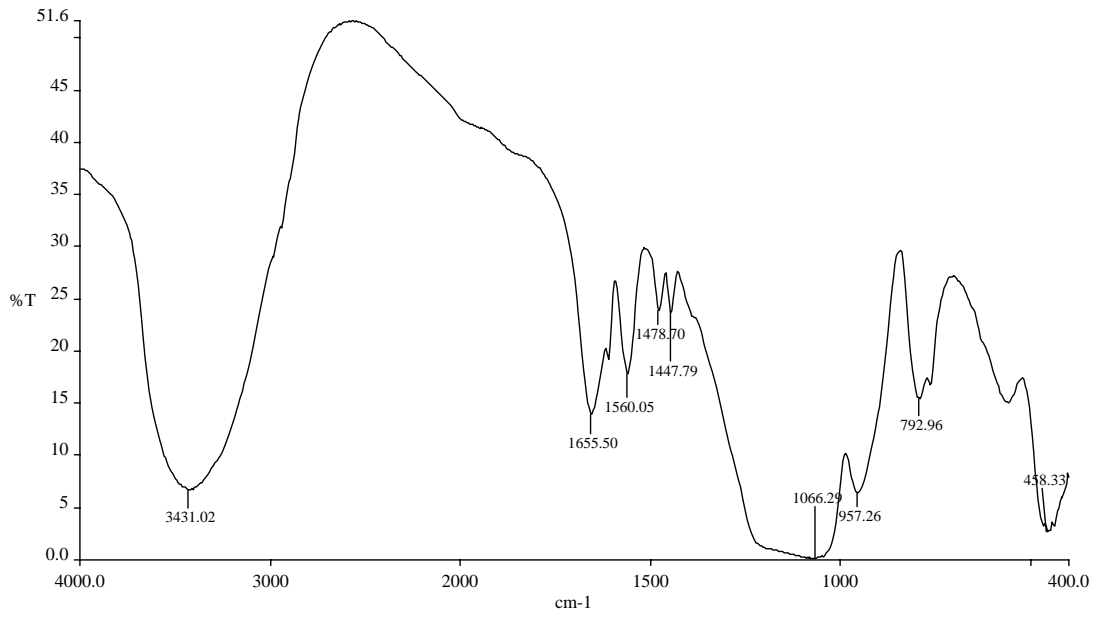


IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

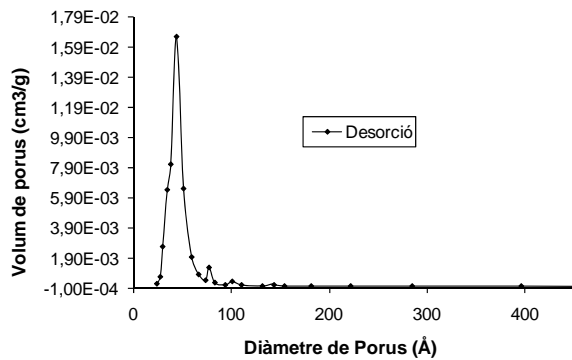
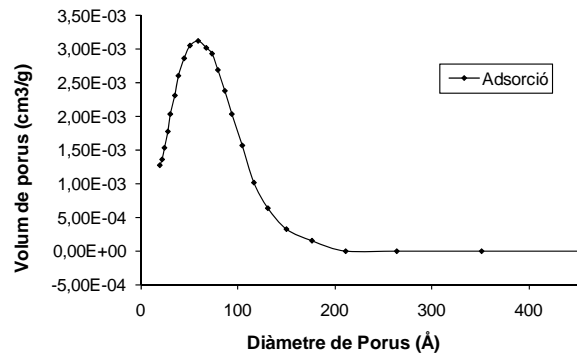
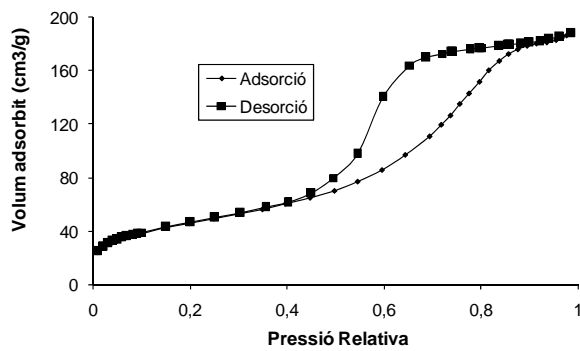


**material híbrid orgànic-inorgànic M1** **$^{29}\text{Si}$ -RMN (79,5 MHz, CP-MAS)** **$^{13}\text{C}$ -RMN (100.62 MHz, CP-MAS)**

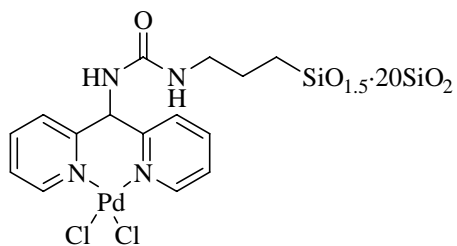
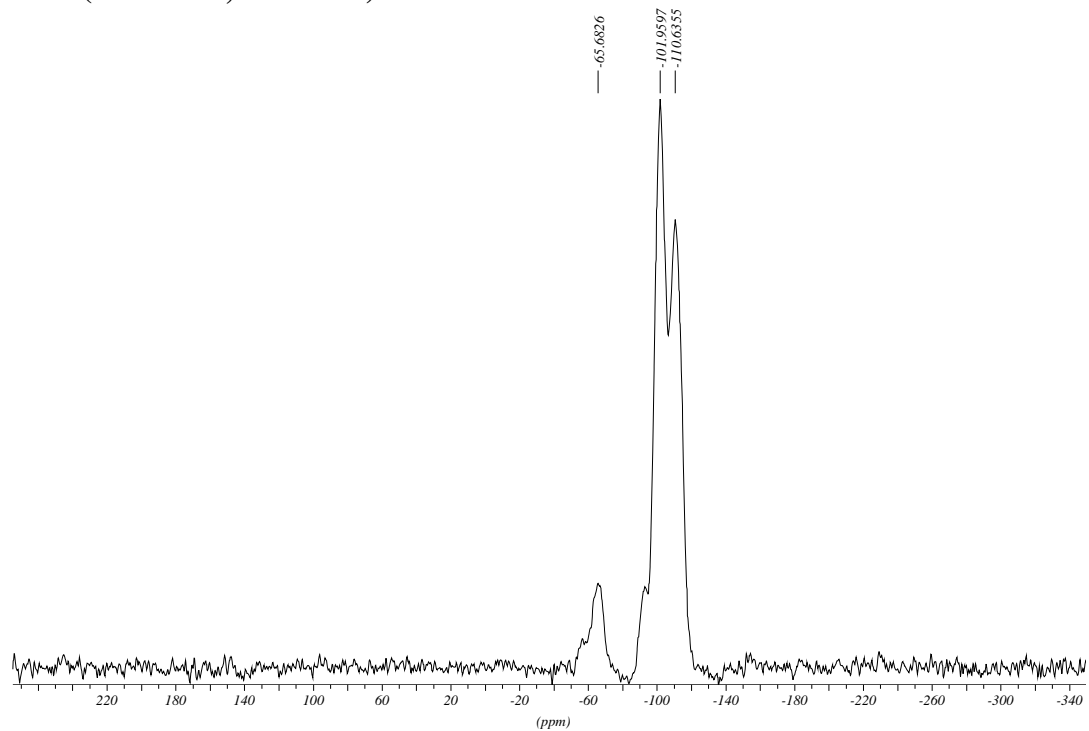
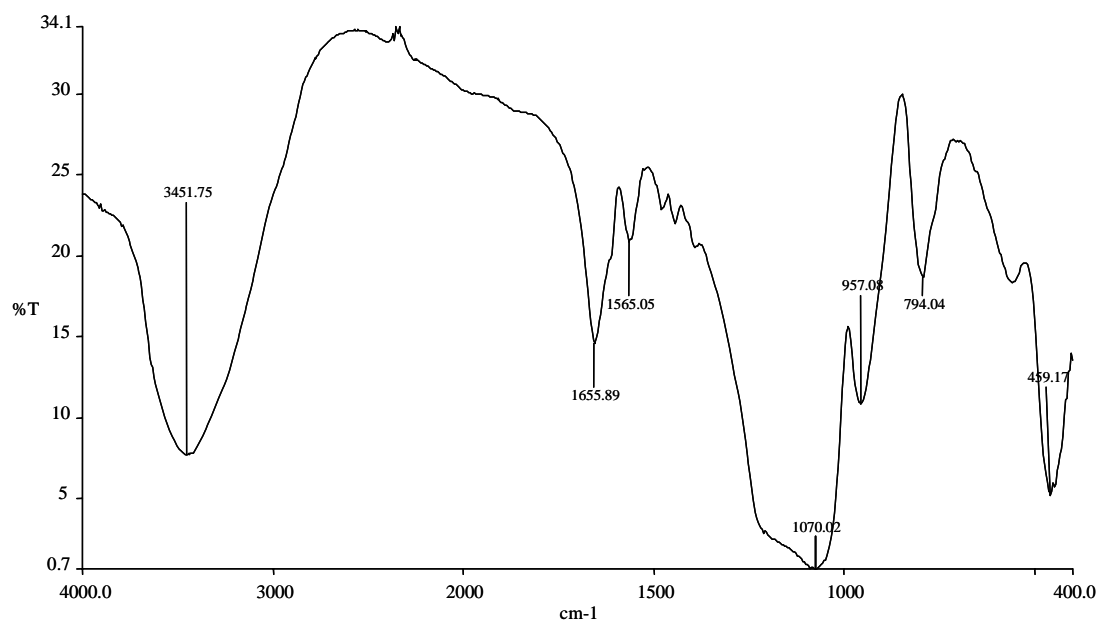
**IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)**



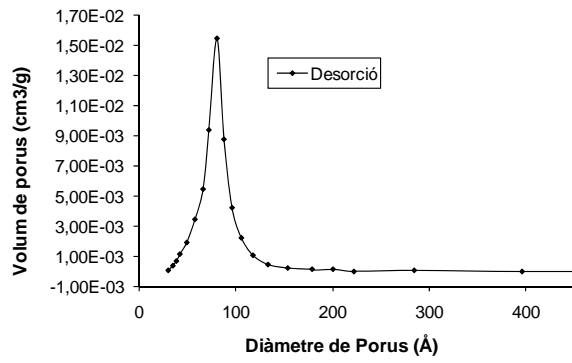
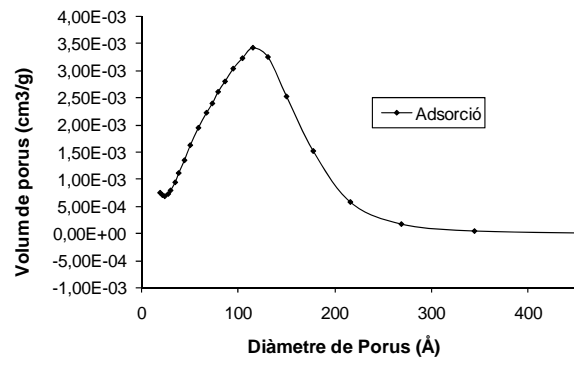
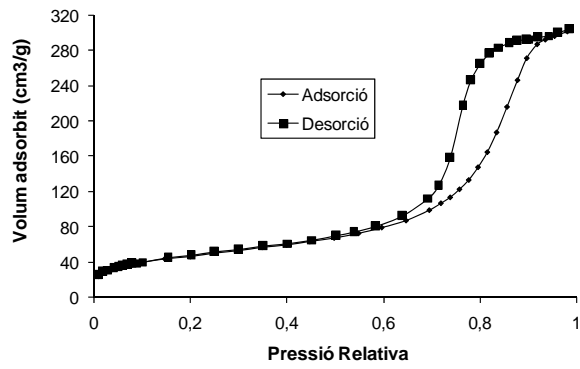
**BET (Brunauer-Emmett-Teller)**

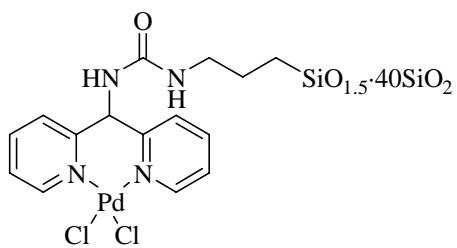
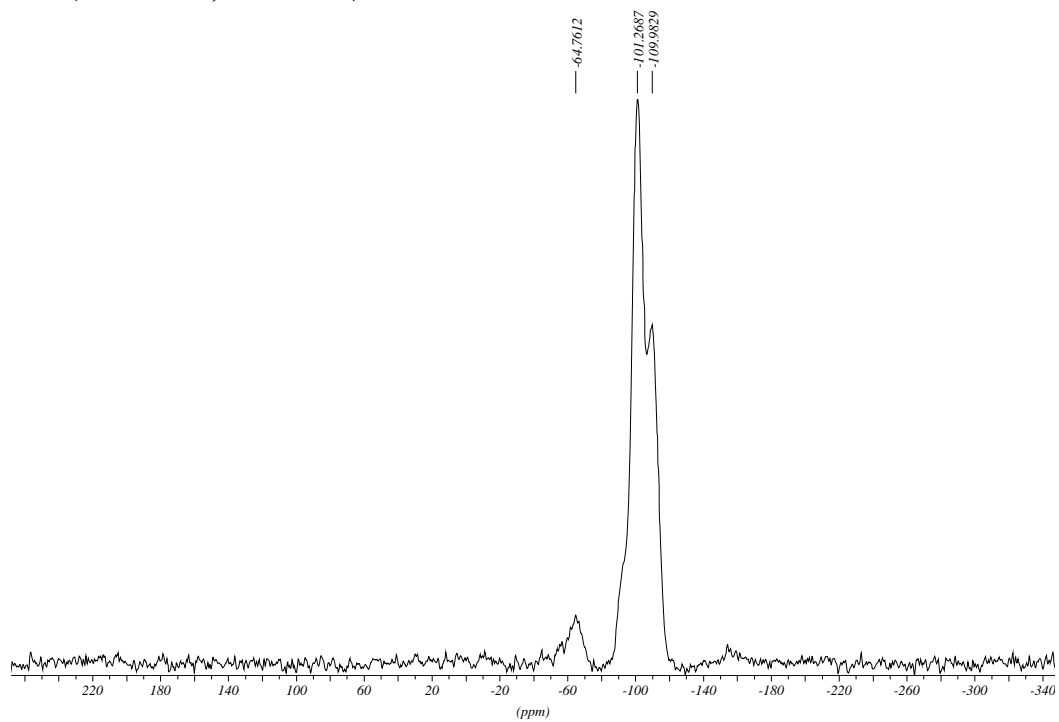
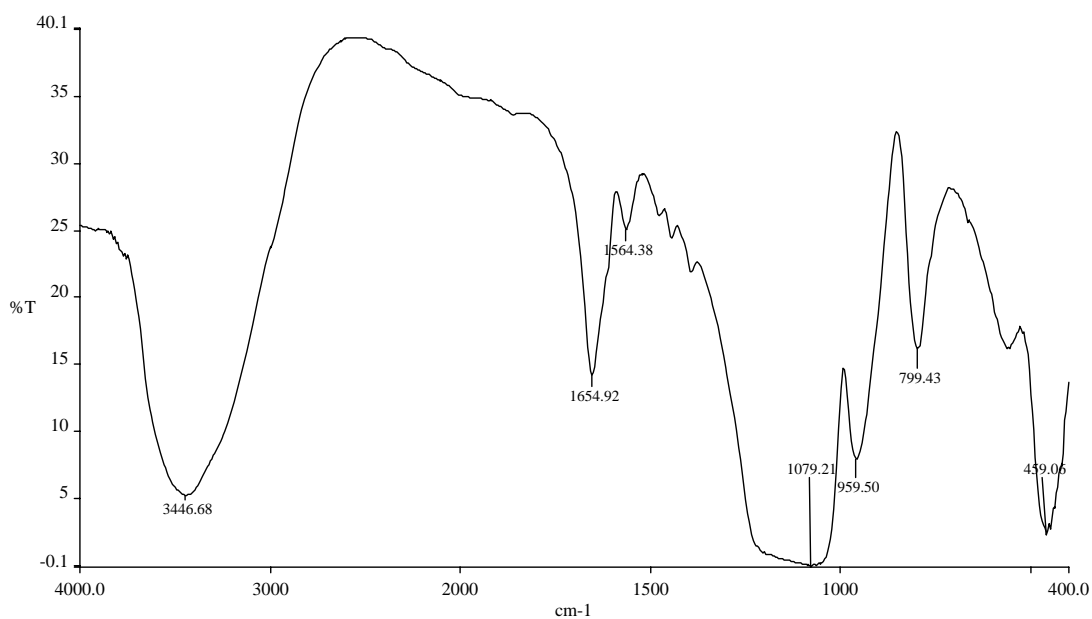


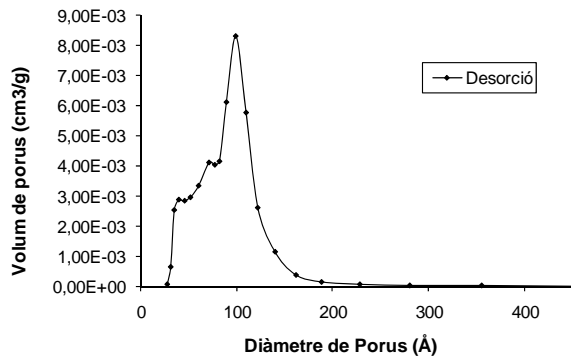
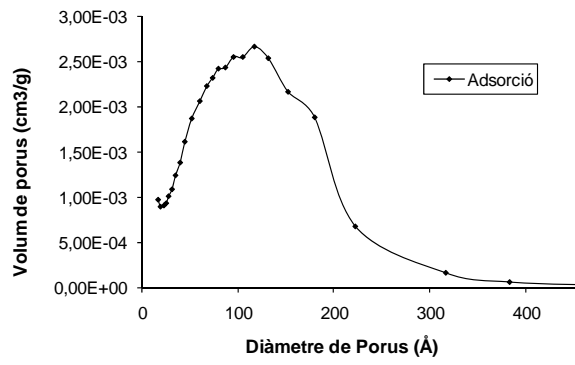
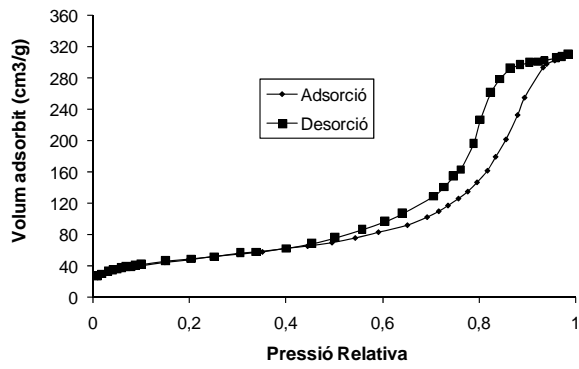


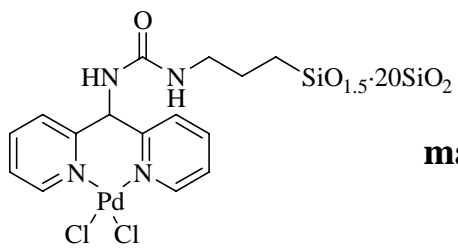
**material híbrid orgànic-inorgànic M2****<sup>29</sup>Si-RMN (79.5 MHz, CP-MAS)****IR ν (cm<sup>-1</sup>) (KBr)**

### BET (Brunauer-Emmett-Teller)



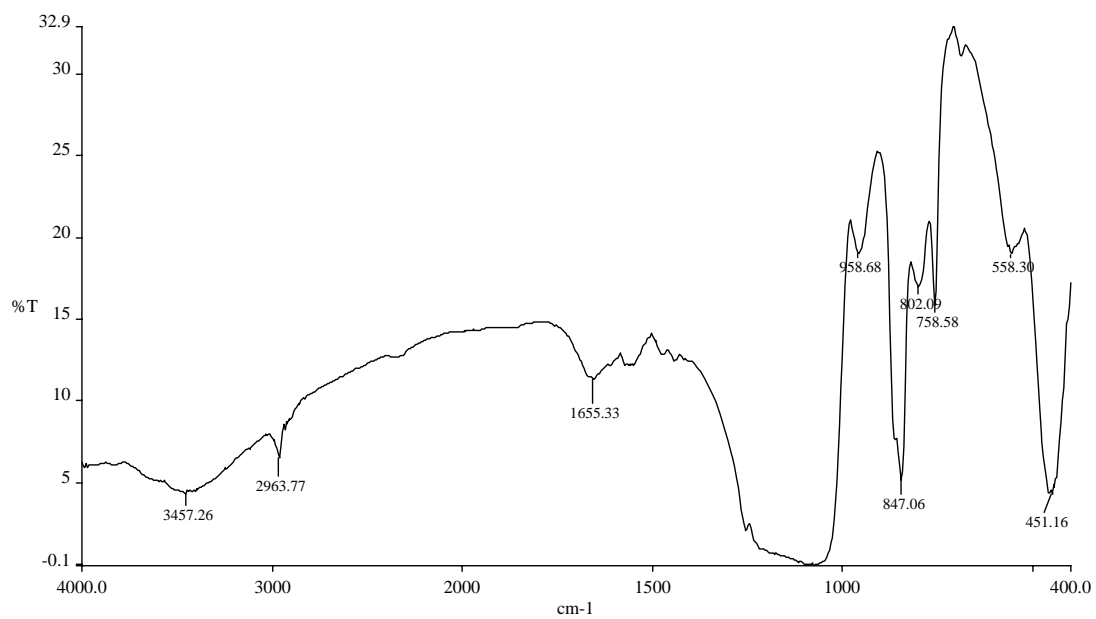
**material híbrid orgànic-inorgànic M3** **$^{29}\text{Si}$ -RMN (79.5 MHz, CP-MAS)****IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)**

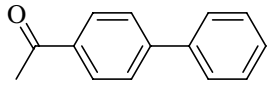
**BET (Brunauer-Emmett-Teller)**



### material híbrid orgànic-inorgànic M2sil

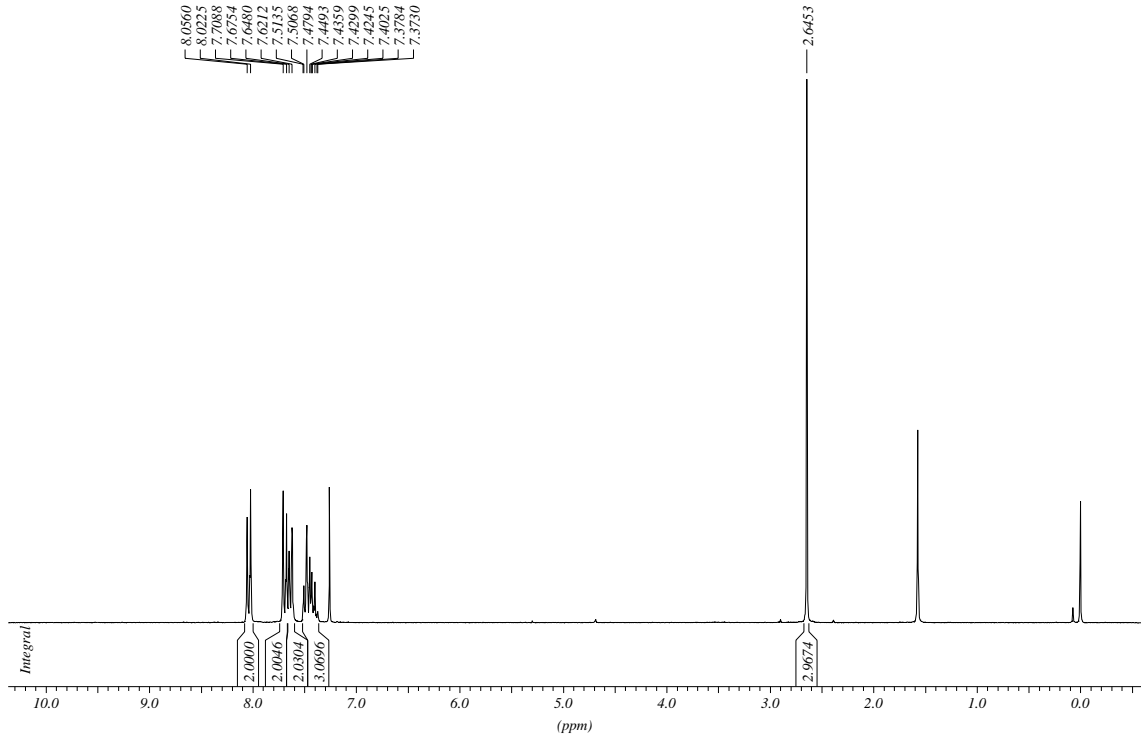
IR  $\nu$  (cm<sup>-1</sup>) (KBr)



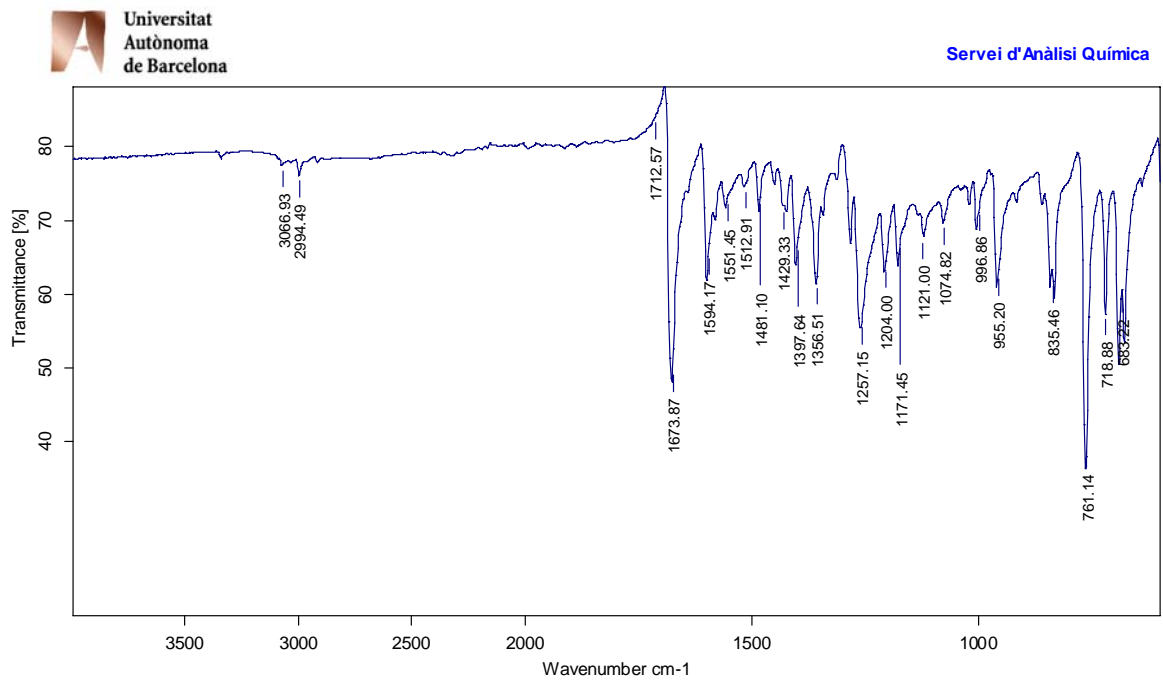


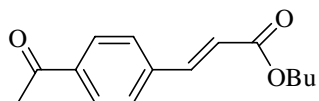
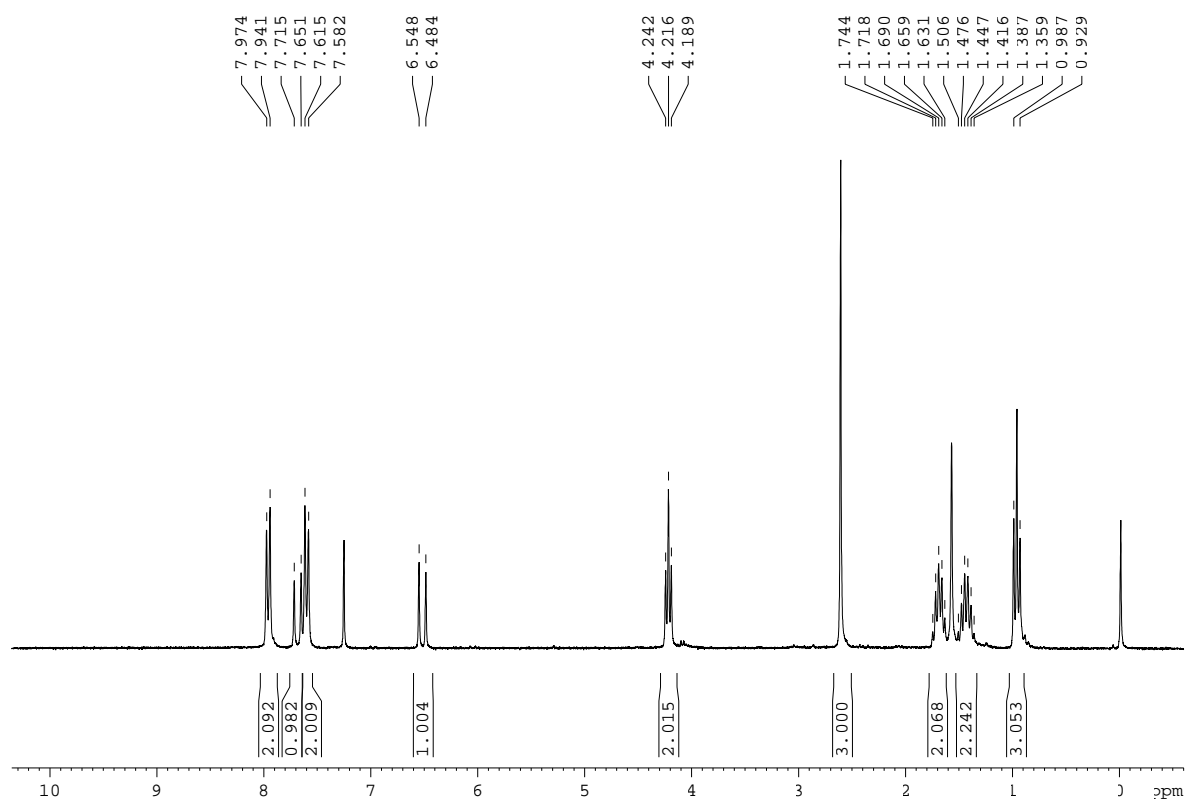
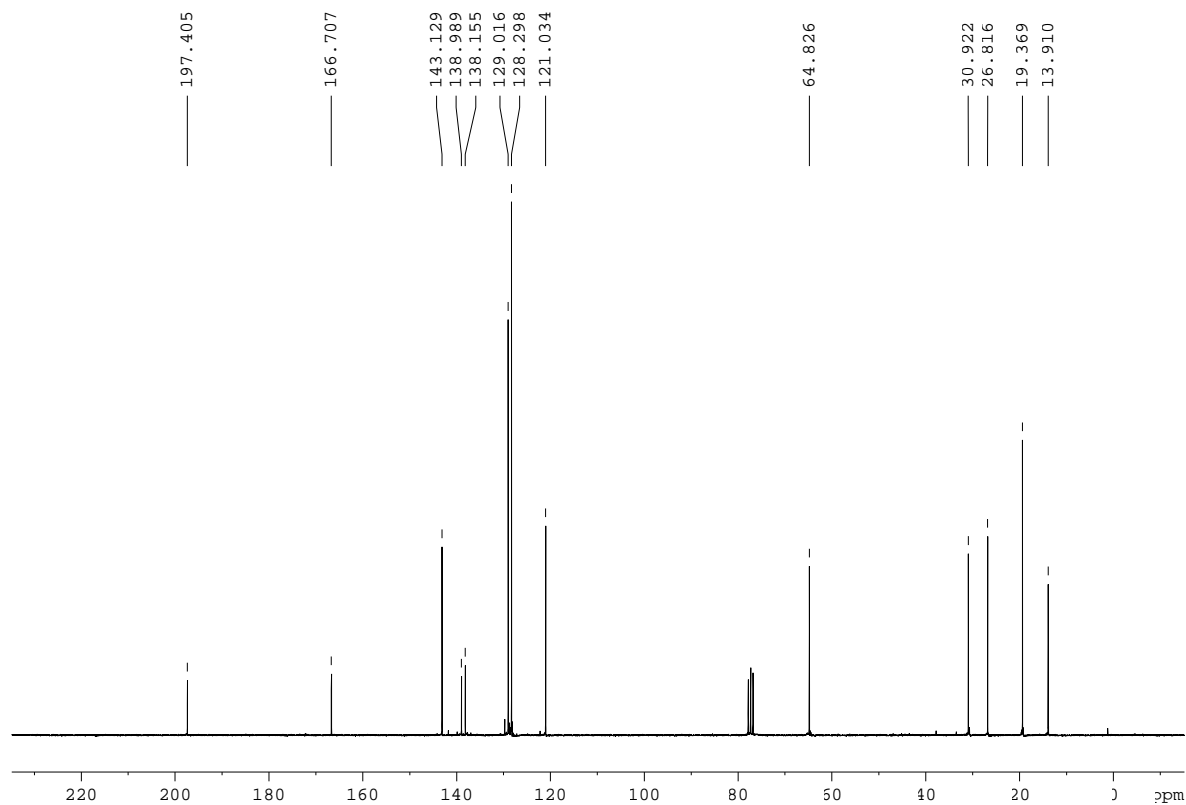
## 4-fenilacetofenona, 21

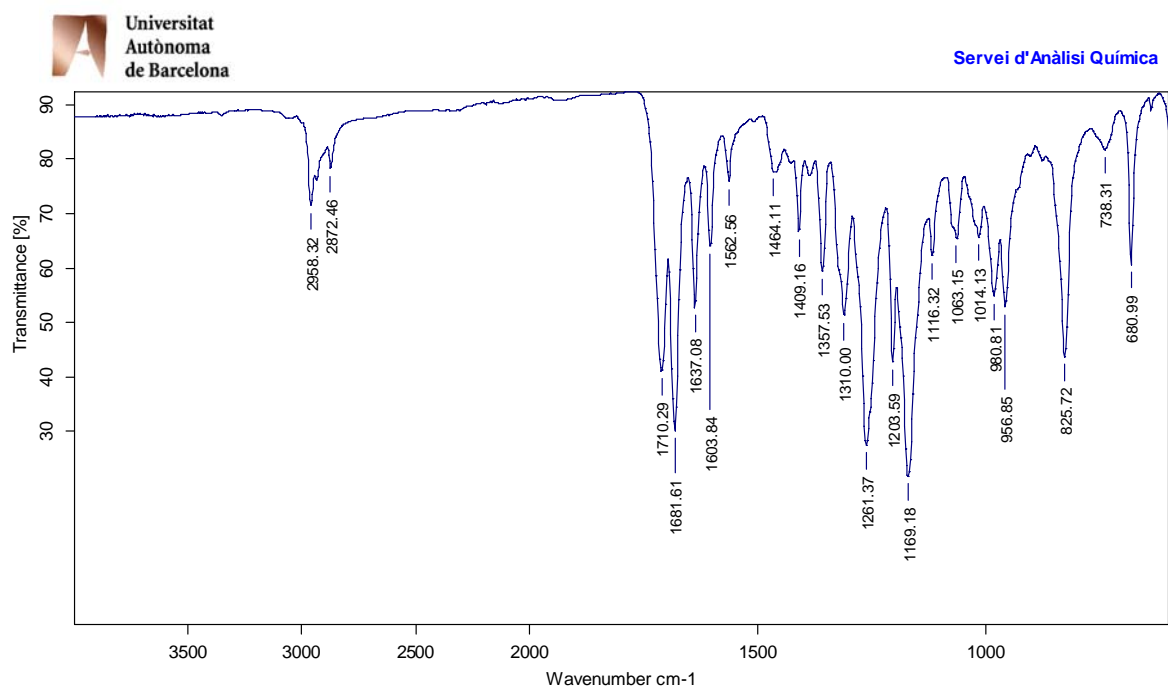
### $^1\text{H-RMN}$ ( $\text{CDCl}_3$ , 250 MHz)



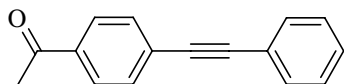
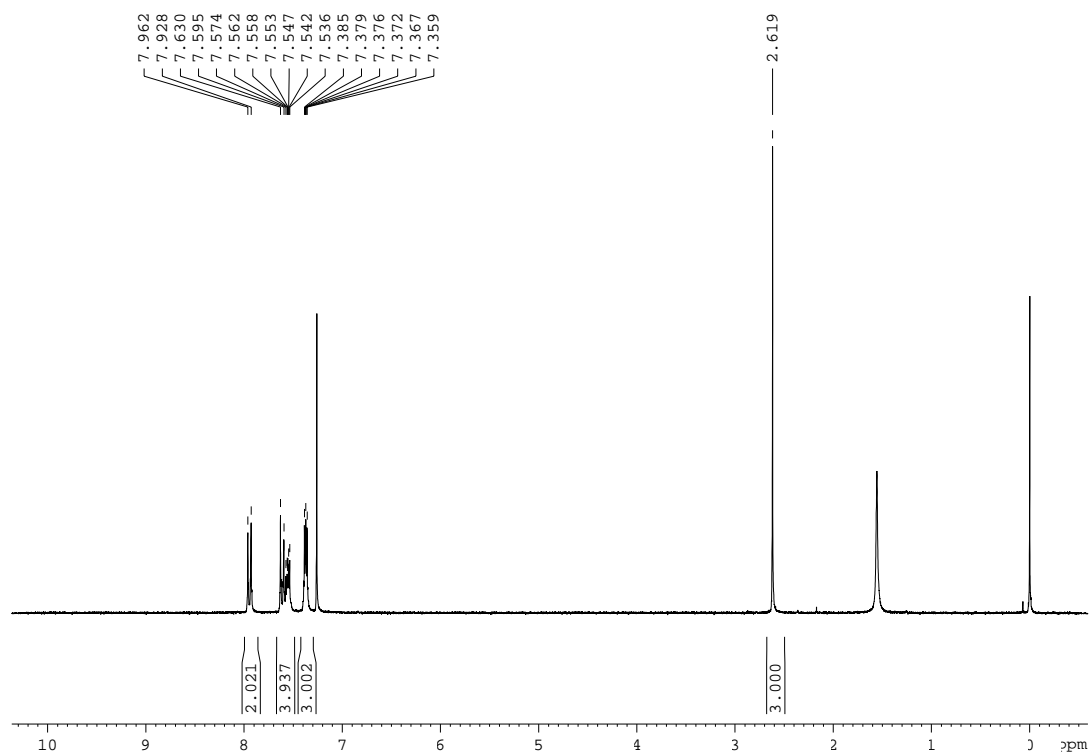
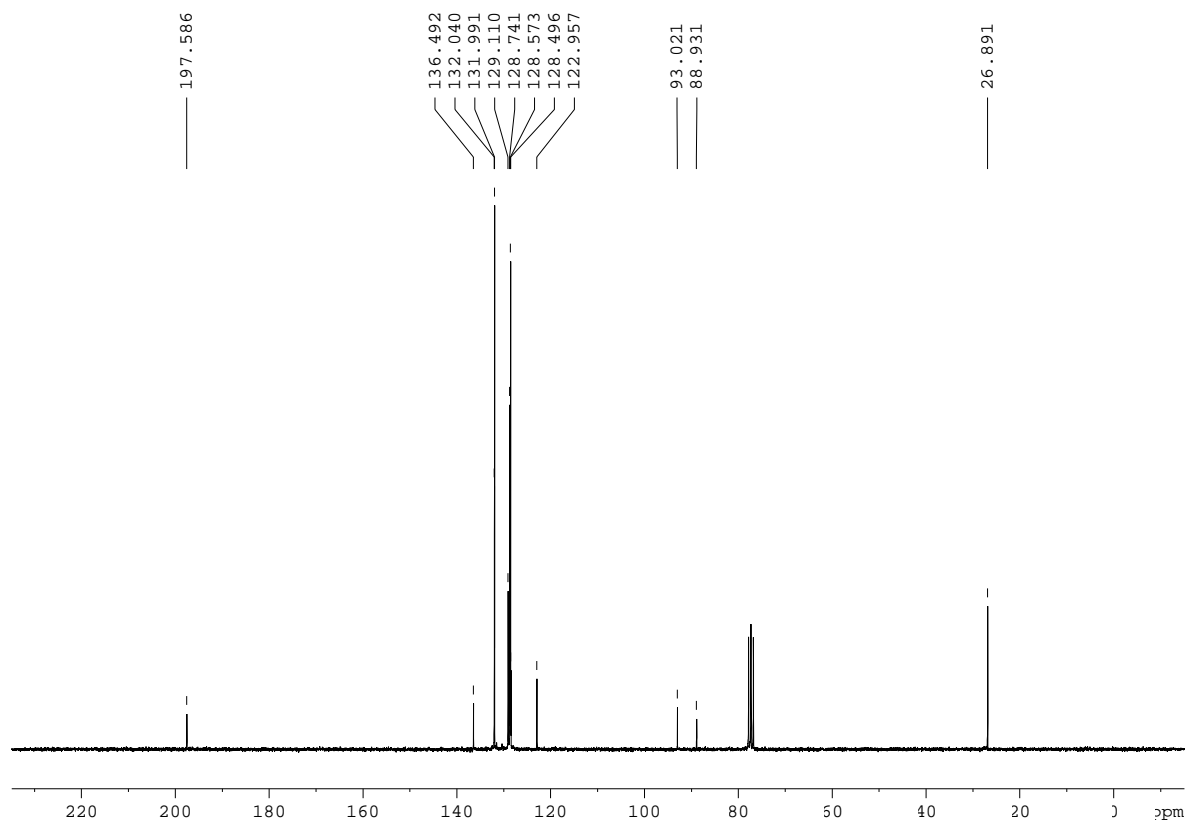
### IR $\nu$ ( $\text{cm}^{-1}$ ) (ATR)



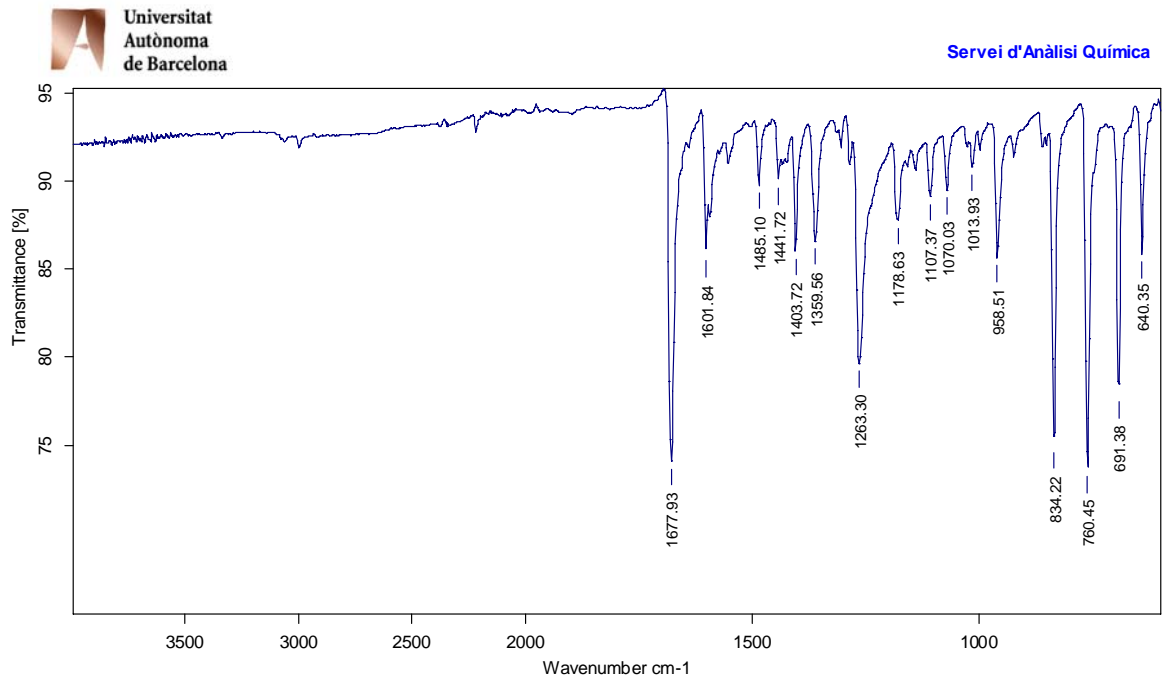
4-acetil-*trans*-cinamat de *n*-butil, 25 $^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz) $^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

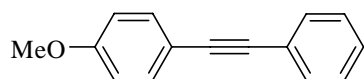
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)



**1-(4-acetilfenil)-2-fenilacetilè, 27****<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)****<sup>13</sup>C-RMN (CDCl<sub>3</sub>, 62.5 MHz)**

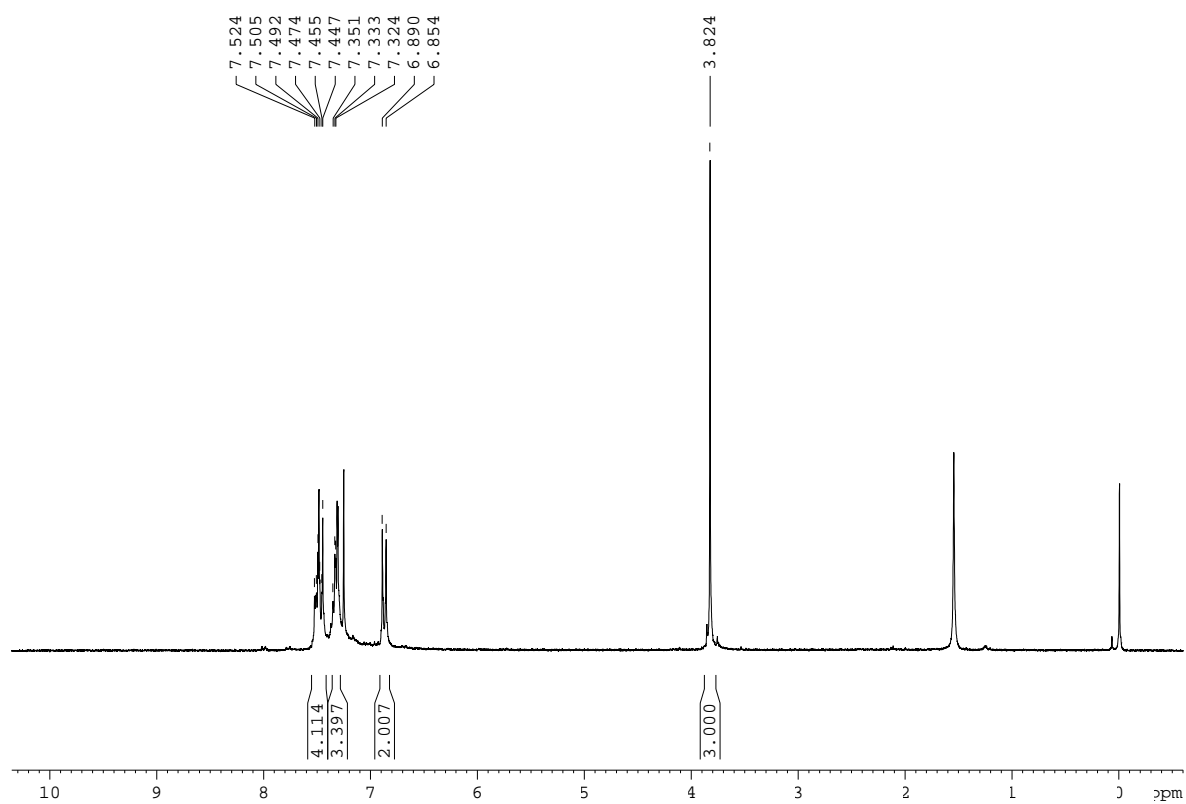
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)



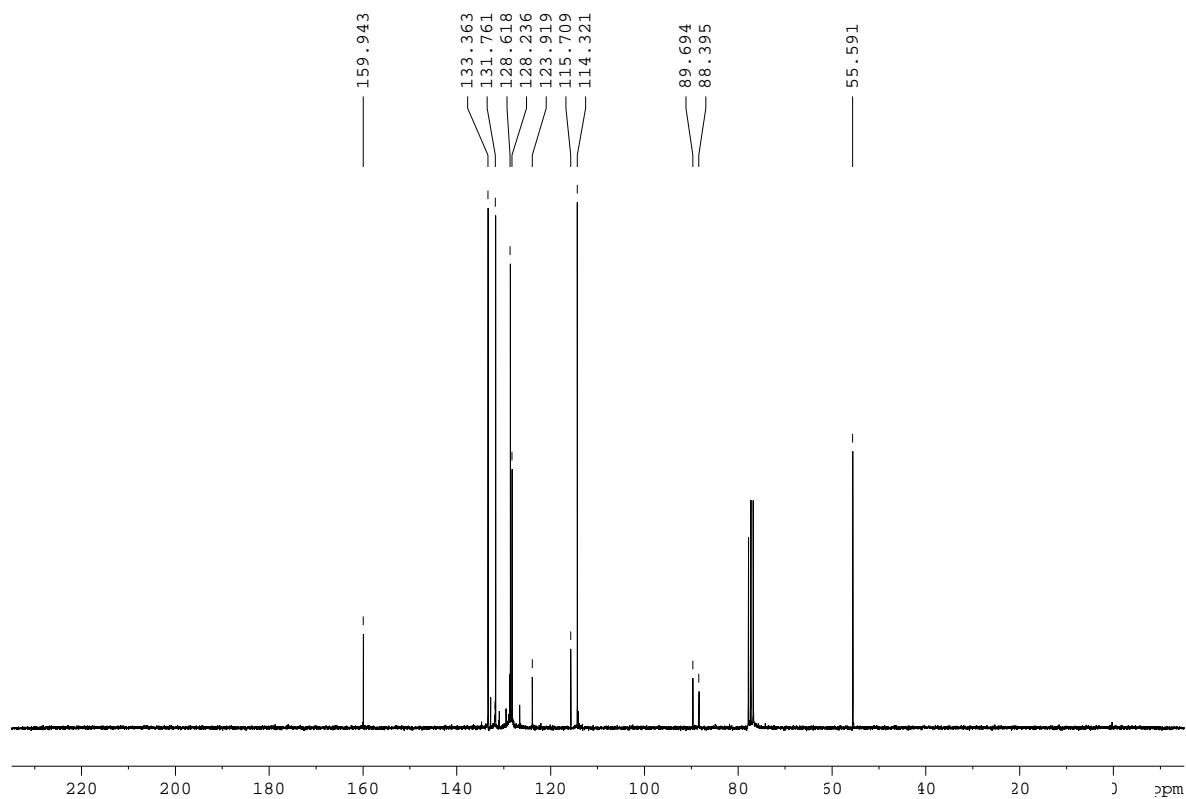


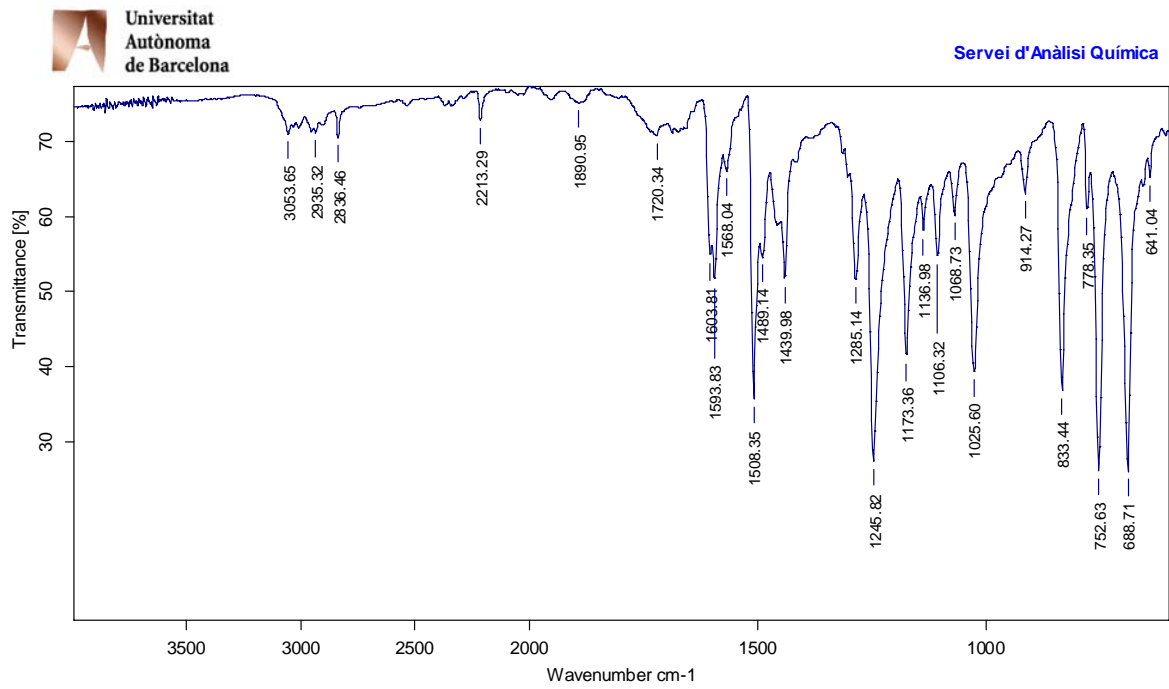
### 1-(4-metoxifenil)-2-fenilacetilè, 29

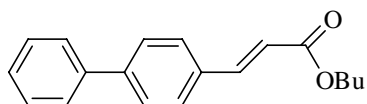
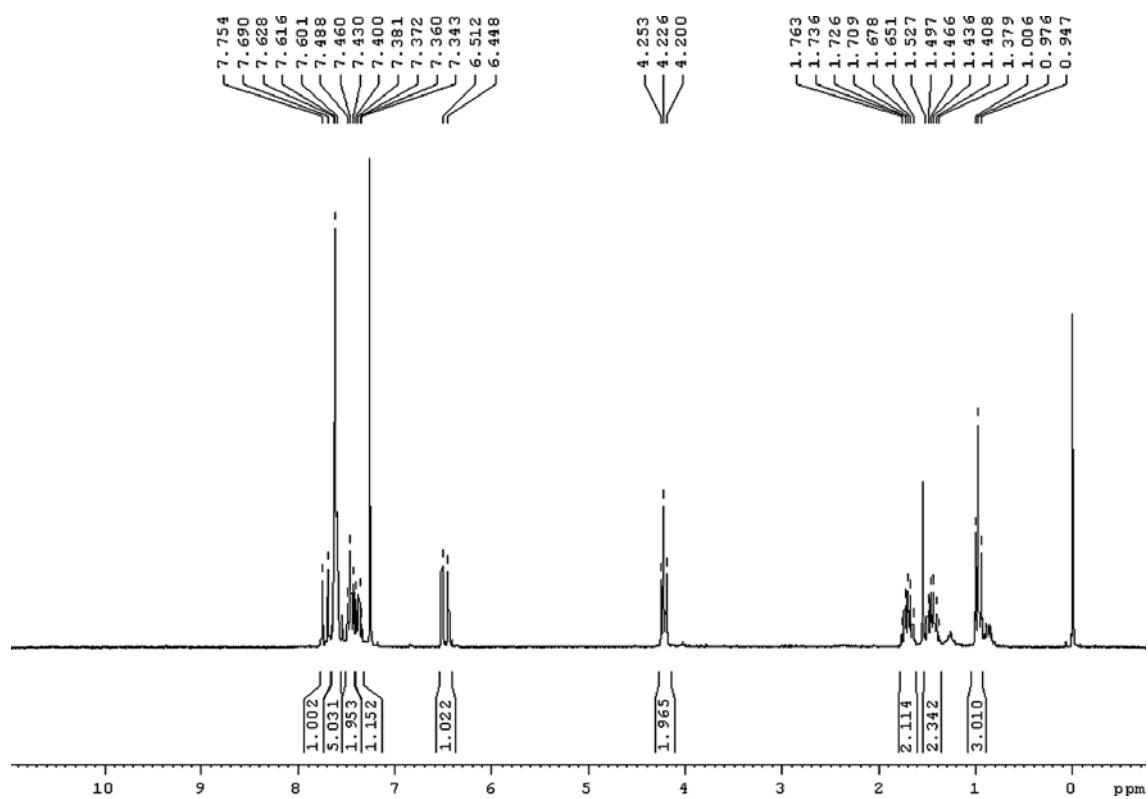
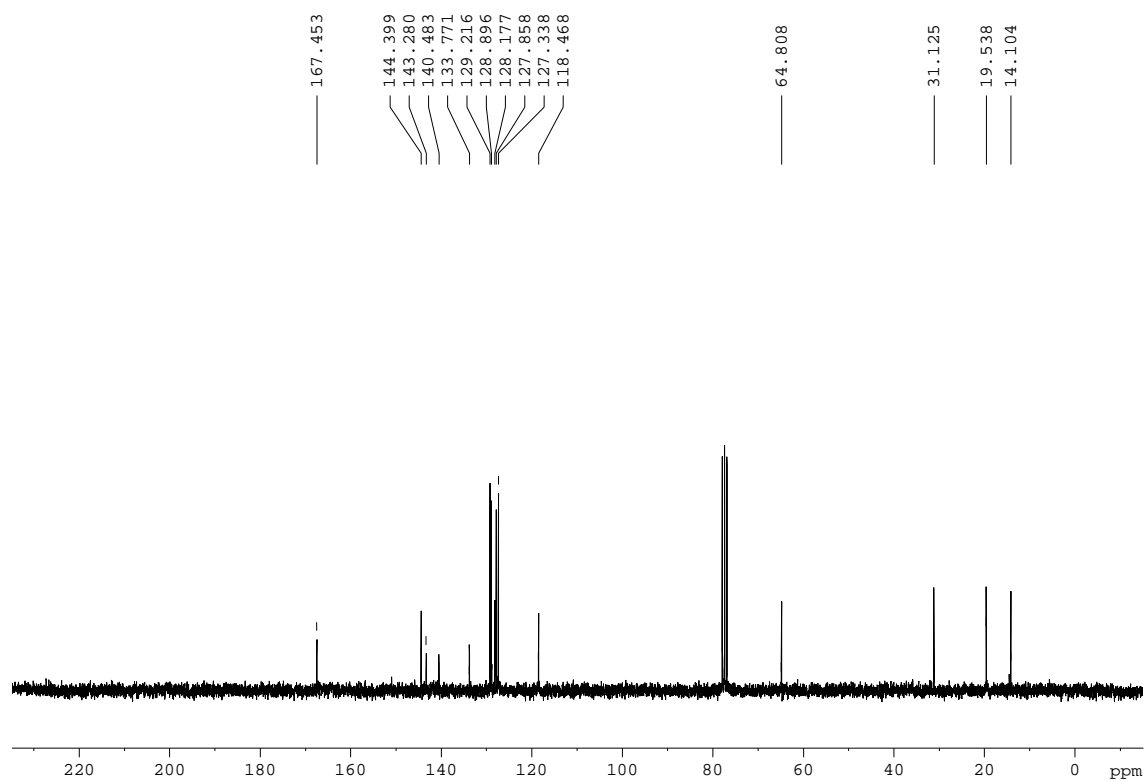
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)

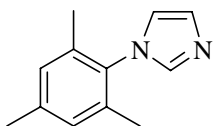
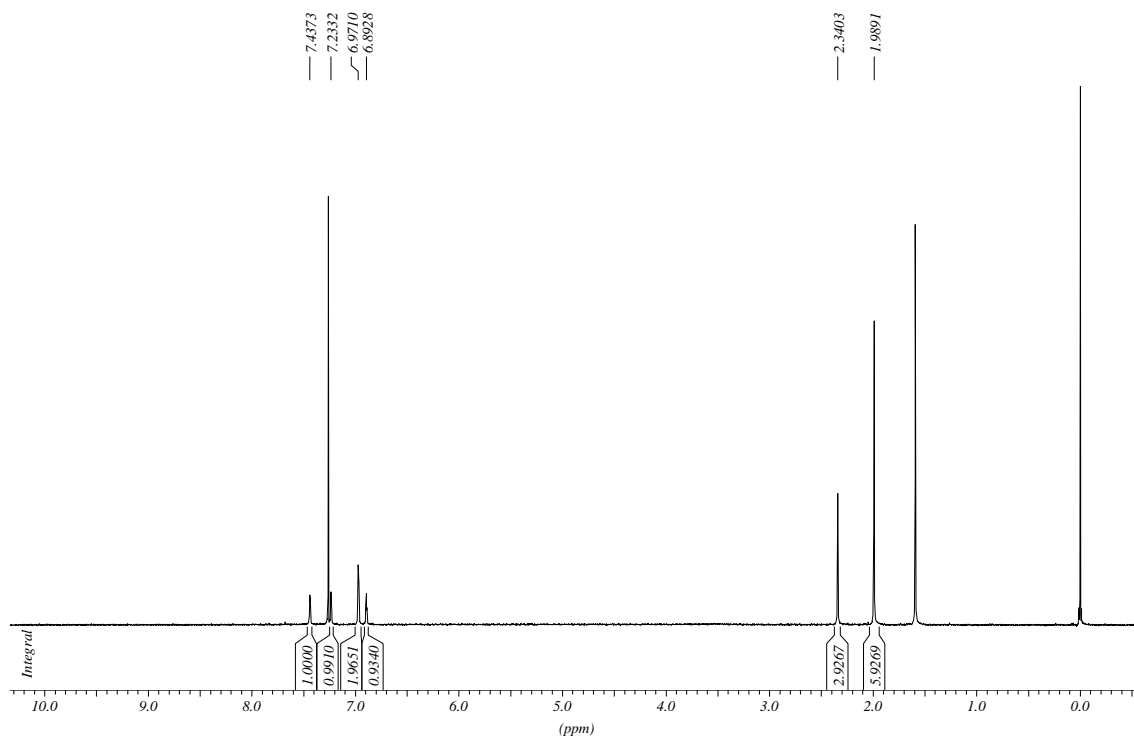
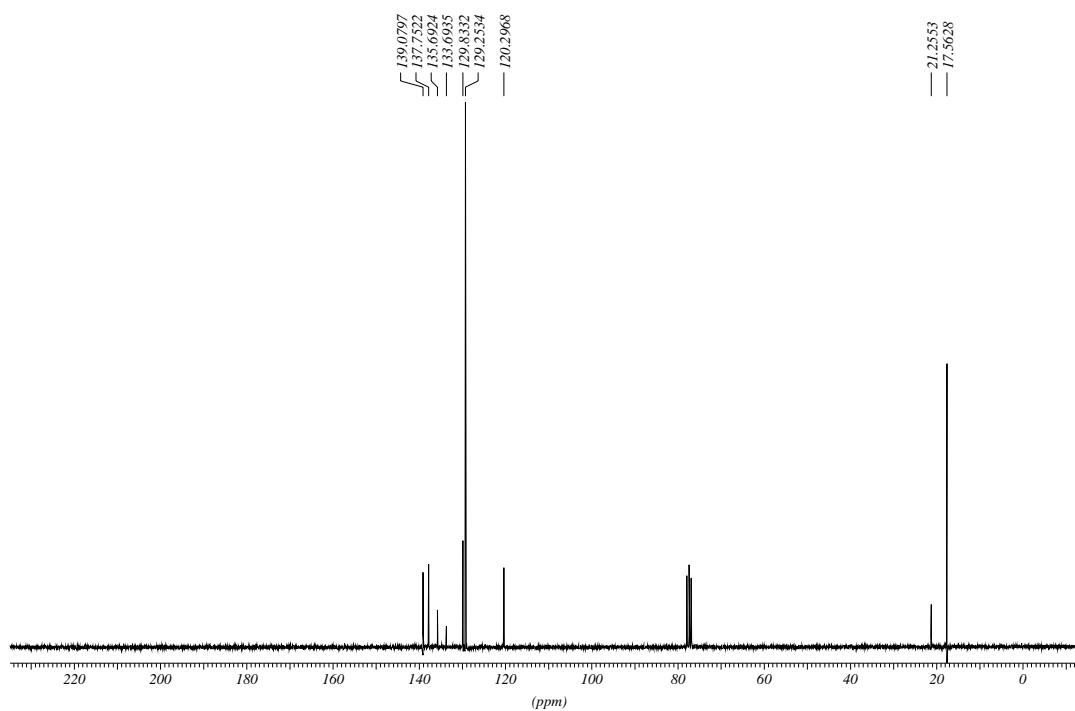


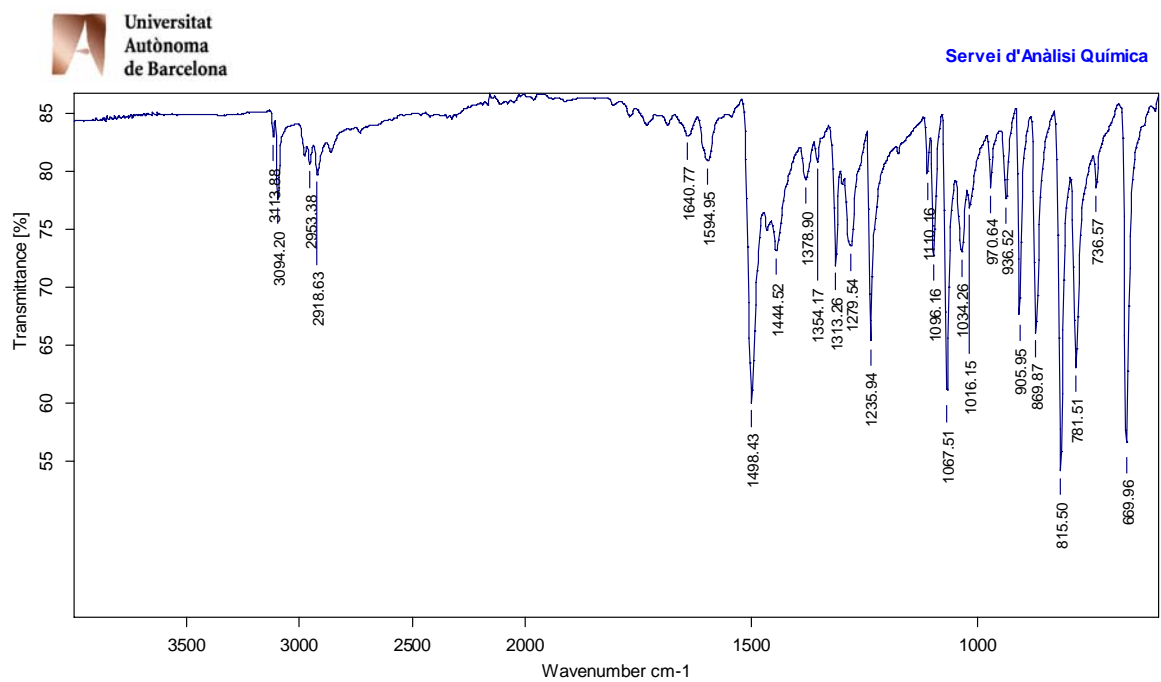
$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

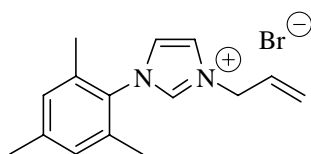


IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

**4-fenil-*trans*-cinamat de *n*-butil, 31** **$^1\text{H}$ -RMN (CDCl<sub>3</sub>, 250 MHz)** **$^{13}\text{C}$ -RMN (CDCl<sub>3</sub>, 62.5 MHz)**

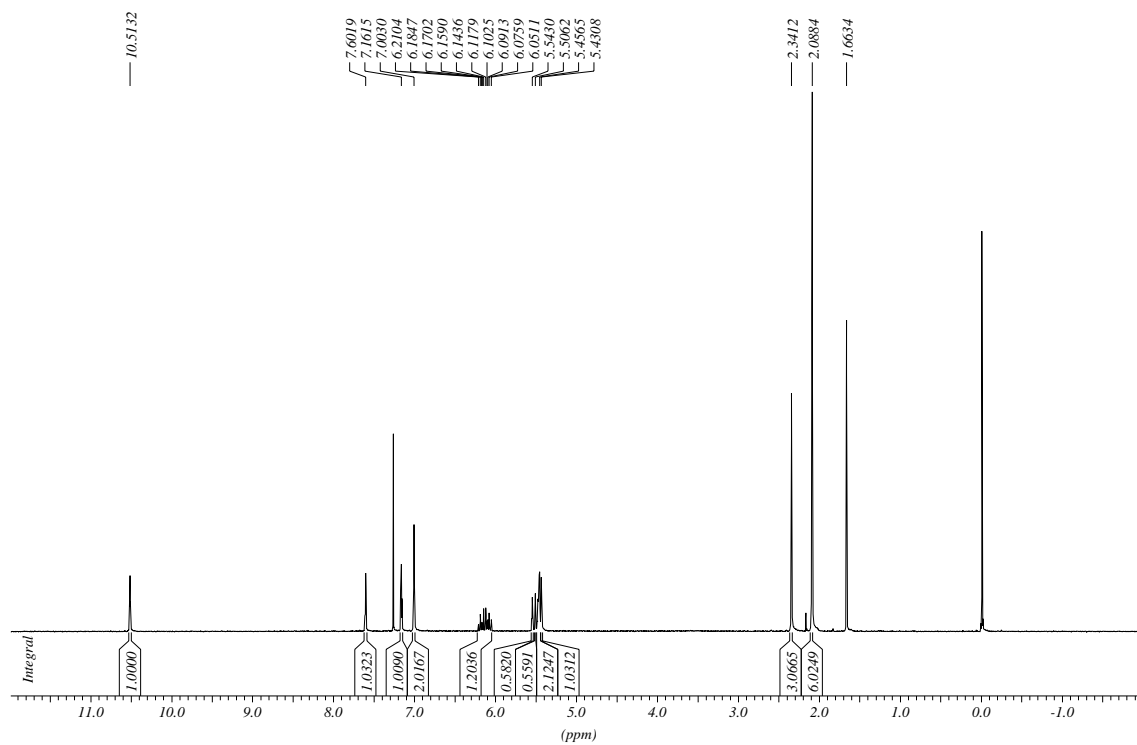
**1-mesitilimidazole, 41** **$^1\text{H}$ -RMN ( $\text{CDCl}_3$ , 250 MHz)** **$^{13}\text{C}$ -RMN ( $\text{CDCl}_3$ , 62.5 MHz)**

IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

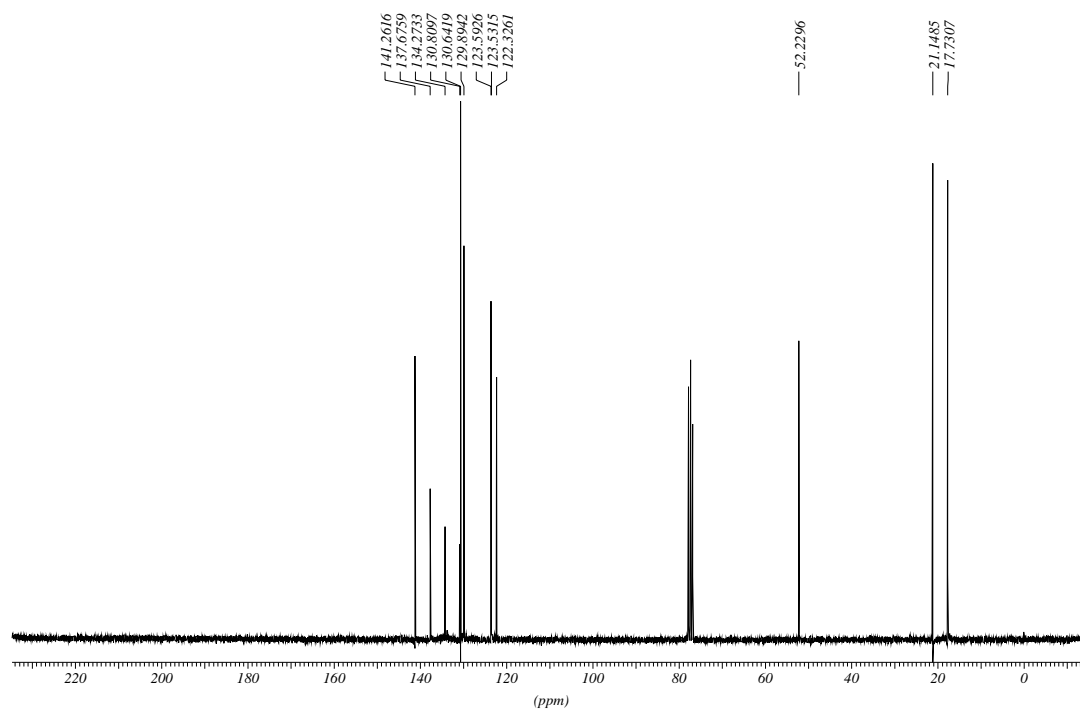


### 1-mesitil-3-(2-propenil)imidazoli, 42

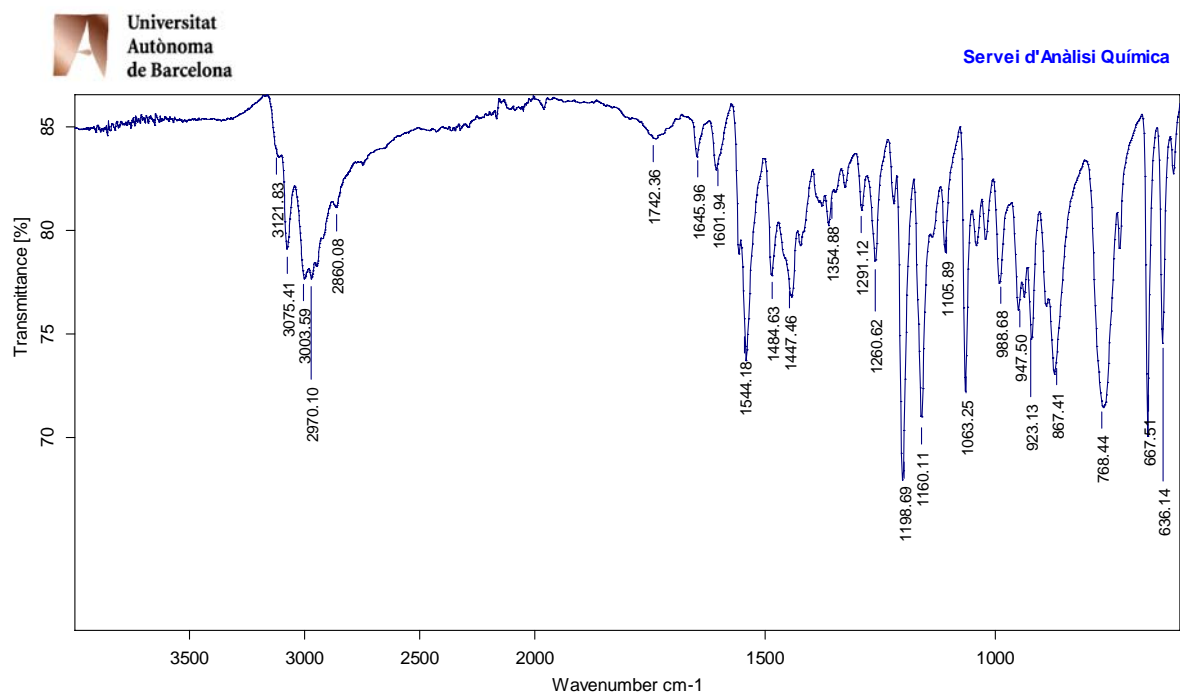
<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)

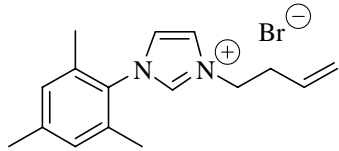


<sup>13</sup>C-RMN (CDCl<sub>3</sub>, 62.5 MHz)



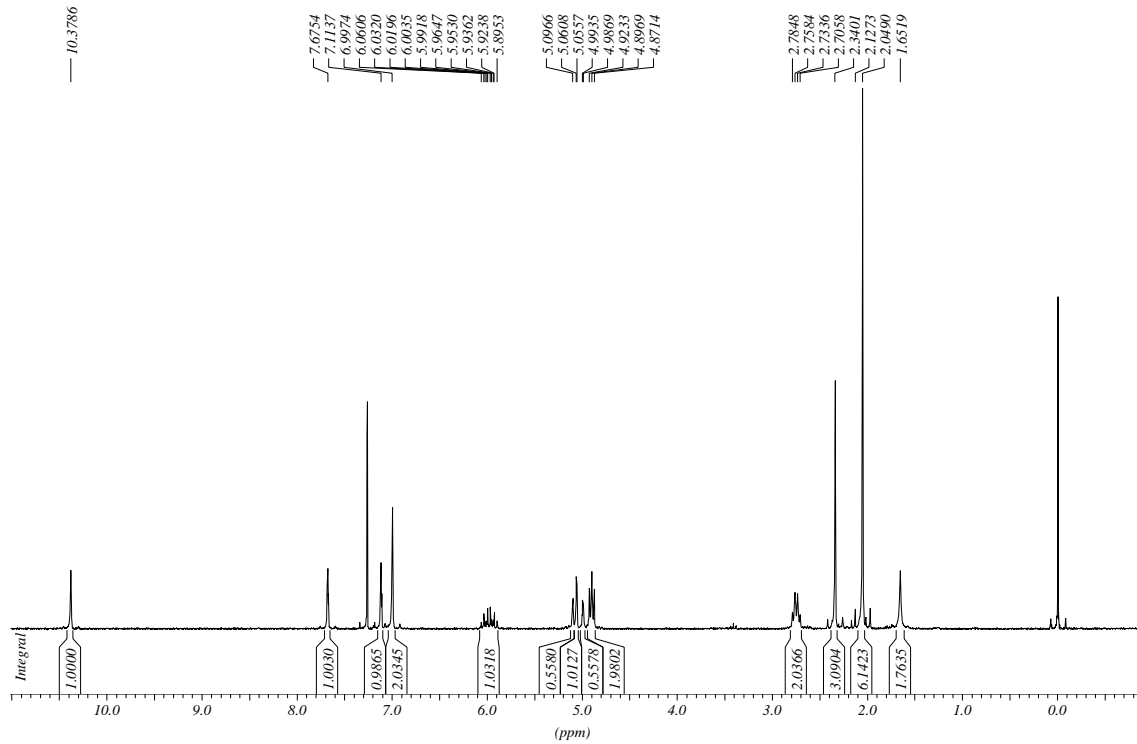


IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

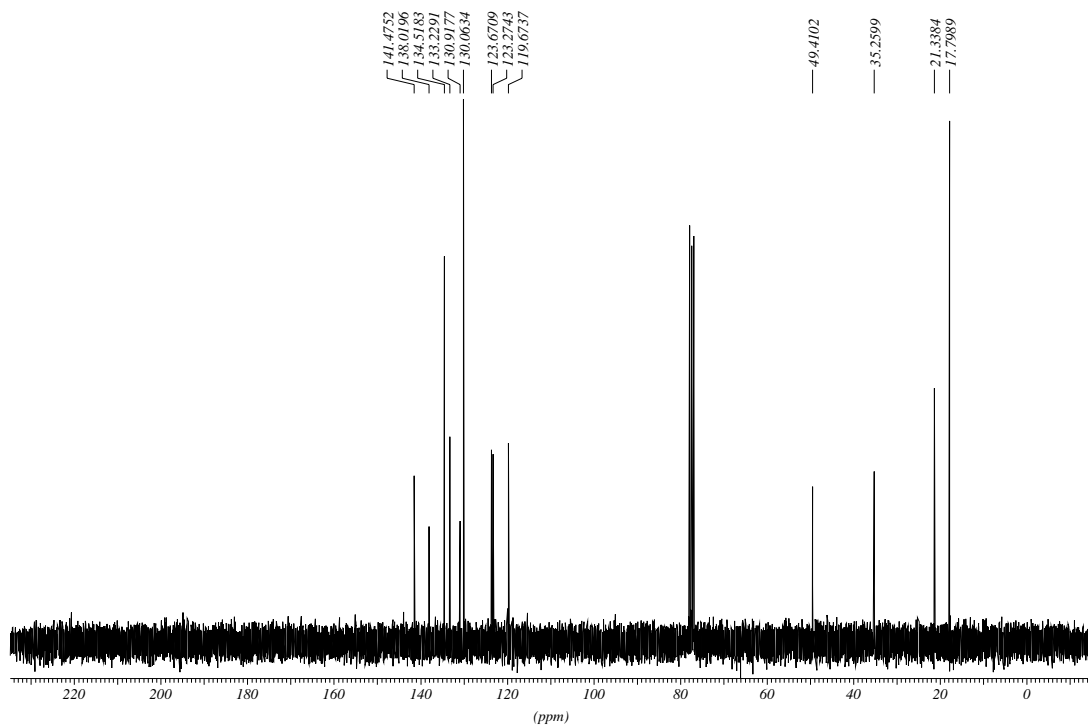


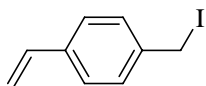
### 3-(3-butenil)-1-mesitilimidazoli, 43

$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)

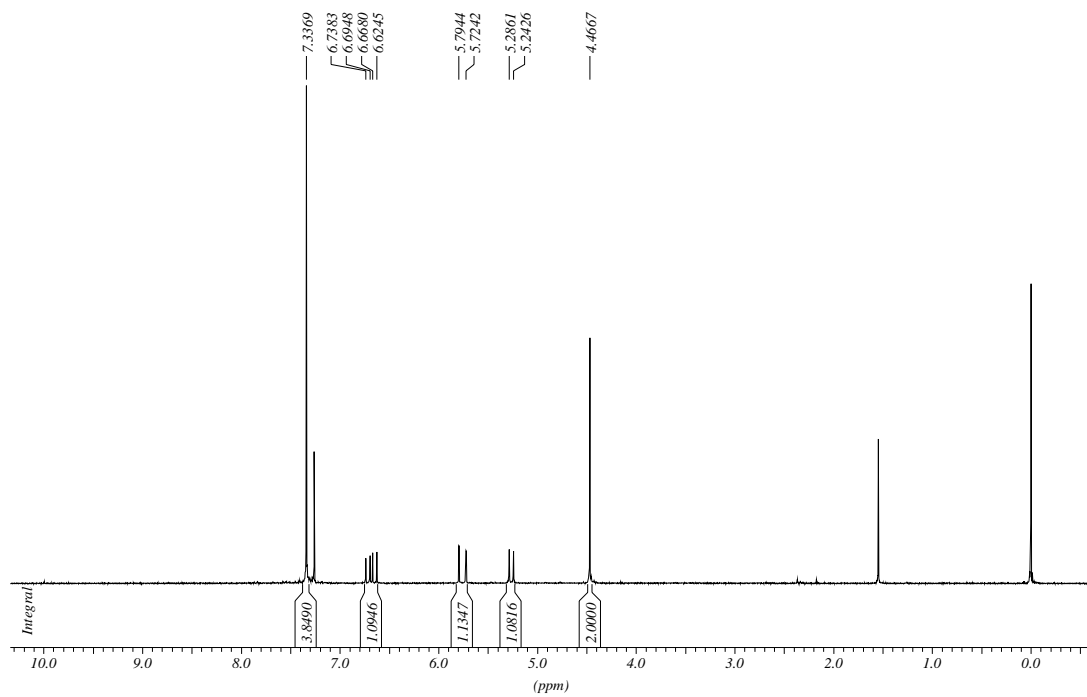


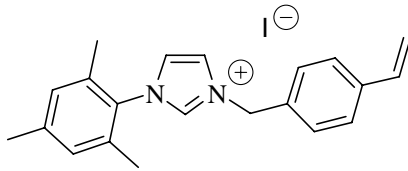
$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)



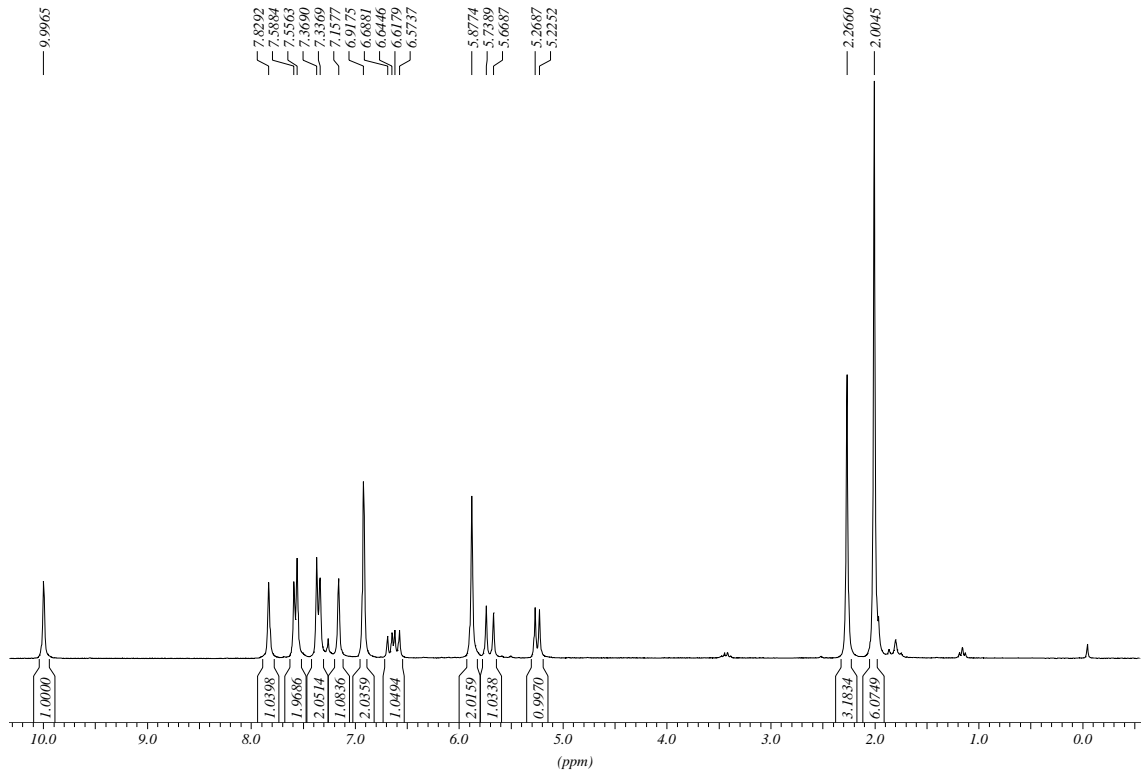
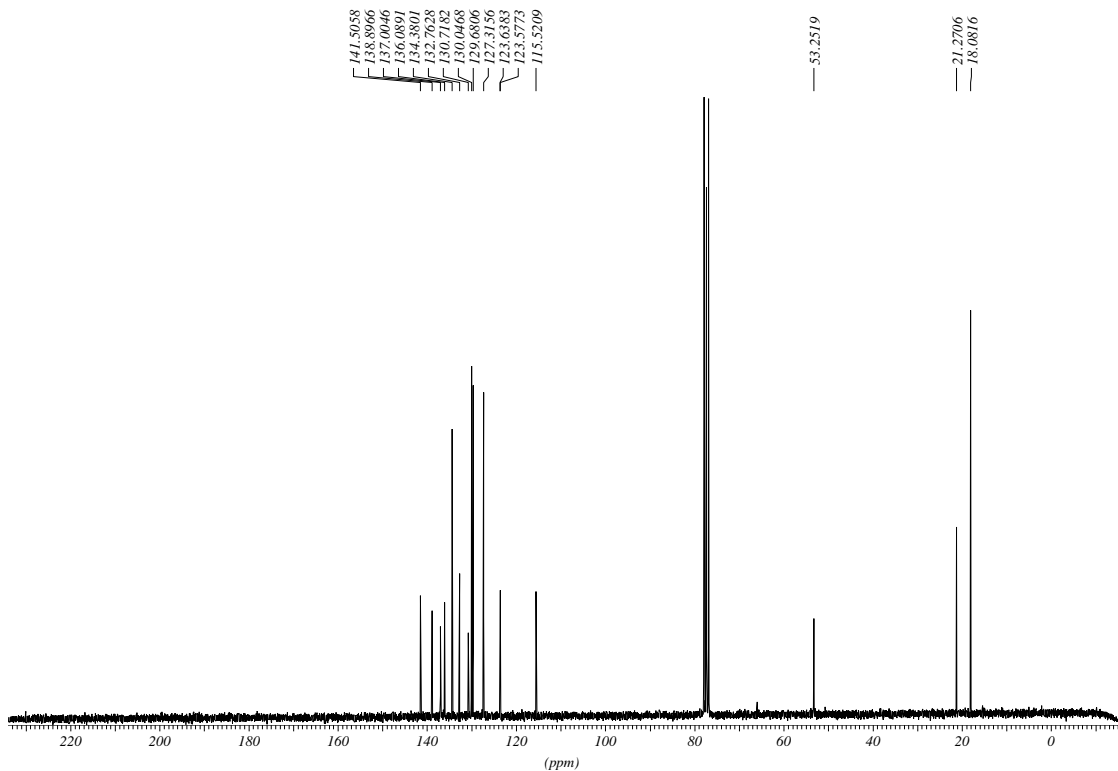


iodur de 4-vinilbenzil, 45

 $^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)

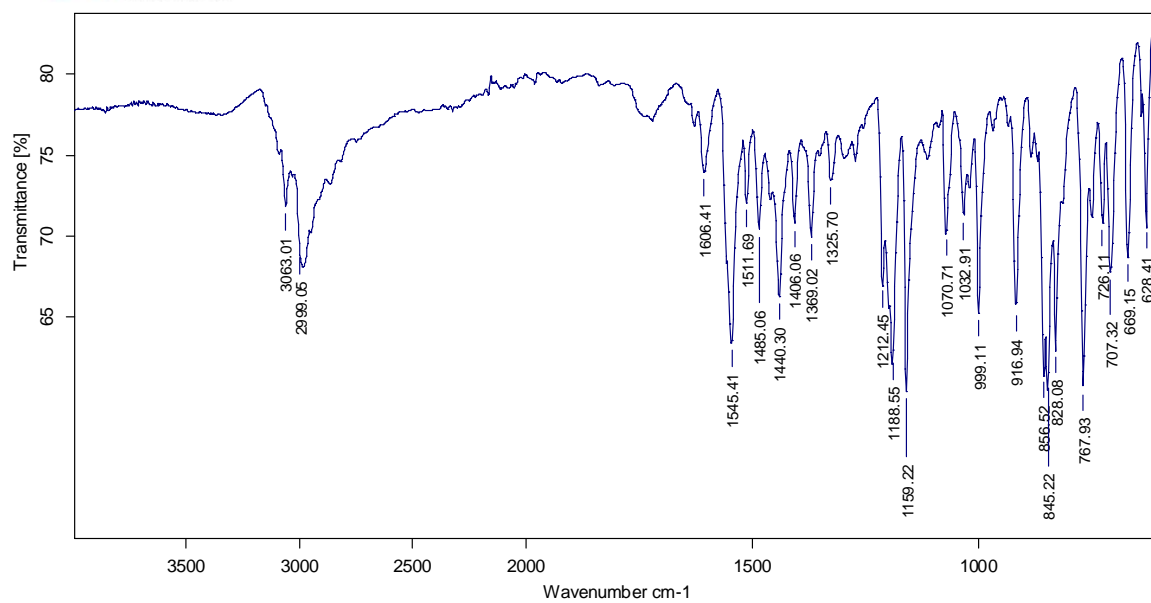


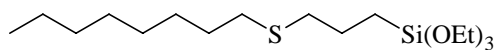
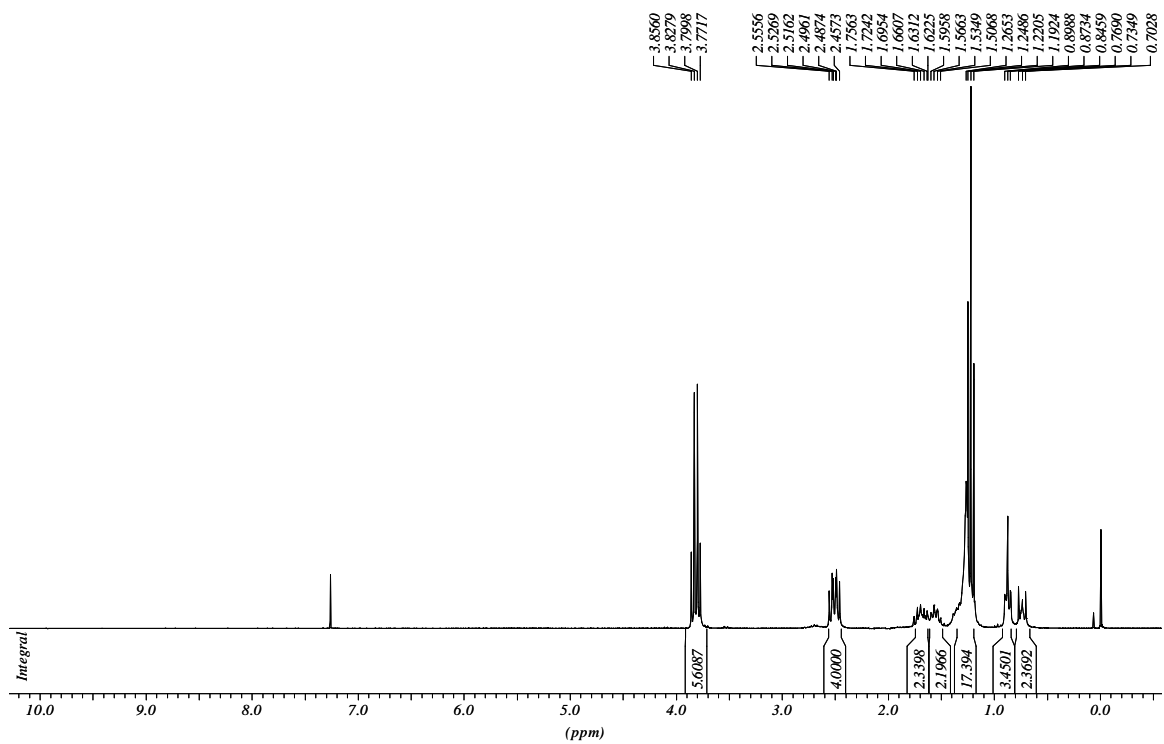
iodur de 1-mesitil-3-(4-vinilbenzil)imidazoli, 46

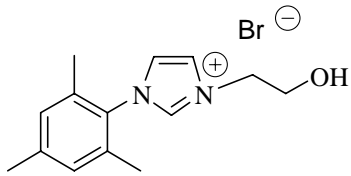
 $^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz) $^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)Universitat  
Autònoma  
de Barcelona

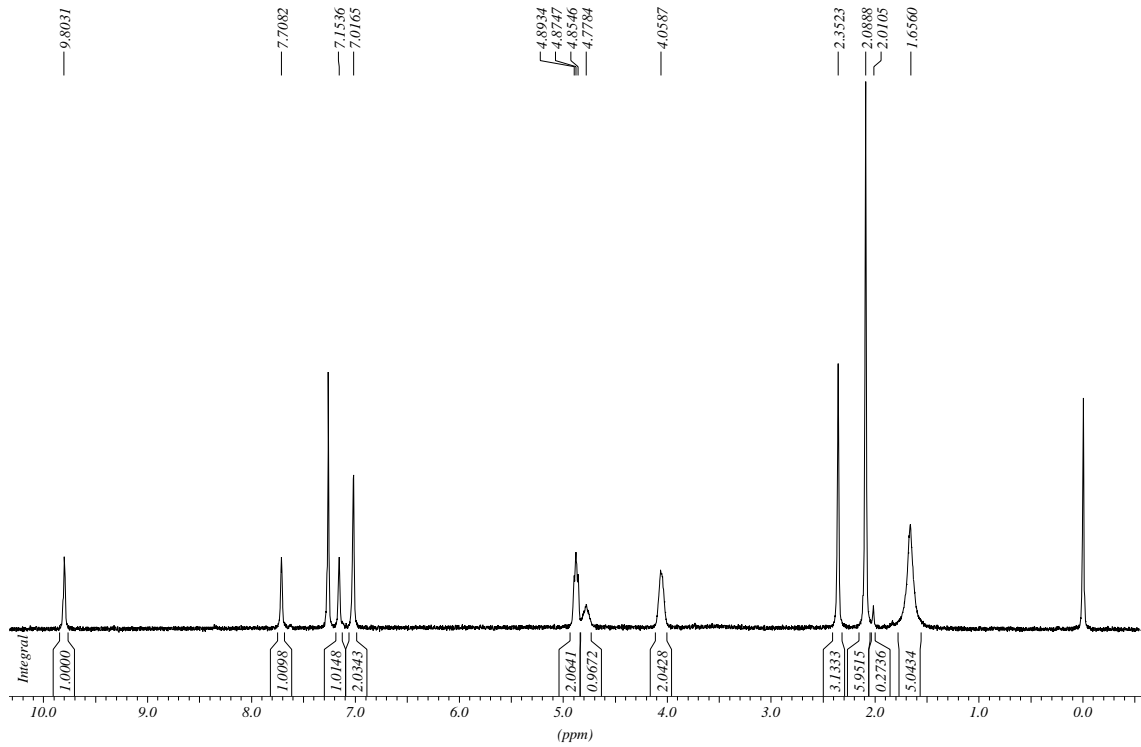
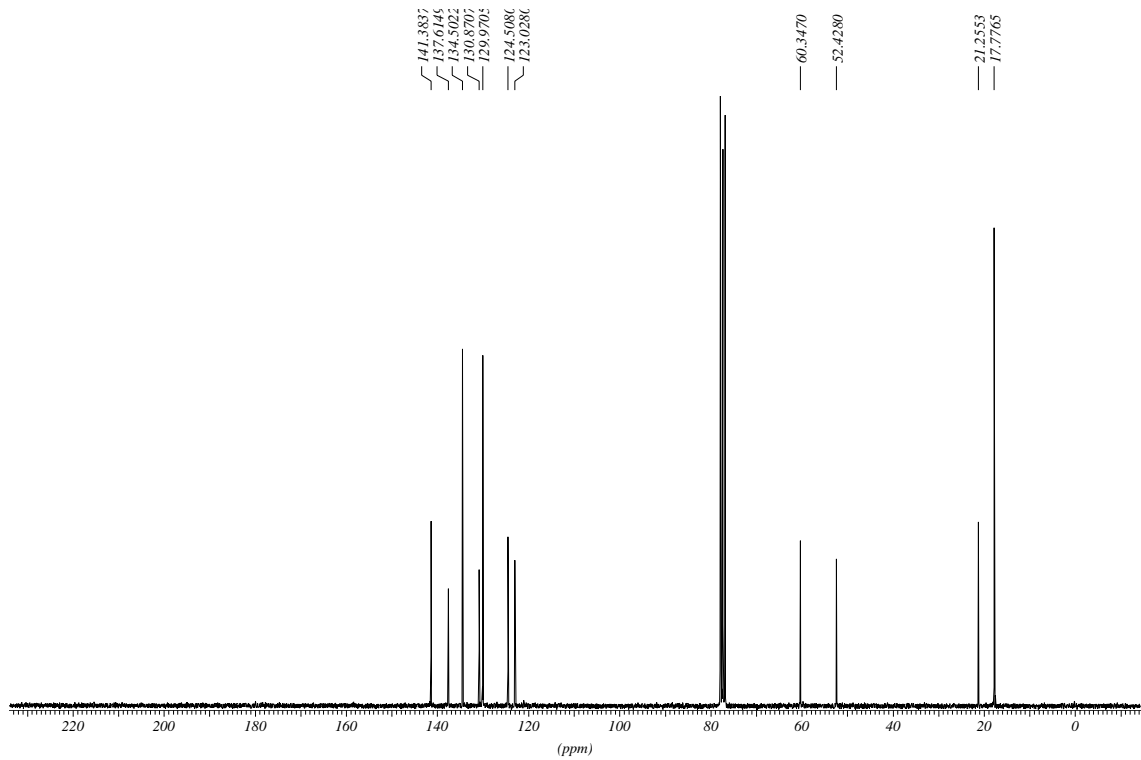
Servei d'Anàlisi Química

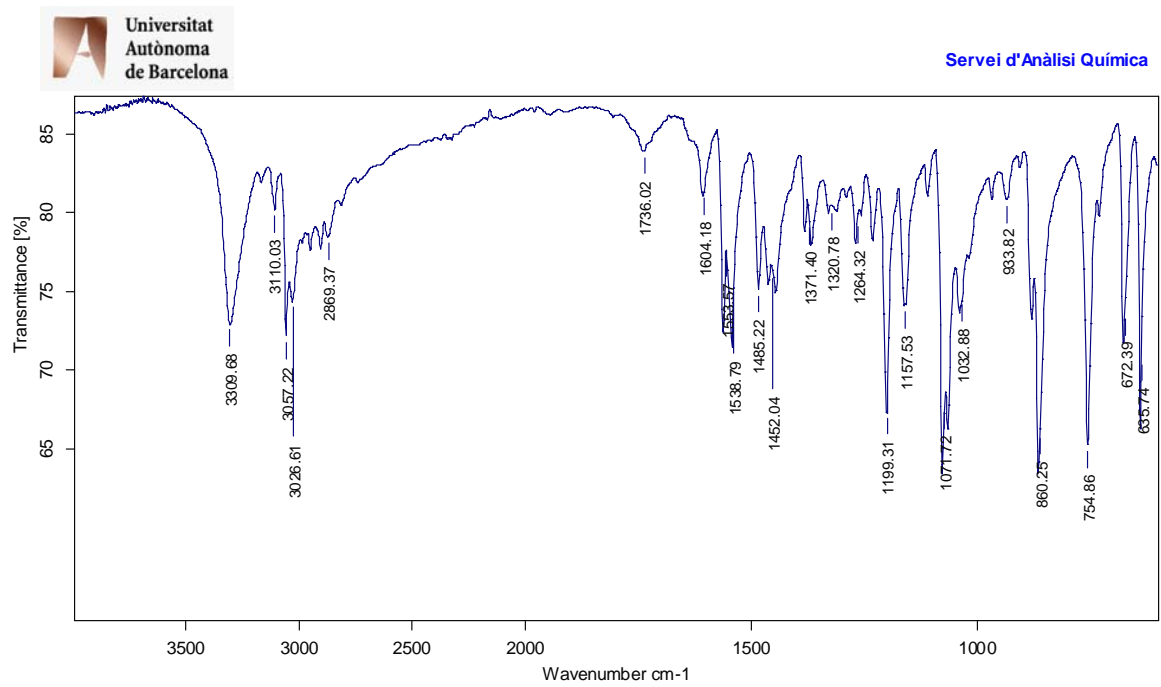


**trietoxi(3-(octilio)propil)silà, 52**<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)

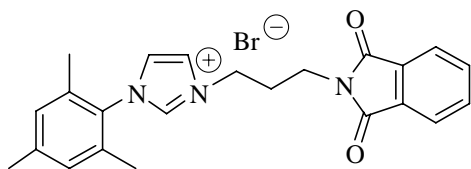


bromur de 3-(2-hidroxietil)-1-mesitilimidazoli, 53

 $^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz) $^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

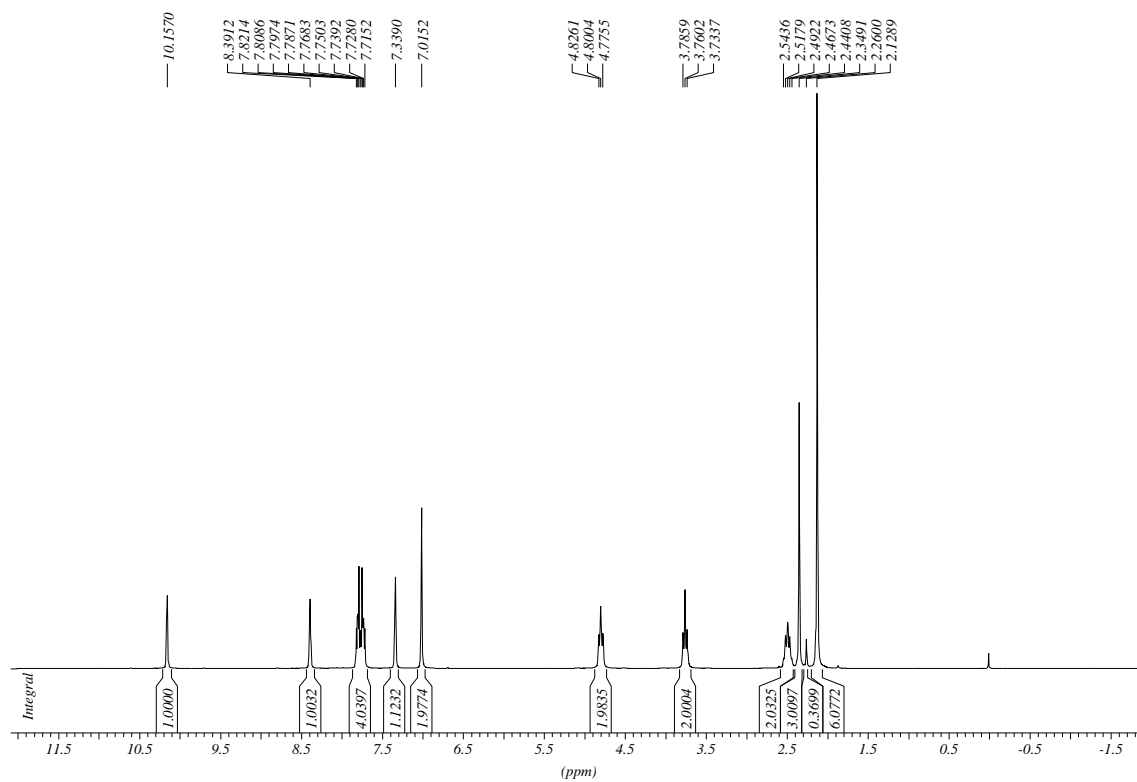
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)



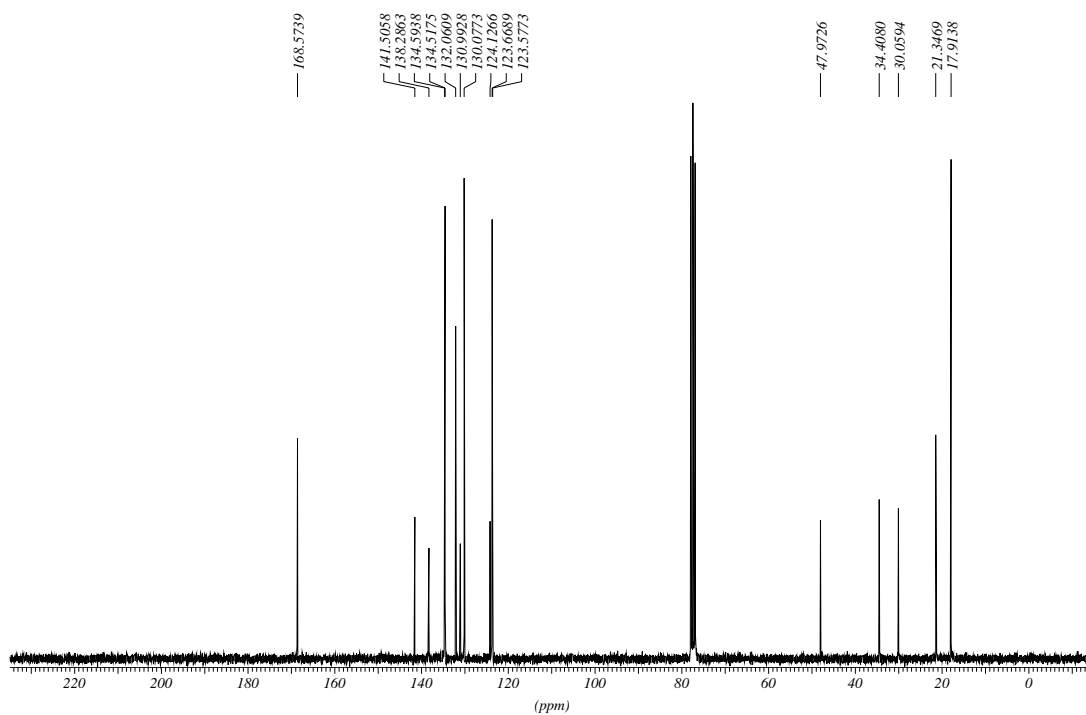


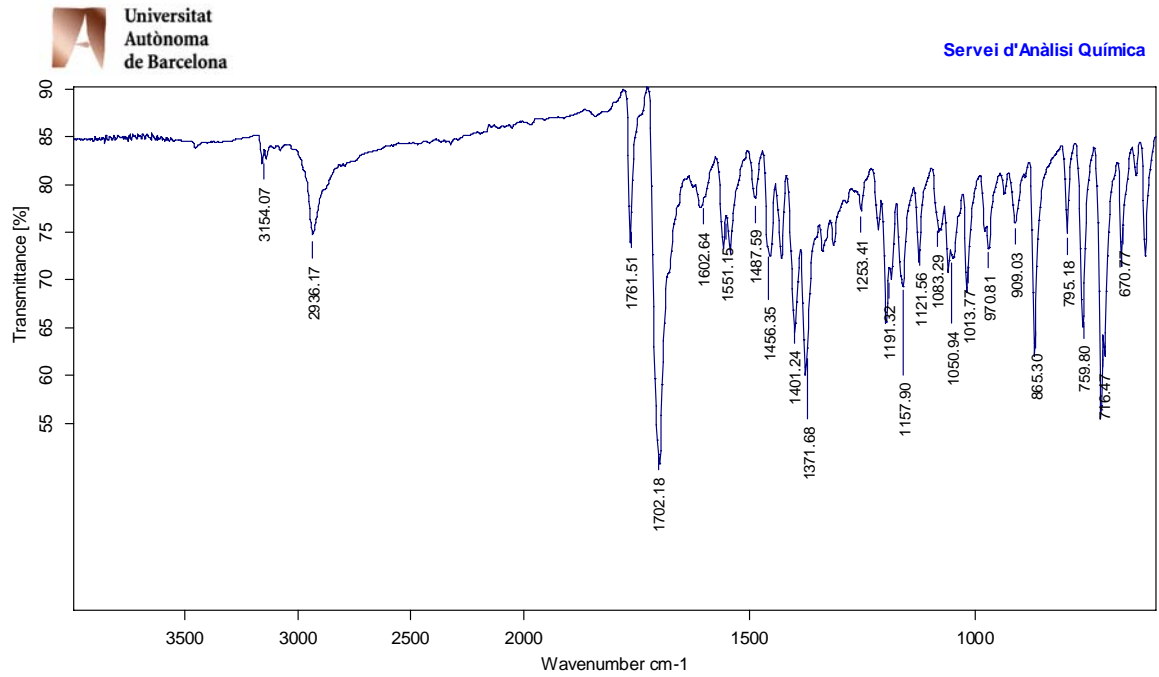
**bromur de 3-(3-ftalimidopropil)-1-mesitilimidazoli, 55**

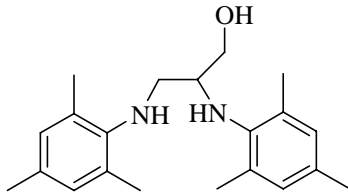
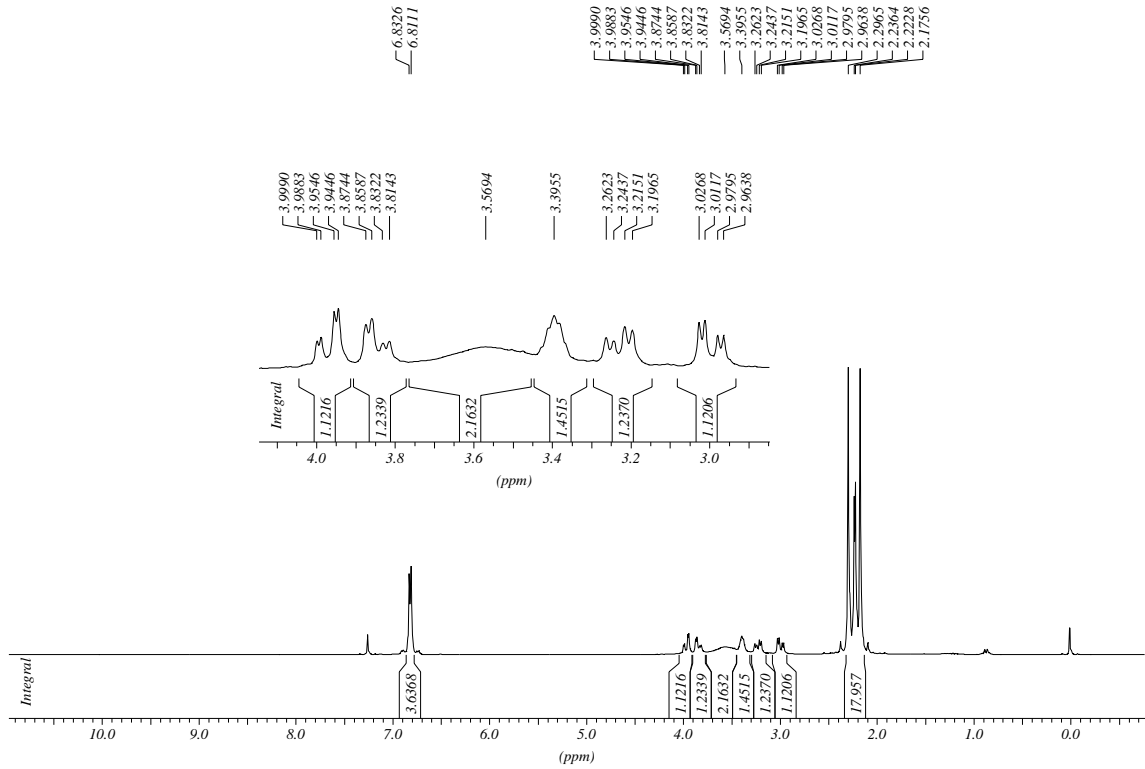
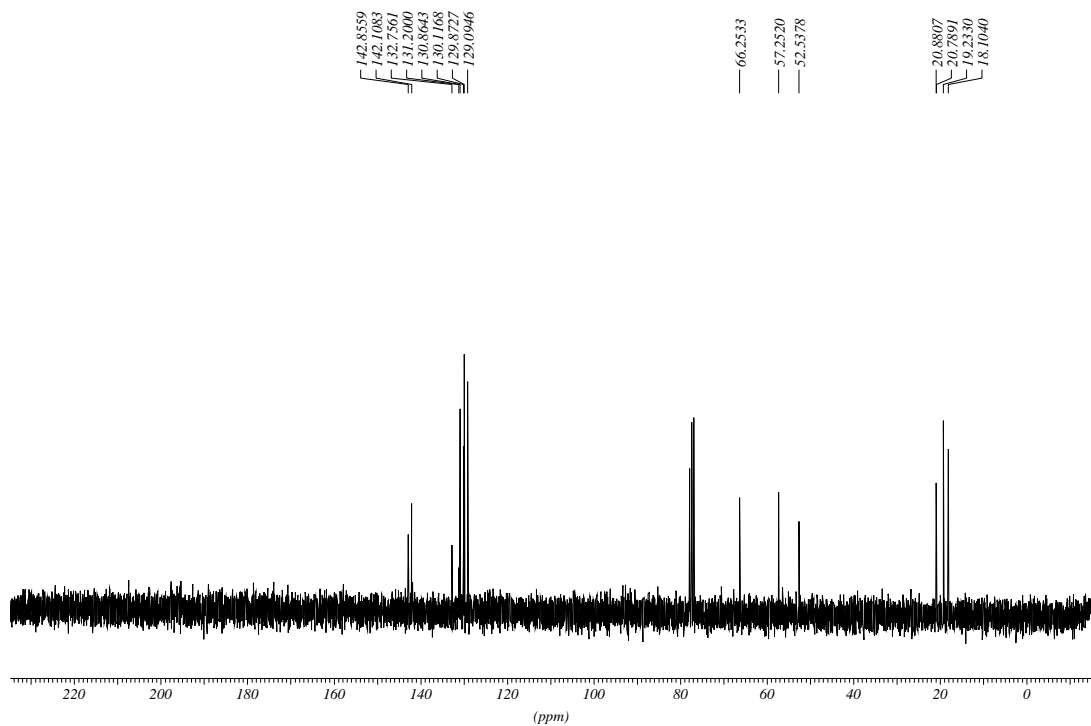
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)

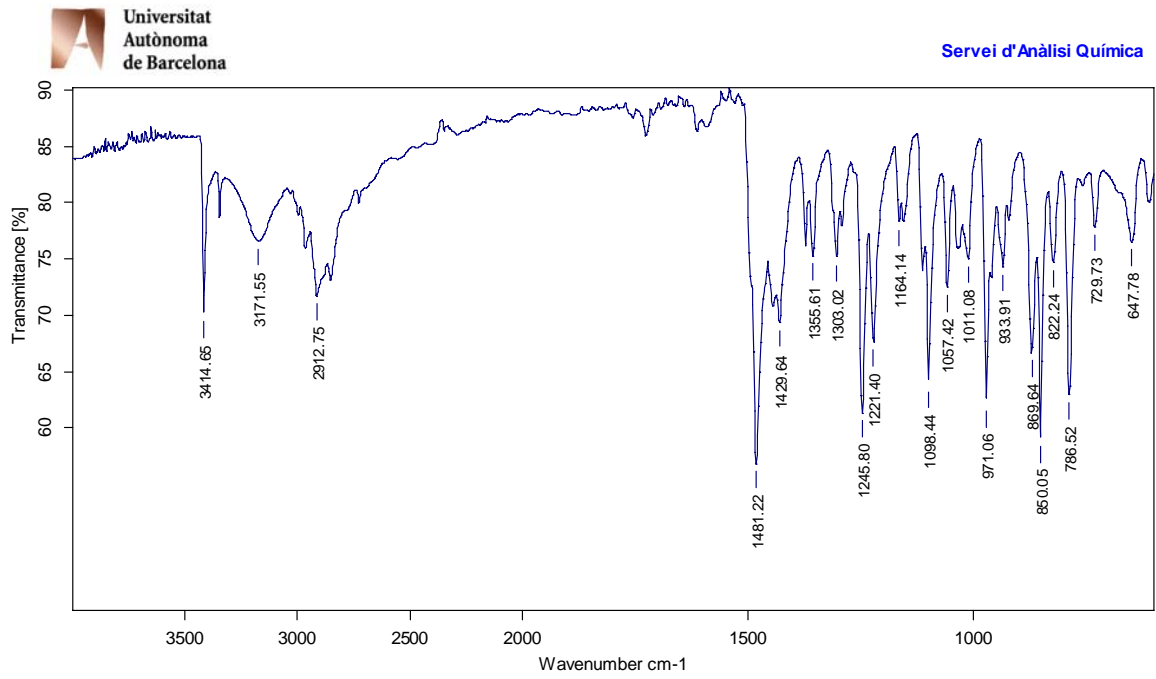


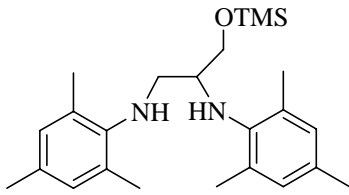
$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)



IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

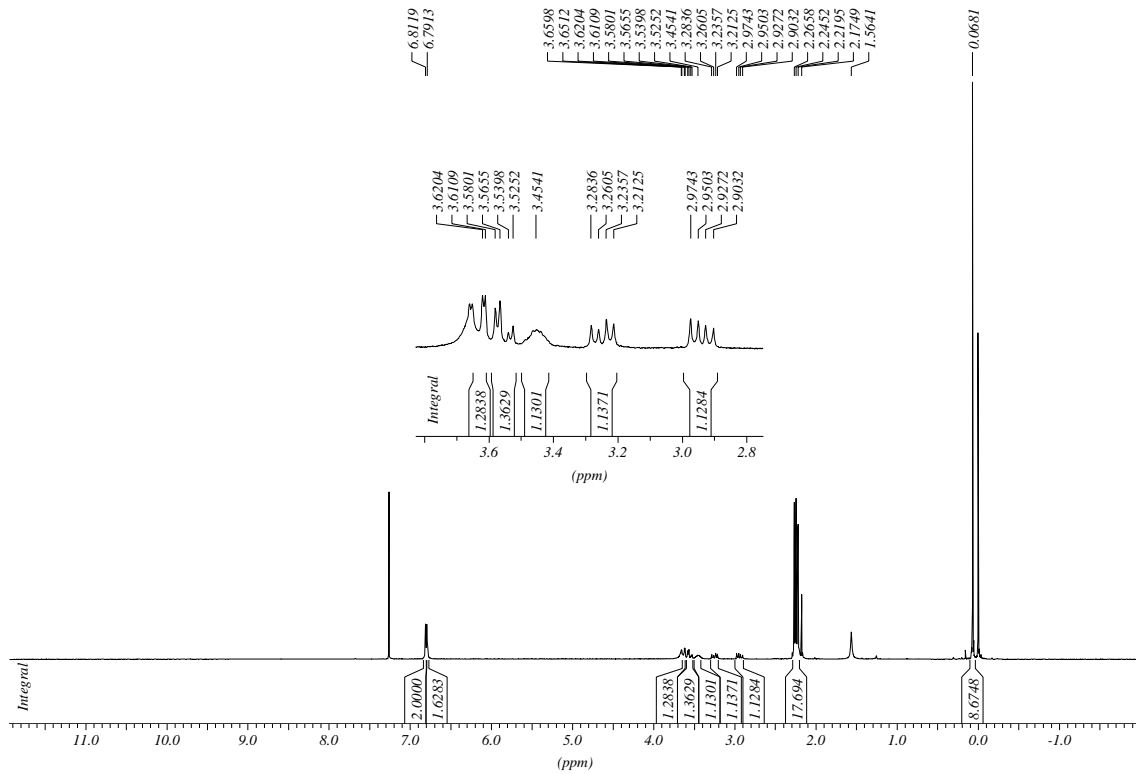
***N,N'*-dimesitol-2,3-diamino-1-propanol, 60****<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)****<sup>13</sup>C-RMN (CDCl<sub>3</sub>, 62.5 MHz)**

IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

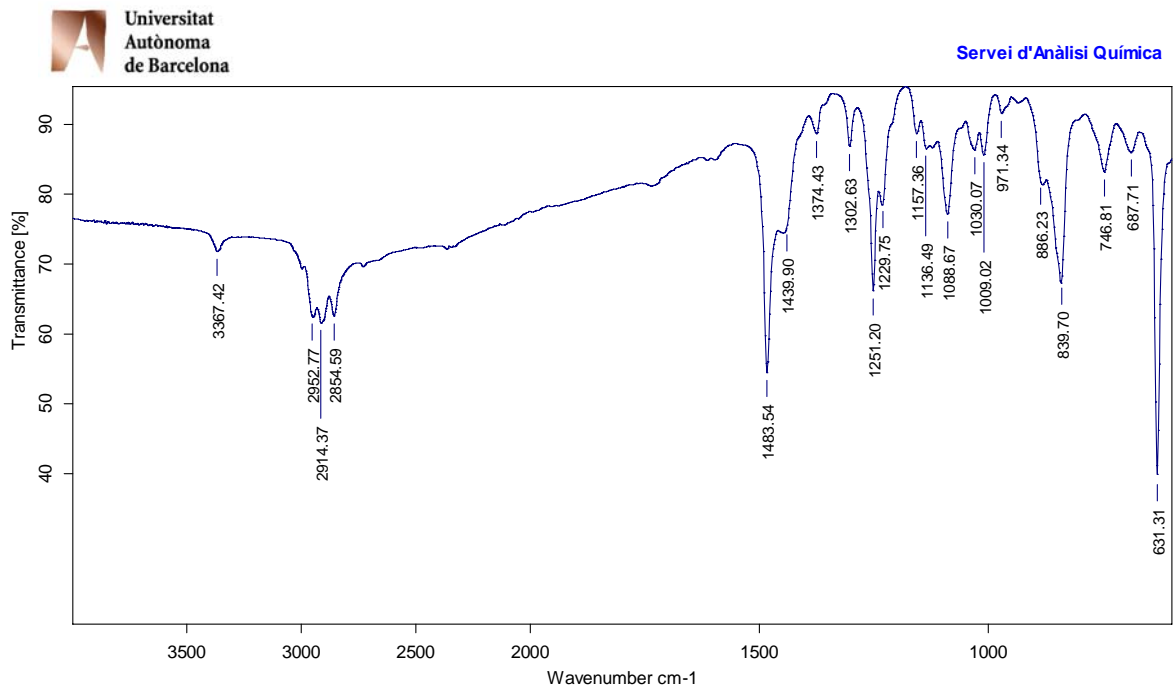


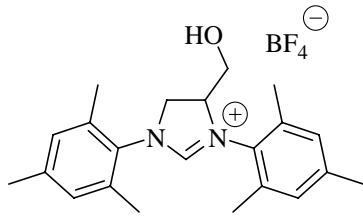
***N,N'*-dimesitil-3-trimetilsililoxipropan-1,2-diamina, 62**

$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



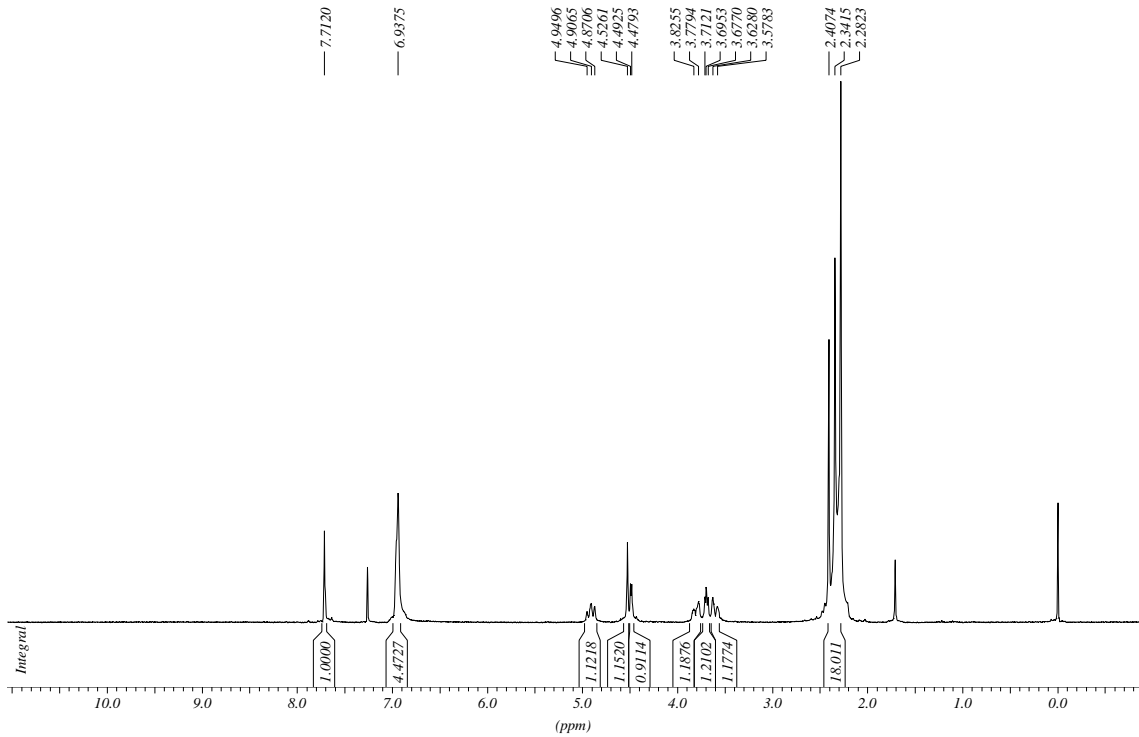
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)



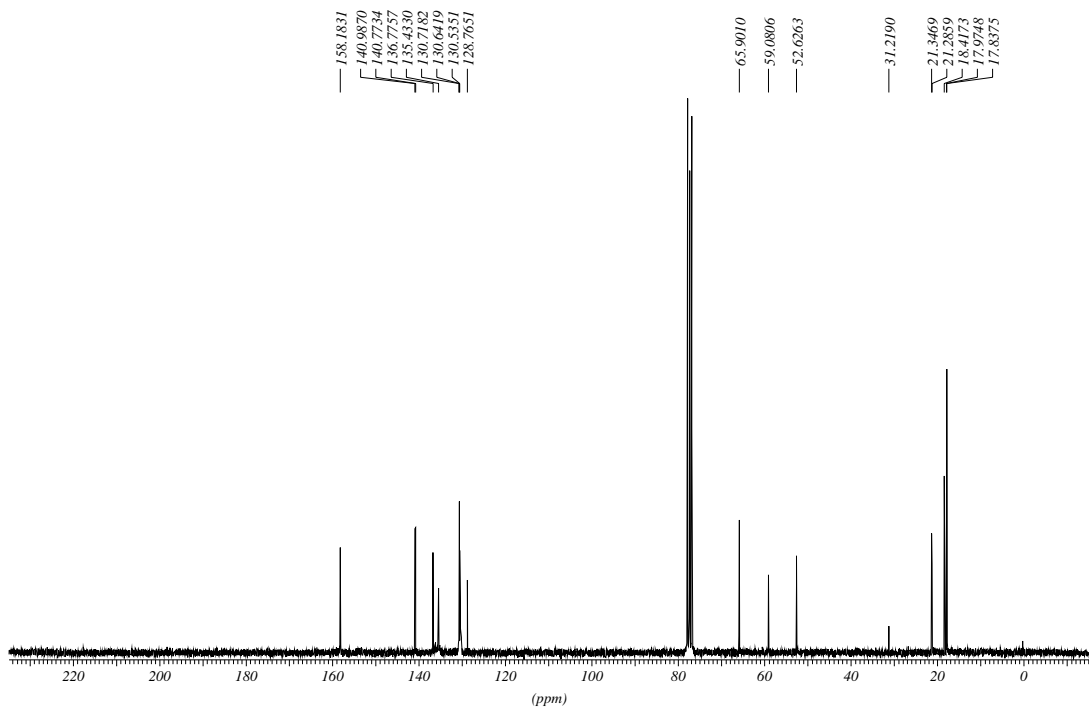


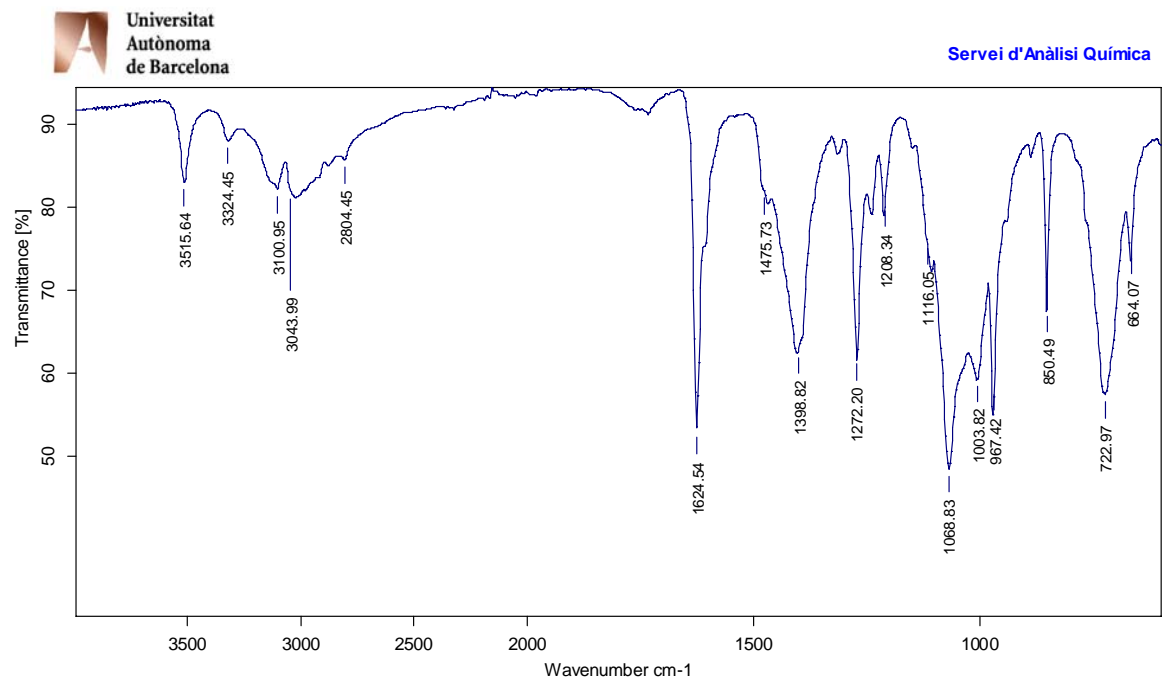
**tetrafluoroborat de 4-hidroximetil-1,3-dimesitil-4,5-dihidroimidazoli, 61**

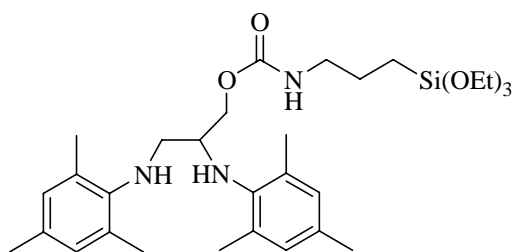
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

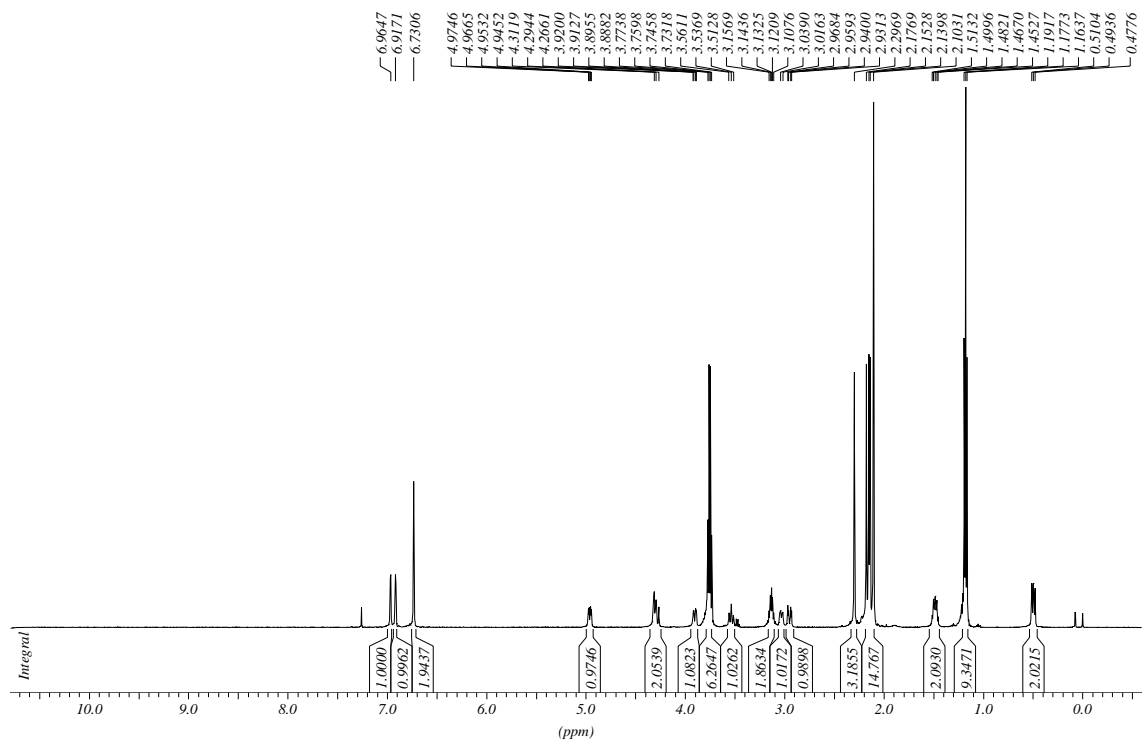


IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

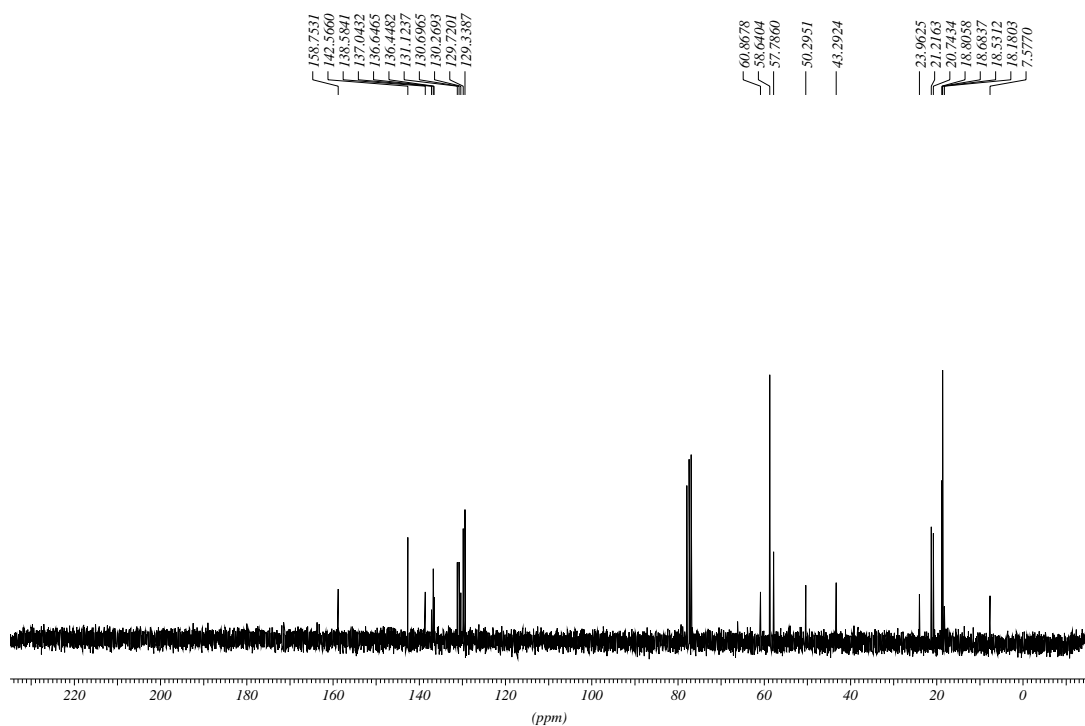


### 3-(triethoxisilil)propilcarbamtat de 2,3-bis(mesitilamino)propil, 63

$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 500 MHz)

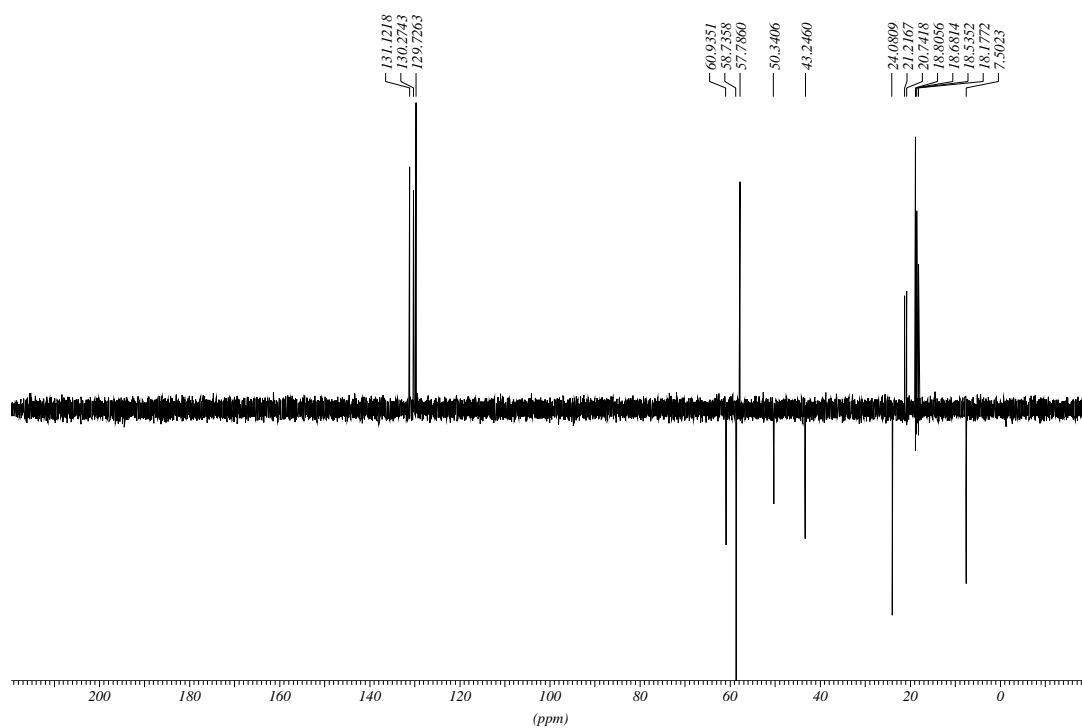


$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

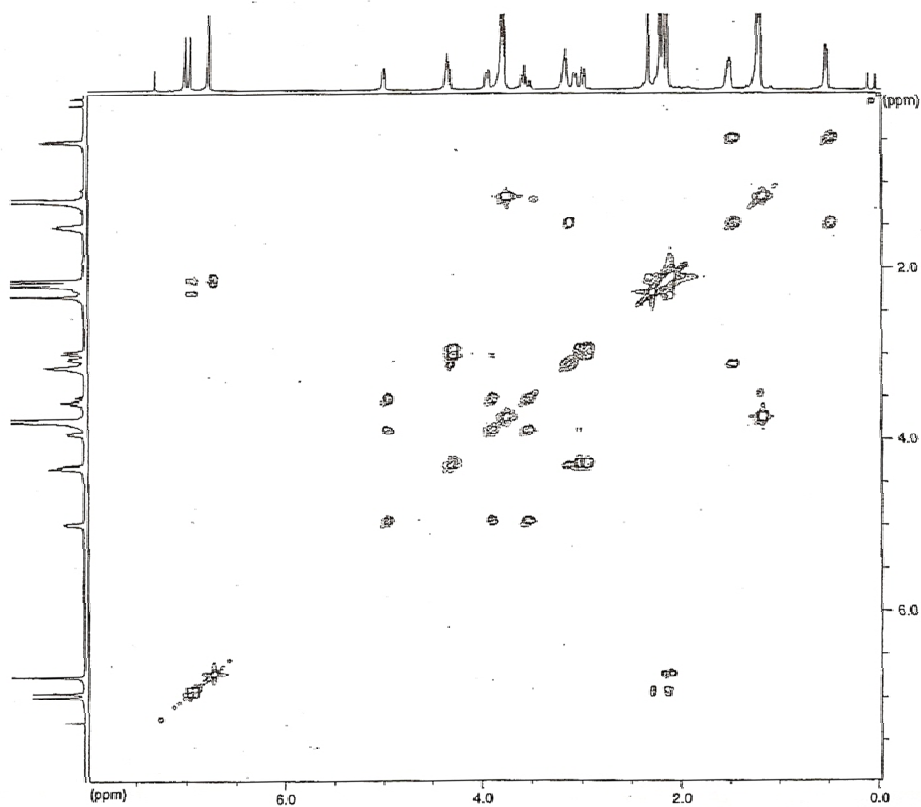




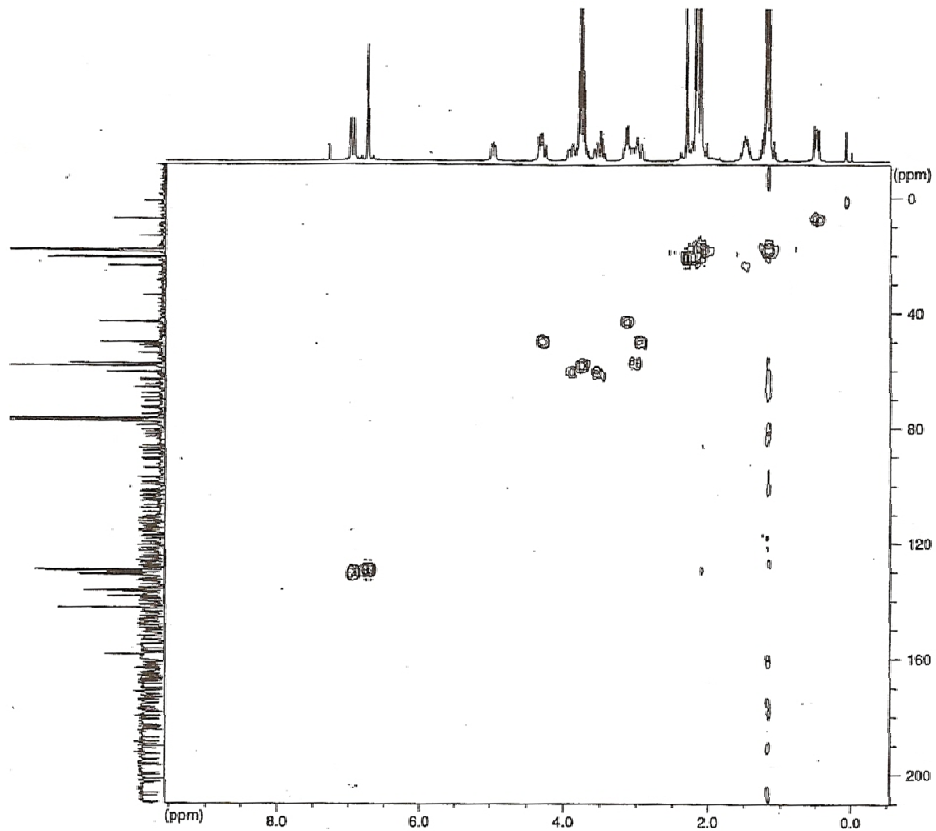
DEPT (CDCl<sub>3</sub>, 62.5 MHz)



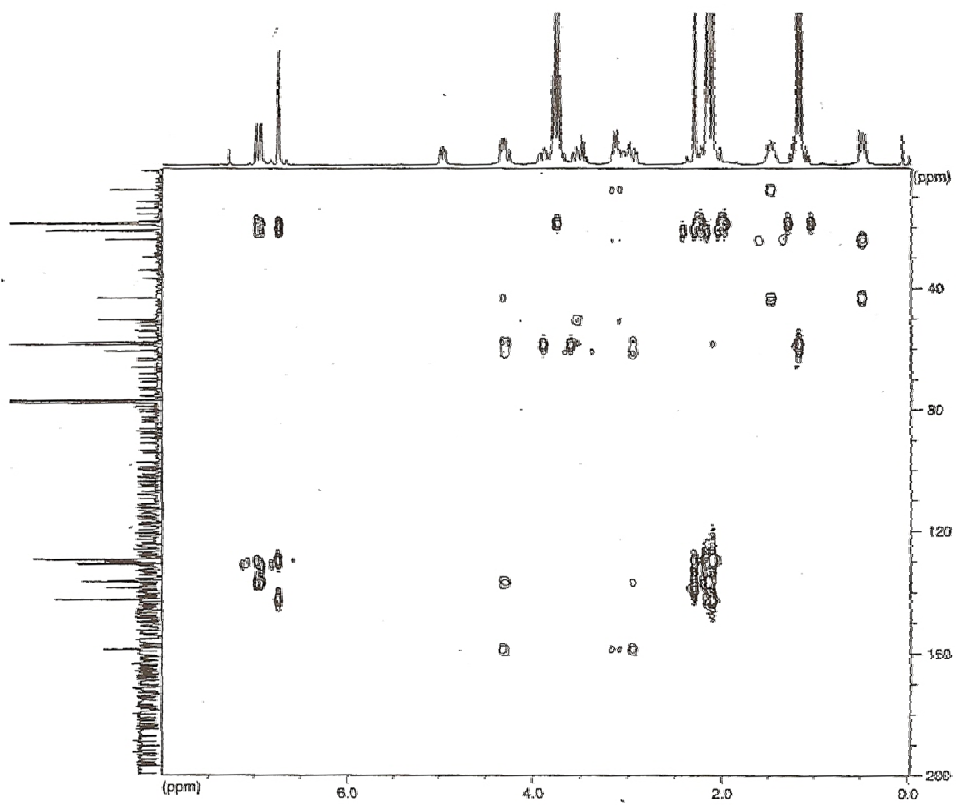
COSY

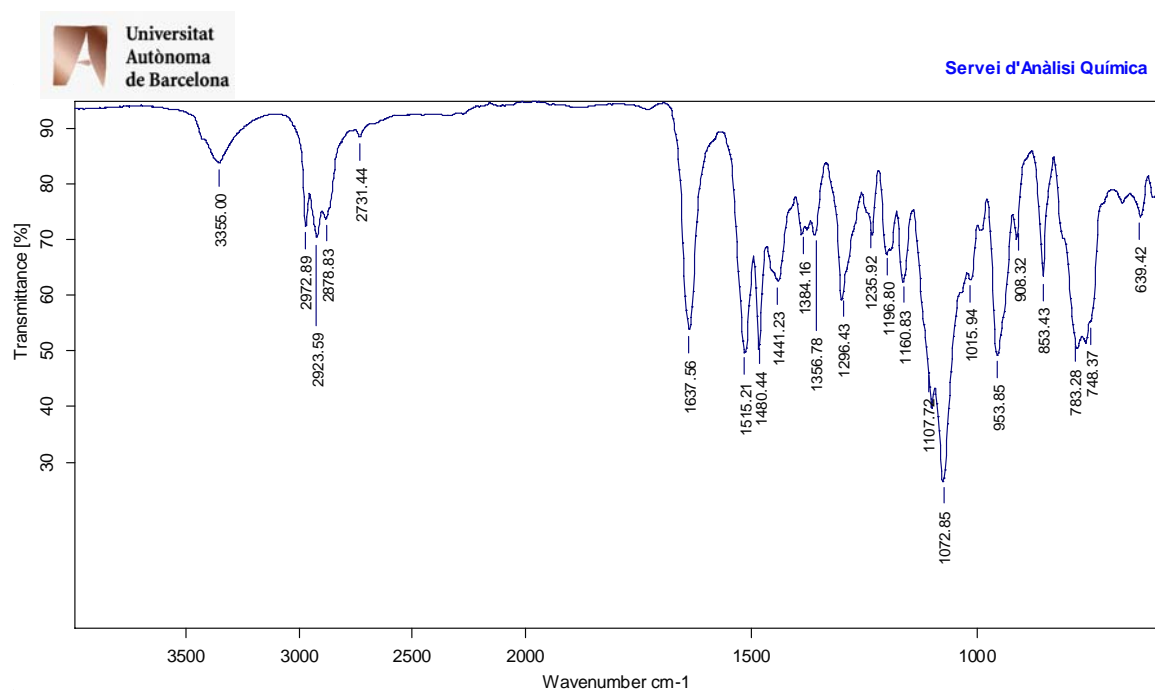


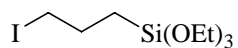
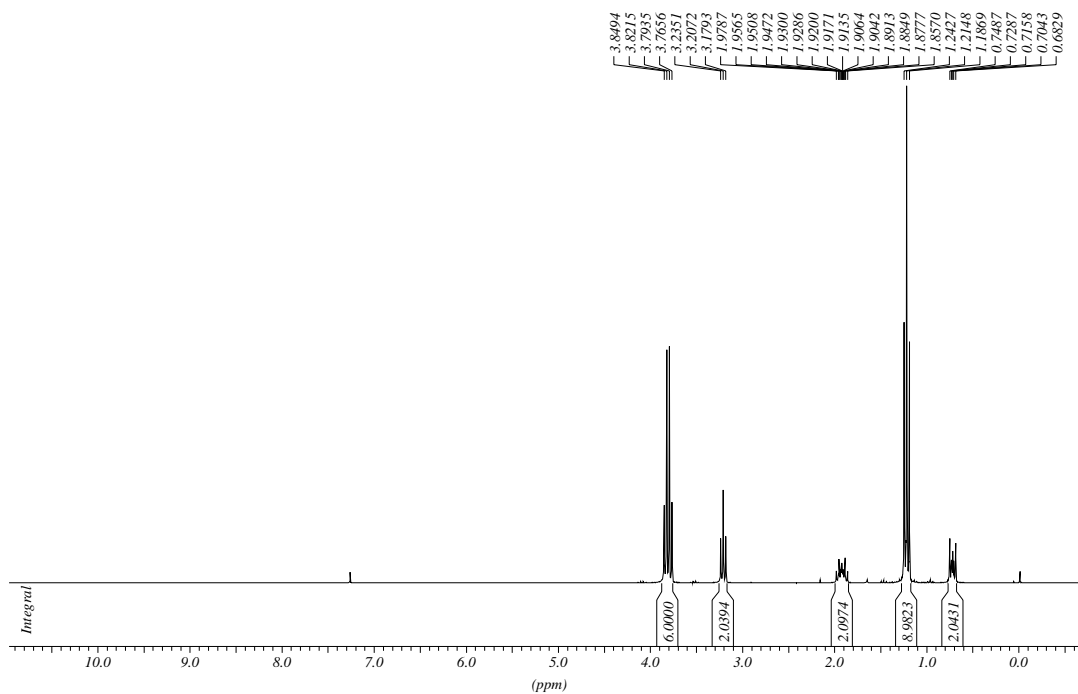
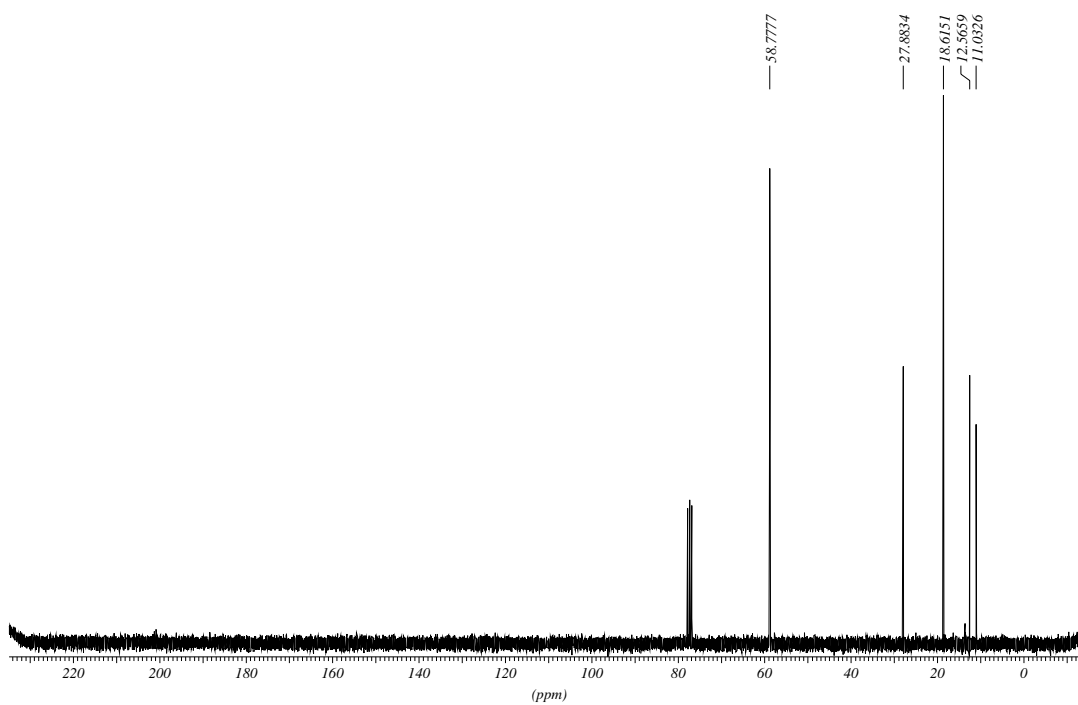
HMQC

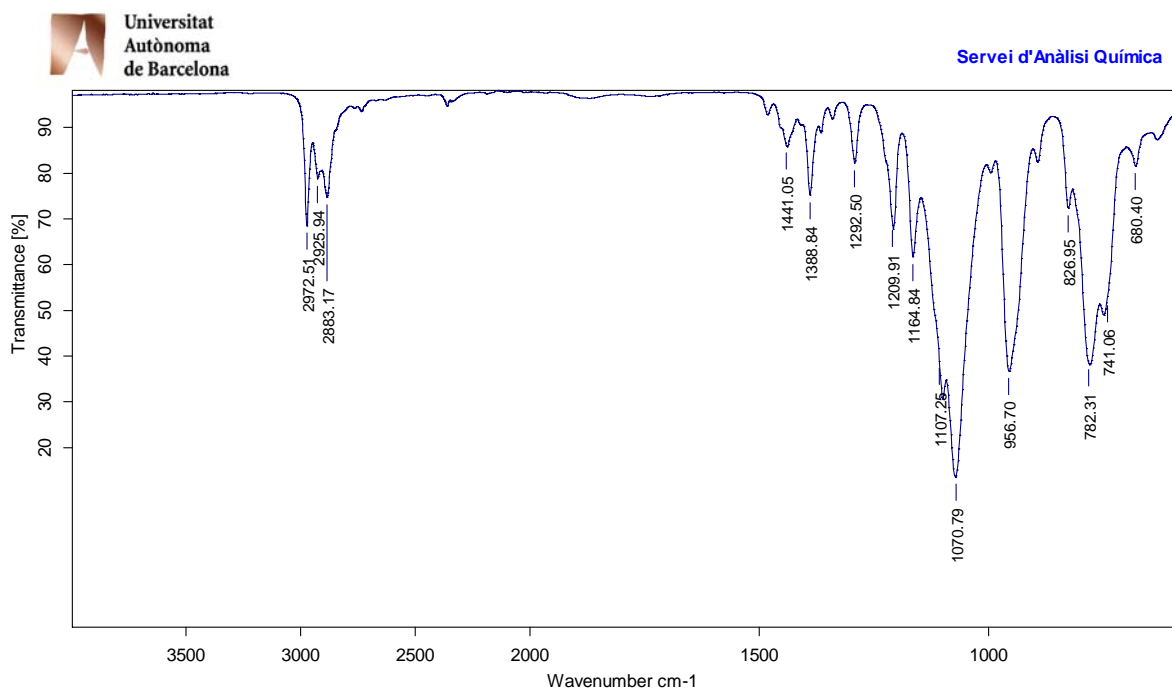


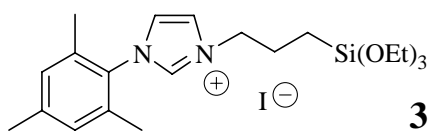
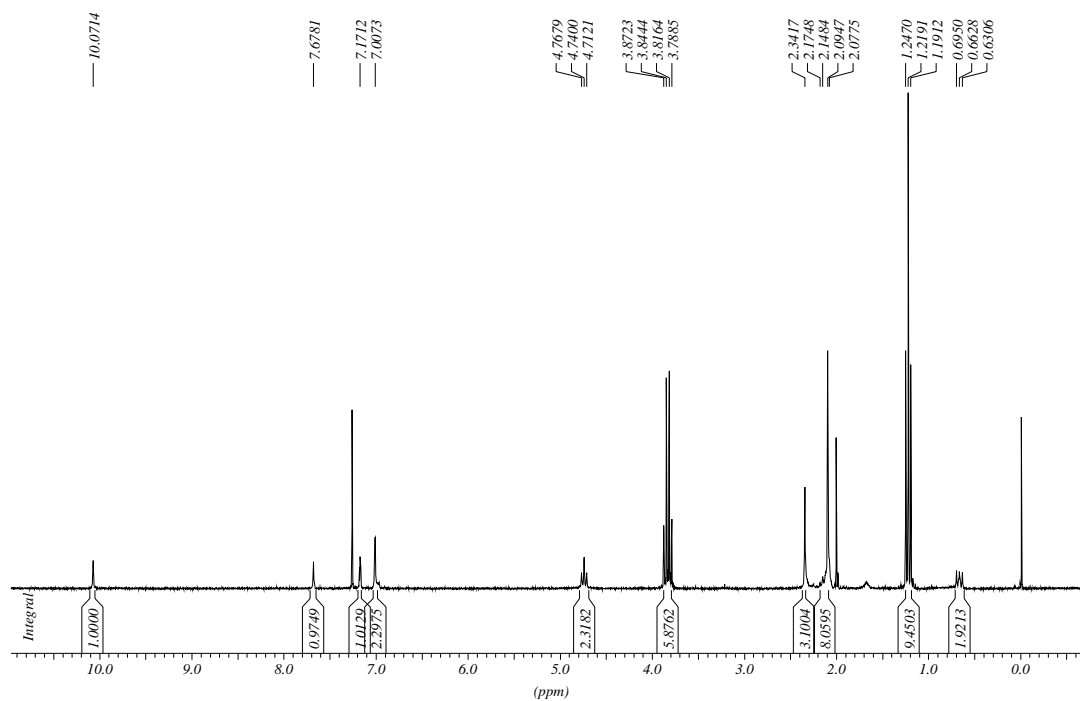
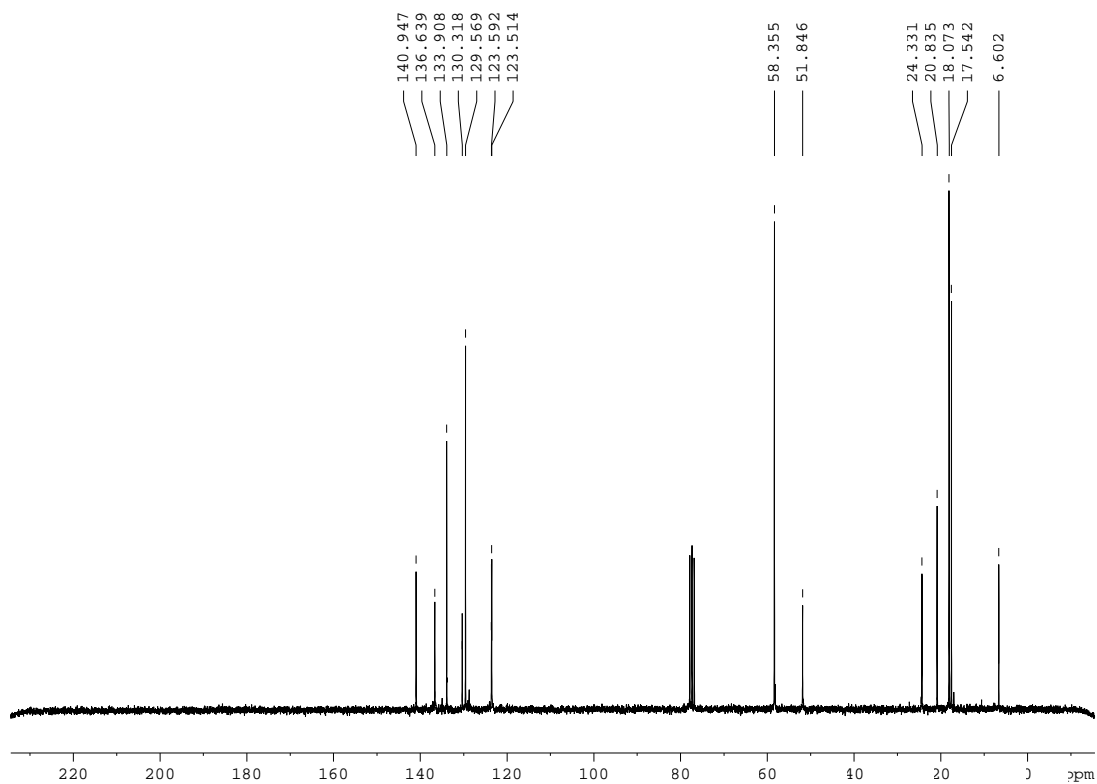
HMBC



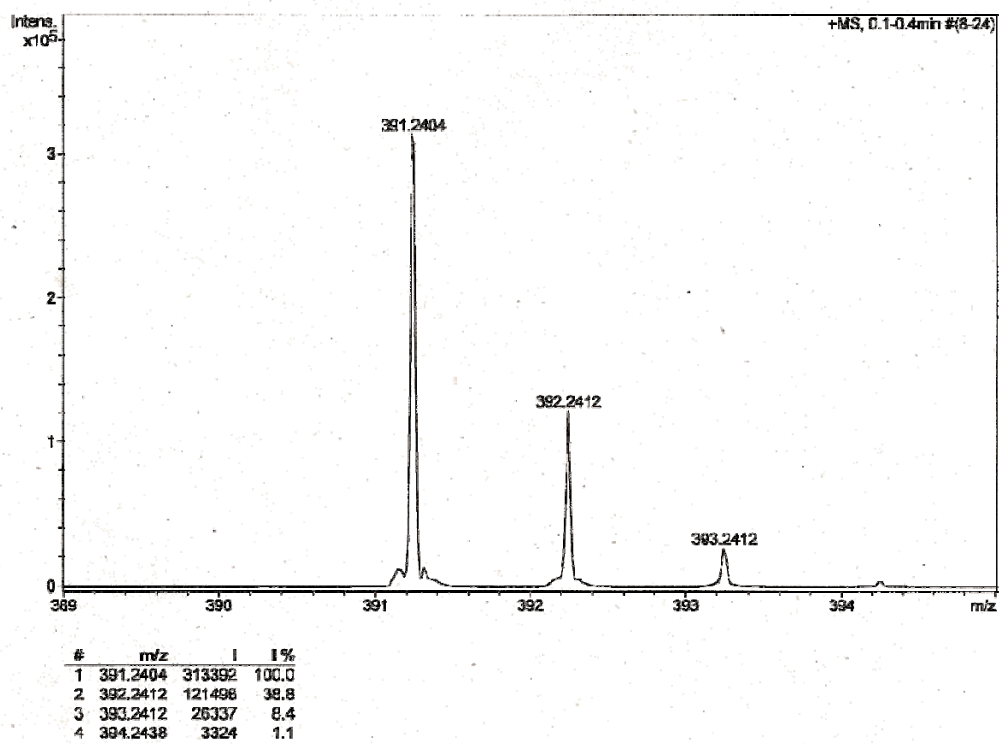
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

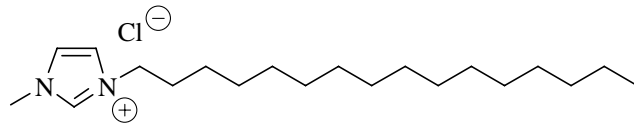
**3-iodopropiltriètoxissilà, 58****<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)****<sup>13</sup>C-RMN (CDCl<sub>3</sub>, 62.5 MHz)**

IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

**3-(3-triethoxysililpropil)-1-mesitilimidazoli, 59****<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)****<sup>13</sup>C-RMN (CDCl<sub>3</sub>, 62.5 MHz)**

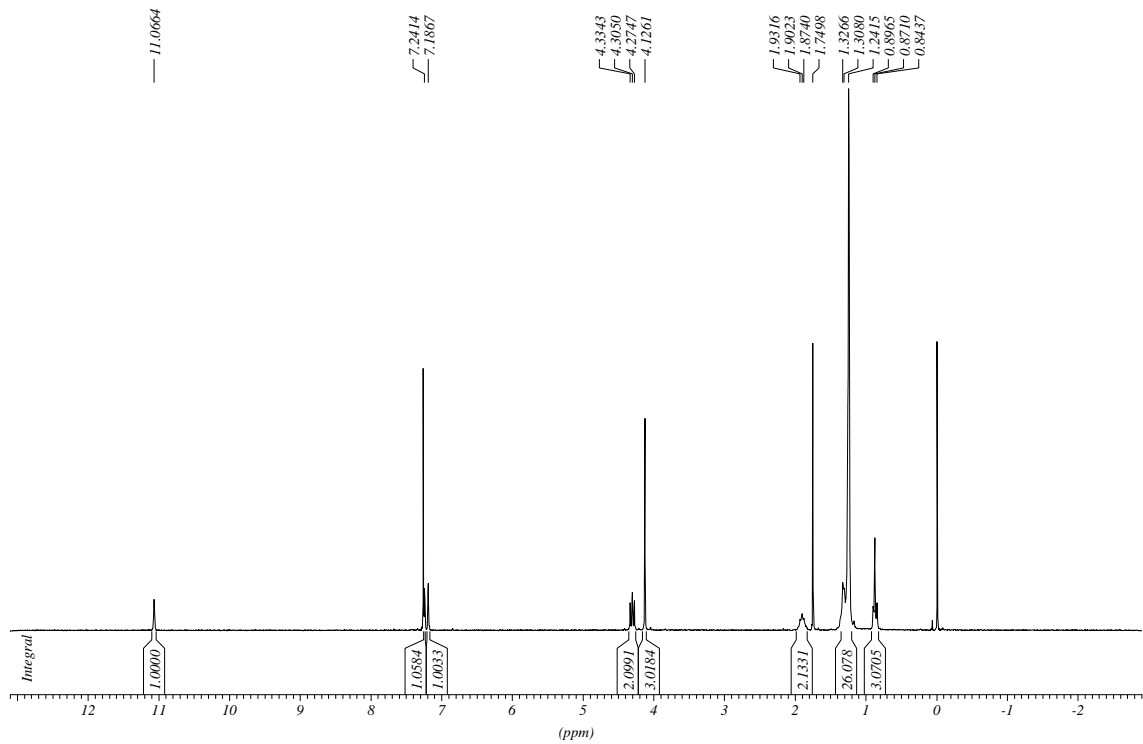
## HR-MS



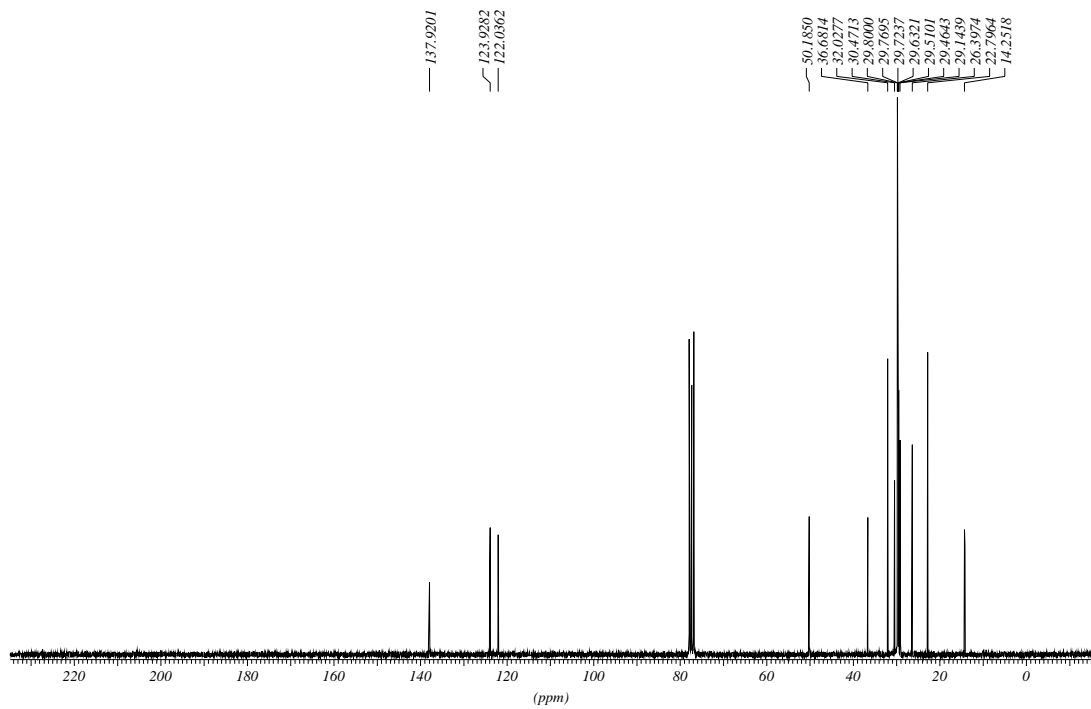


**clorur de 1-hexadecil-3-metilimidazoli**

$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

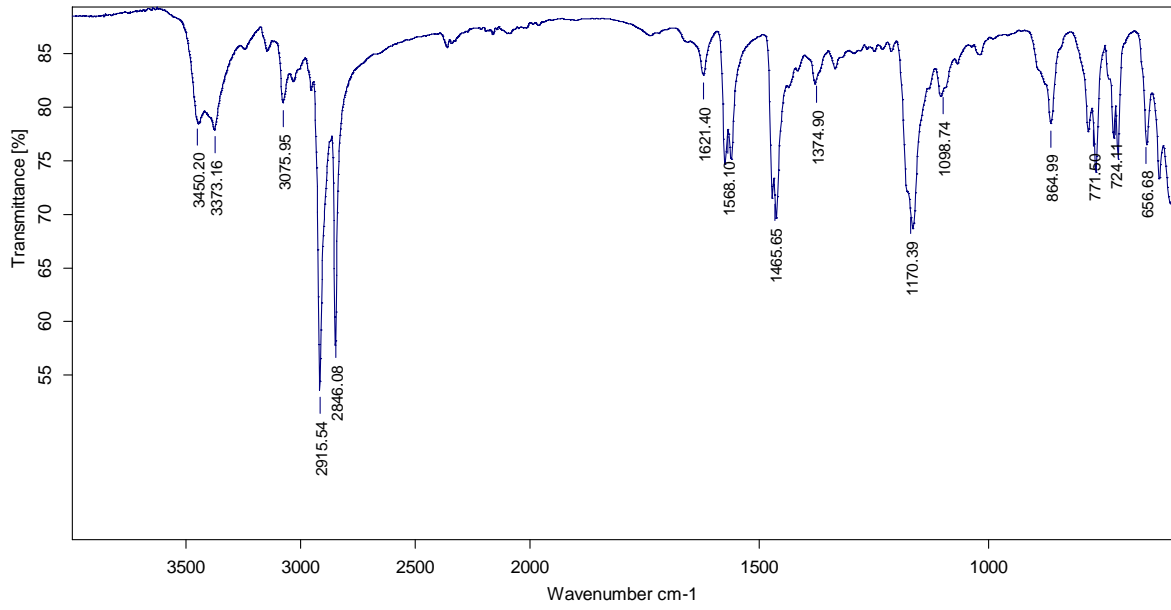


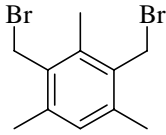


IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

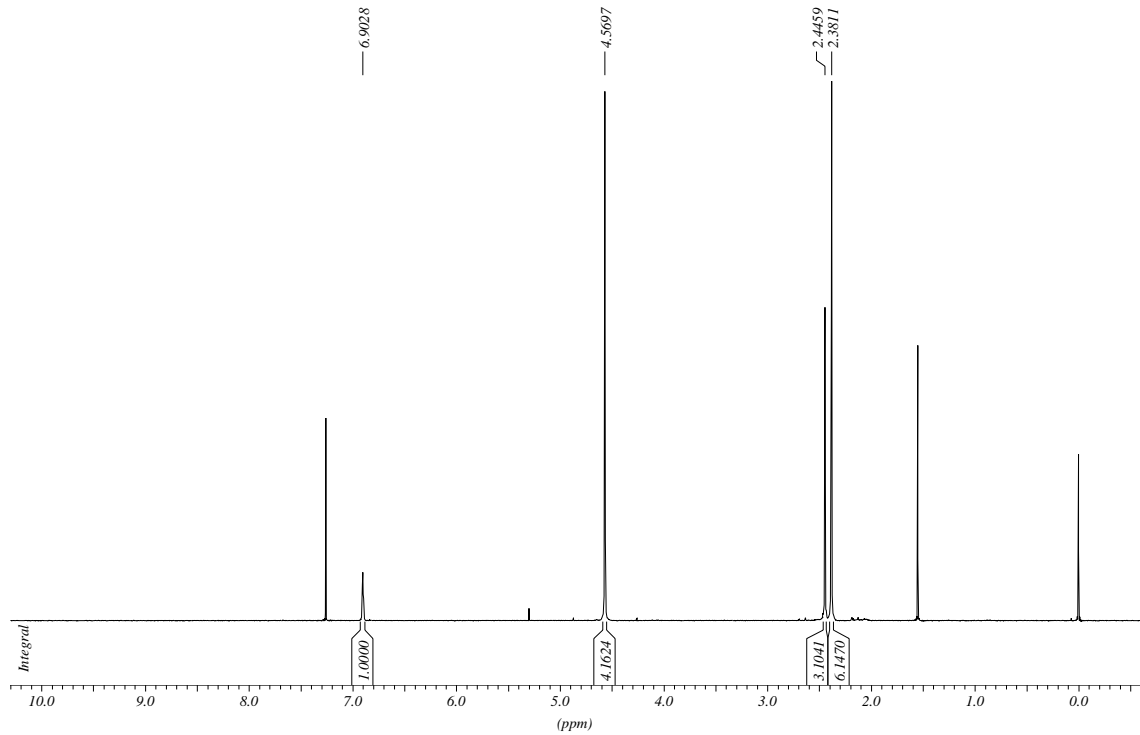
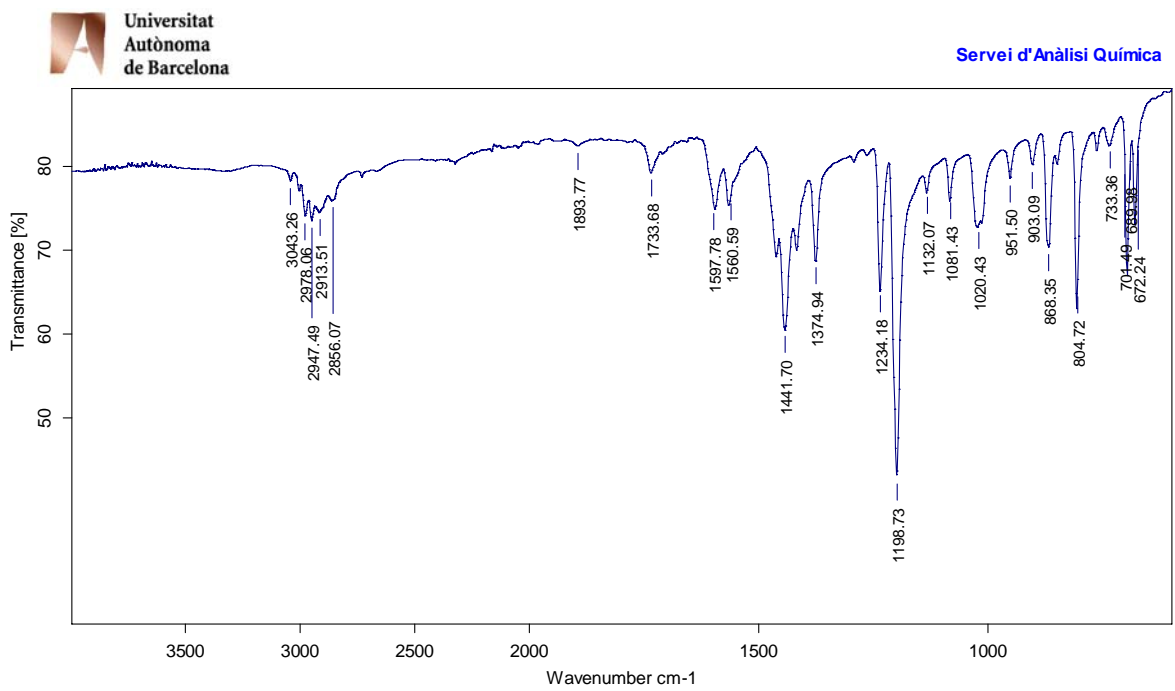


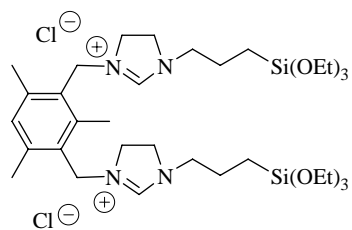
Servei d'Anàlisi Química





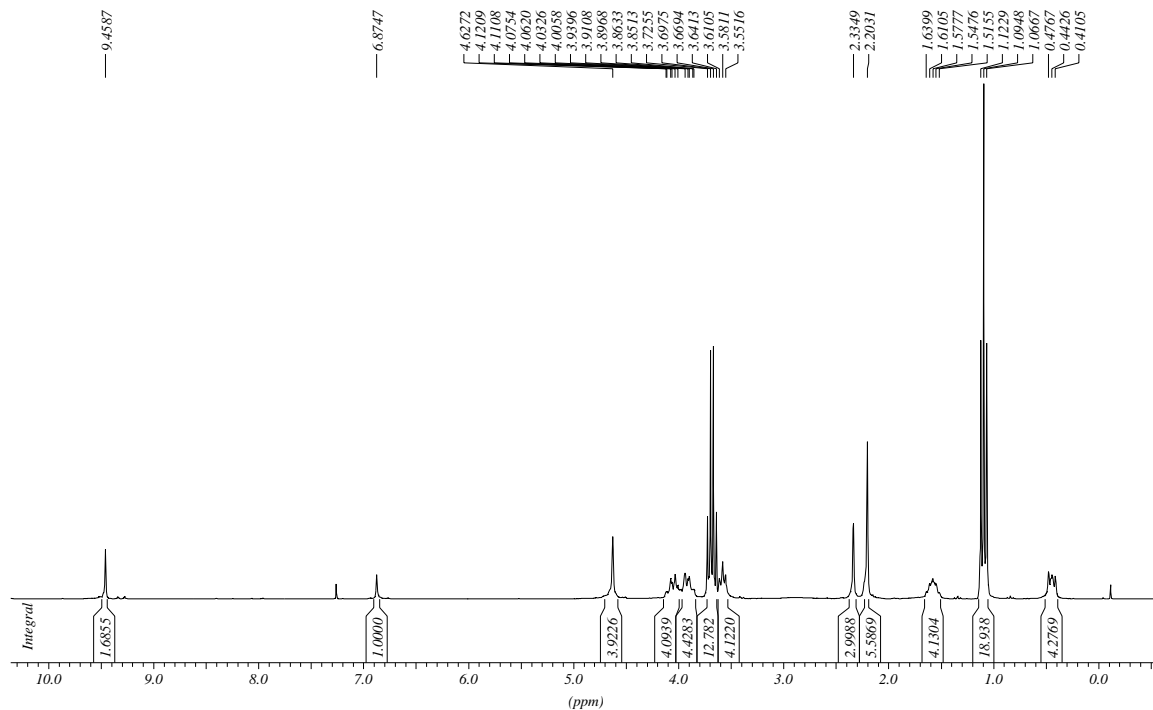
2,4-bis(bromometil)mesitolè, 66

 $^1\text{H}$ -RMN ( $\text{CDCl}_3$ , 250 MHz)IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

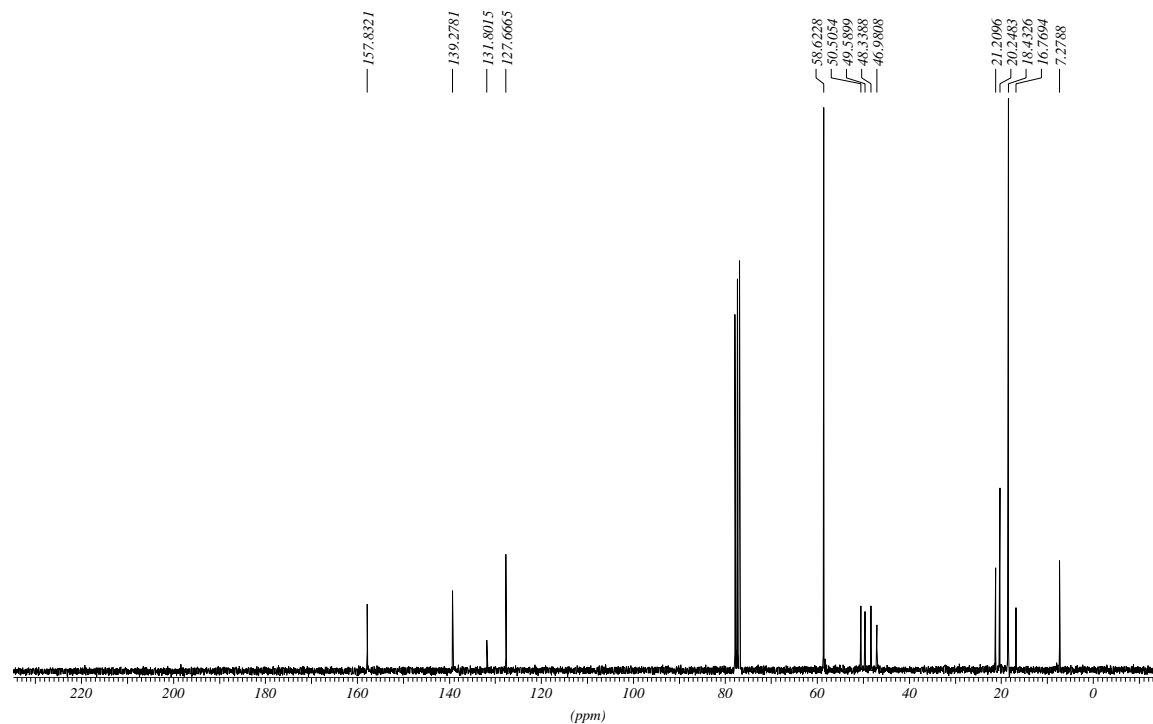


**clorur de 1,1'-(1,3-mesitilè)bis(metilè)-3,3'-(3-trietoxisilil)propil)-4,5-dihidroimidazoli, 10a**

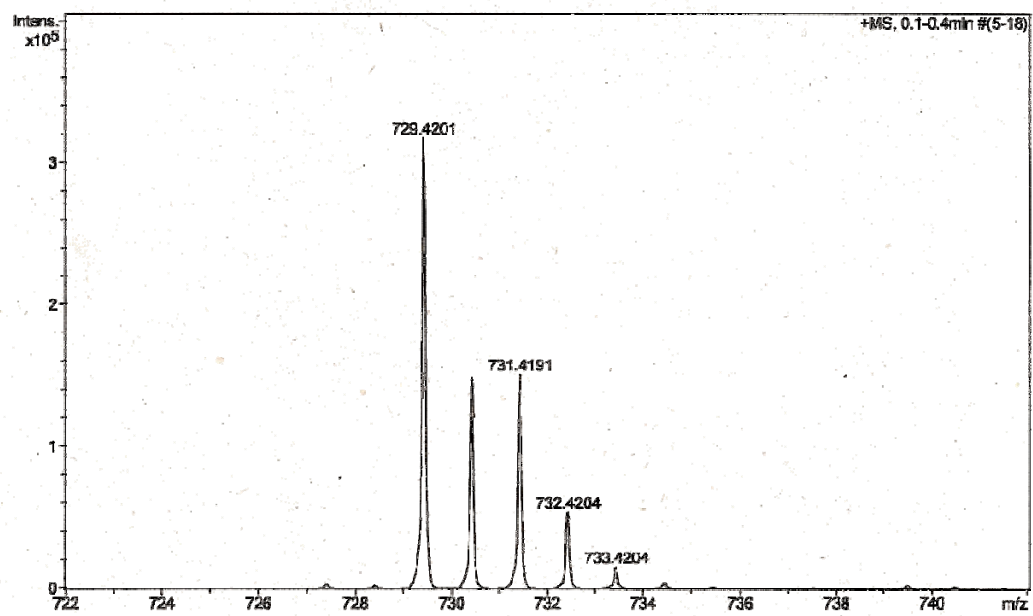
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



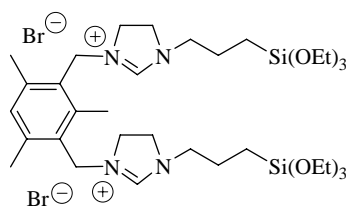
$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)



## HR-MS

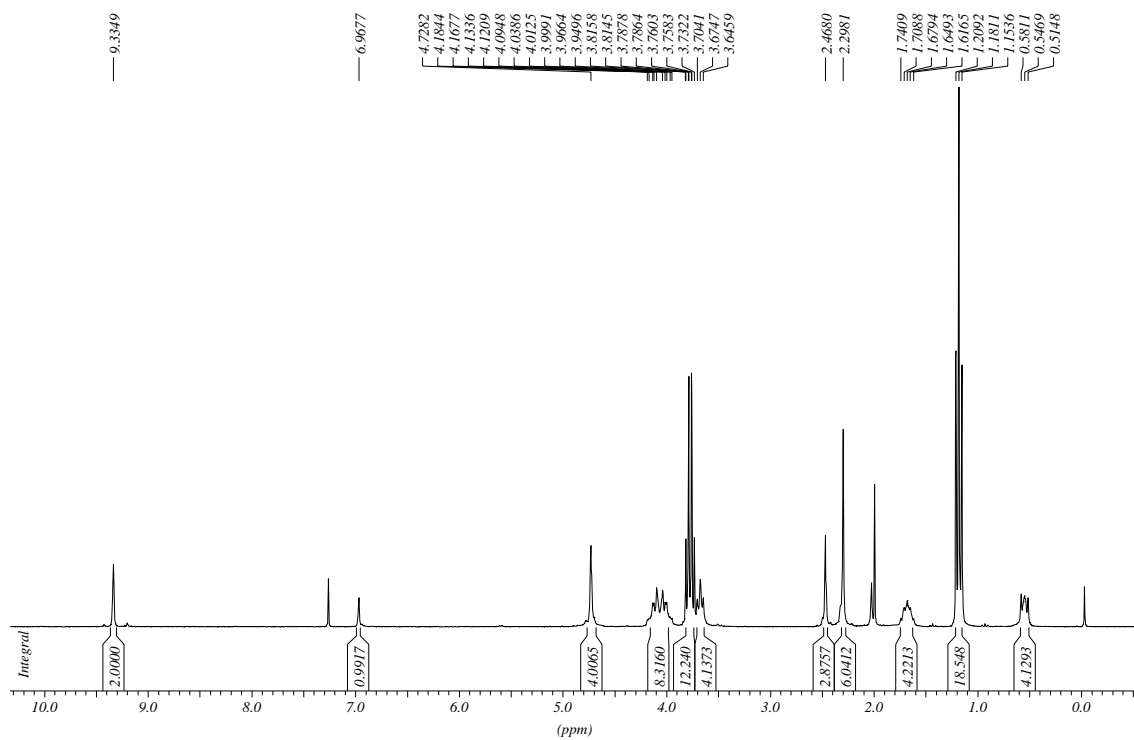


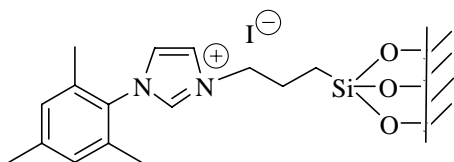
#	m/z	I	I%
1	729.4201	317065	100.0
2	730.4222	149112	47.0
3	731.4191	150782	47.6
4	732.4204	53804	17.0
5	733.4204	15317	4.8
6	734.4213	3413	1.1



**bromur de 1,1'-(1,3-mesitilè)bis(metilè)-3,3'-(3-trietoxisilil)propil)-4,5-dihidroimidazole, 10b**

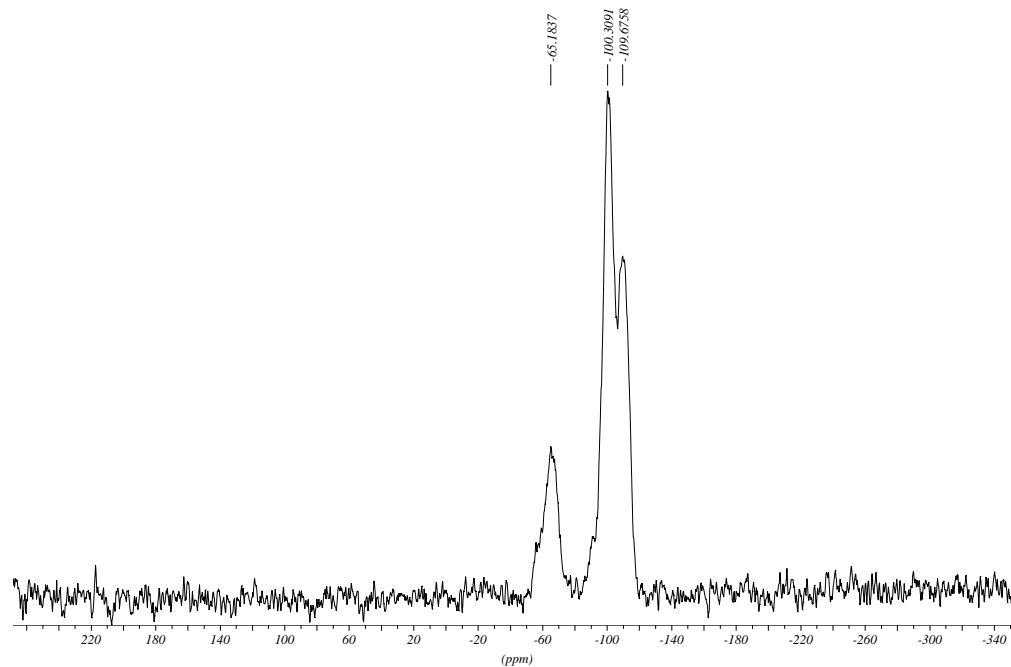
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



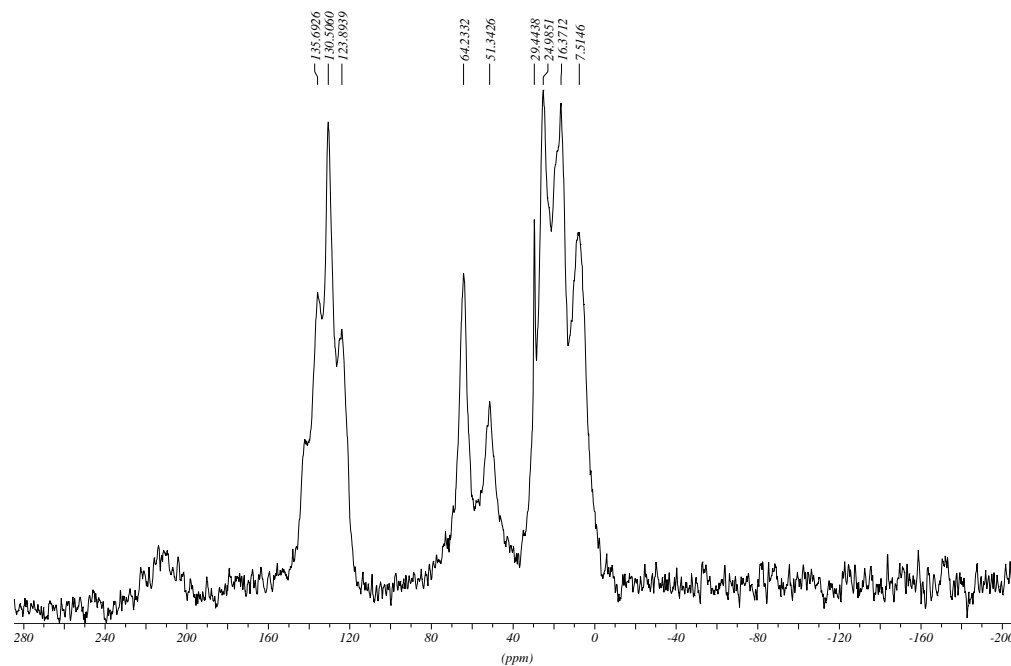


## gel de sílice mesoestructurat M4

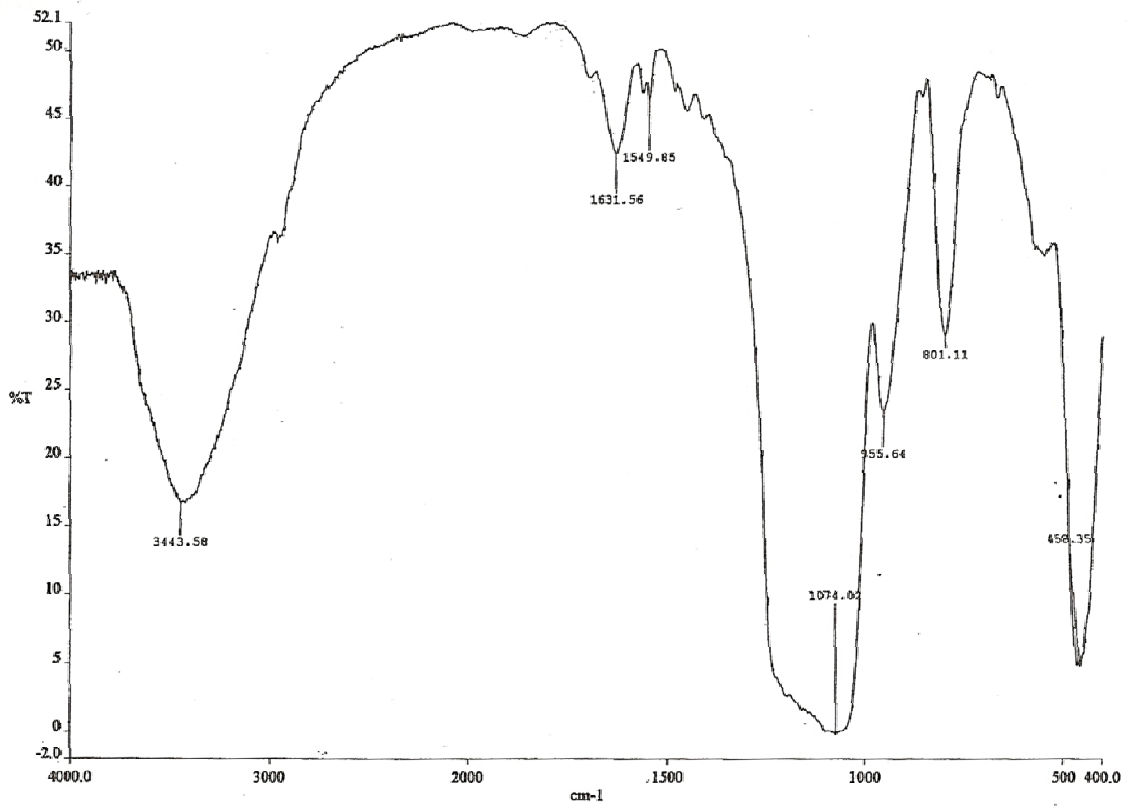
<sup>29</sup>Si-RMN (79.5 MHz, CP-MAS)



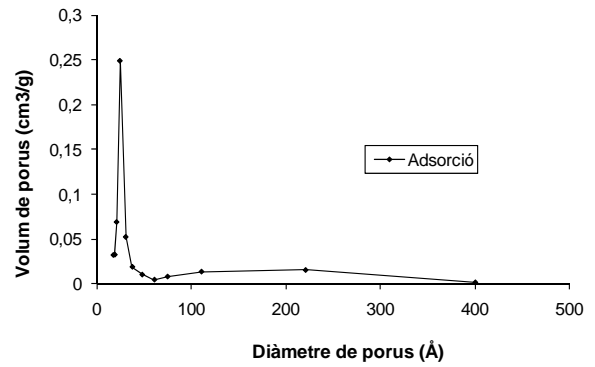
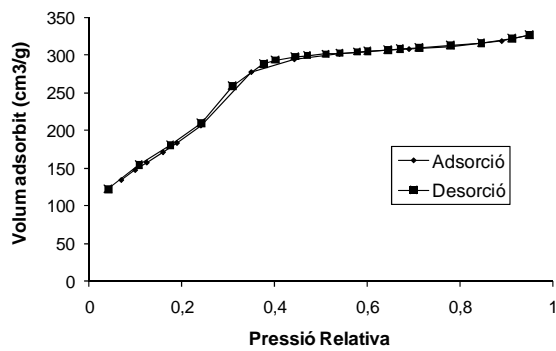
<sup>13</sup>C-RMN (100.62 MHz, CP-MAS)

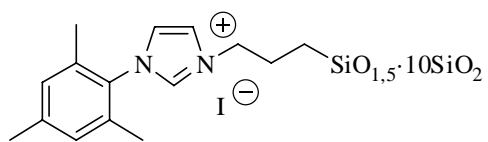


IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)



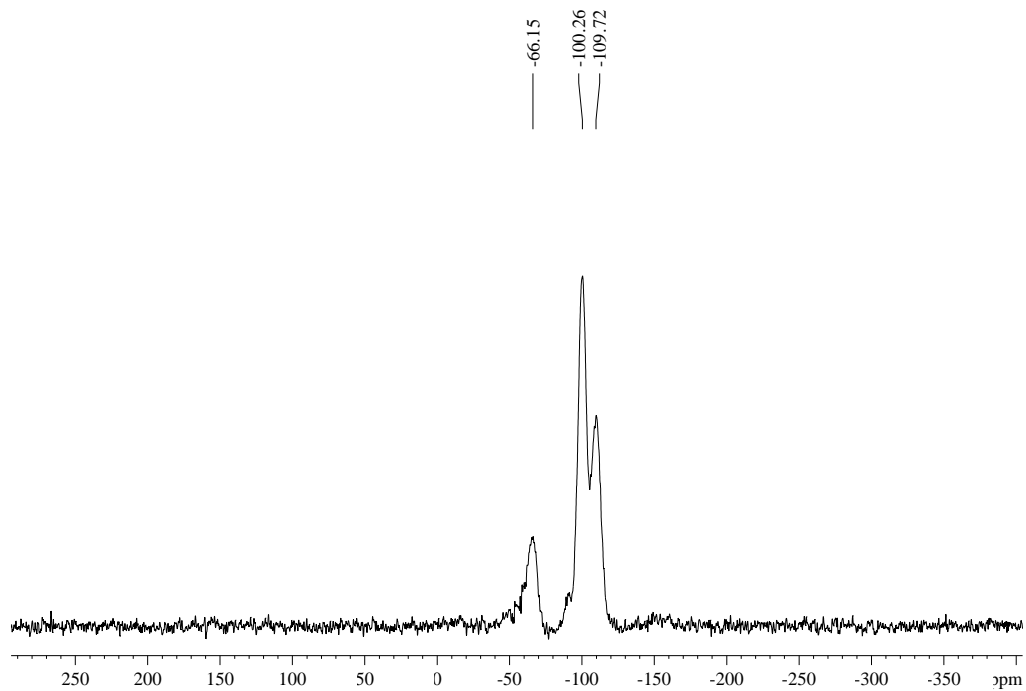
BET (Brunauer-Emmett-Teller)



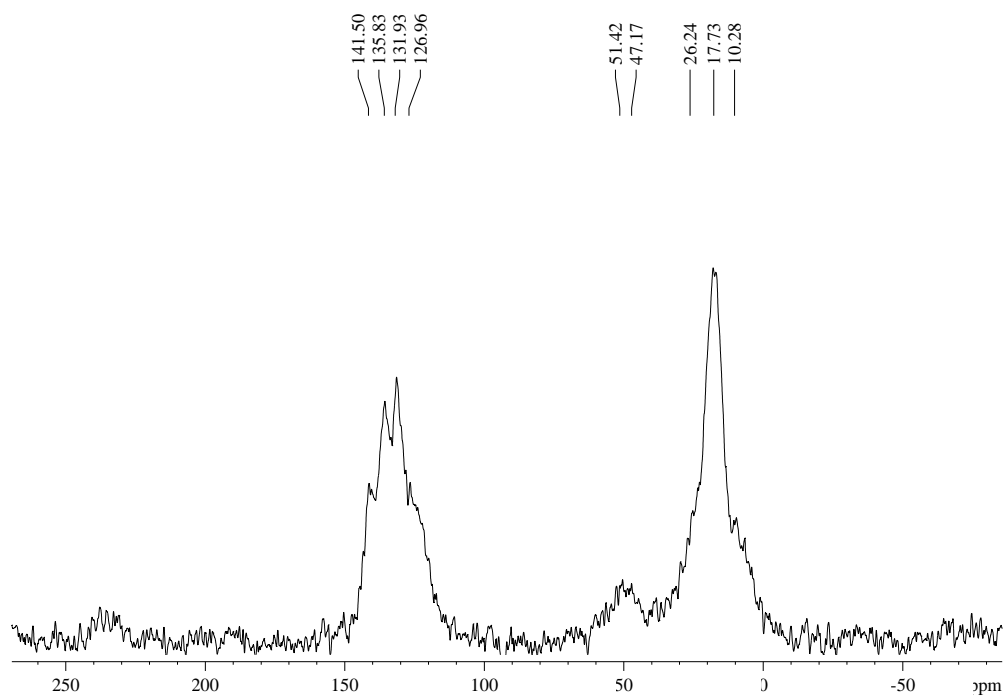


material híbrid orgànic-inorgànic, M5

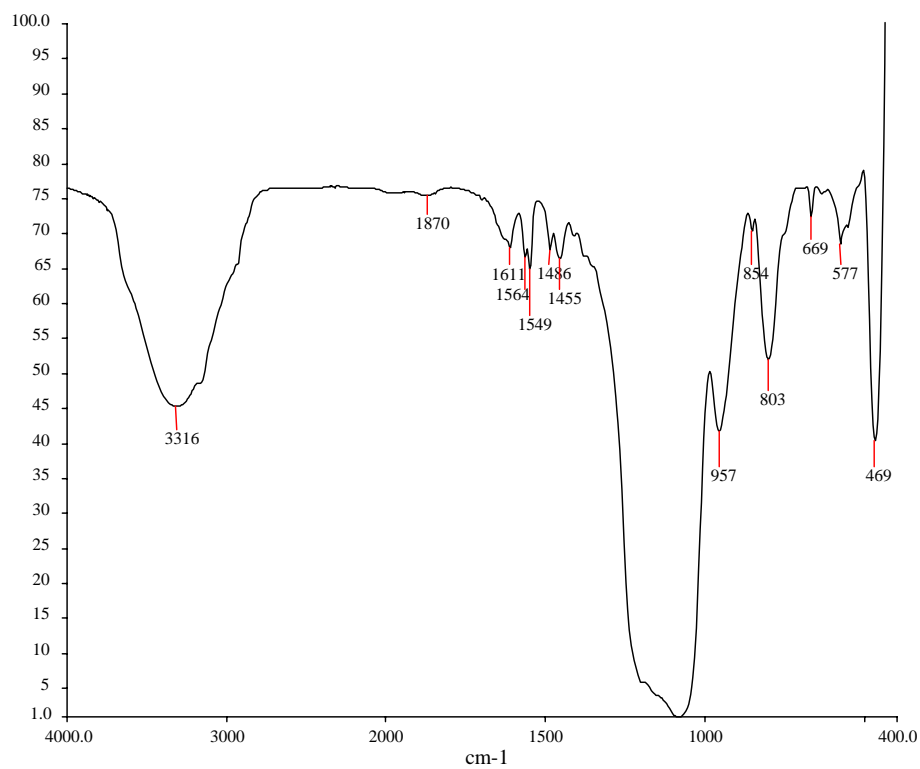
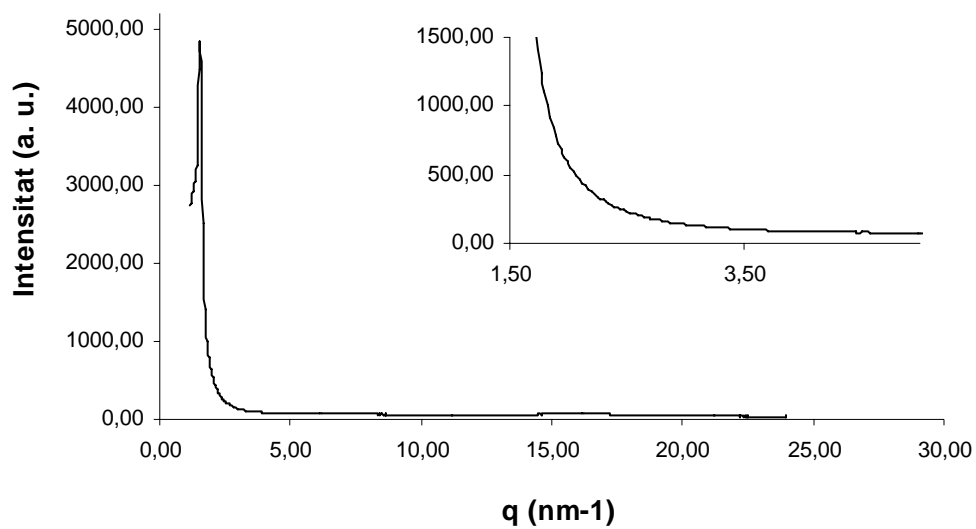
<sup>29</sup>Si-RMN (CP-MAS)



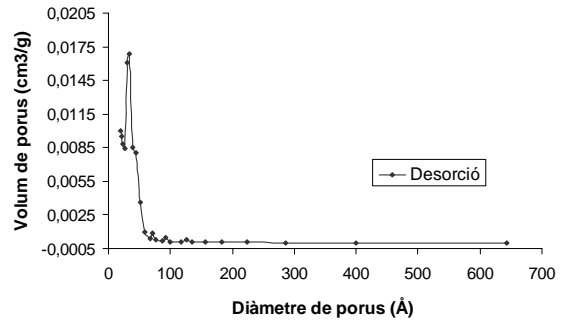
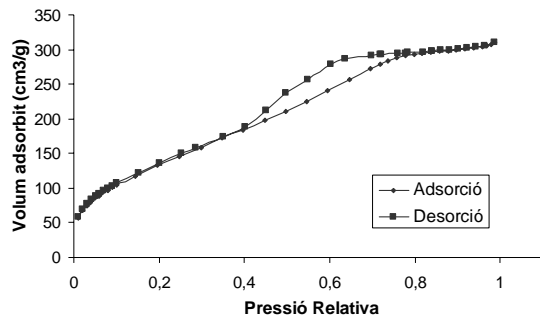
<sup>13</sup>C-RMN (CP-MAS)



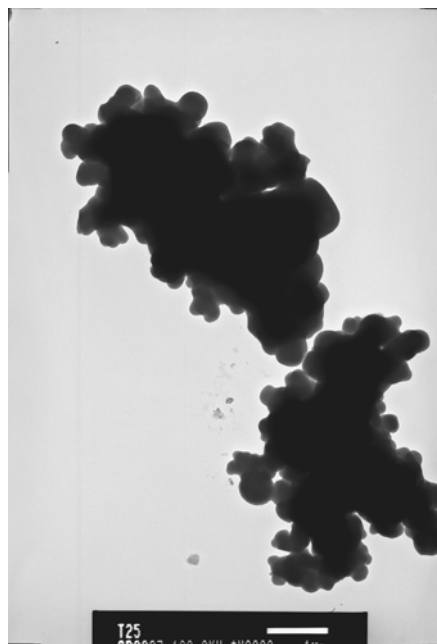
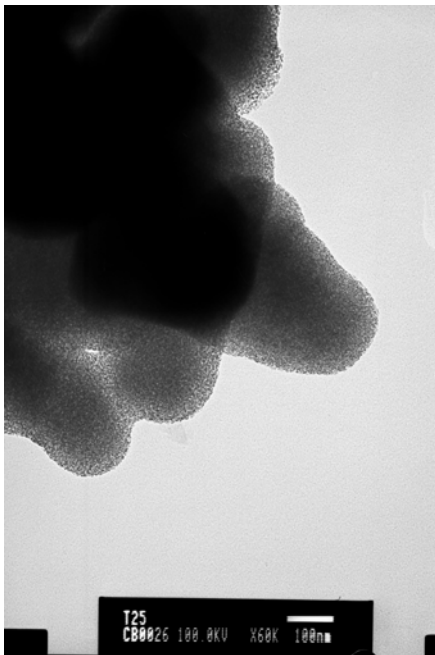


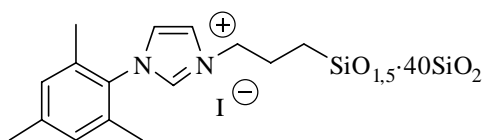
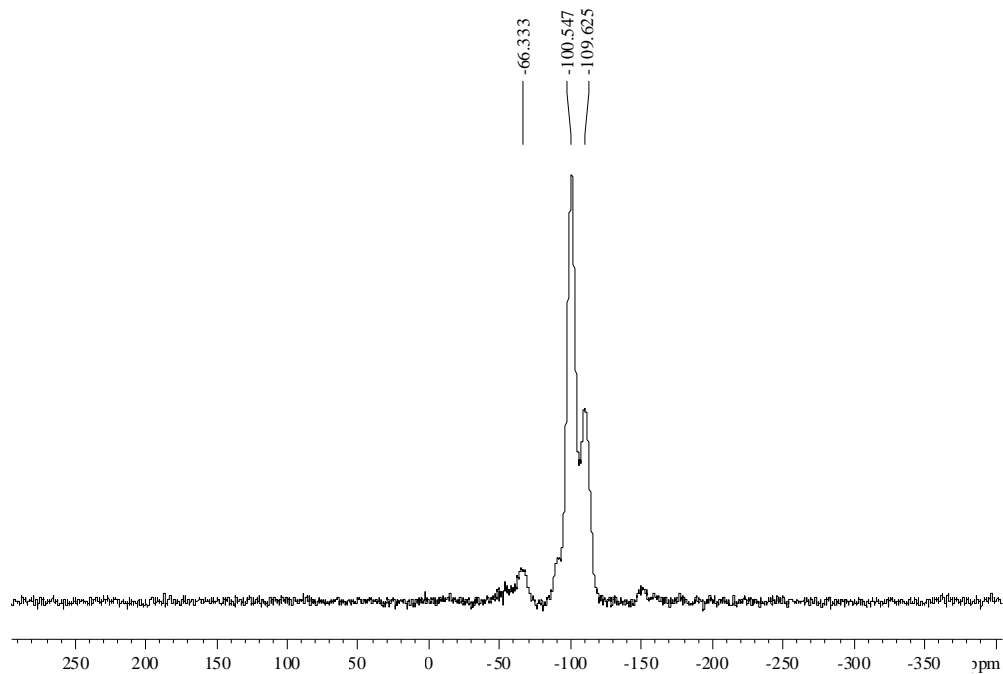
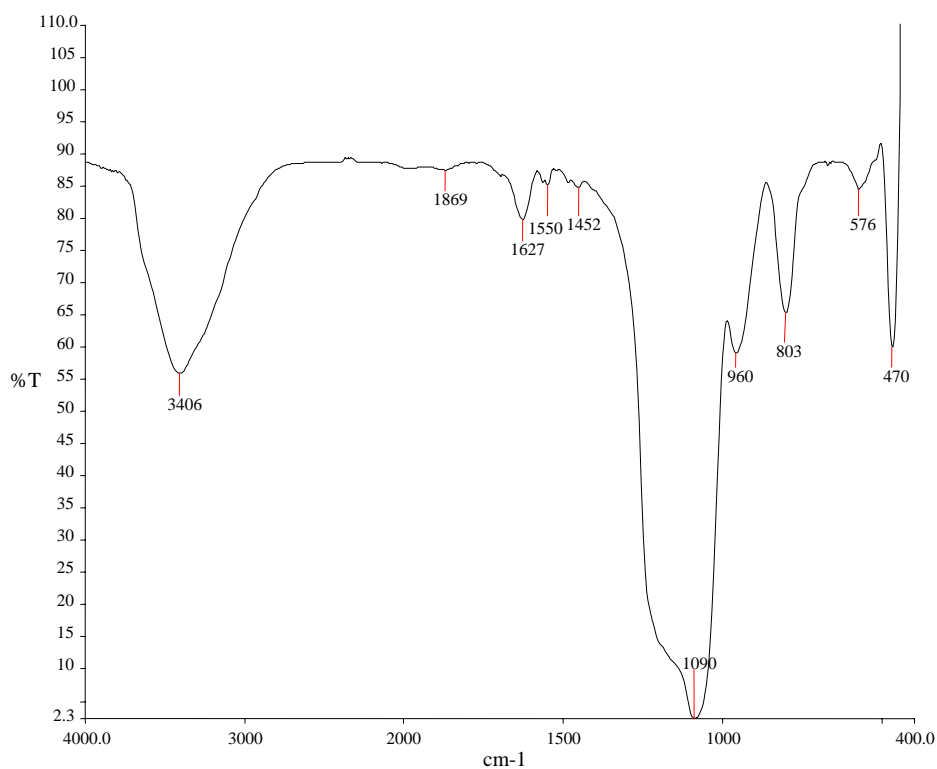
**IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)****Raigs X de pols**

### BET (Brunauer-Emmett-Teller)

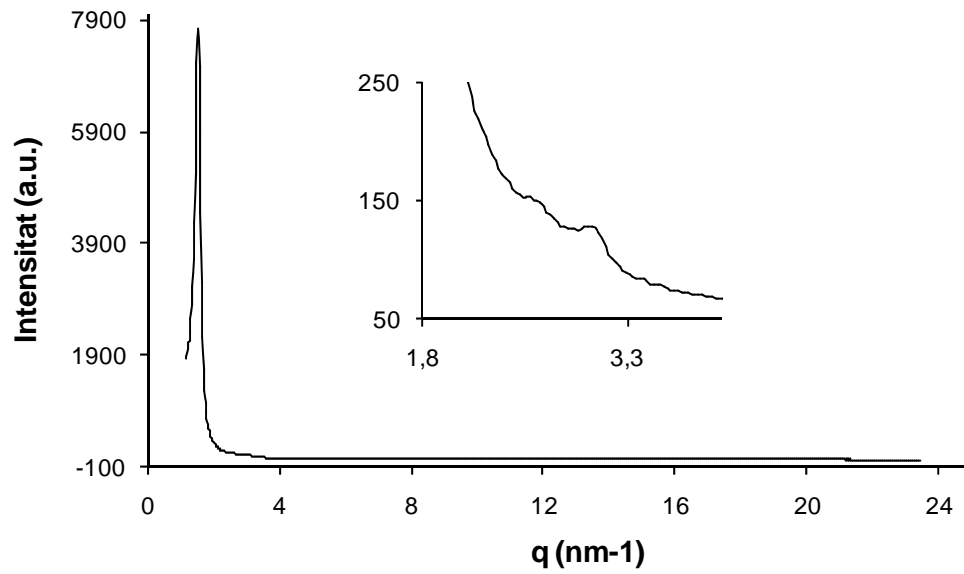


### TEM

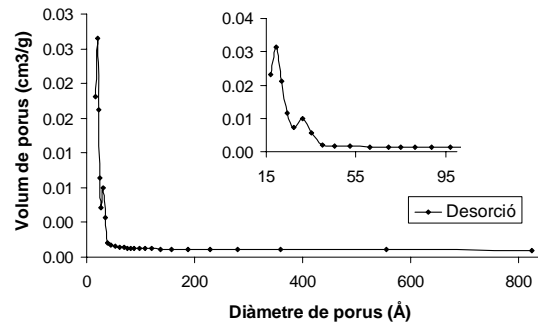
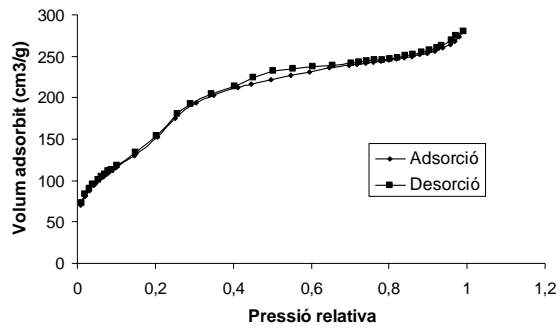


**material híbrid orgànic-inorgànic, M6****<sup>29</sup>Si-RMN (79.5 MHz, CP-MAS)****IR ν (cm<sup>-1</sup>) (KBr)**

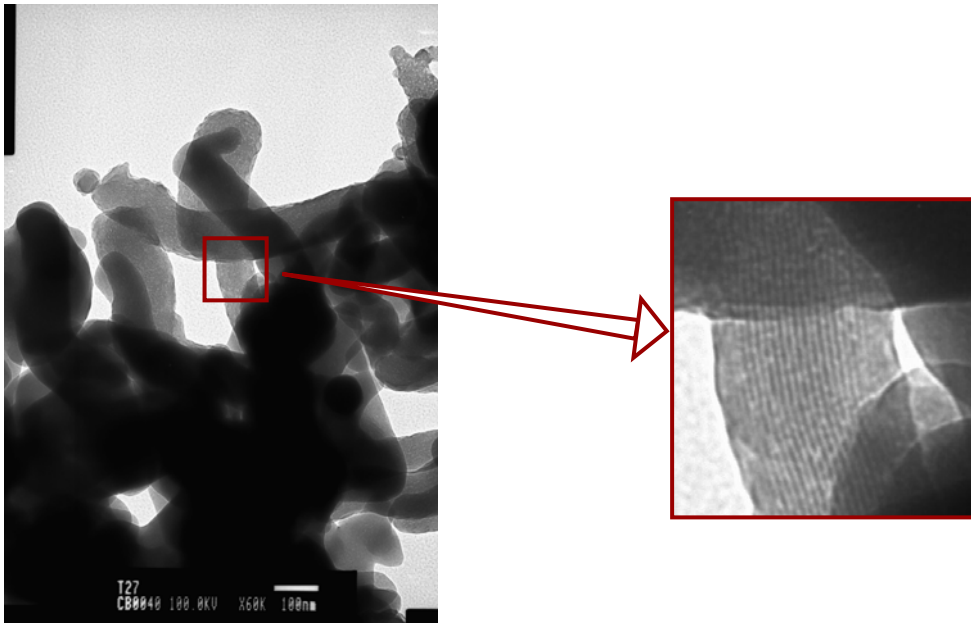
## Raigs X de pols

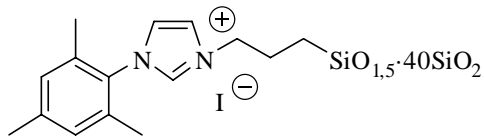


## BET (Brunauer-Emmett-Teller)

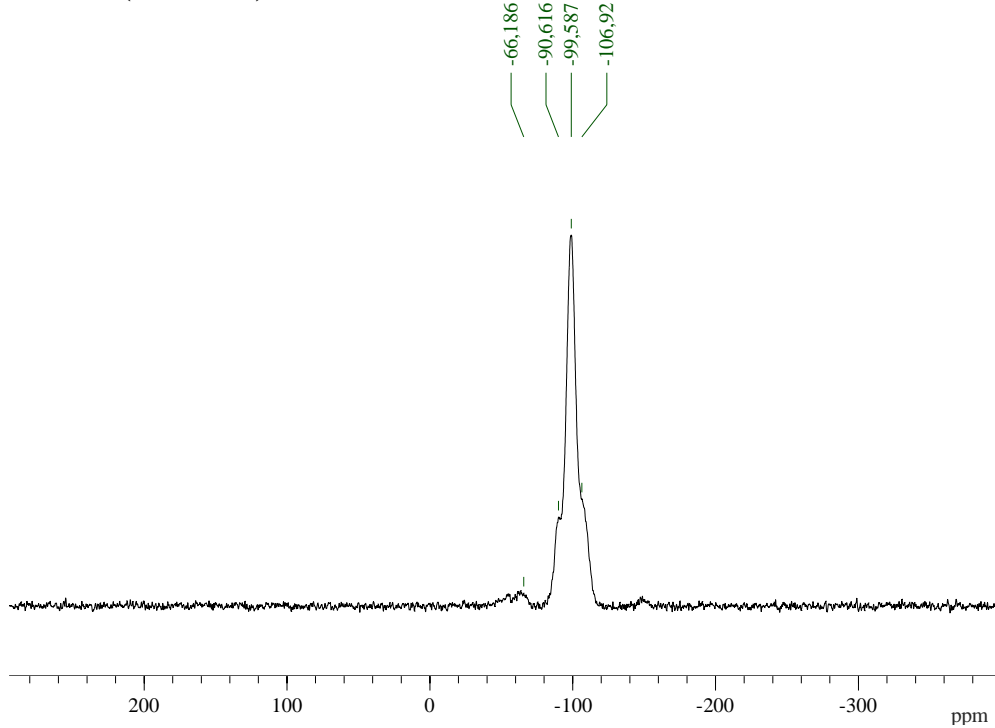
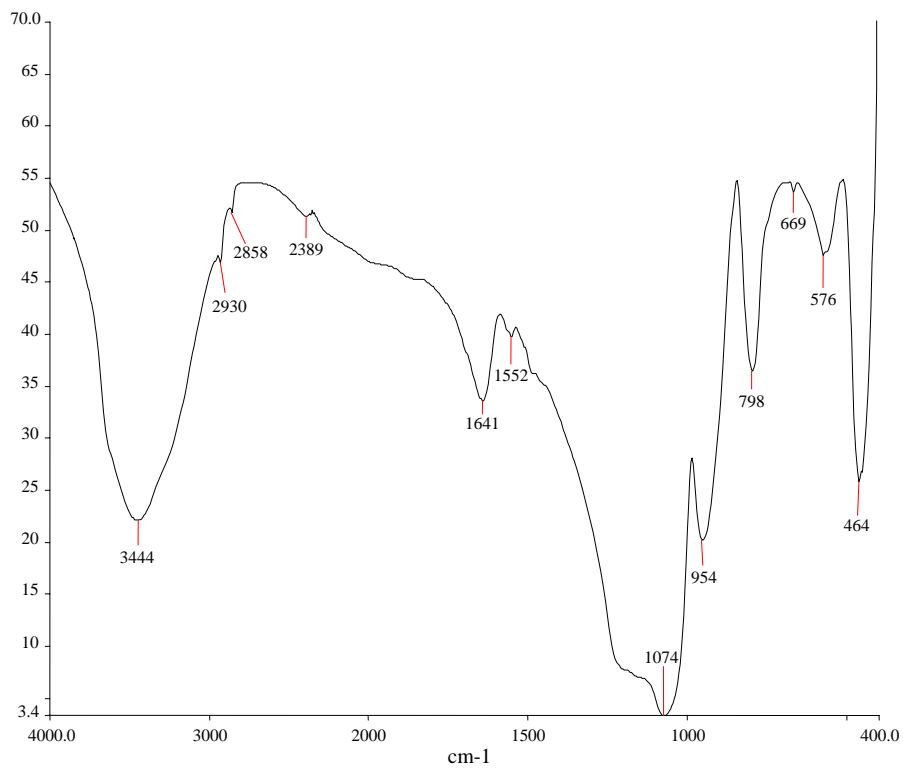


**TEM**

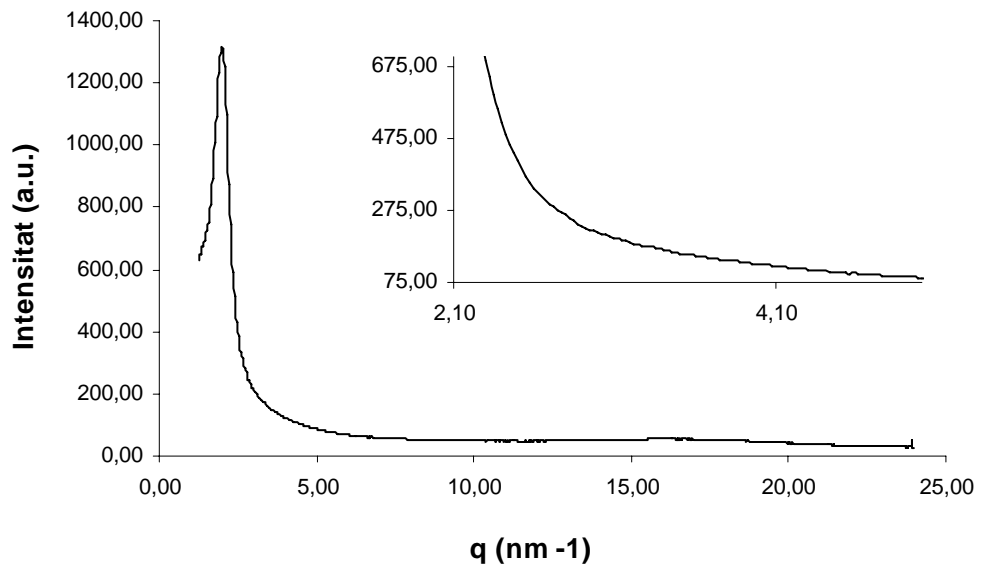




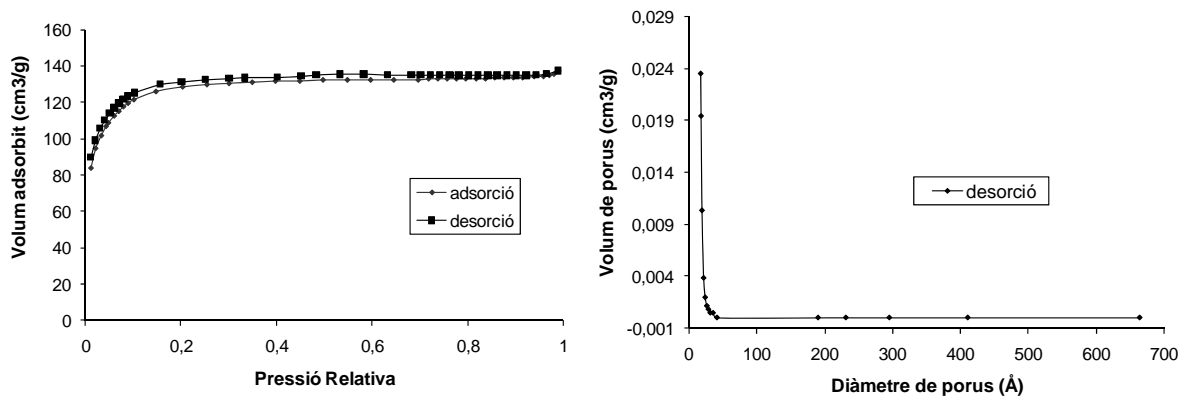
material híbrid orgànic-inorgànic, M7

<sup>29</sup>Si-RMN (CP-MAS)IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)

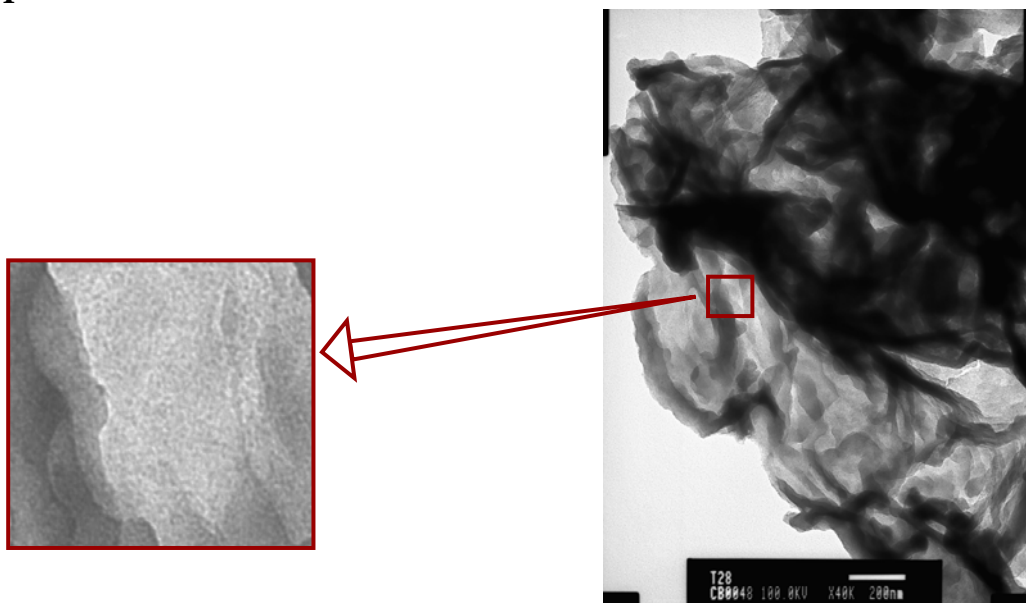
### Raigs X de pols

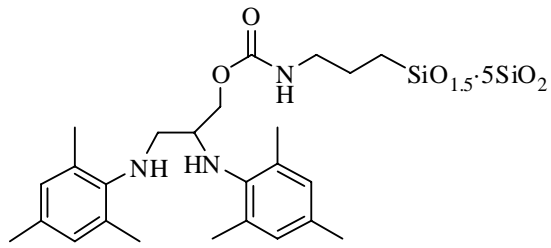


### BET (Brunauer-Emmett-Teller)

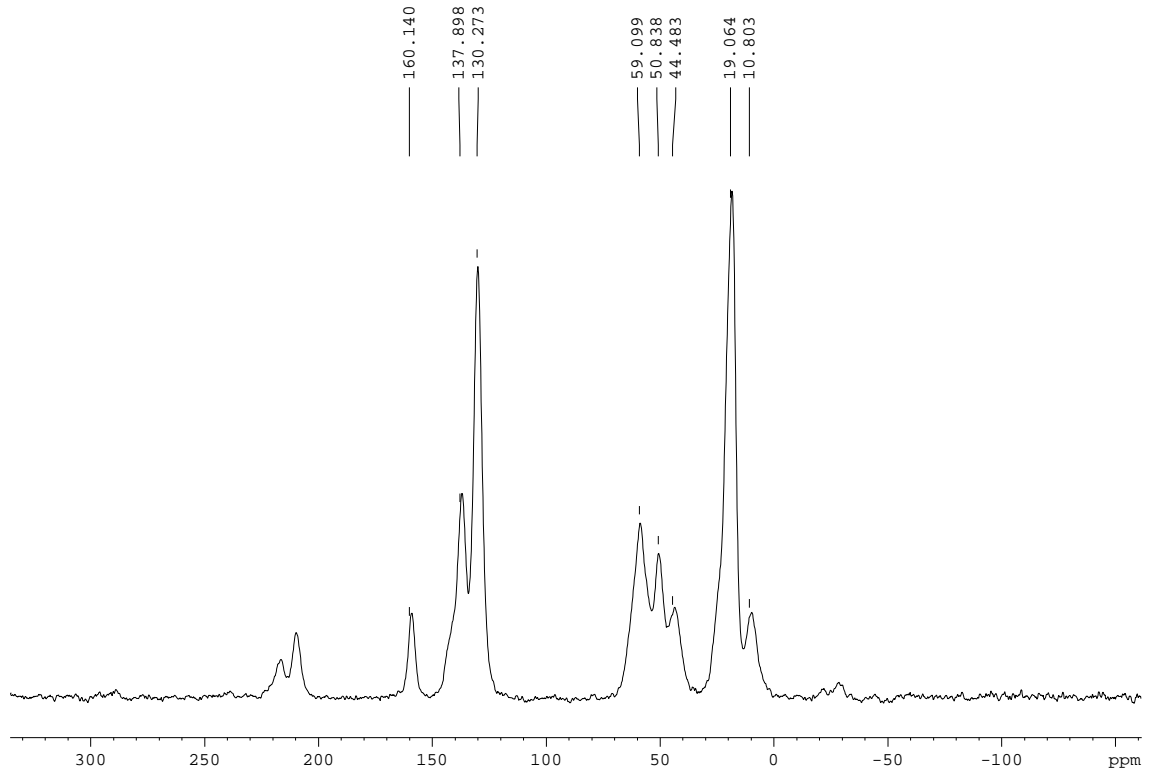
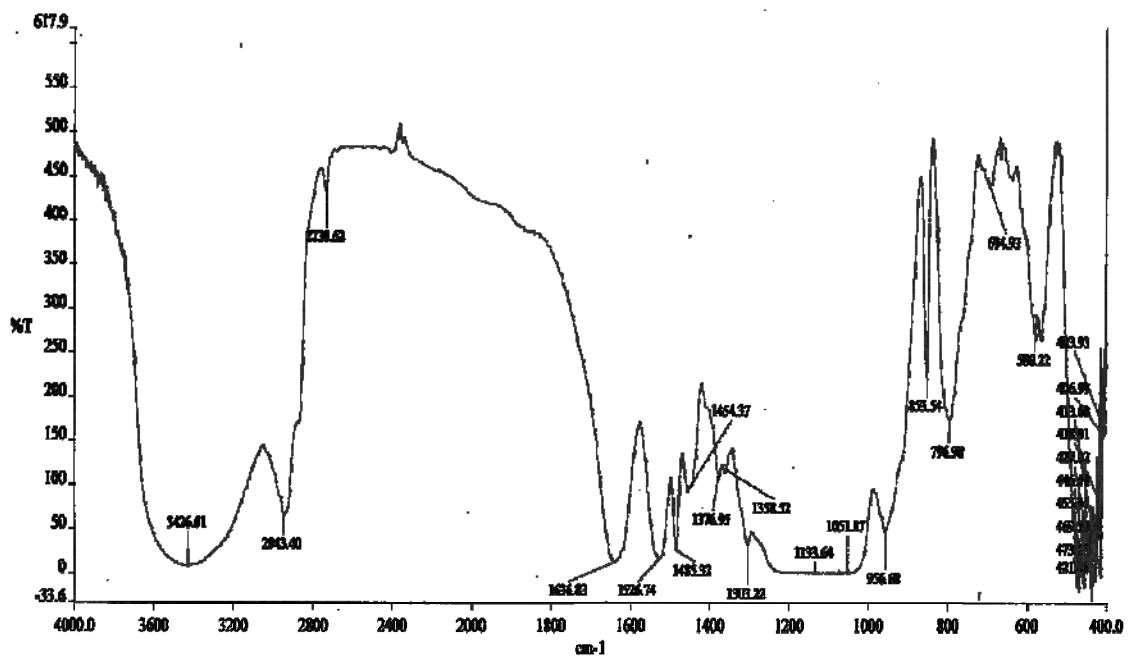


### TEM



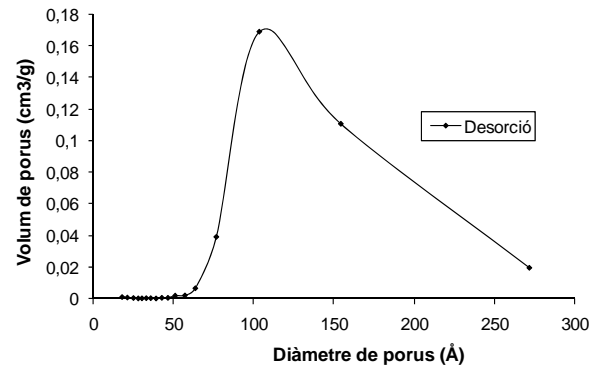
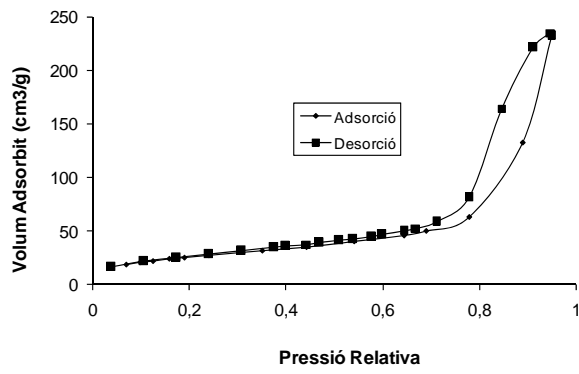


material híbrid orgànic-inorgànic M8

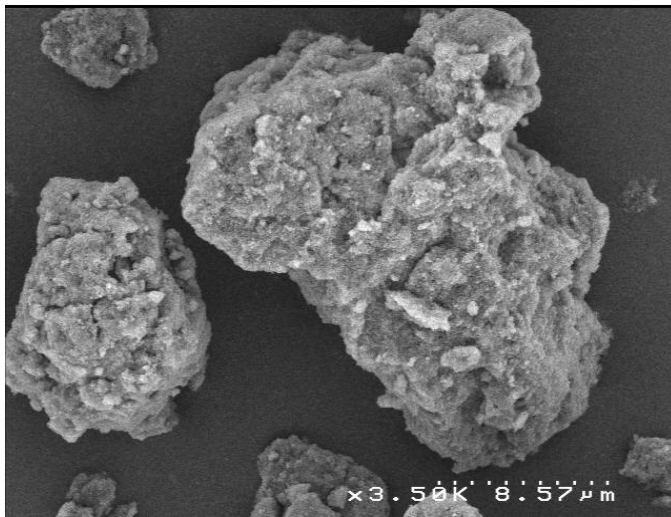
 $^{13}\text{C}$ -RMN (100.62 MHz, CP-MAS)IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)

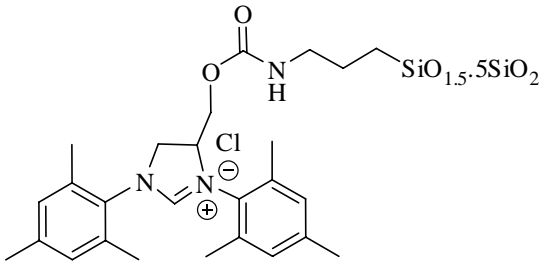


### BET (Brunauer-Emmett-Teller)

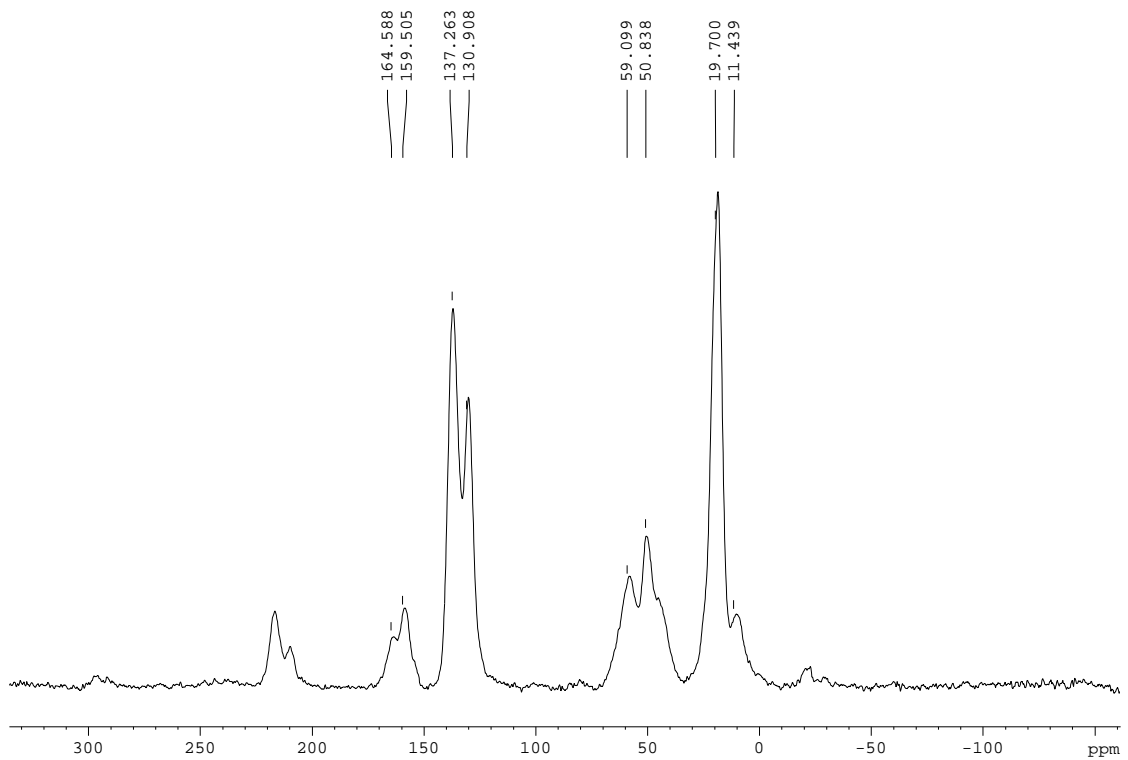
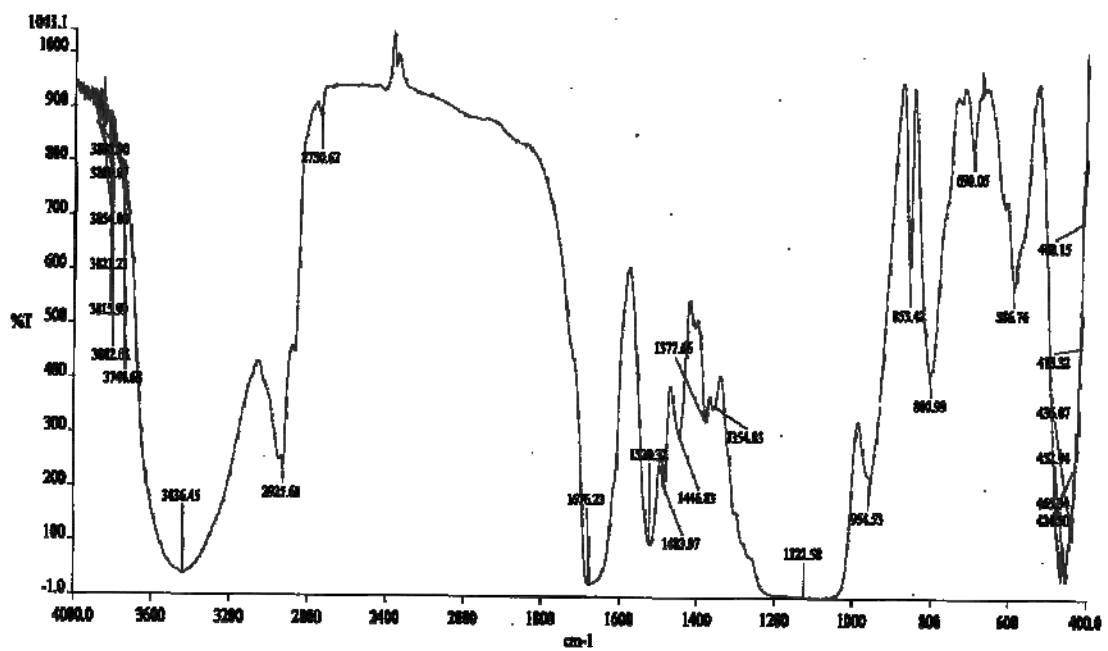


### SEM

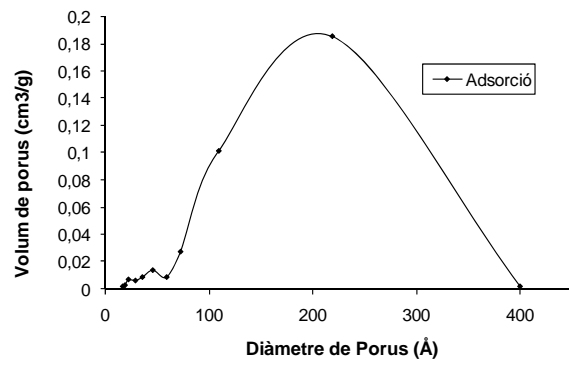
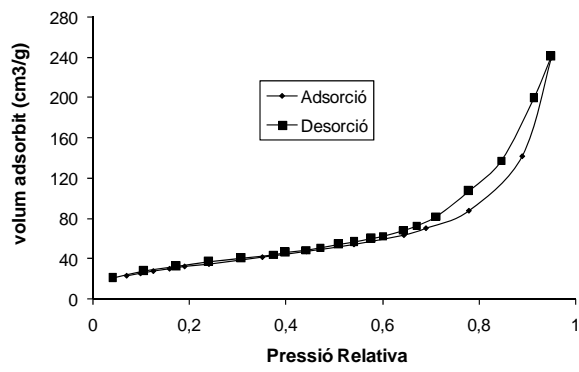




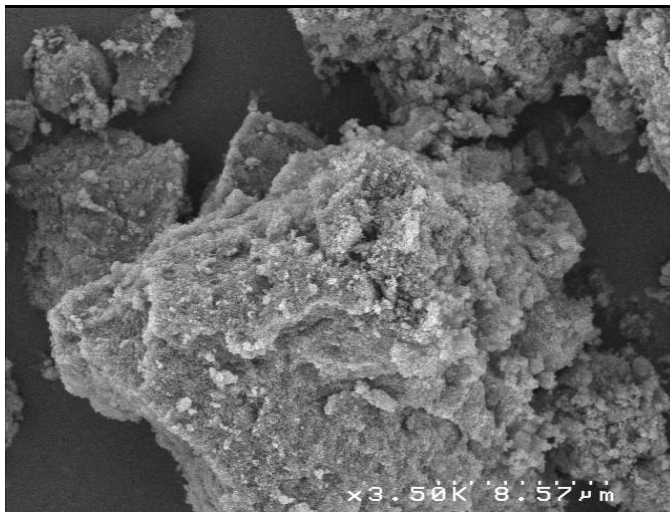
material híbrid orgànic-inorgànic M9

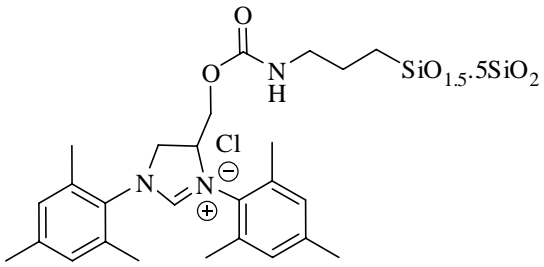
 $^{13}\text{C}$ -RMN (100.62 MHz, CP-MAS)IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)

### BET (Brunauer-Emmett-Teller)

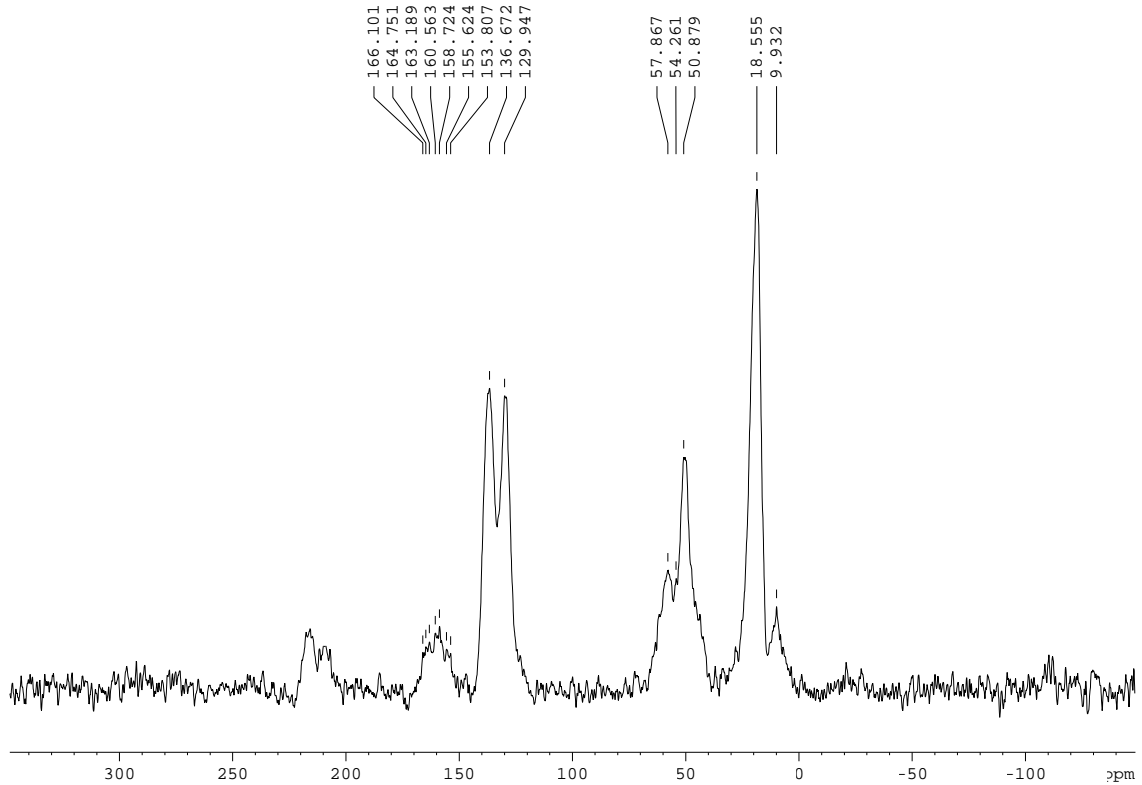
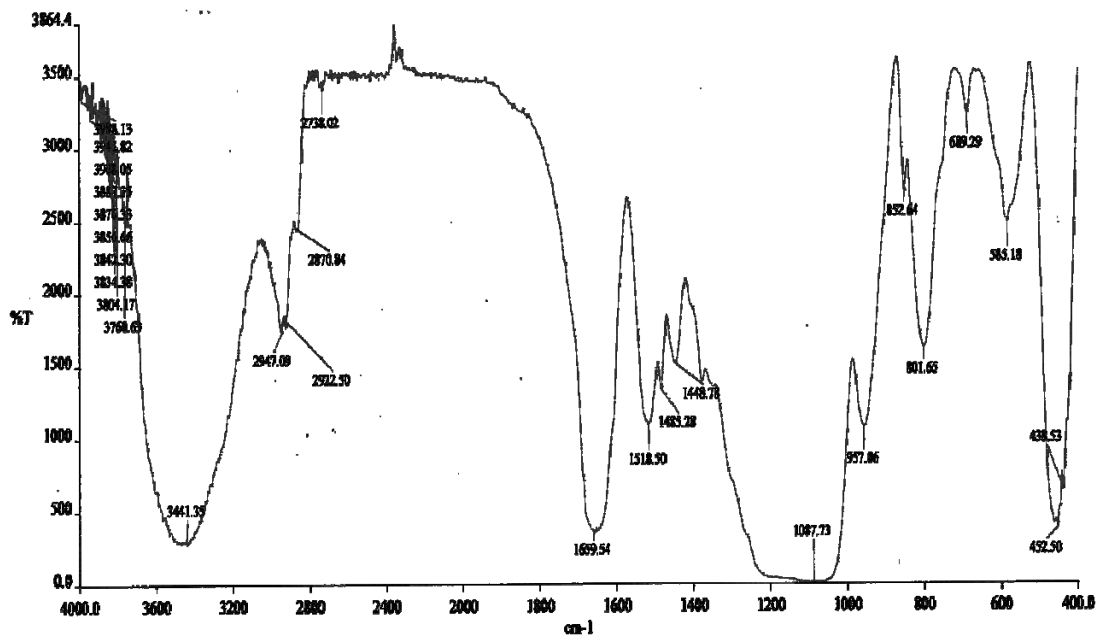


### SEM

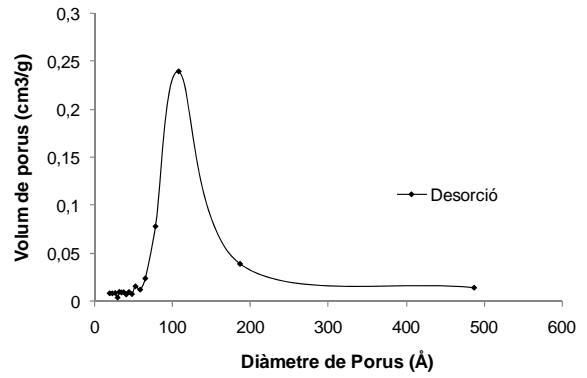
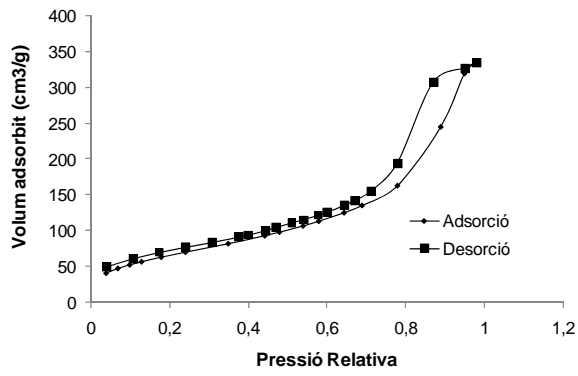


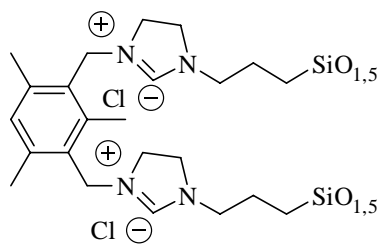
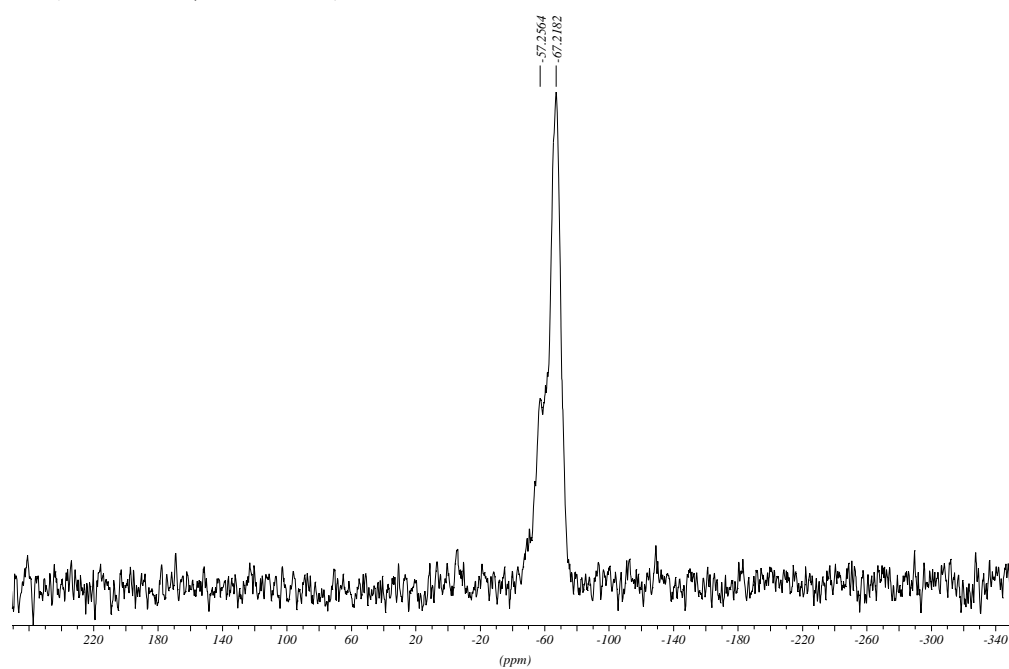
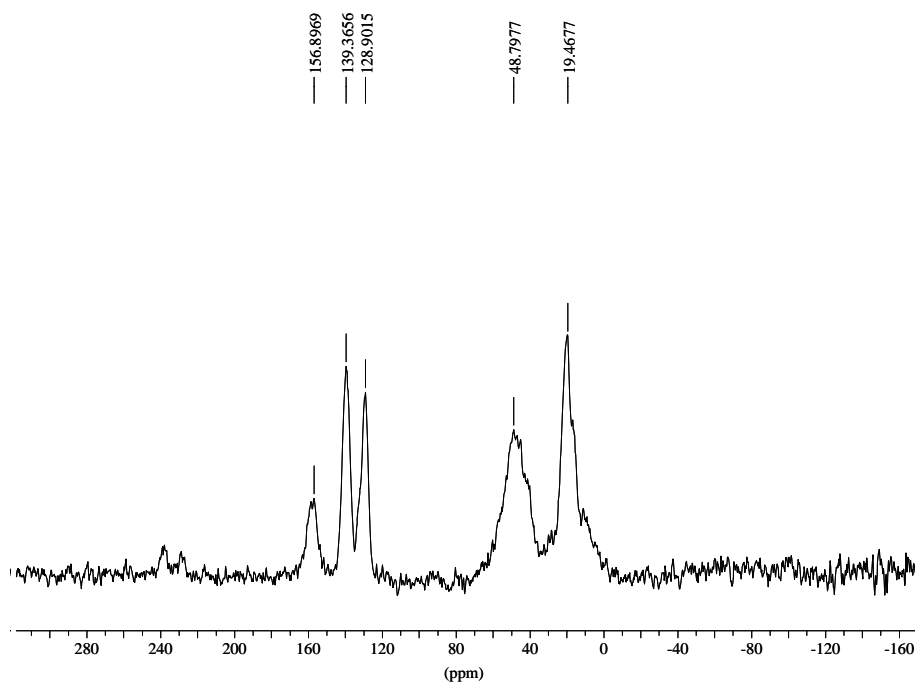


material híbrid orgànic-inorgànic M9B

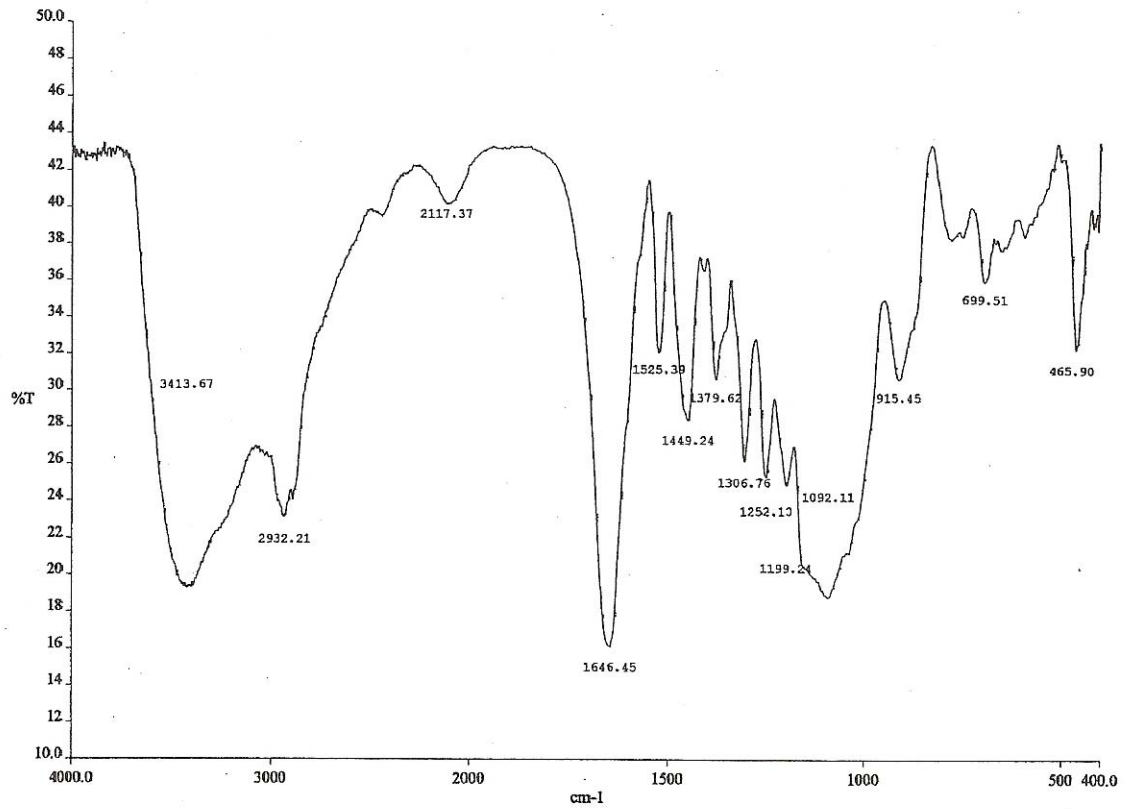
 $^{13}\text{C}$ -RMN (100.62 MHz, CP-MAS)IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)

### BET (Brunauer-Emmett-Teller)

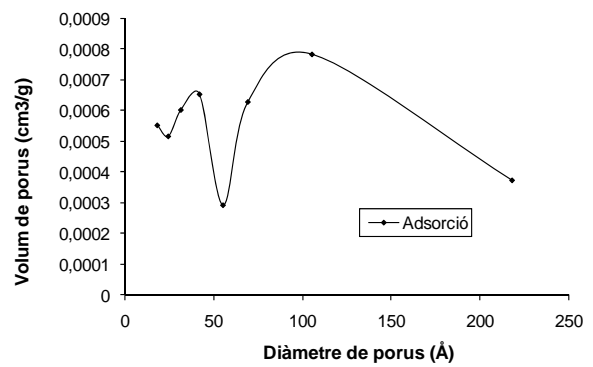
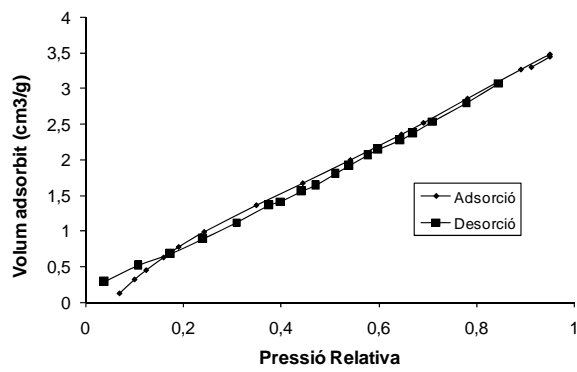


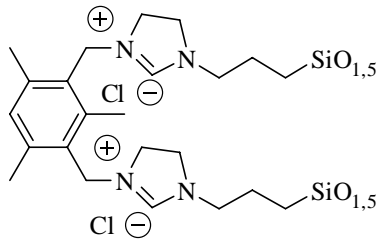
**material híbrid orgànic-inorgànic M10****<sup>29</sup>Si-RMN (79.5 MHz, CP-MAS)****<sup>13</sup>C-RMN (100.62 MHz, CP-MAS)**

IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)



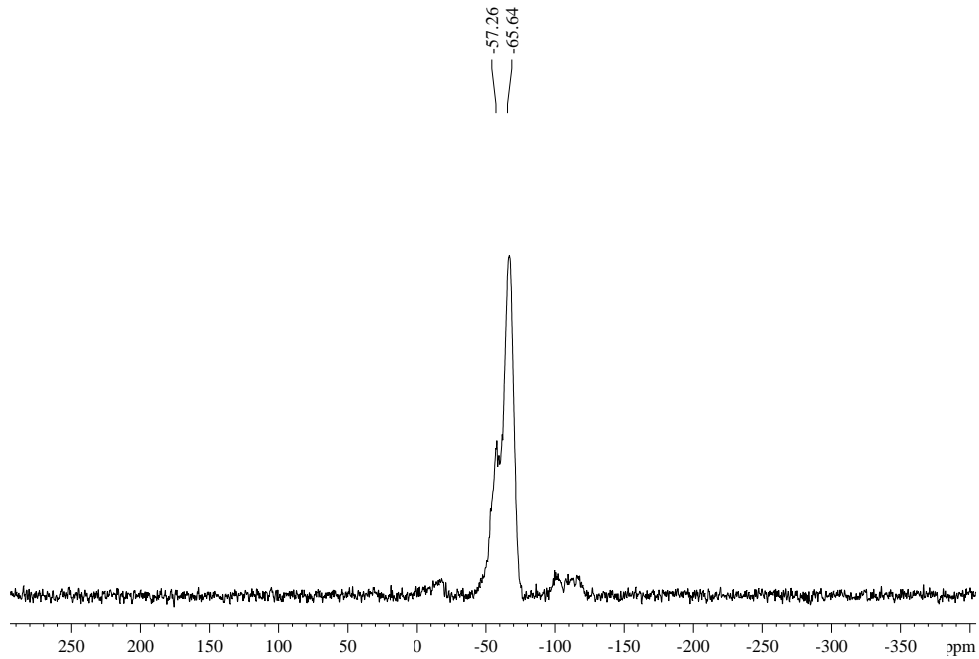
BET (Brunauer-Emmett-Teller)



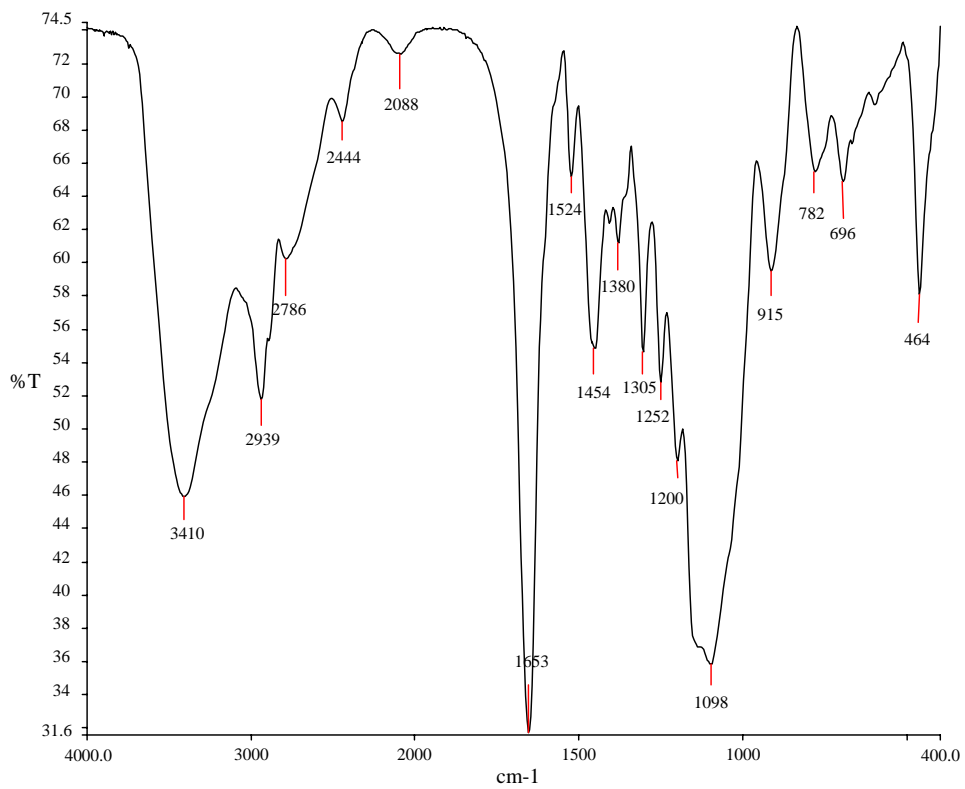


### material híbrid orgànic-inorgànic M11

#### $^{29}\text{Si}$ -RMN (CP-MAS)

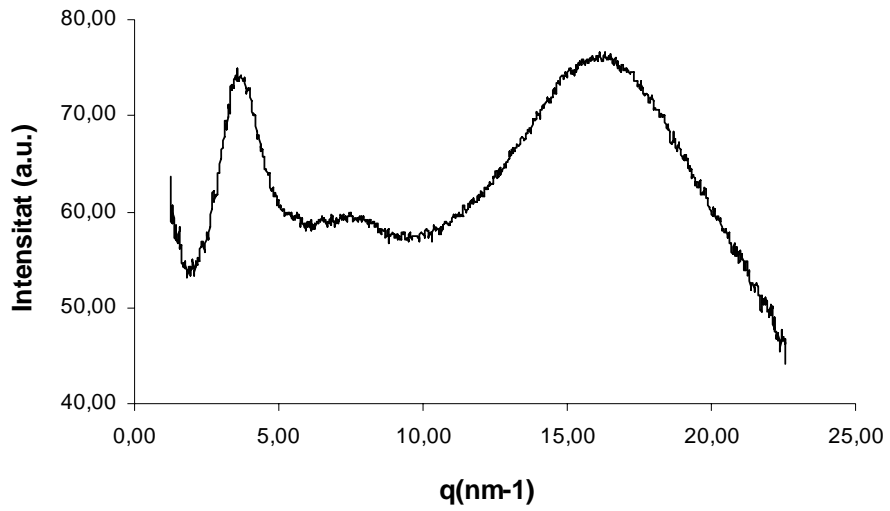


#### IR $\nu$ ( $\text{cm}^{-1}$ ) (KBr)

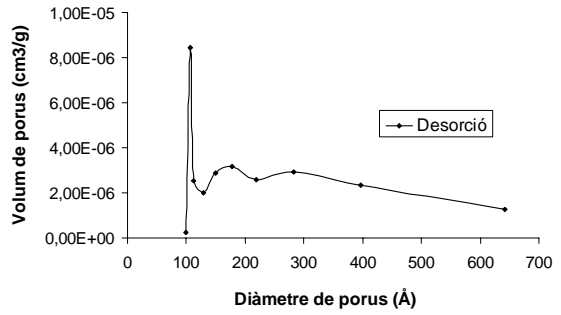
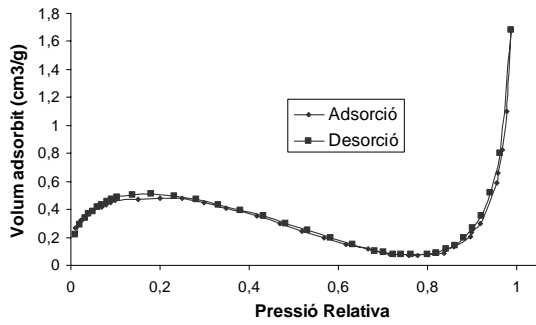




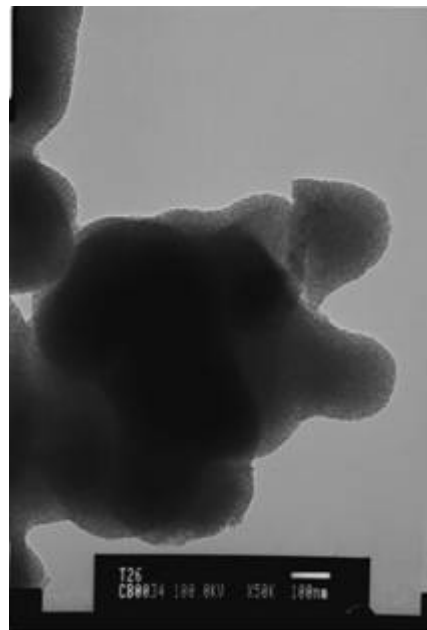
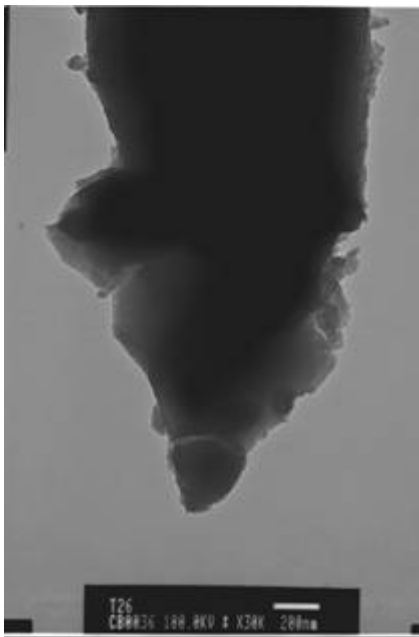
### Raigs X de pols

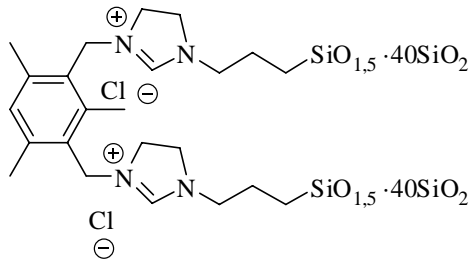


### BET (Brunauer-Emmett-Teller)



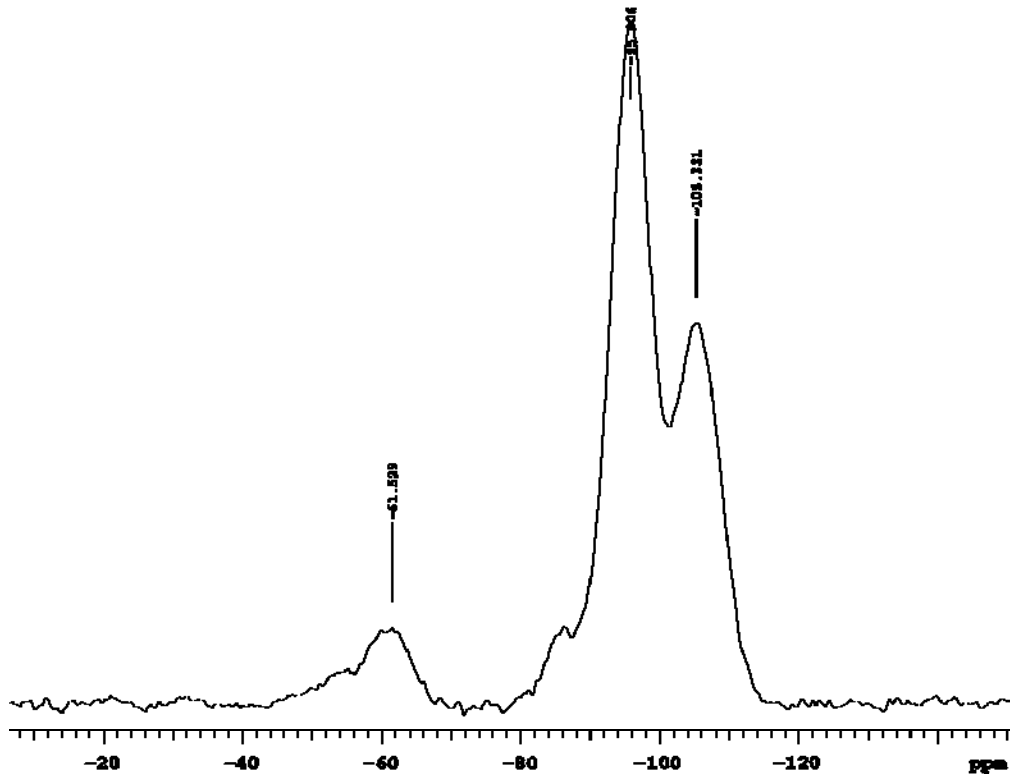
### TEM



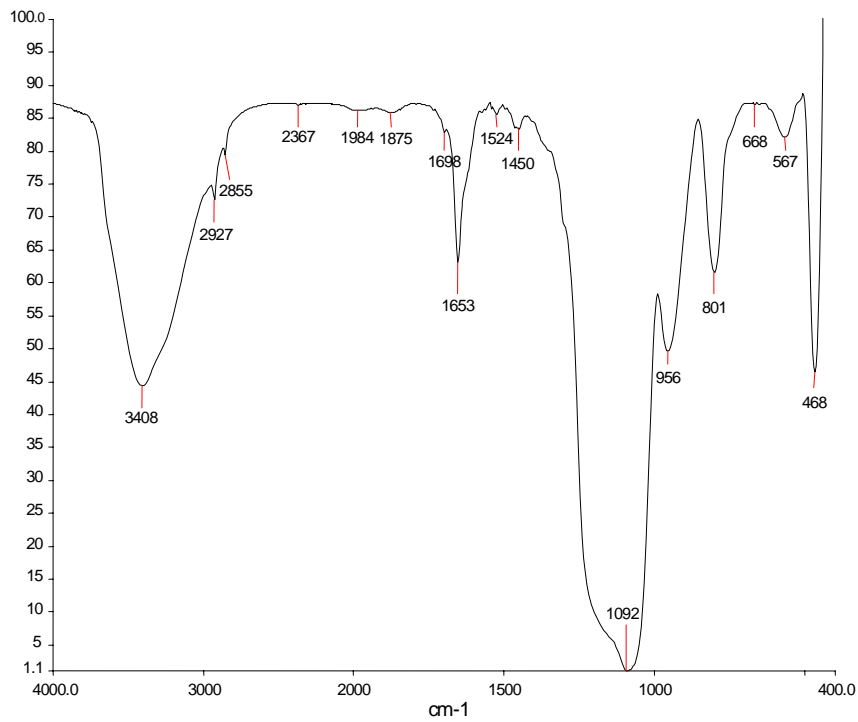


## Material híbrid orgànic-inorgànic M12

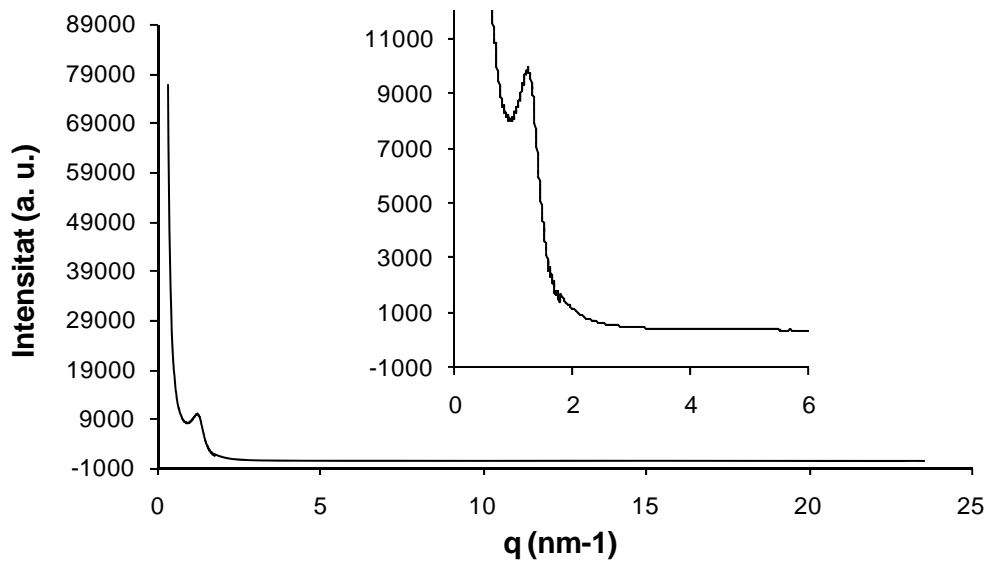
$^{29}\text{Si}$ -RMN (CP-MAS)



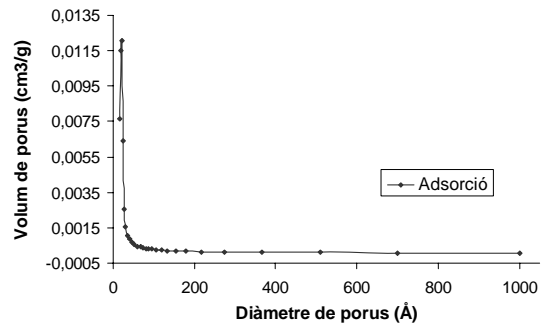
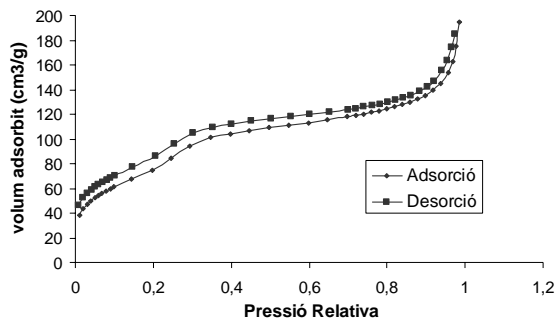
IR  $\nu$  (cm $^{-1}$ ) (KBr)



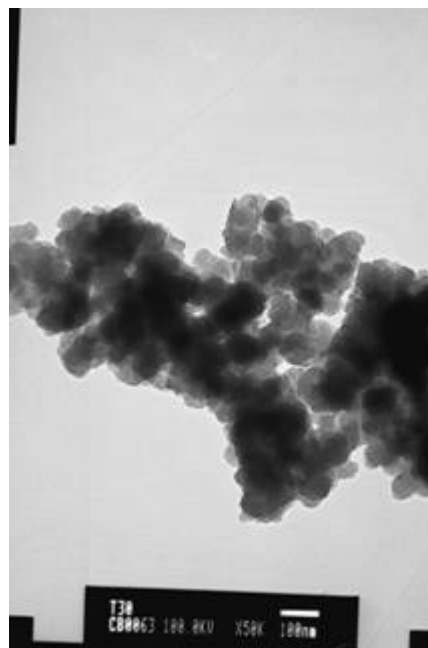
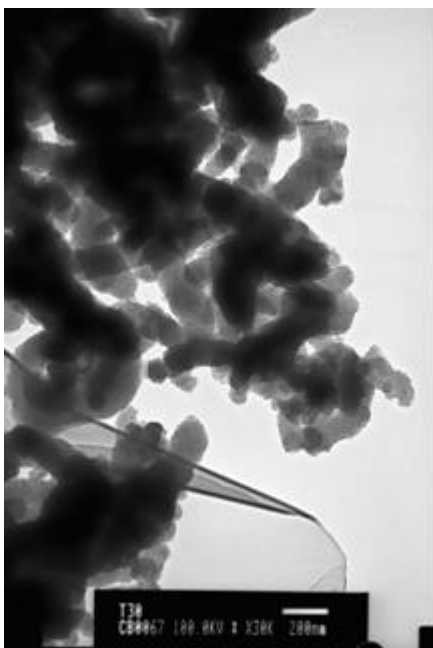
## Raigs X de pols

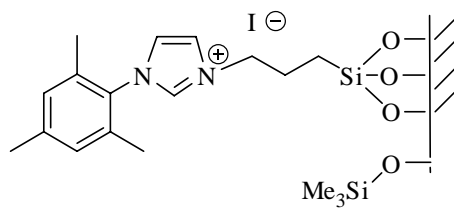
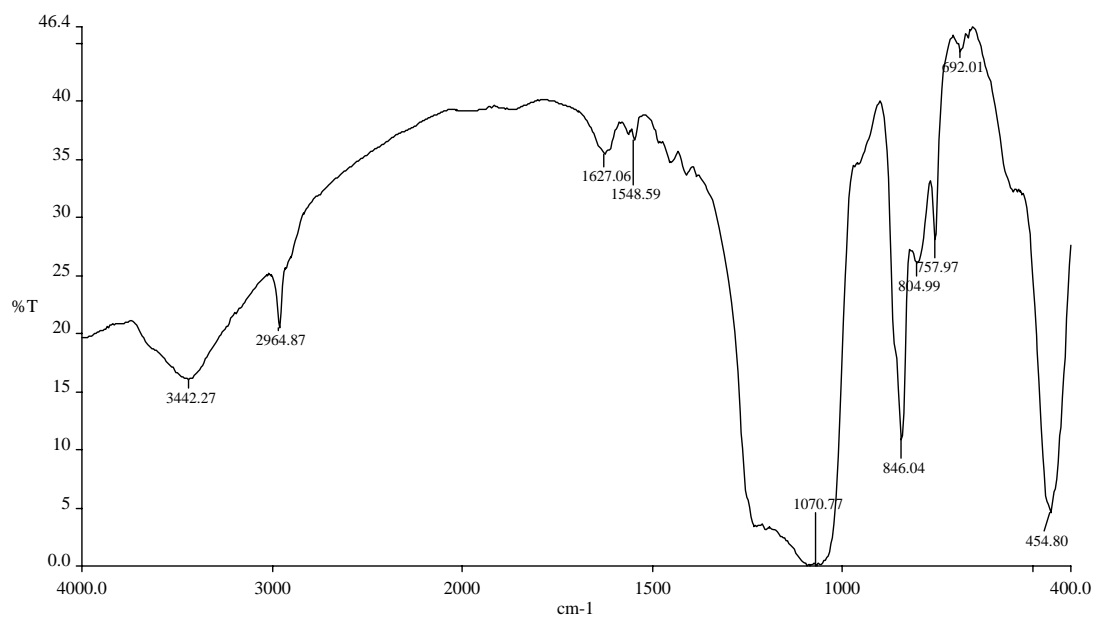


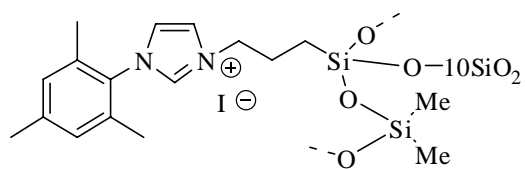
## BET (Brunauer-Emmett-Teller)



## TEM

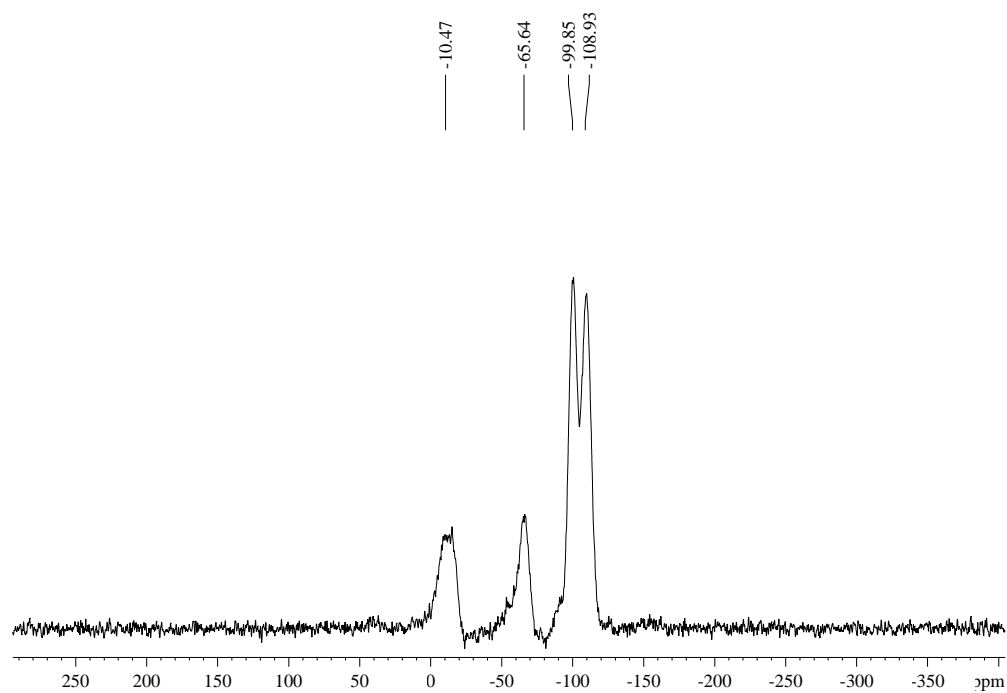


**material híbrid orgànic-inorgànic M4sil****IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)**

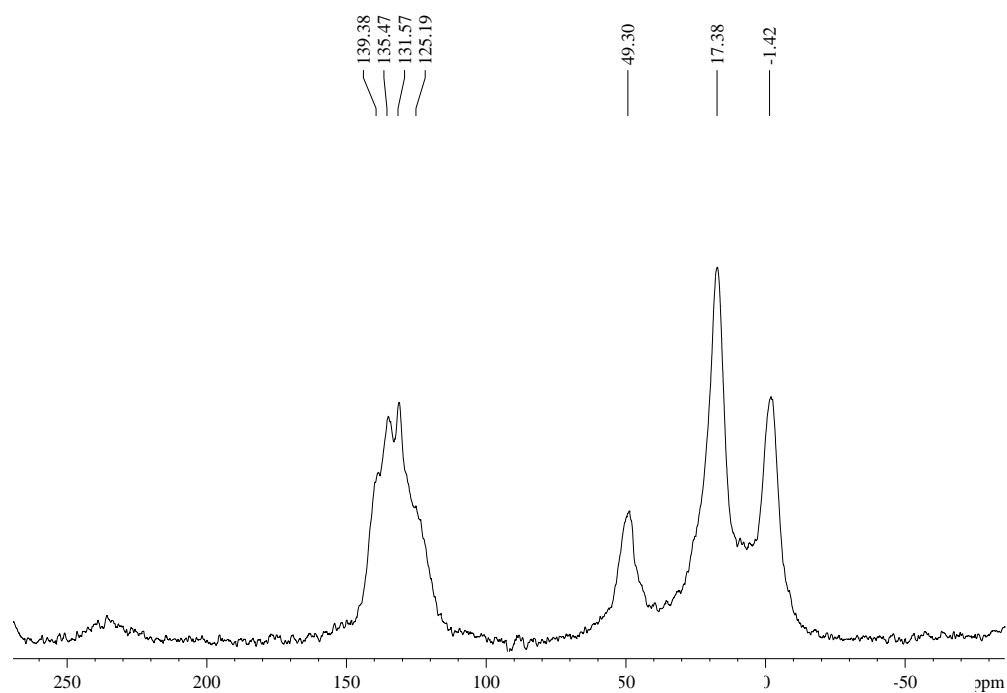


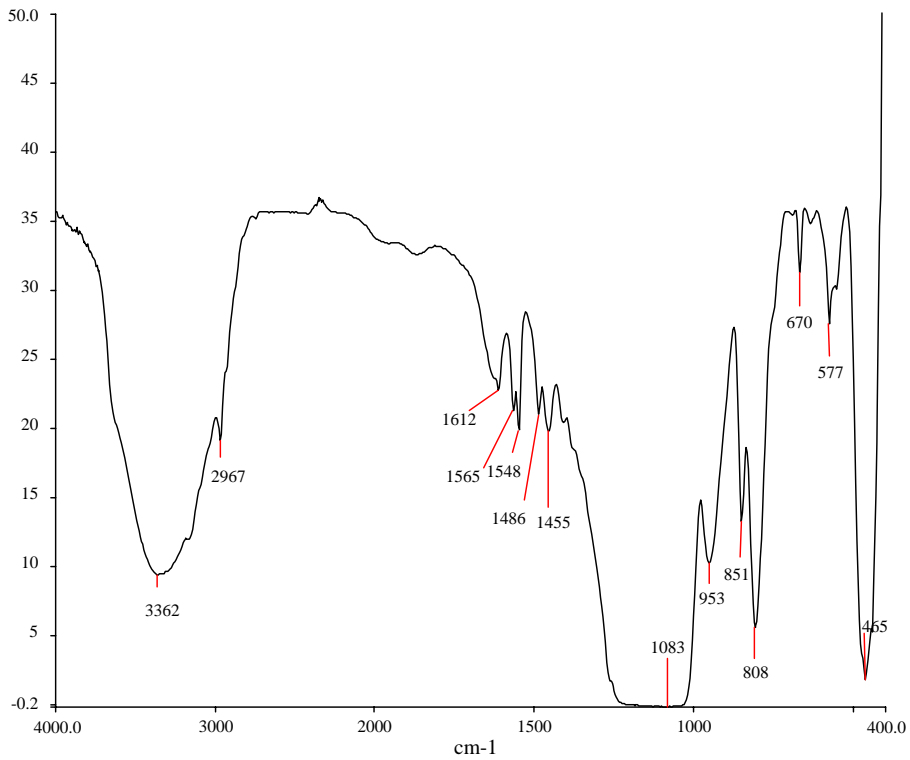
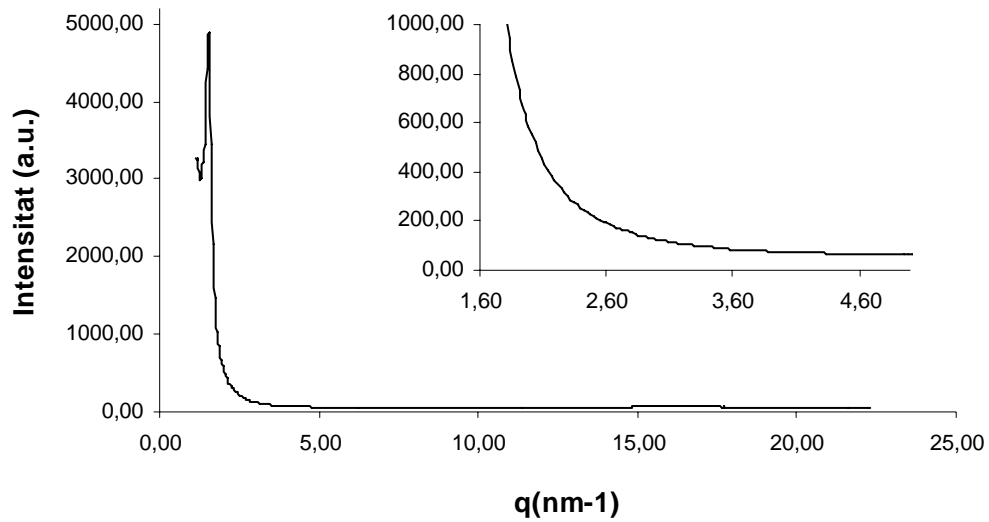
material híbrid orgànic-inorgànic M5sil

<sup>29</sup>Si-RMN (79.5 MHz, CP-MAS)

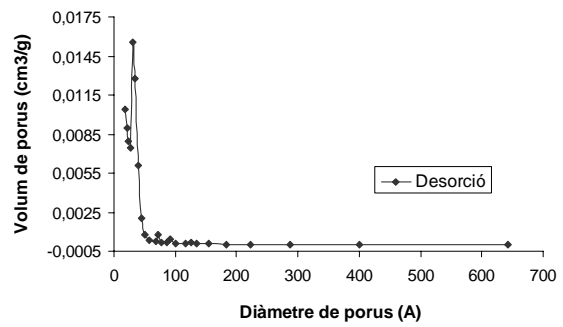
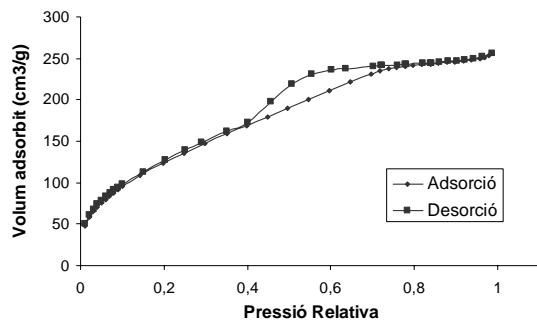


<sup>13</sup>C-RMN (100.62 MHz, CP-MAS)

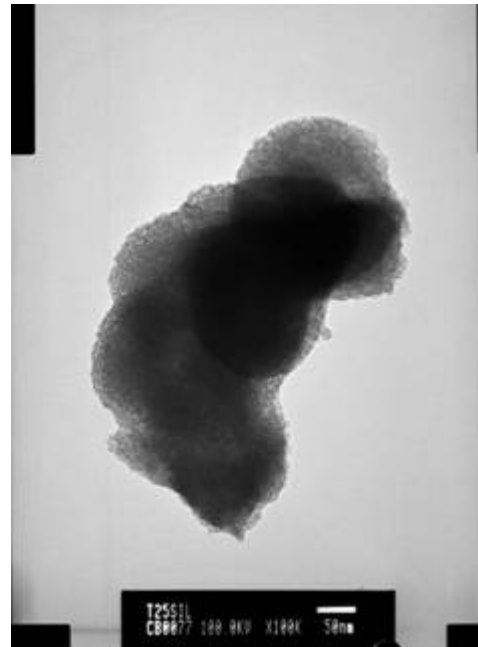
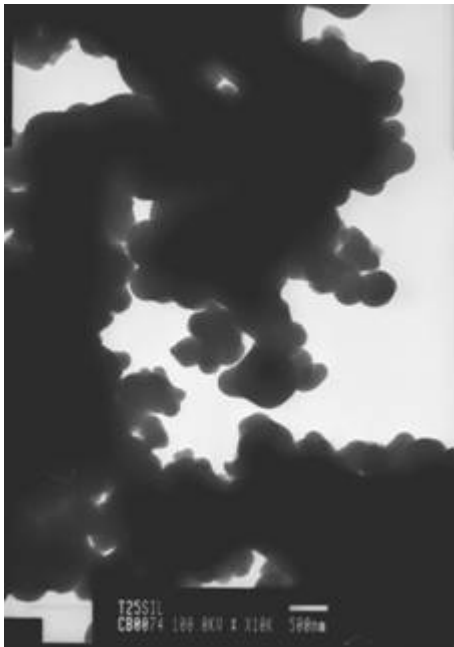


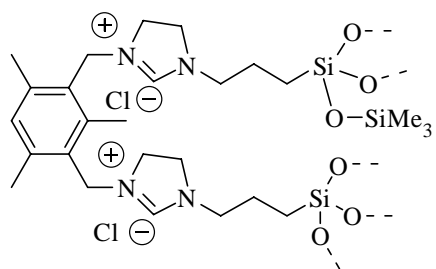
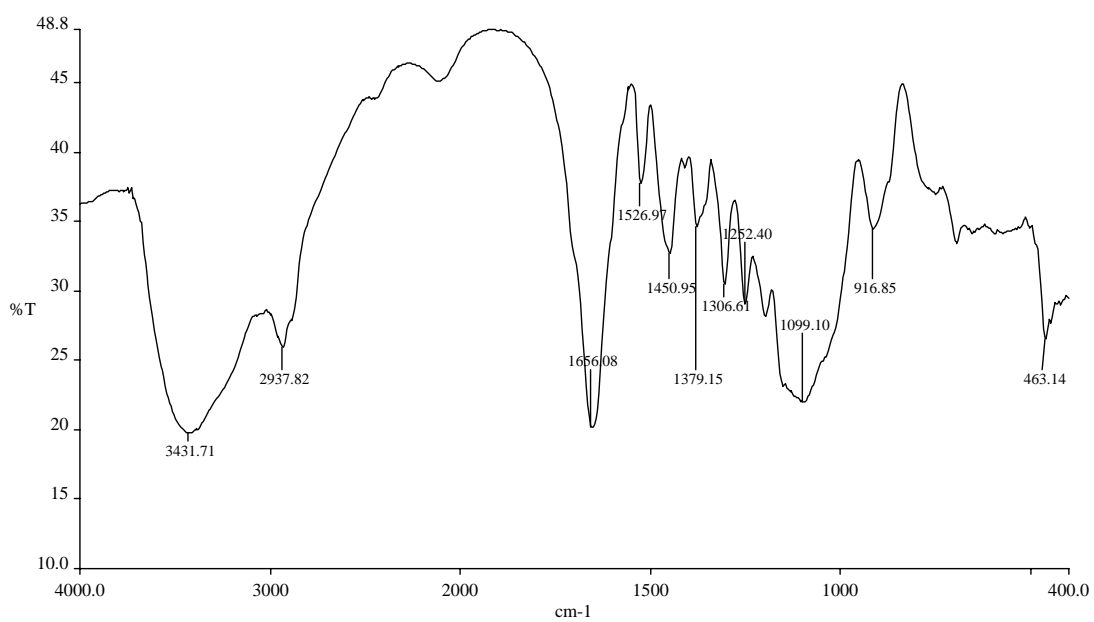
**IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)****Raigs X de pols**

### BET (Brunauer-Emmett-Teller)

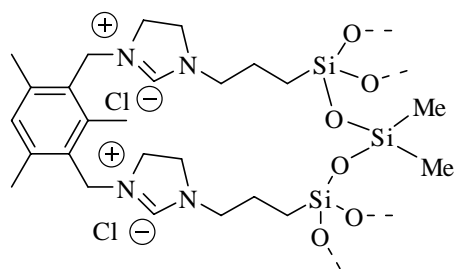


### TEM

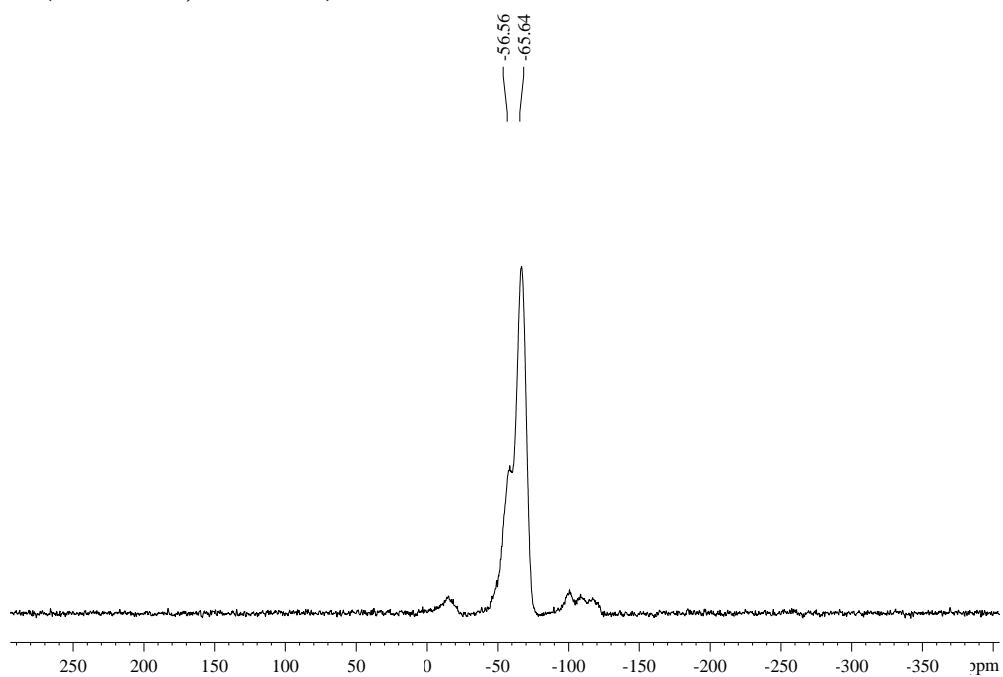


**material híbrid orgànic-inorgànic M10sil****IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)**

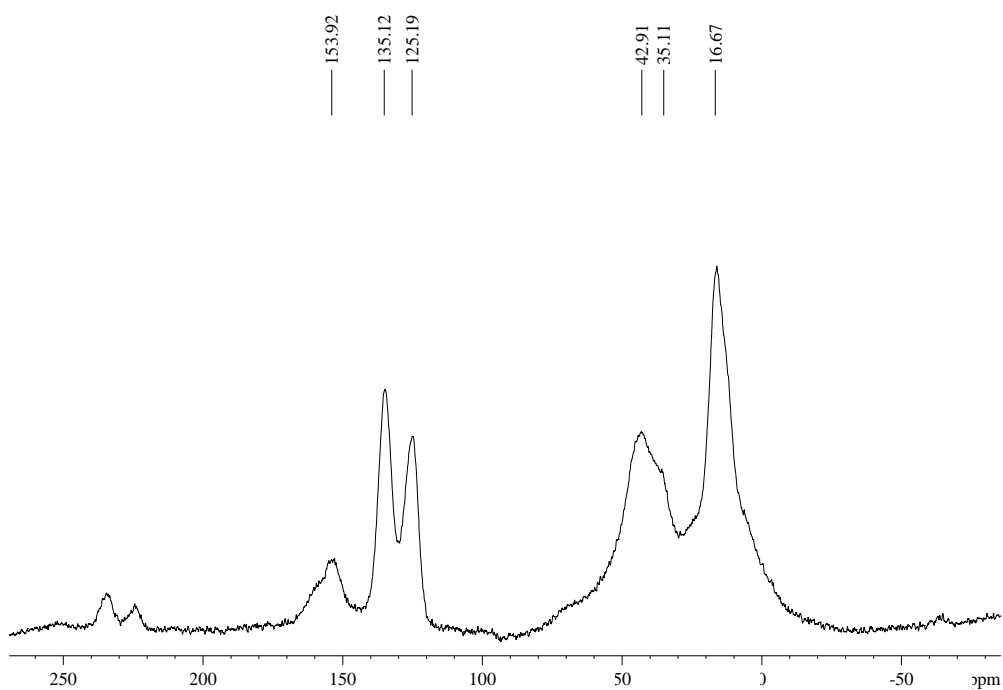


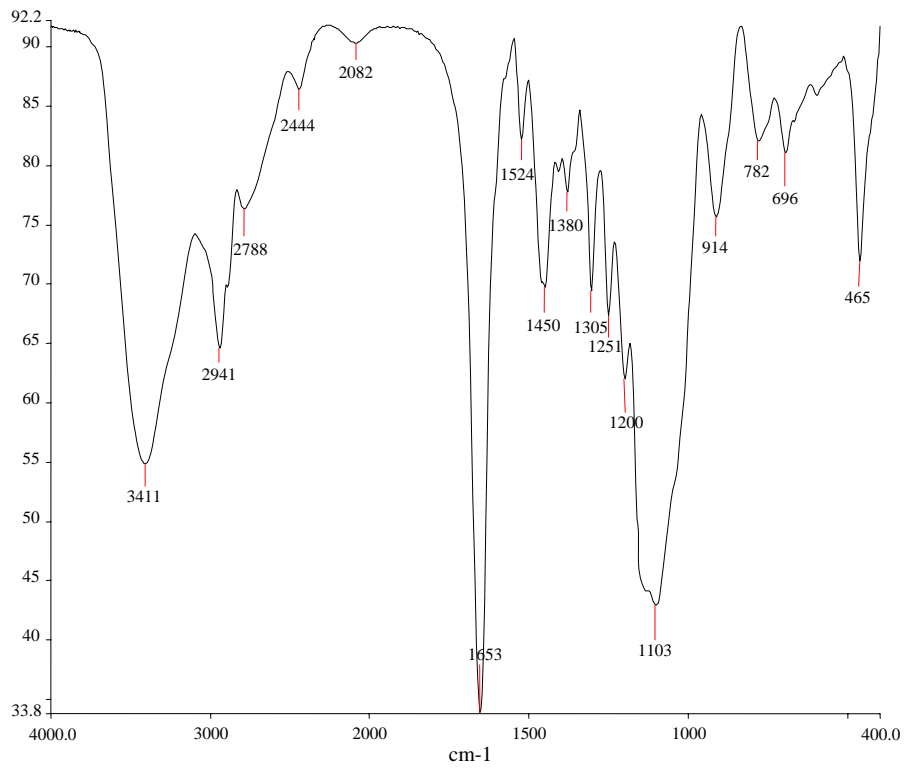
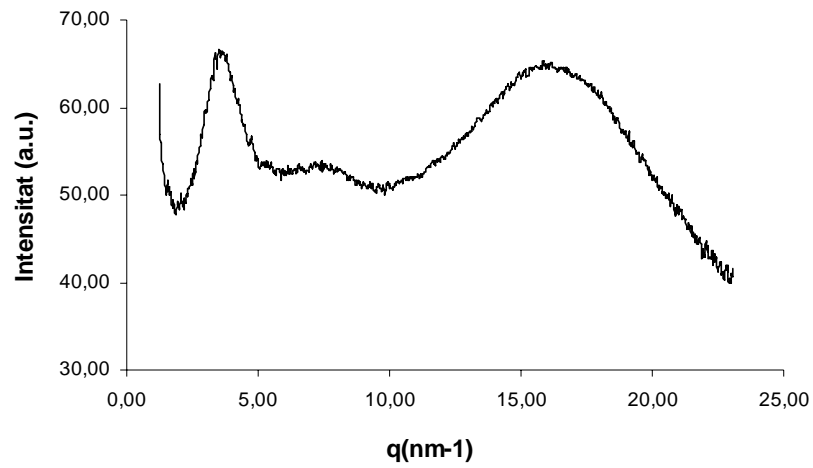


$^{29}\text{Si}$ -RMN (79.5 MHz, CP-MAS)

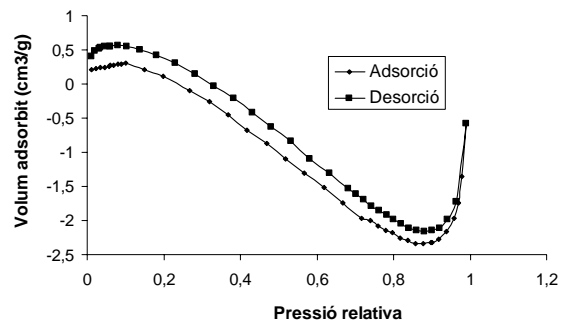


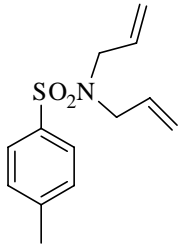
$^{13}\text{C}$ -RMN (100.62 MHz, CP-MAS)



**IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)****Raigs X de pols**

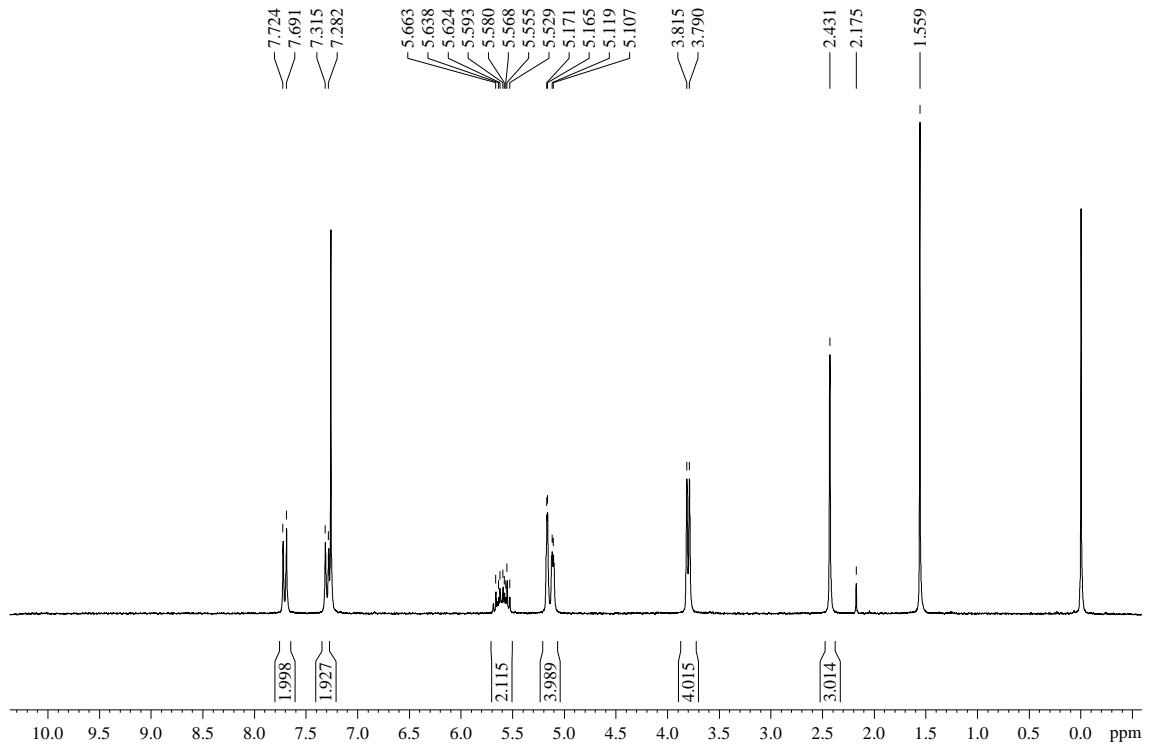
## BET (Brunauer-Emmett-Teller)



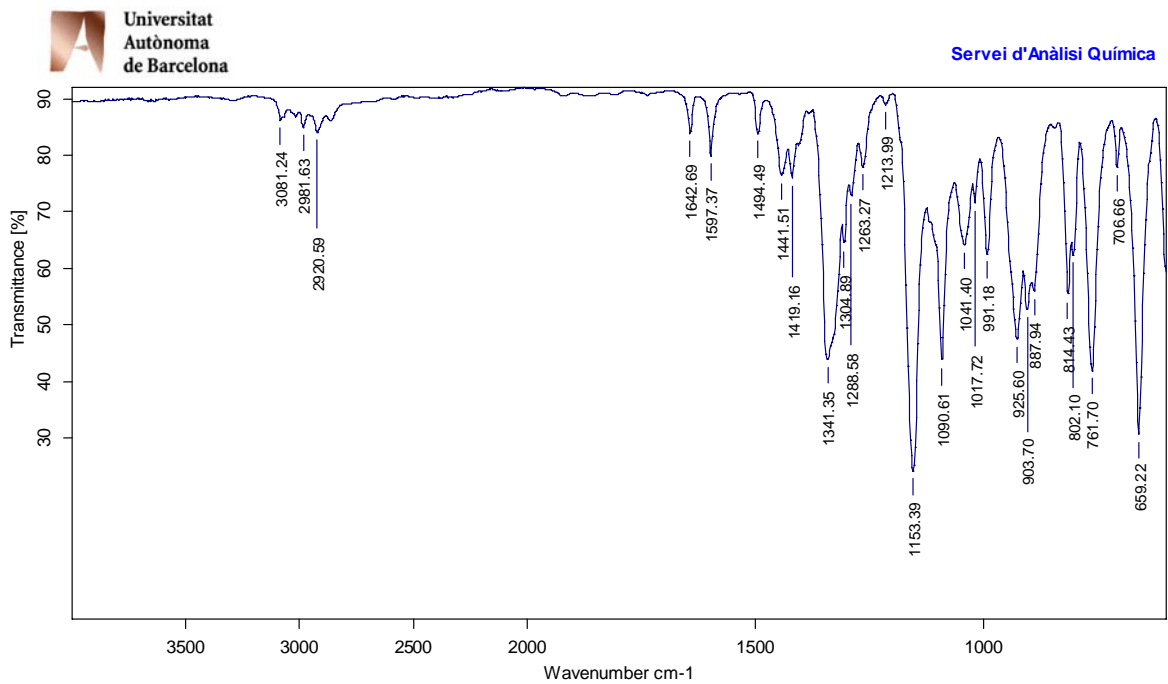


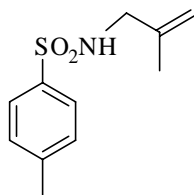
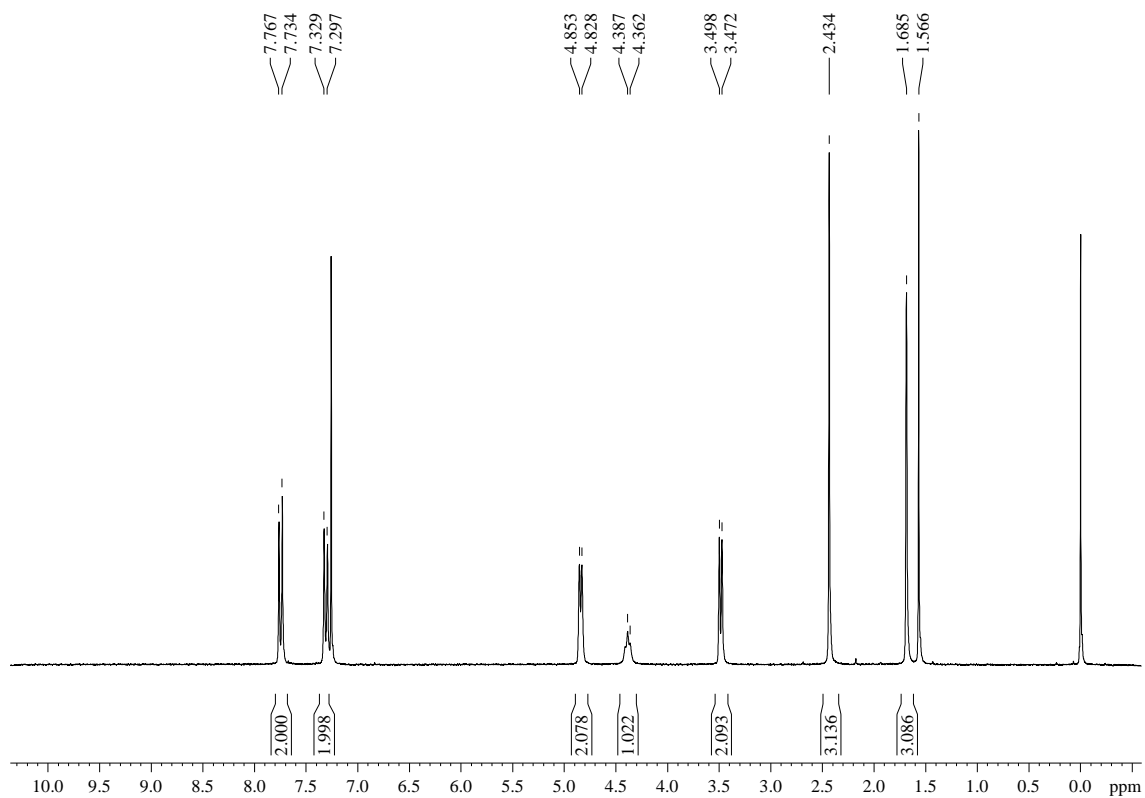
### *N,N*-dial·lil-4-toluensulfonamida, 67

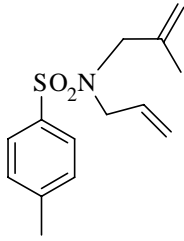
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

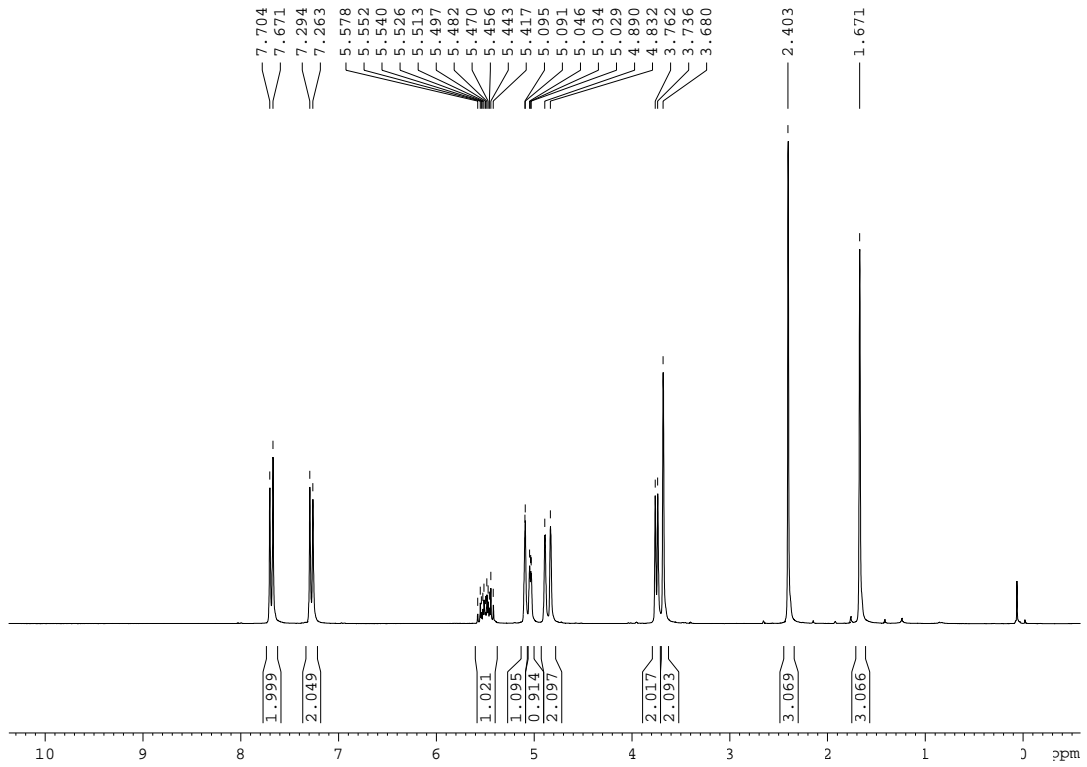


**N-2-metil·lil-4-toluensulfonamida, 71**<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)

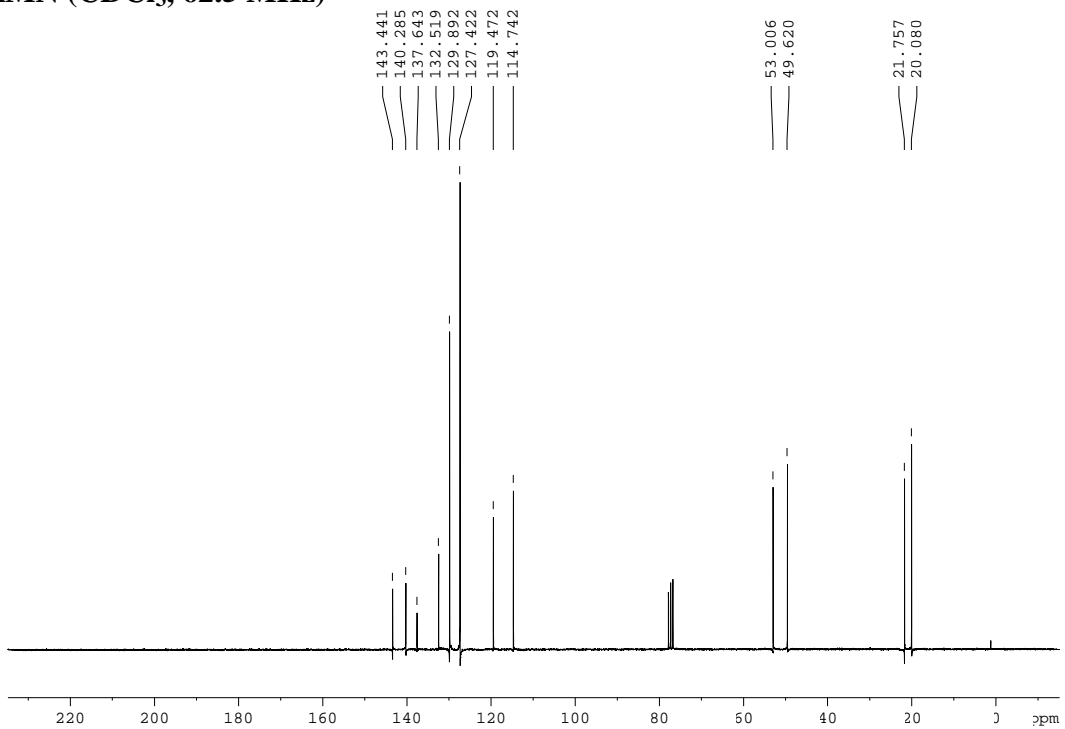


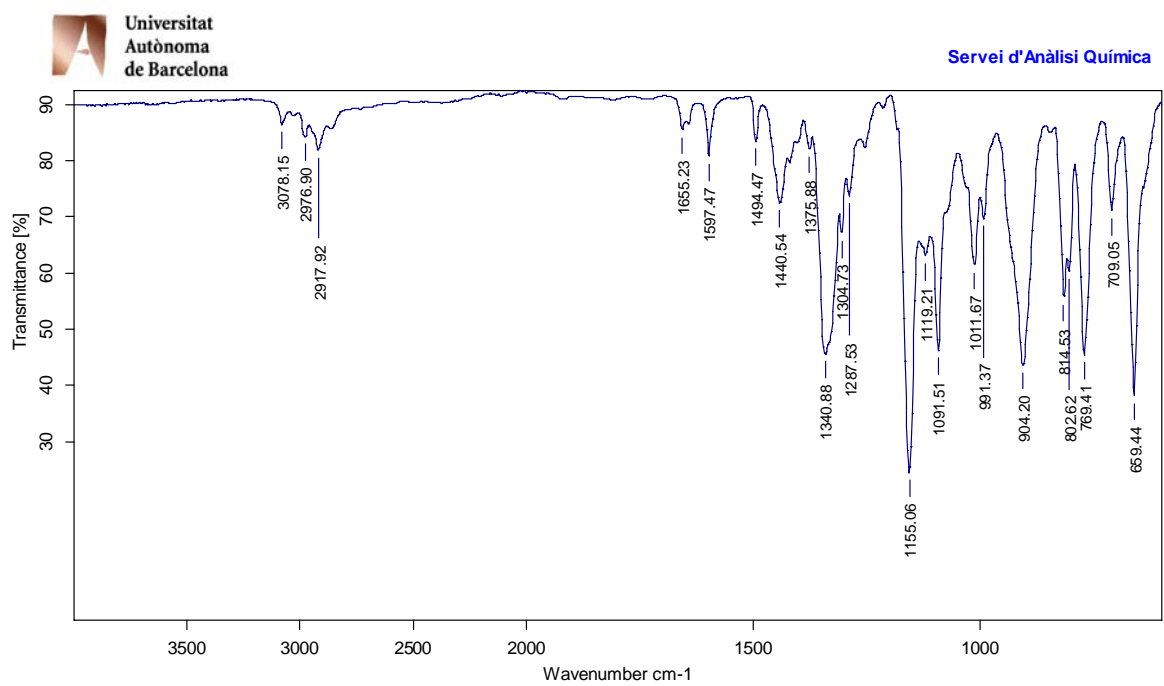
### N-ali·lil-N-(2-metilal·lil)-4-toluensulfonamida, 68

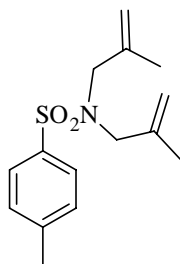
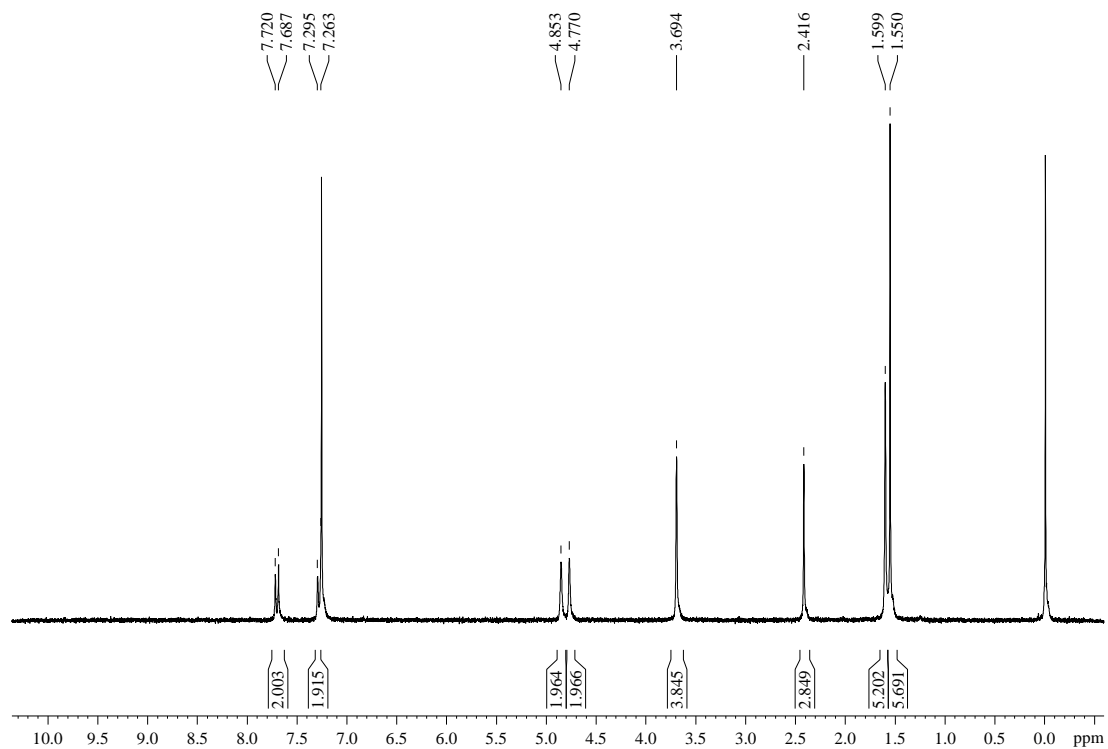
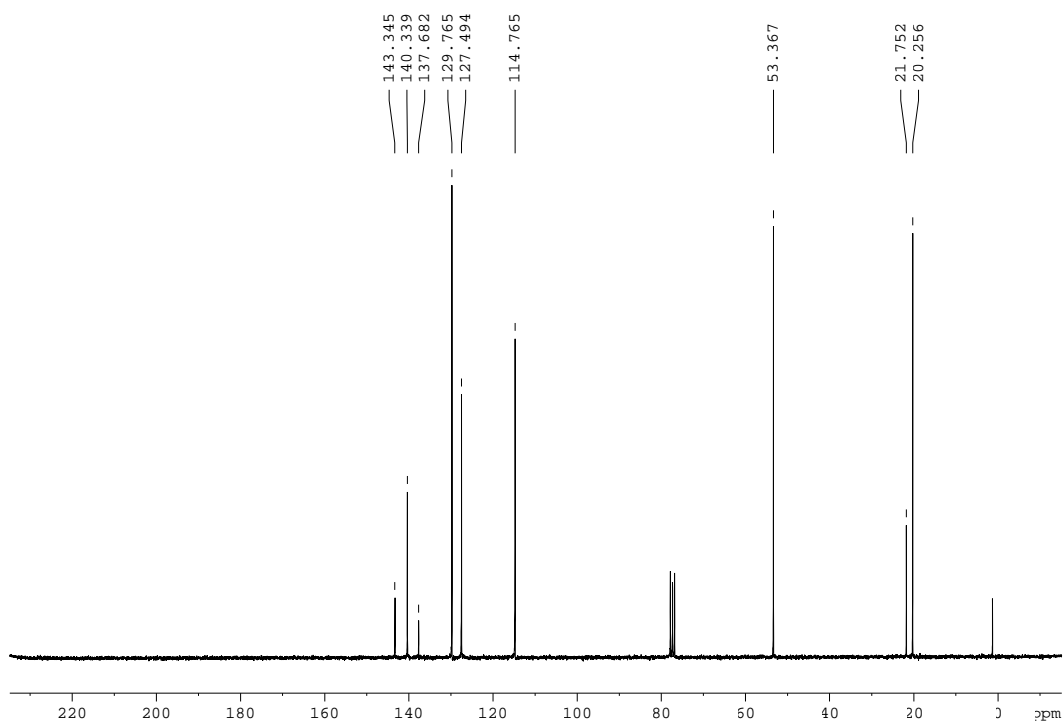
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



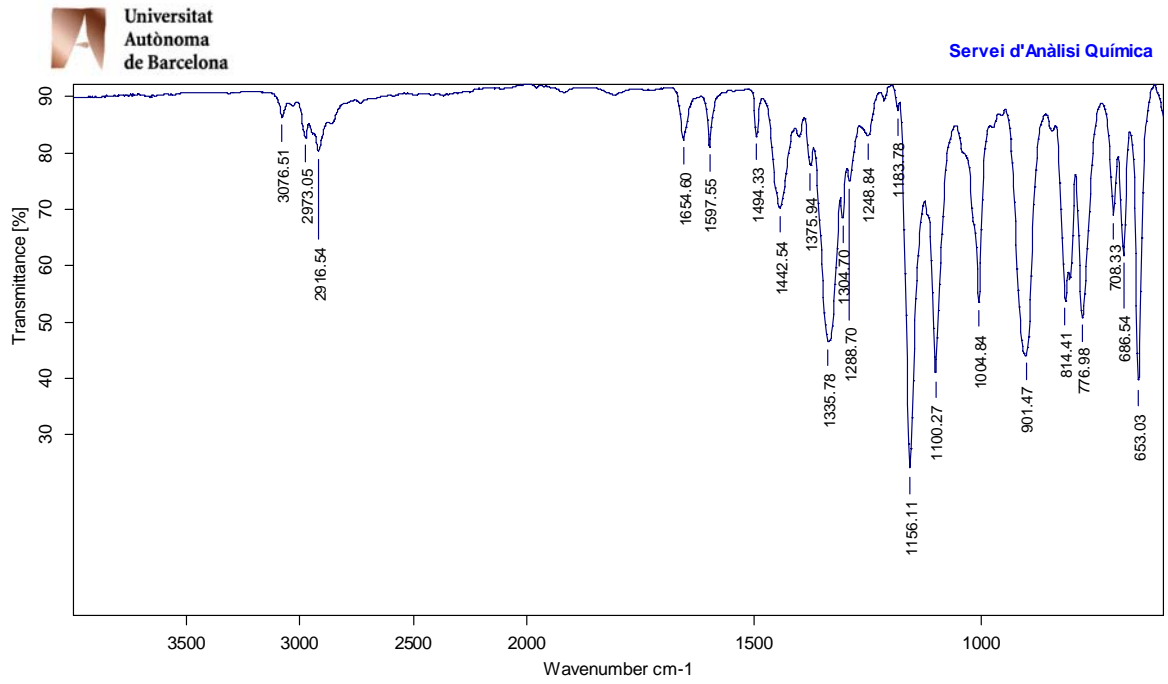
$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

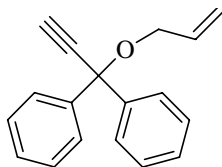


IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

***N,N*-bis-(2-metil·lil)-4-toluensulfonamida, 69****<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)****<sup>13</sup>C-RMN (CDCl<sub>3</sub>, 62.5 MHz)**

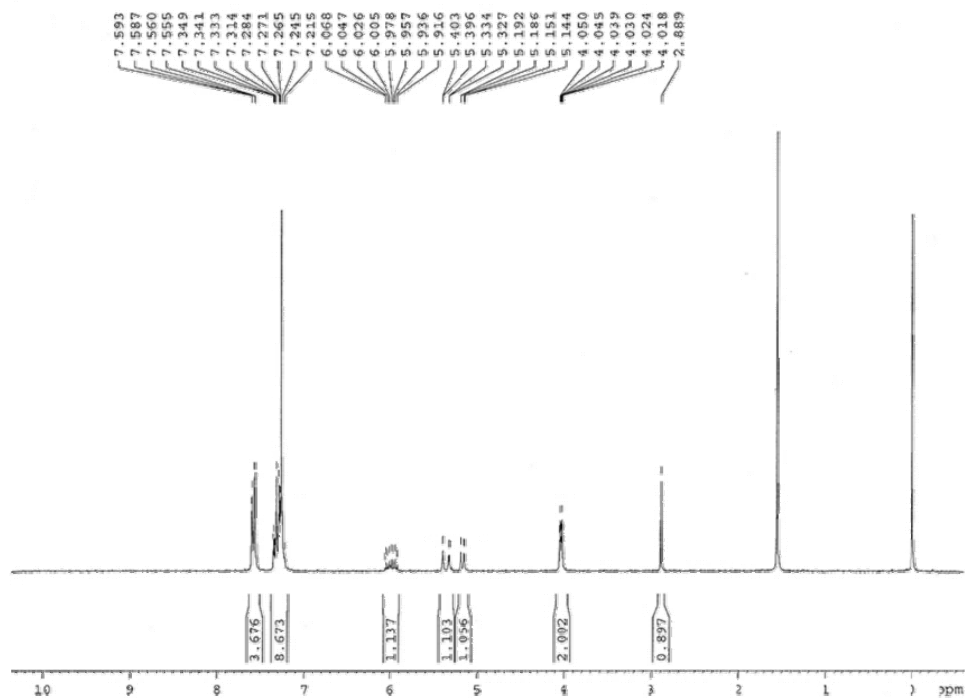


IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

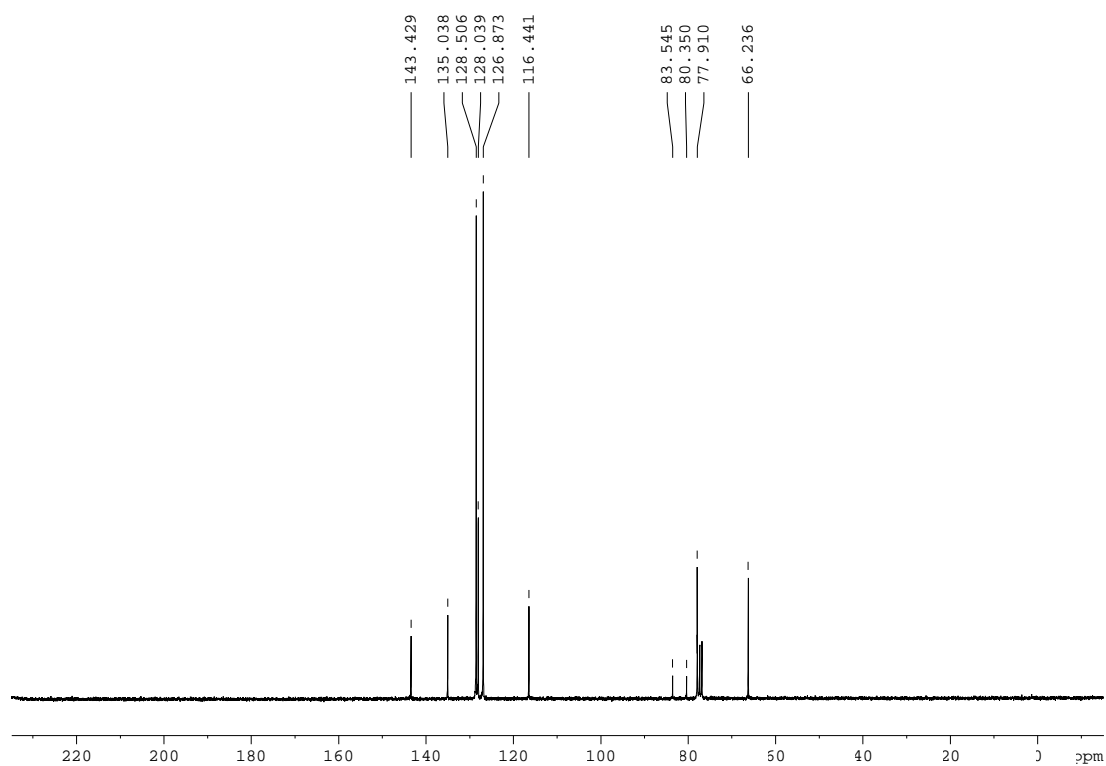


### 1-al·liloxi-1,1-difenil-2-propí, 70

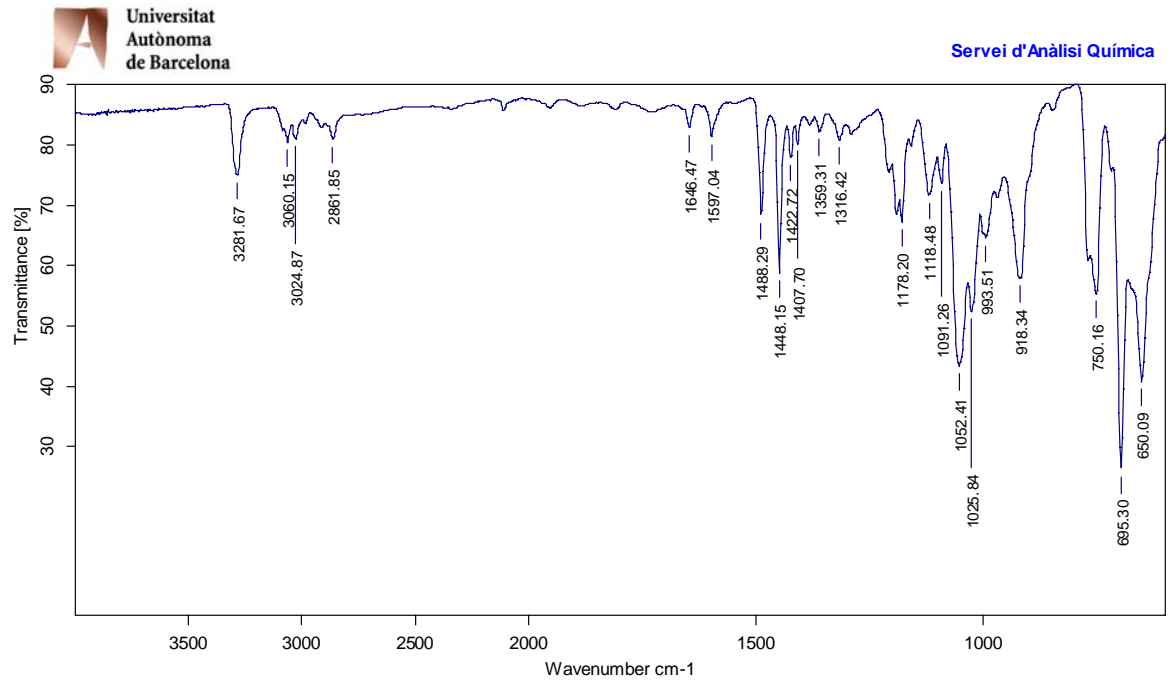
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)

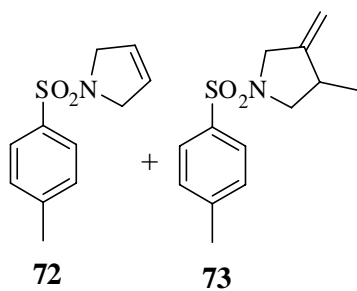


$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)



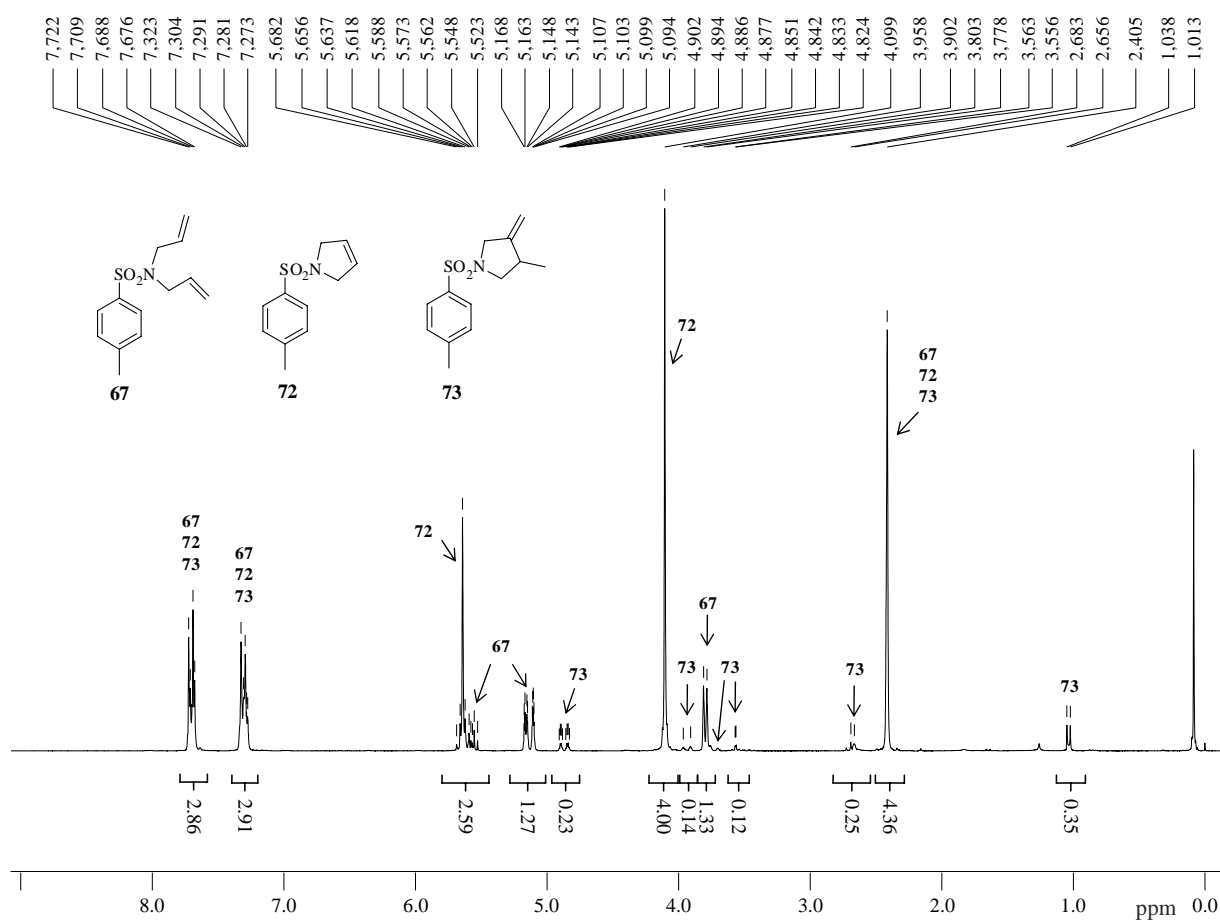
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

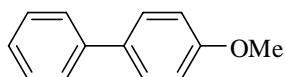
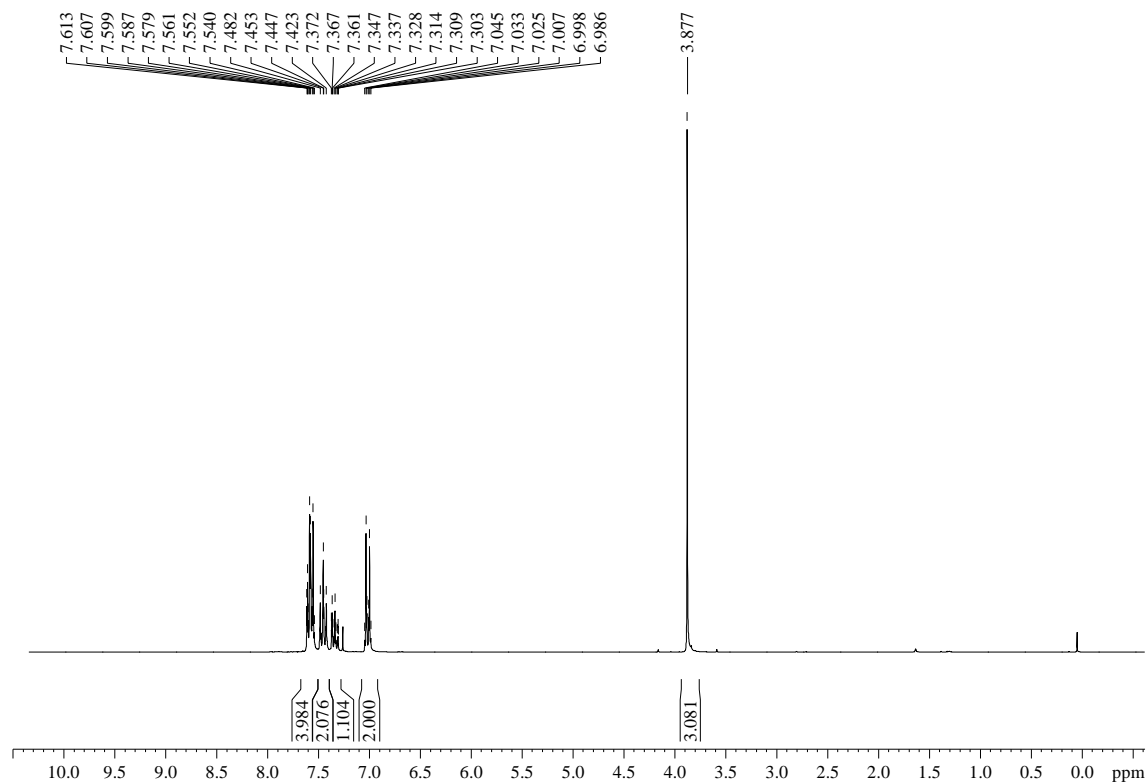
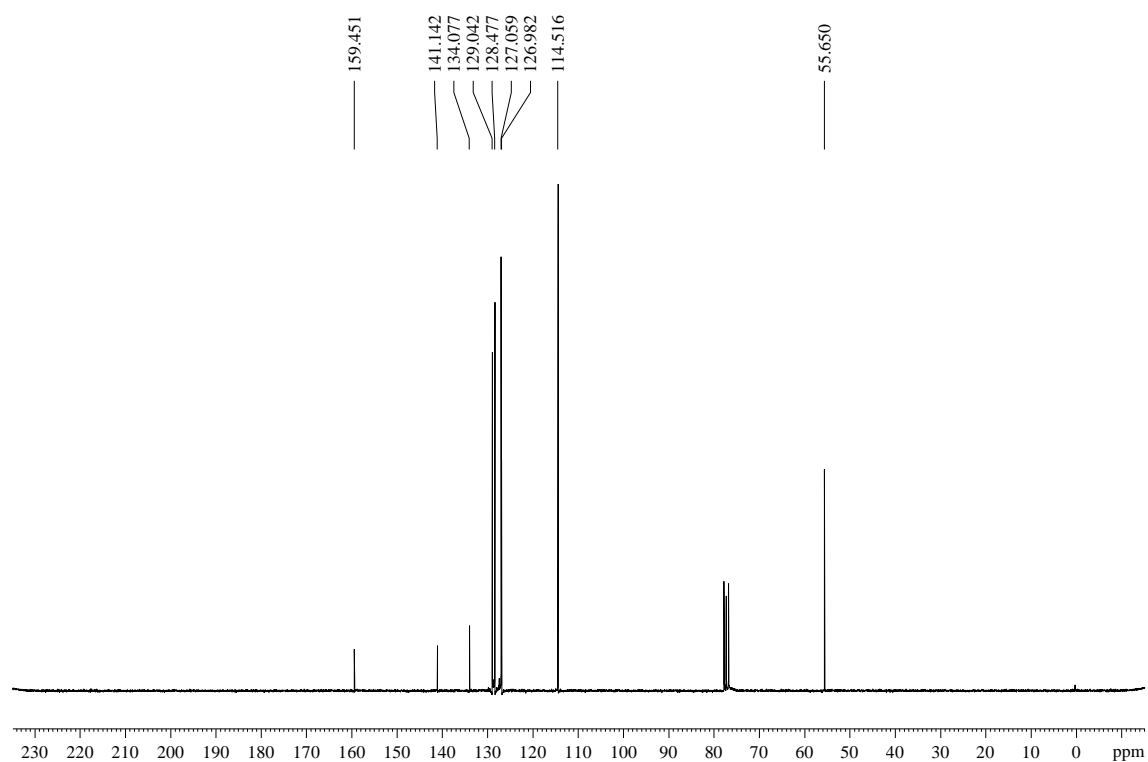


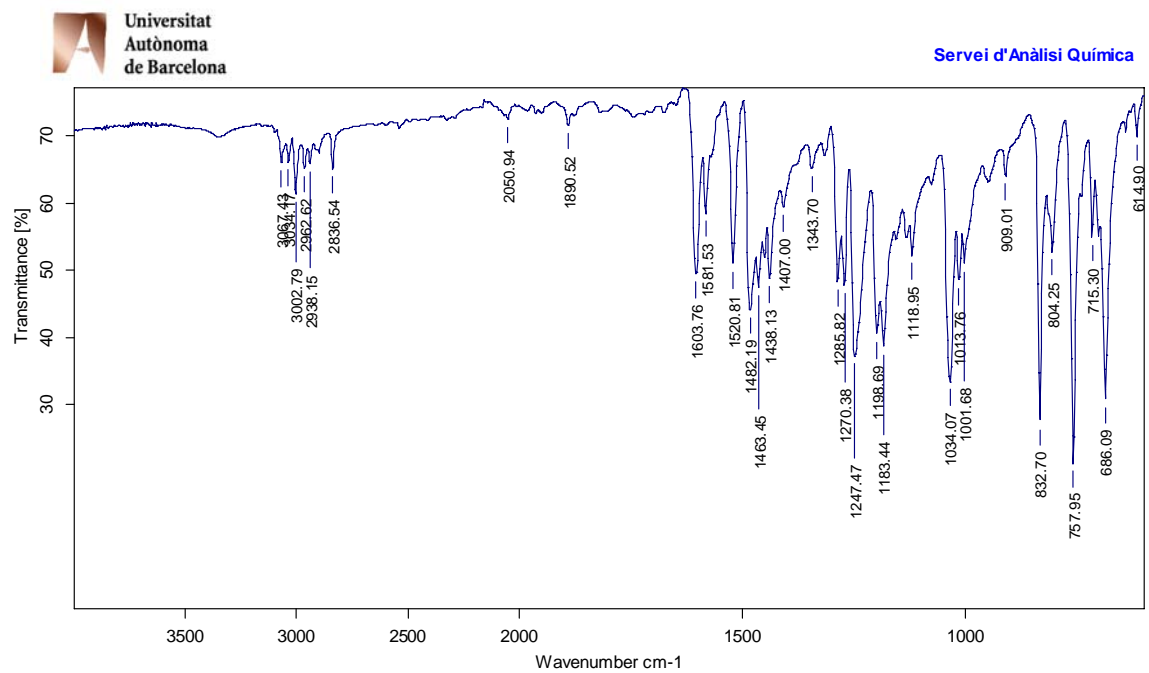


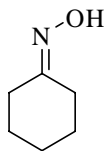
**1-(4-toluensulfonil)-2,5-dihidro-1*H*-pirrole, 72  
i 3-metil-4-metilen-1-(4-toluensulfonil)pirrolidina, 73**

<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)

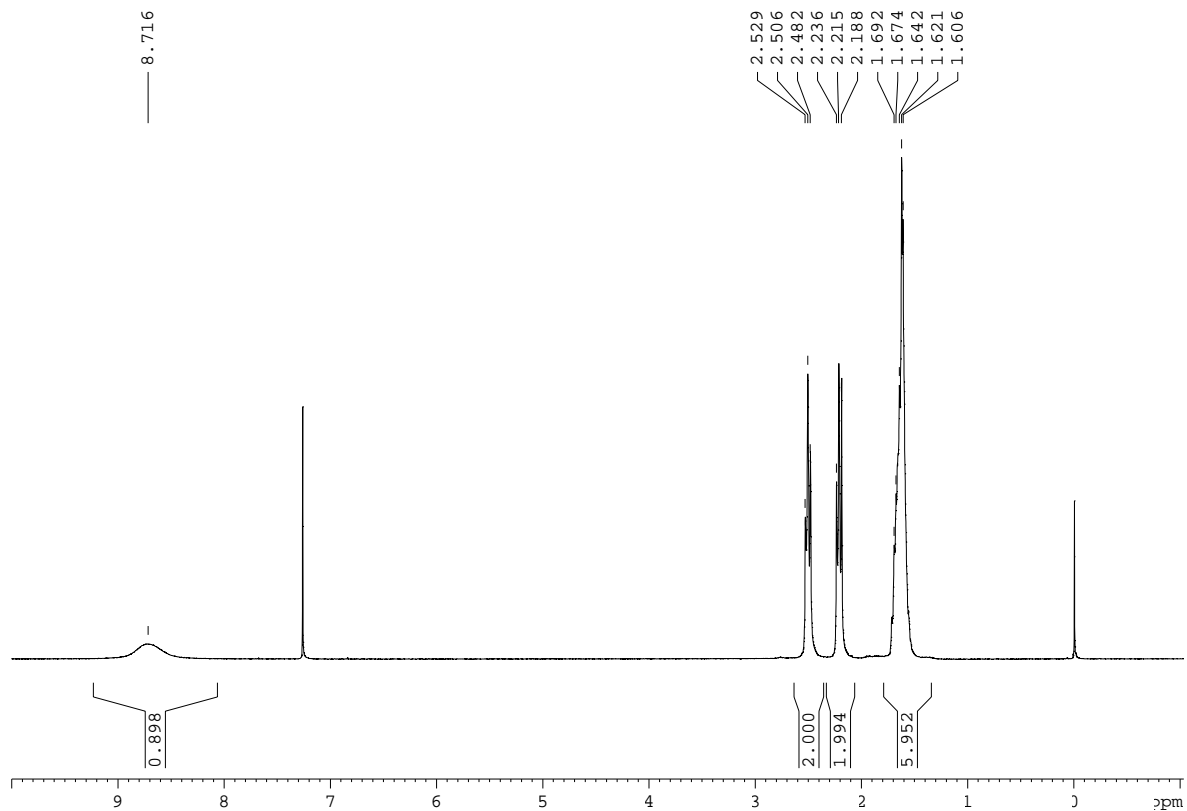


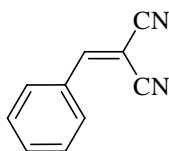
**4-metoxibifenil, 79** **$^1\text{H}$ -RMN (CDCl<sub>3</sub>, 250 MHz)** **$^{13}\text{C}$ -RMN (CDCl<sub>3</sub>, 62.5 MHz)**

IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)



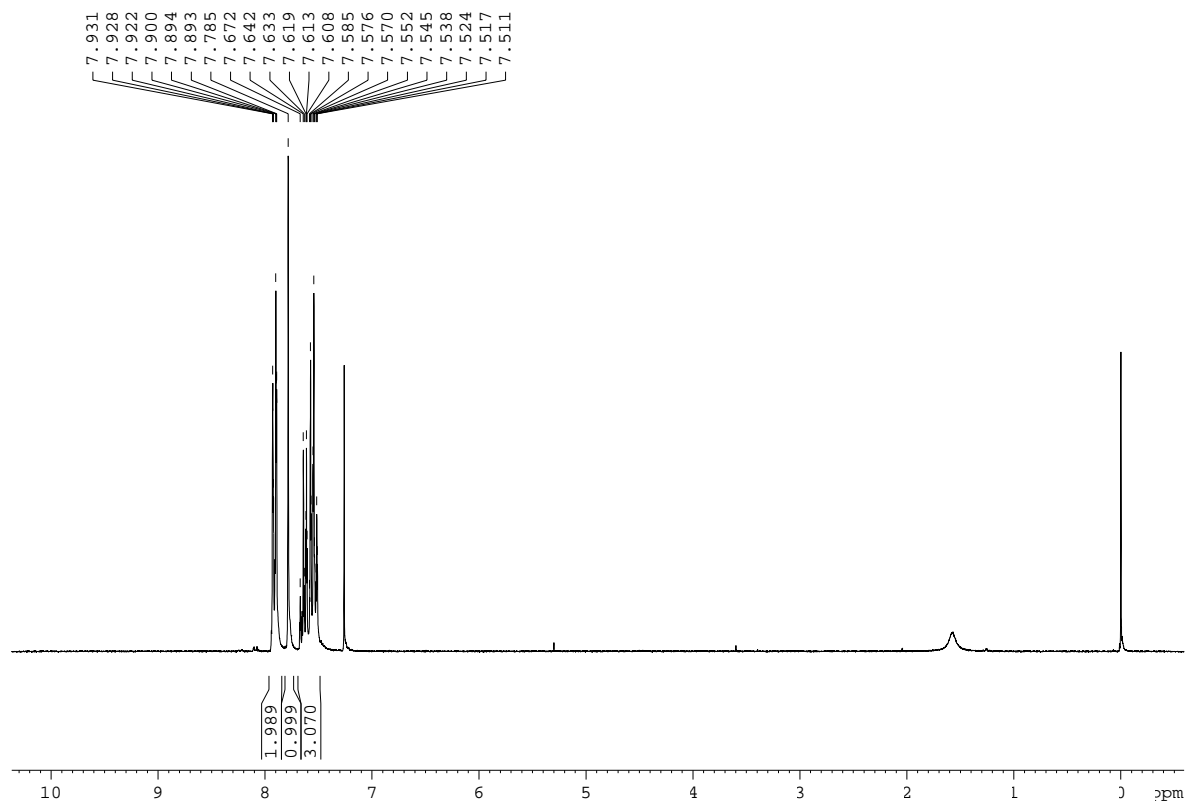
## oxima de la ciclohexanona, 88

 $^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)

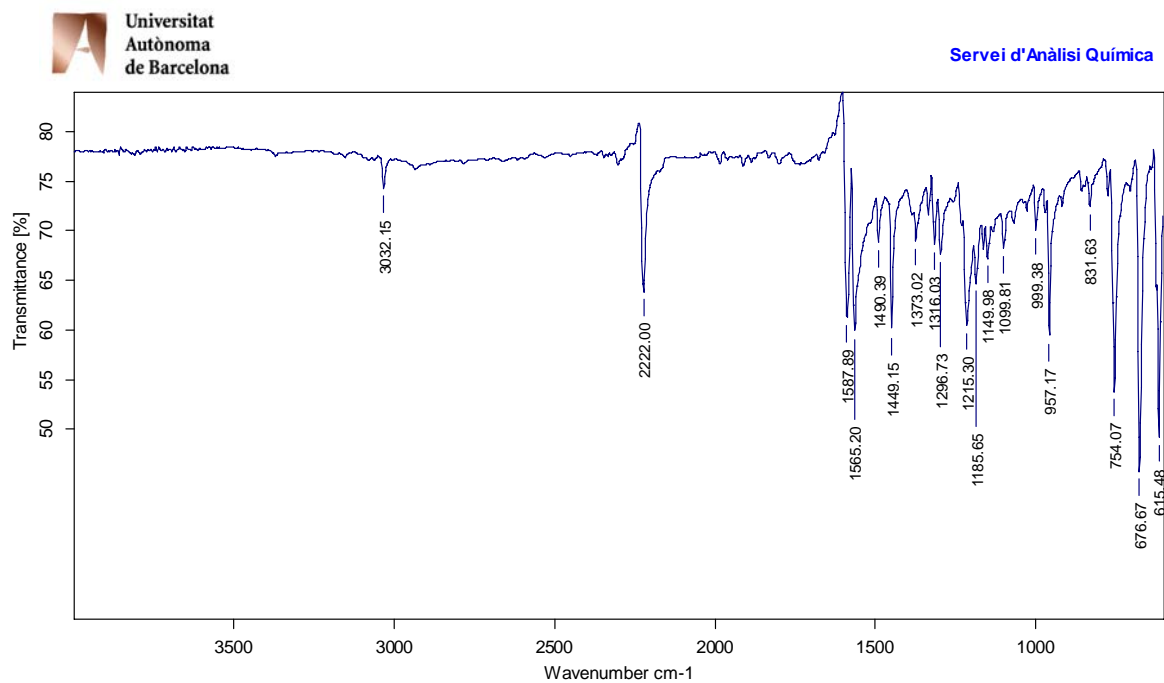


## 2-benzilidenmalononitril, 93

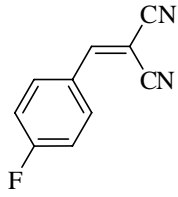
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

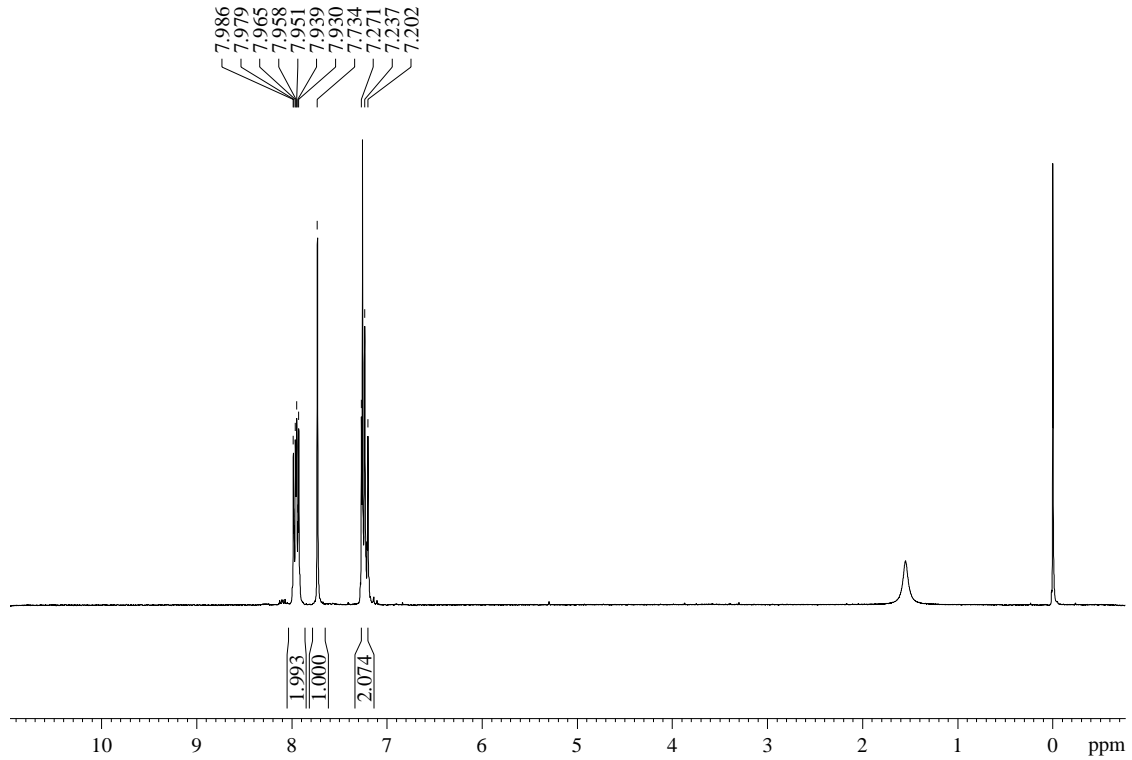




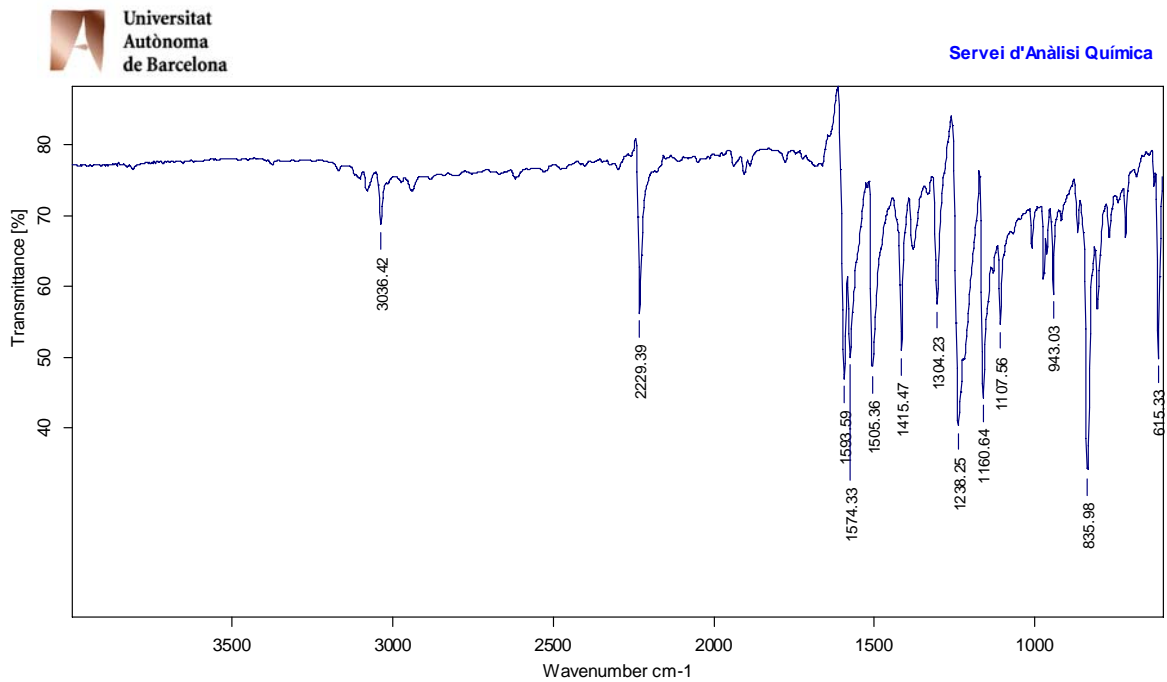


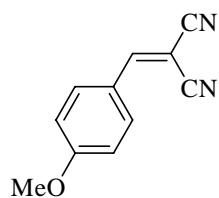
## 2-(4-fluorobenziliden)malononitril, 95

$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



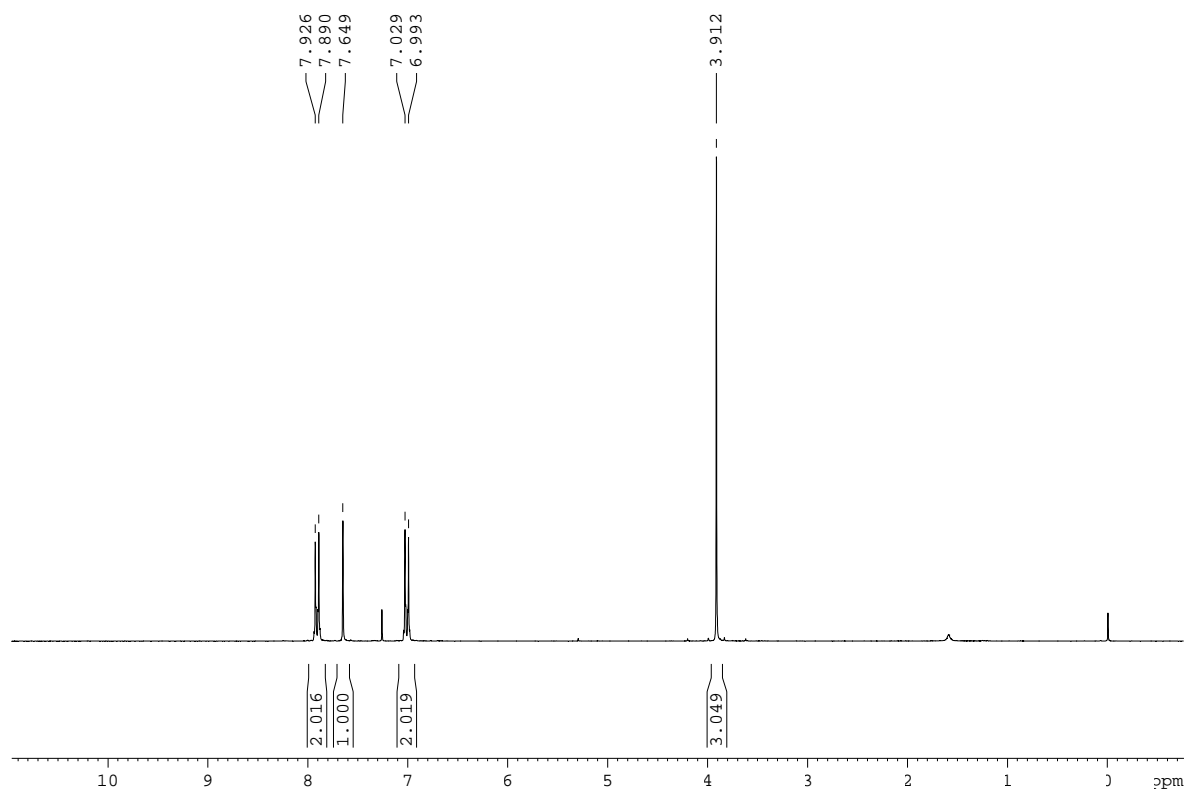
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)



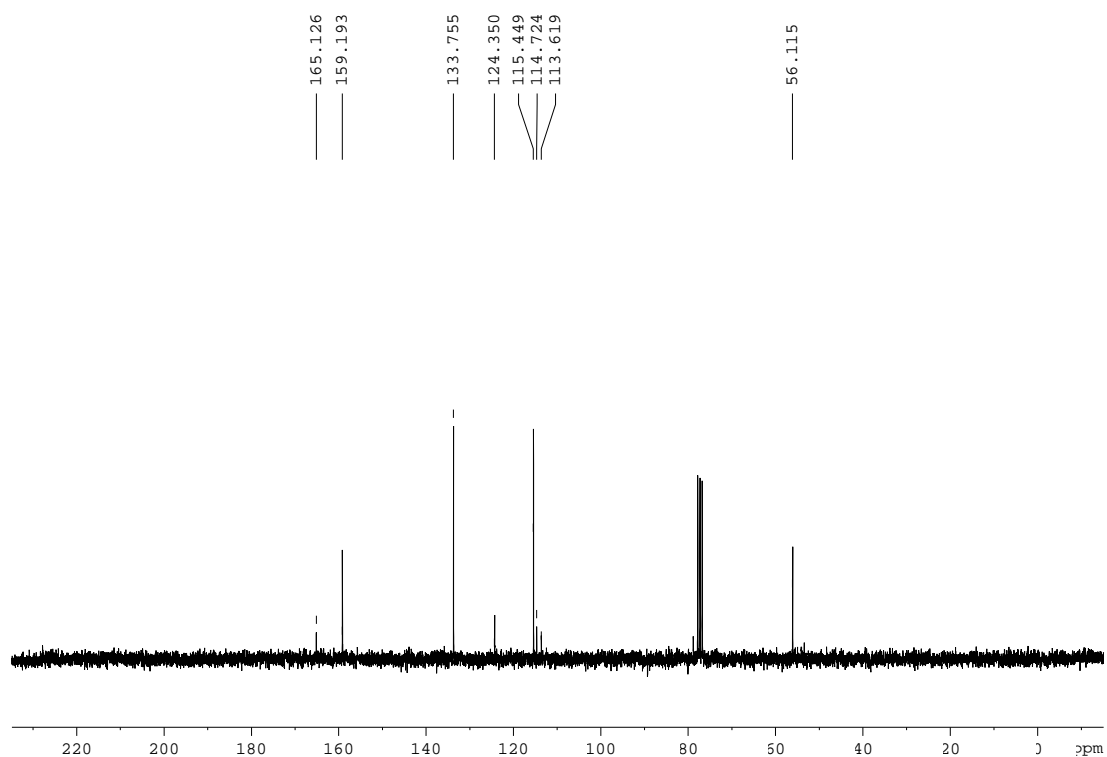


## 2-(4-metoxibenziliden)malononitril, 97

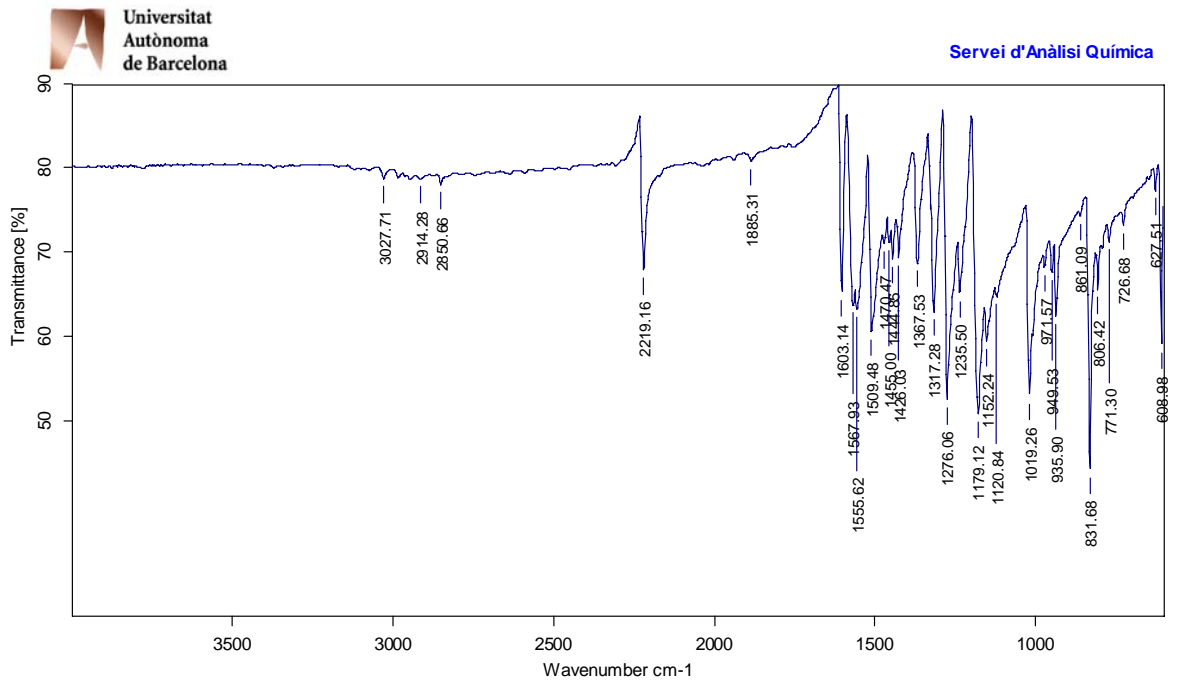
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)

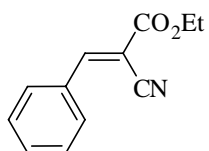
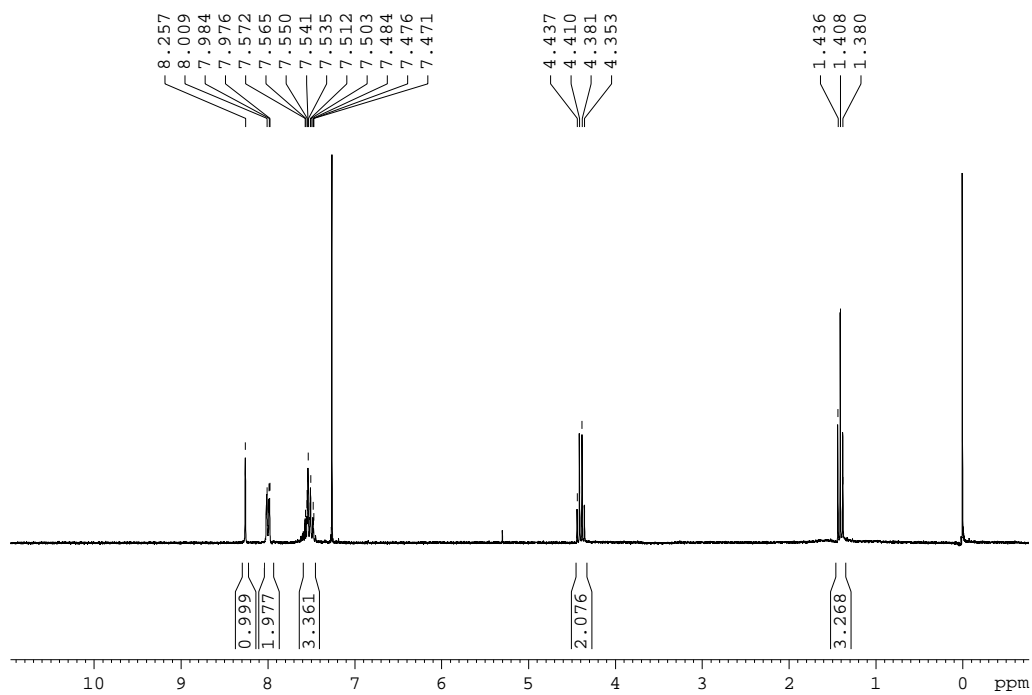
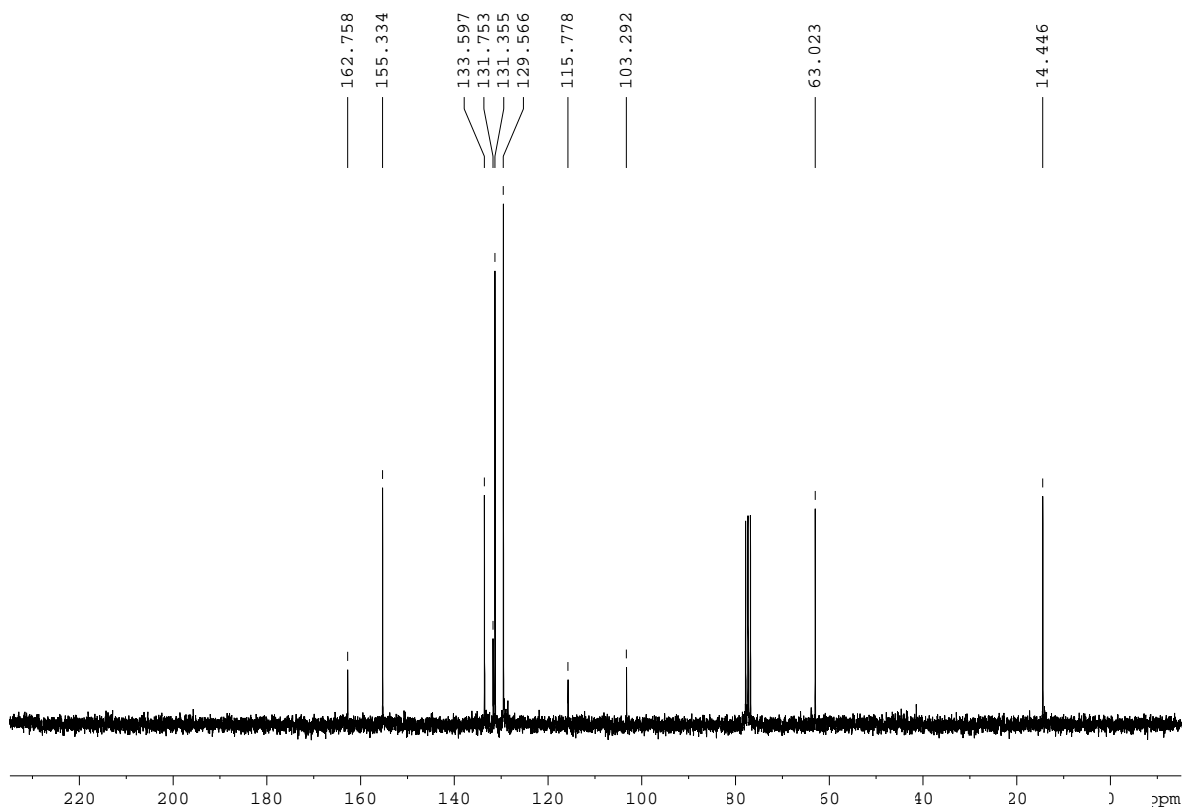


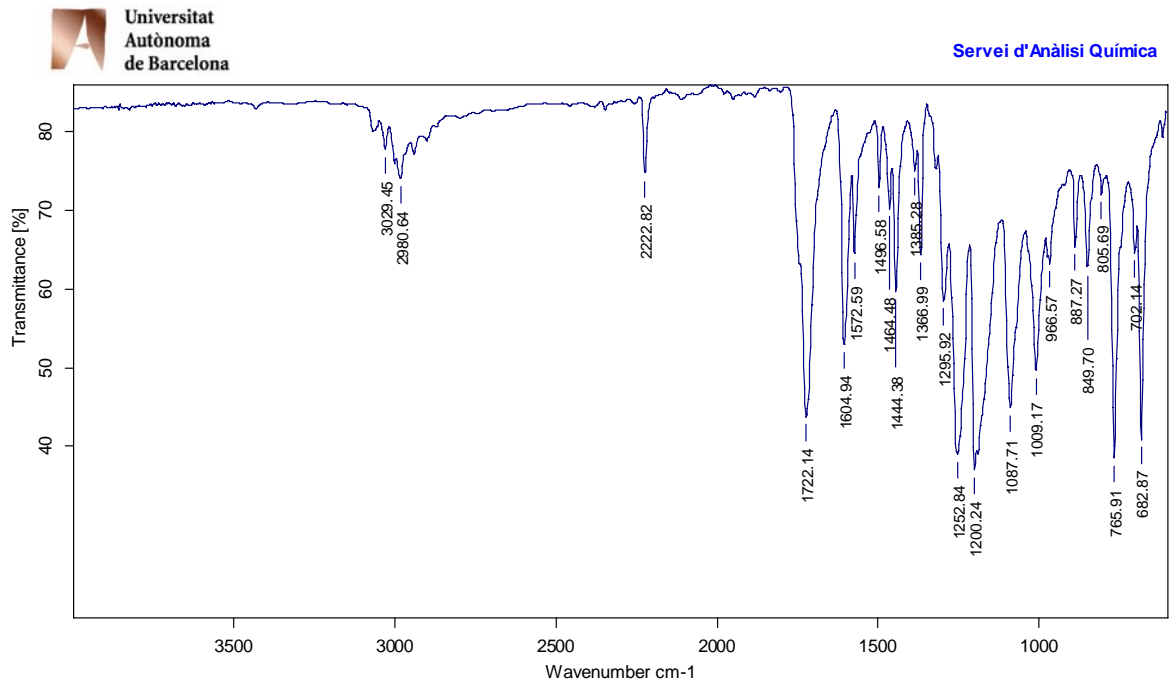
$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

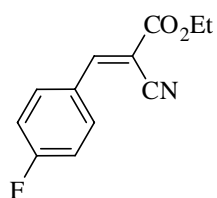
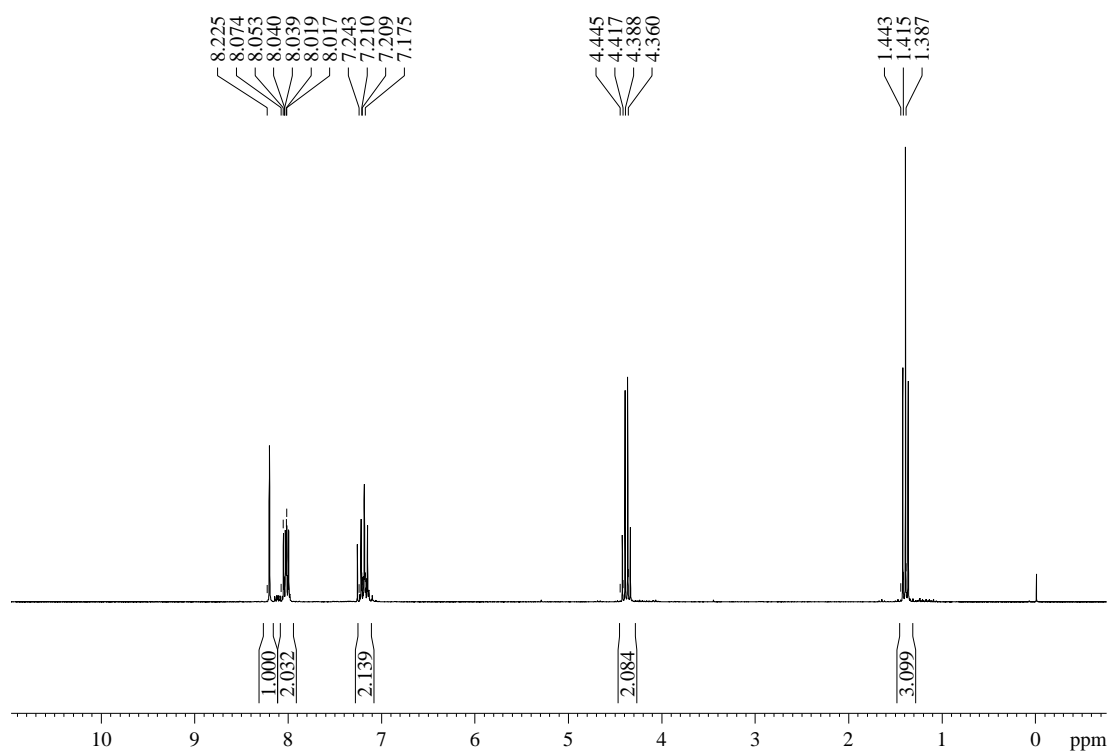
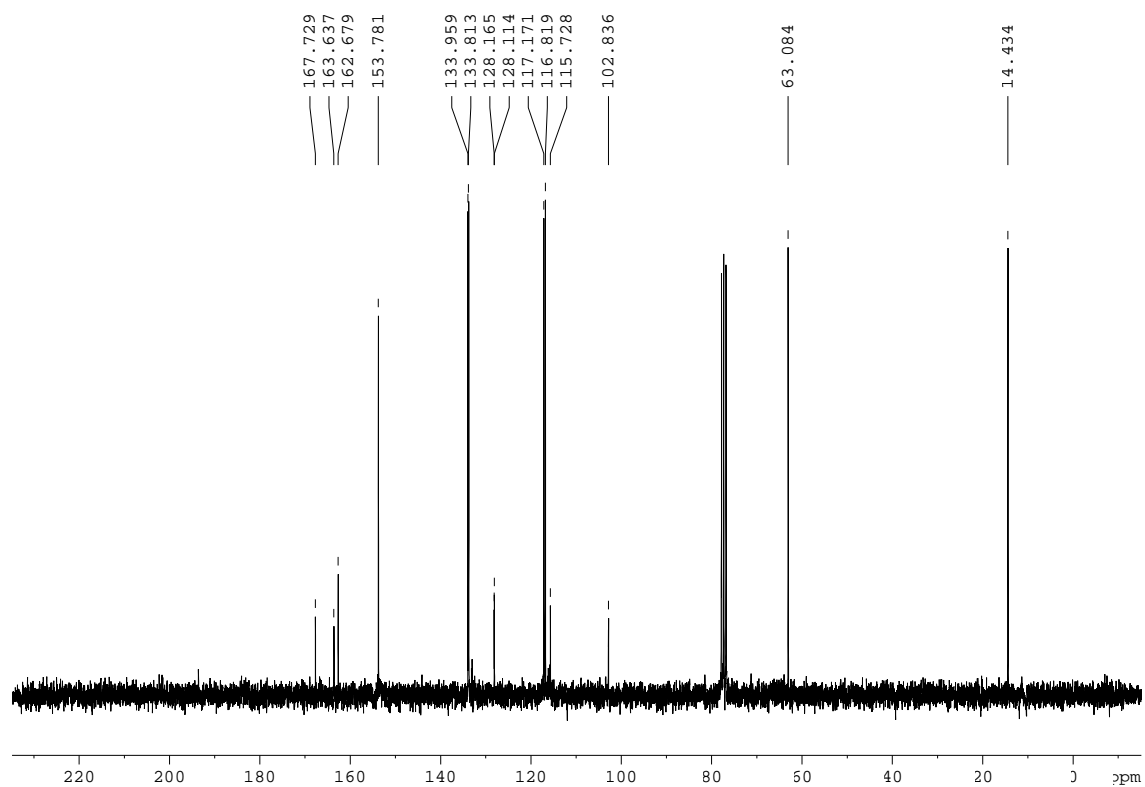


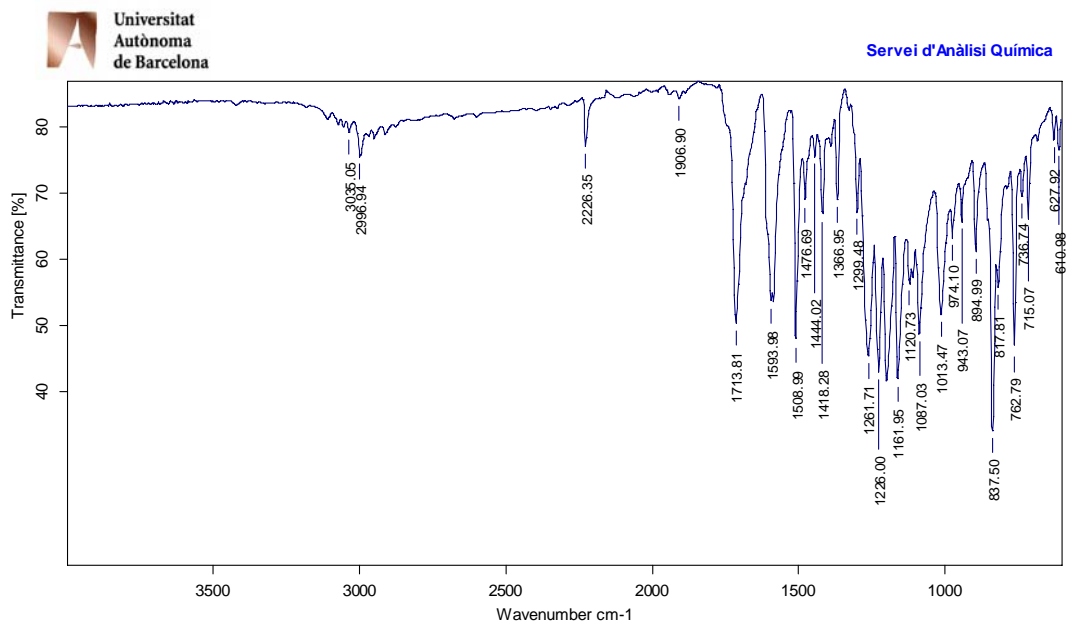
# IR $\nu$ ( $\text{cm}^{-1}$ ) (ATR)

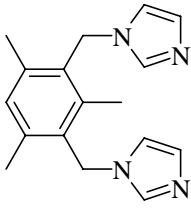


**(E)-2-ciano-3-fenil-2-propenoat d'etil, 99** **$^1\text{H}$ -RMN ( $\text{CDCl}_3$ , 250 MHz)** **$^{13}\text{C}$ -RMN ( $\text{CDCl}_3$ , 62.5 MHz)**

IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

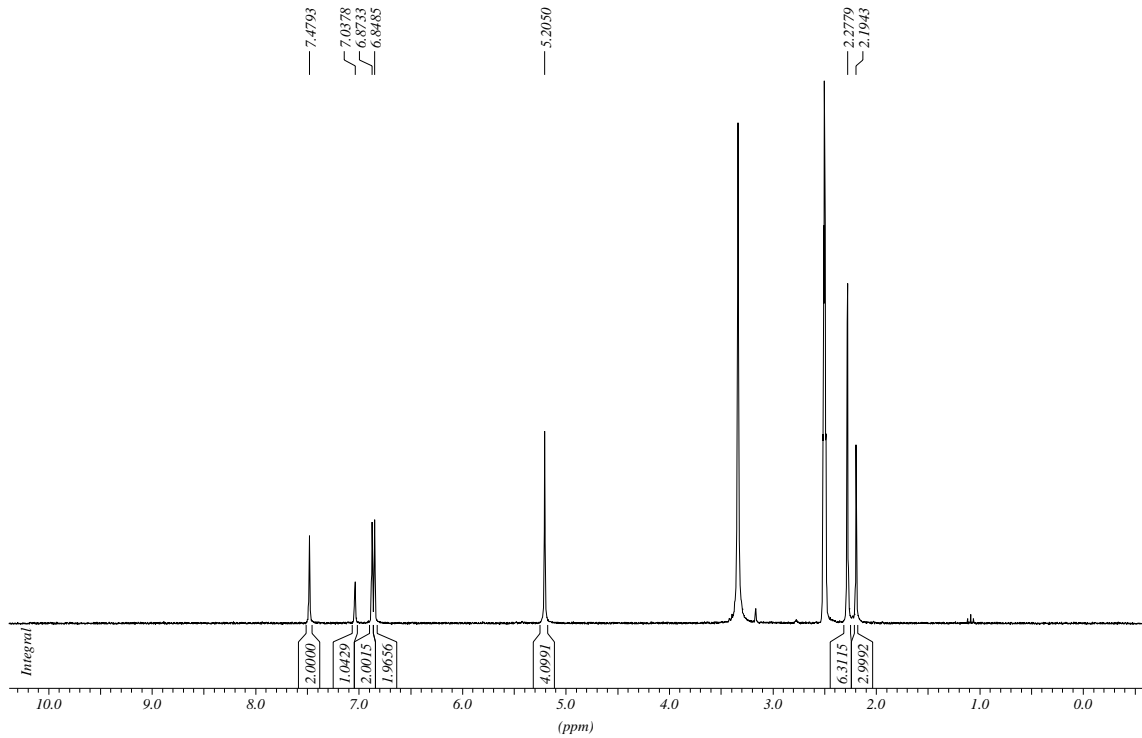
**(E)-2-ciano-3-(4-fluorofenil)-2-propenoat d'etil, 100****<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)****<sup>13</sup>C-RMN (CDCl<sub>3</sub>, 62.5 MHz)**

IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

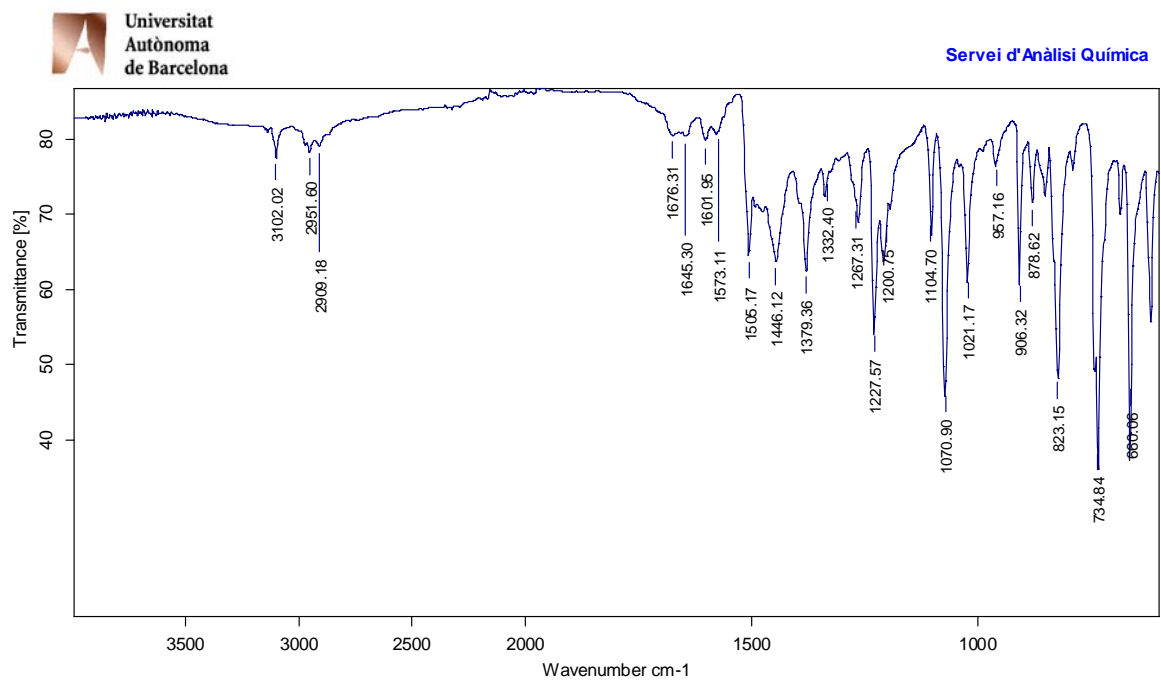


## 2,4-bis(imidazol-1-ylmetil)mesitilè, 101

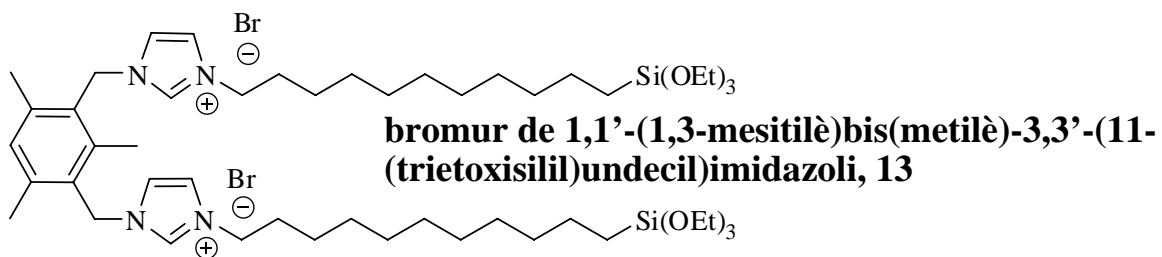
$^1\text{H-RMN}$  (DMSO- $d_6$ , 250 MHz)



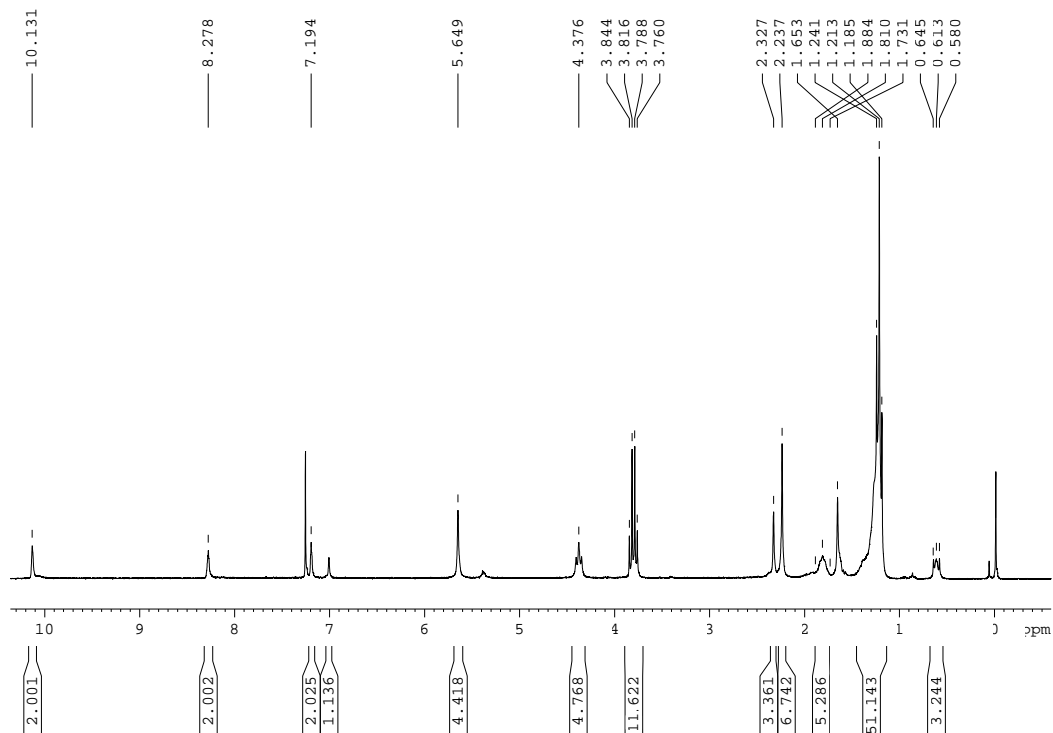
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)



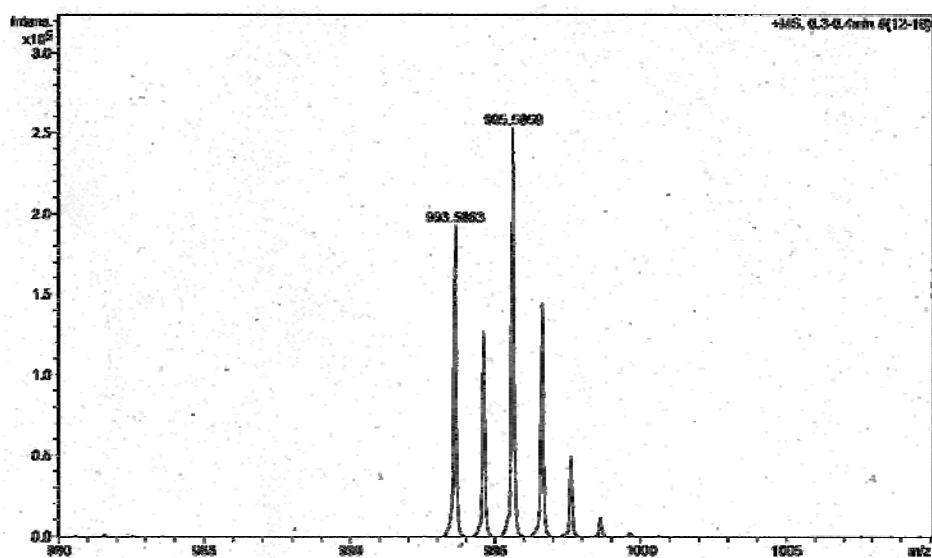




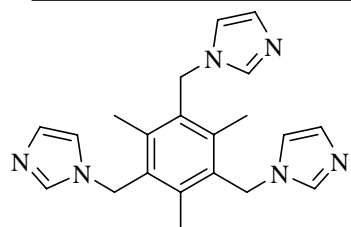
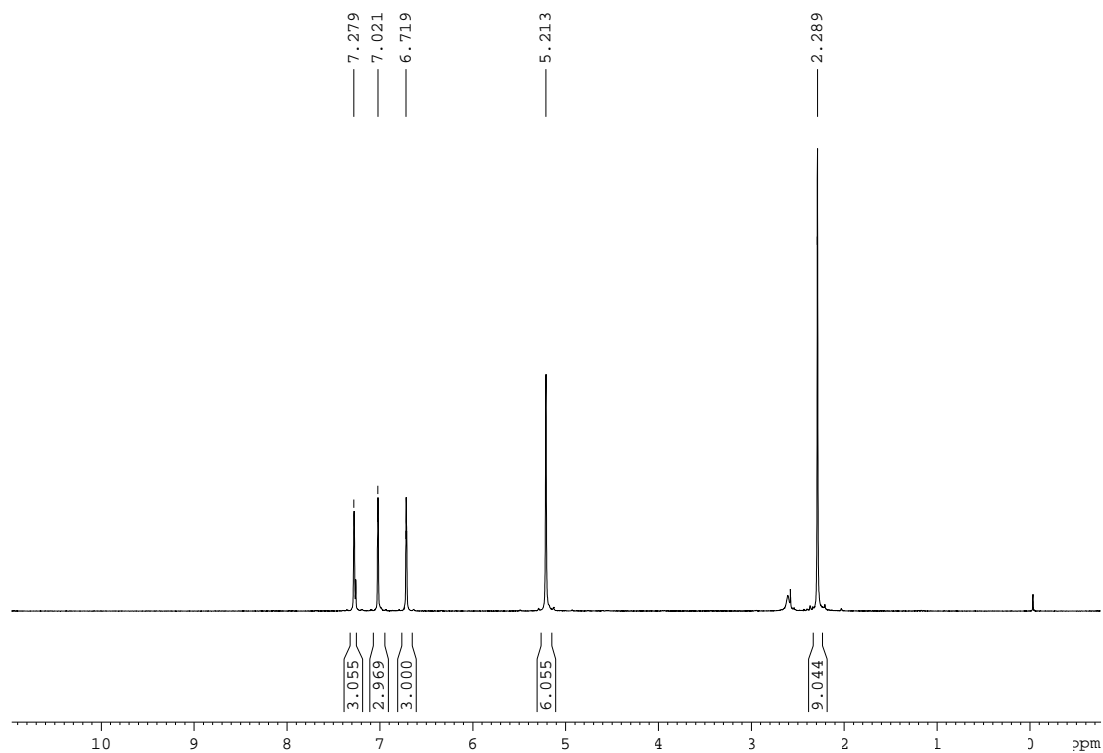
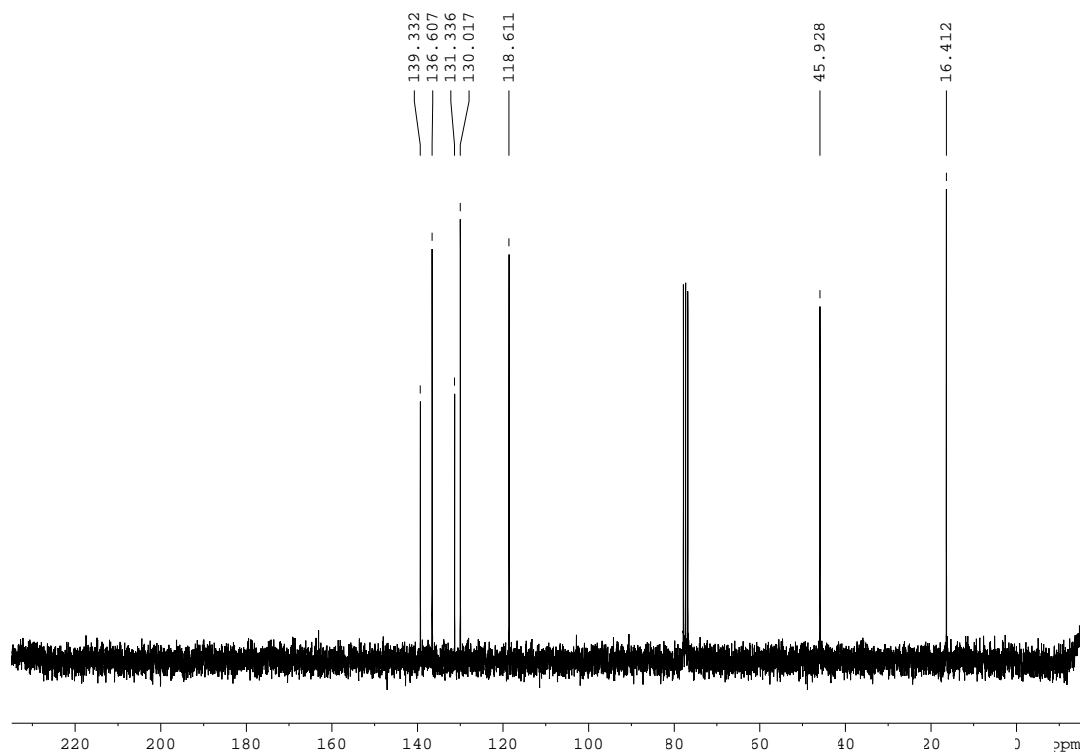
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



HR-MS

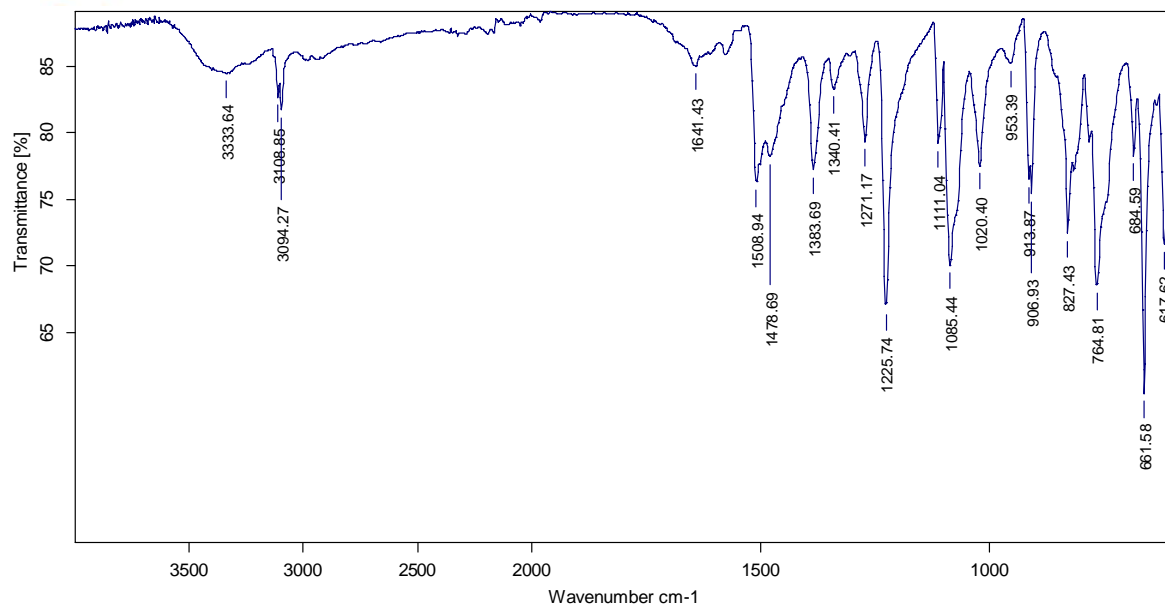


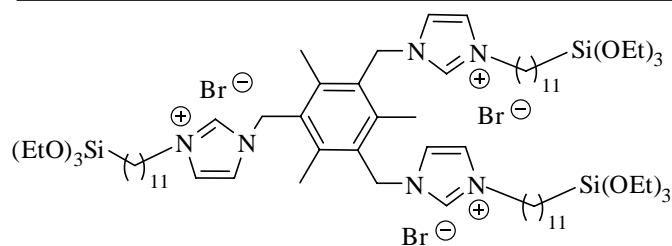
#	m/z	I	I%
1	993.5863	182418	78.1
2	994.5858	127085	50.3
3	996.5858	252310	100.0
4	996.5876	144037	57.0
5	997.5864	43763	19.7
6	998.5860	14223	4.4
7	999.5870	2206	0.9

**1,3,5-tris(imidazol-1-ylmetil)-2,4,6-trimetilbenzè, 102****<sup>1</sup>H-RMN (CDCl<sub>3</sub>, 250 MHz)****<sup>13</sup>C-RMN (CDCl<sub>3</sub>, 62.5 MHz)**

IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)Universitat  
Autònoma  
de Barcelona

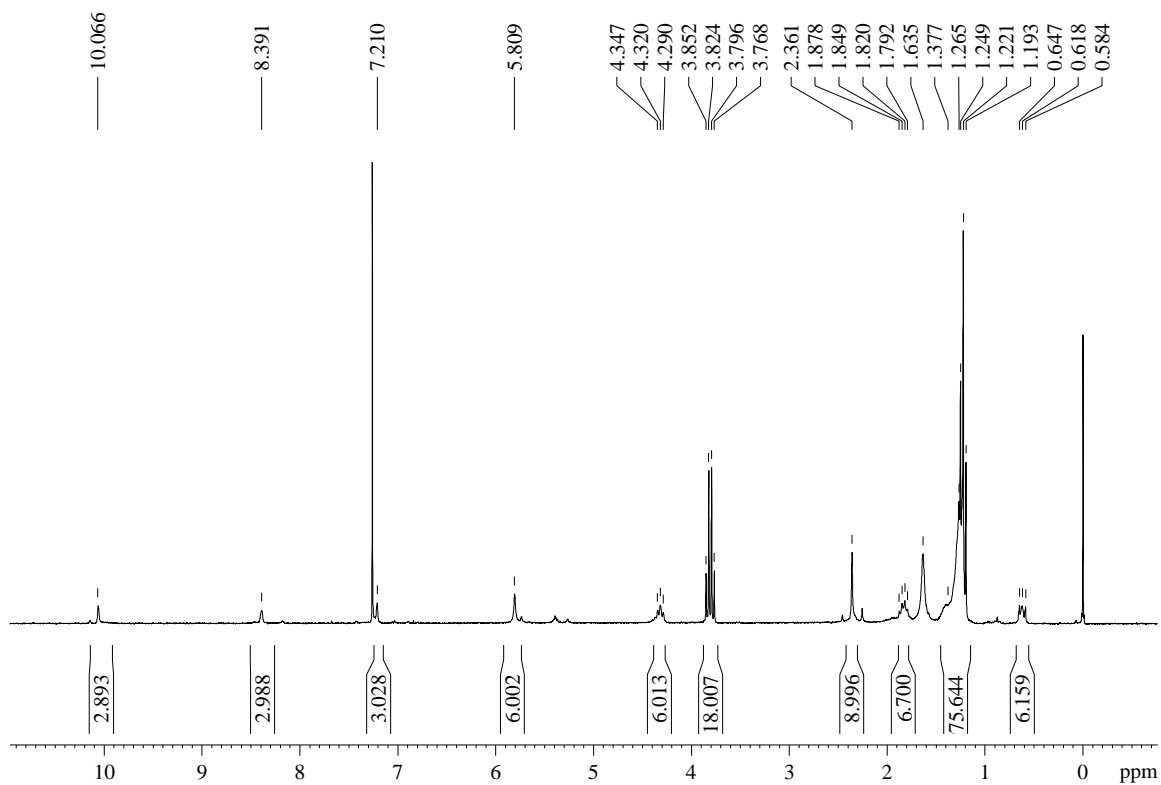
Servei d'Anàlisi Química



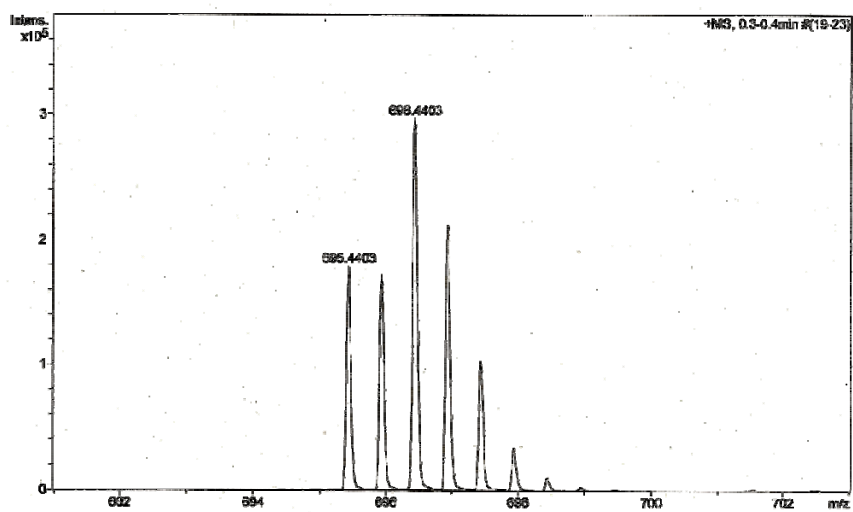


**1,1',1''-(1,3,5-mesityl)tris(metilè)-3,3',3''-(11-trietoxisilil)undecil)imidazoli, 14**

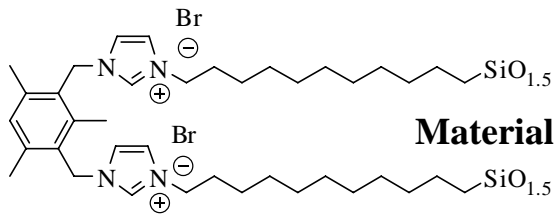
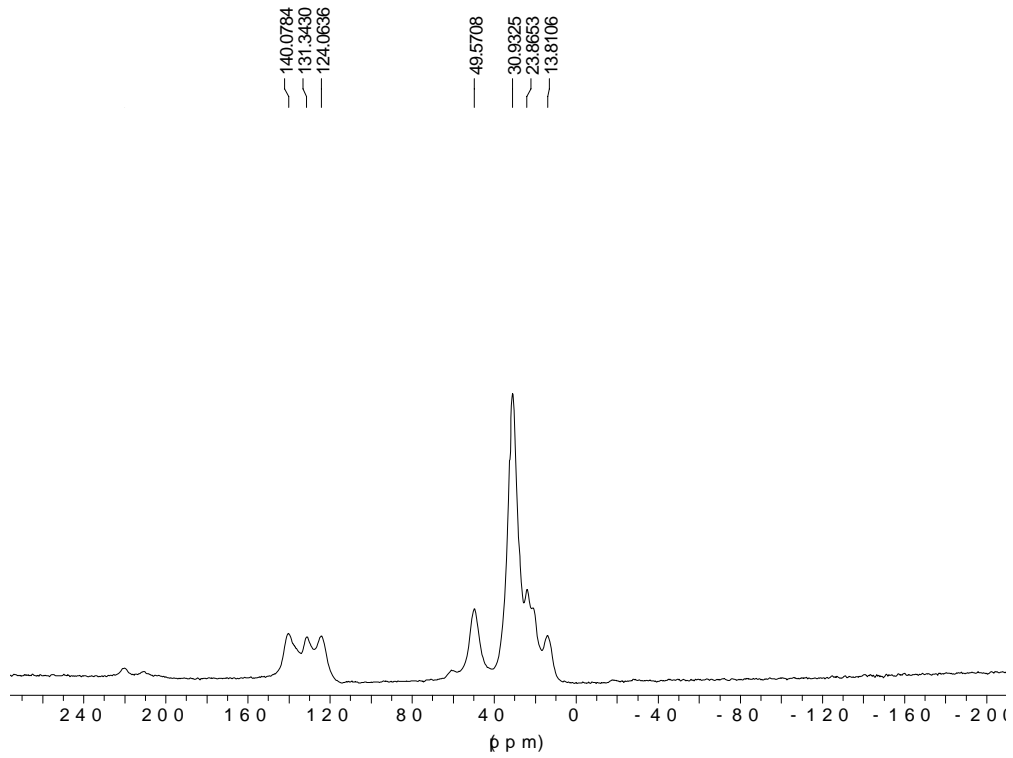
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



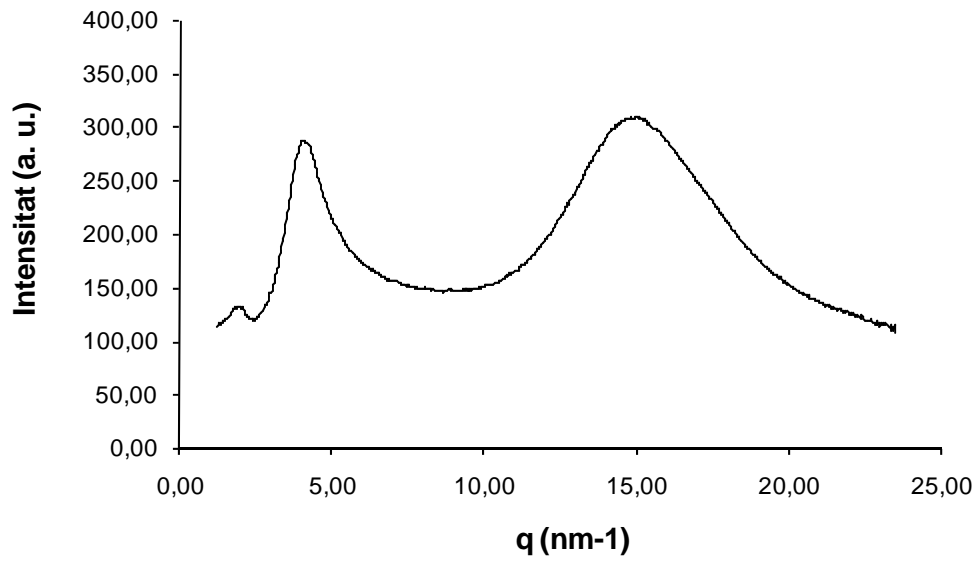
HR-MS



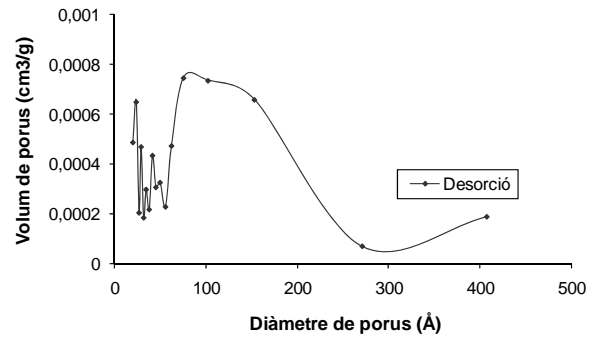
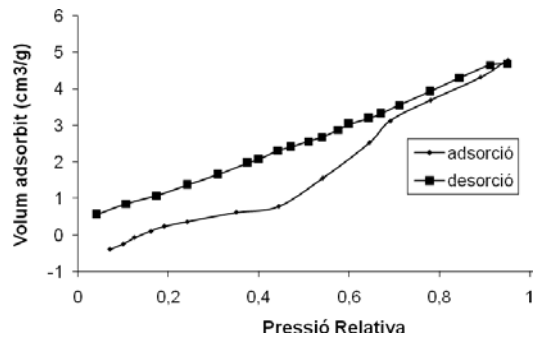
#	m/z	I	I%
1	696.4403	179192	60.4
2	695.9414	172335	58.1
3	696.4403	296710	100.0
4	698.9408	211737	71.4
5	697.4408	102681	34.6
6	697.9407	33684	11.4
7	698.4391	10115	3.4
8	698.9425	2370	0.8

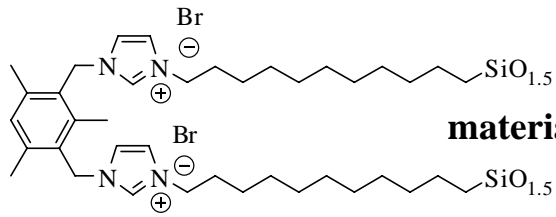
<sup>13</sup>C-RMN (100.62, CP-MAS)

## Raigs X de pols

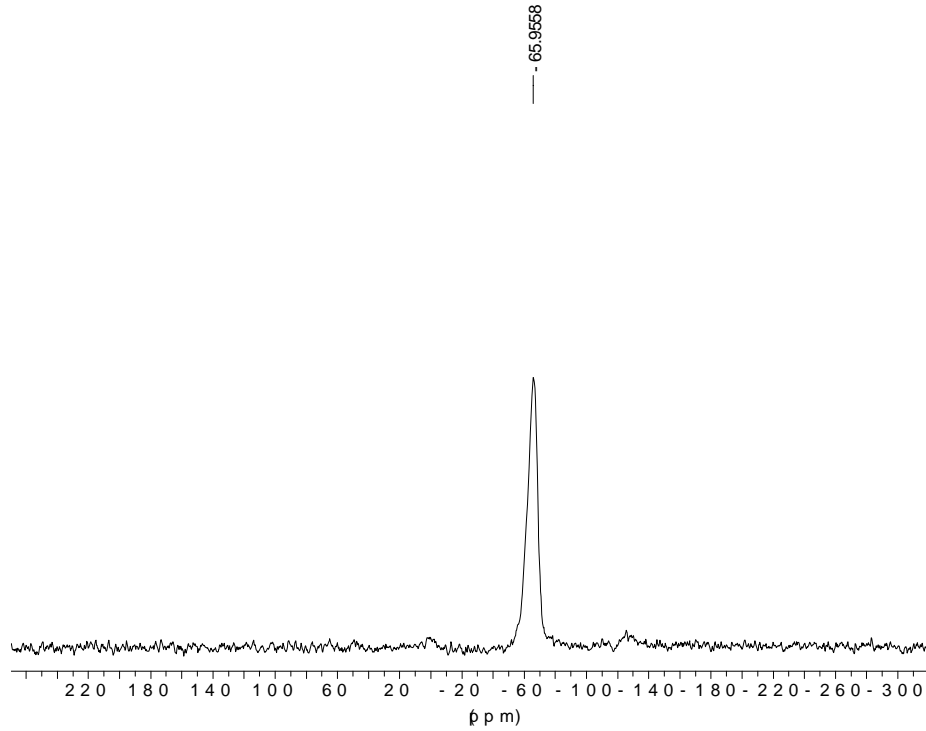


### BET (Brunauer-Emmett-Teller)

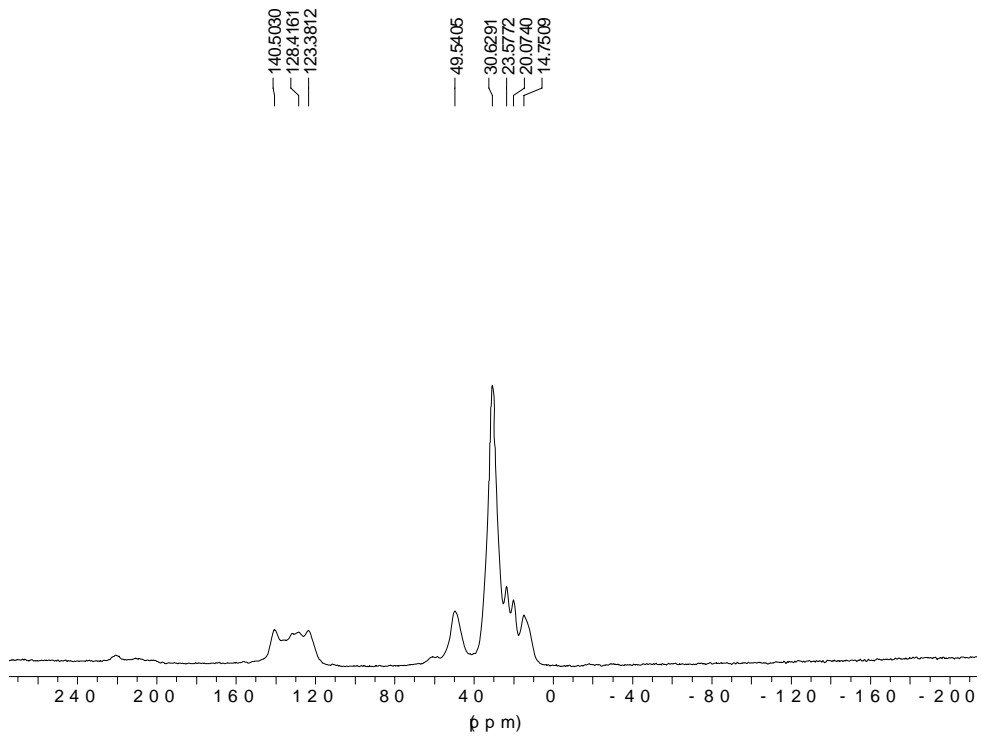


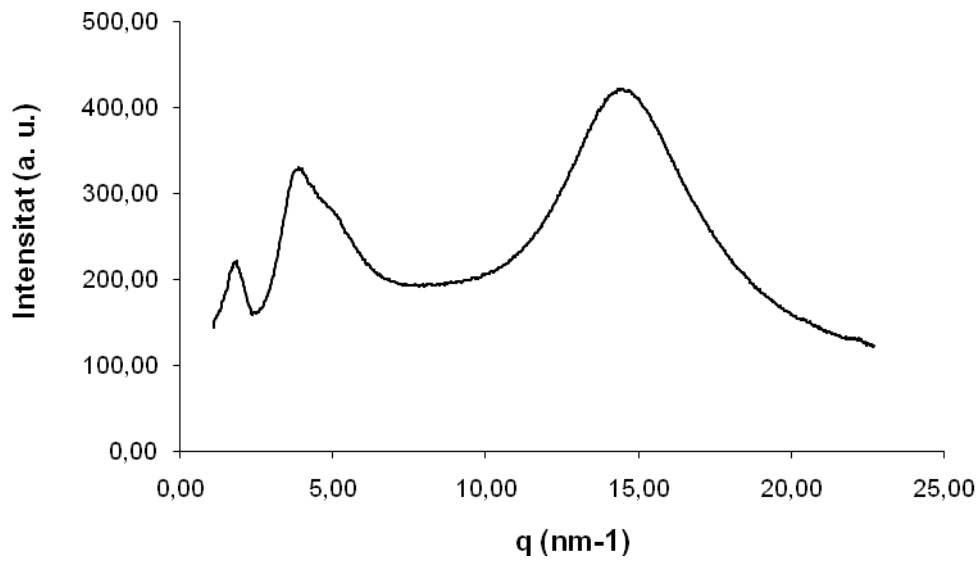
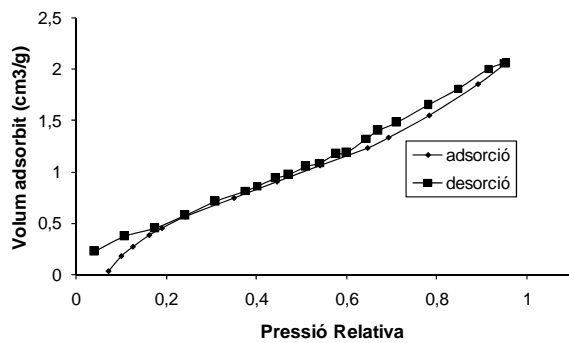


$^{29}\text{Si}$ -RMN (79.5 MHz, CP-MAS)

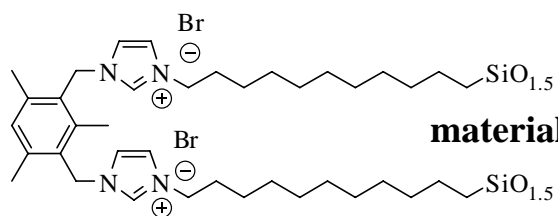


$^{13}\text{C}$ -RMN (100.62 MHz, CP-MAS)

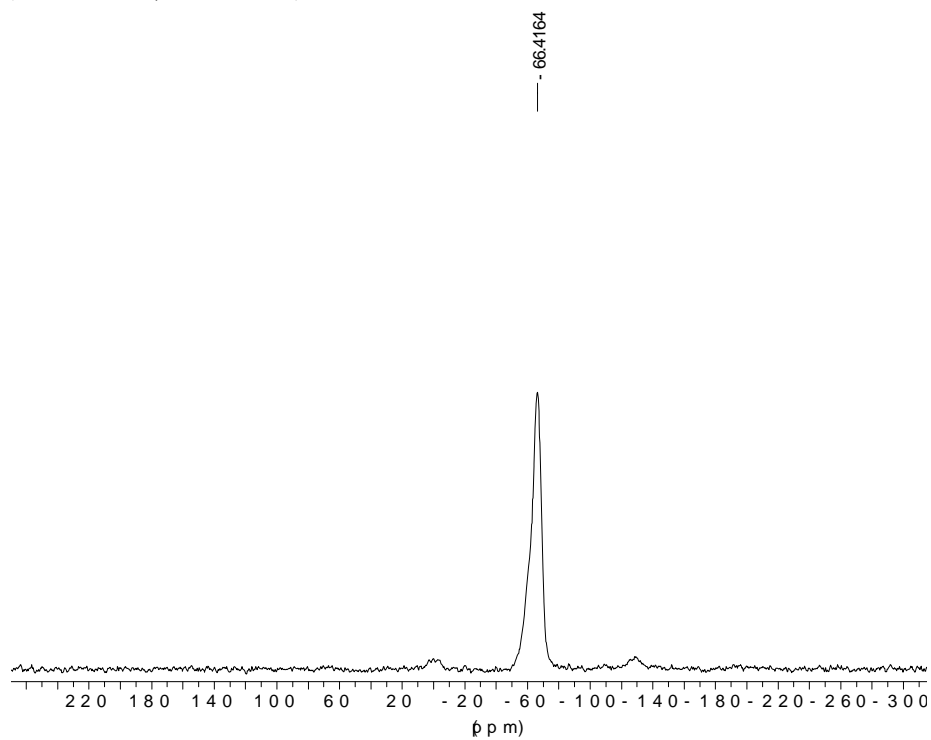


**Raigs X de pols****BET (Brunauer-Emmett-Teller)**

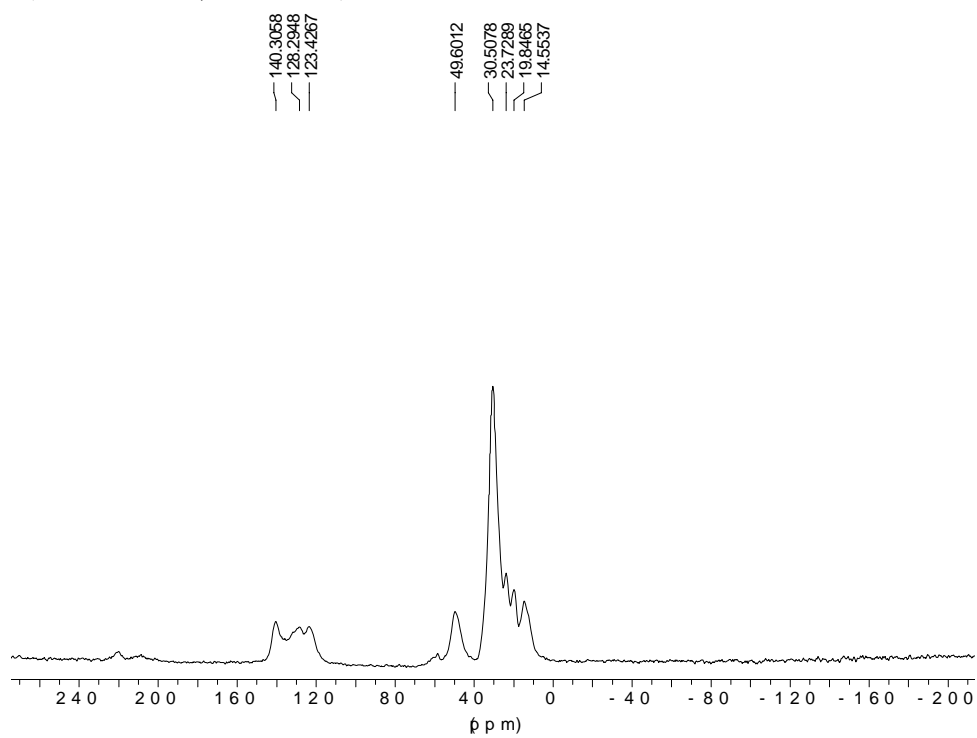


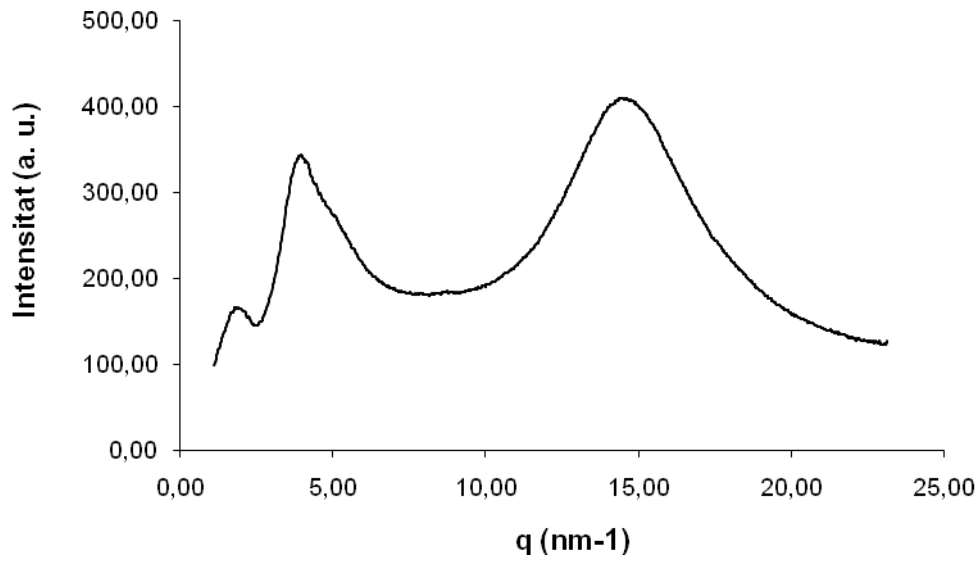
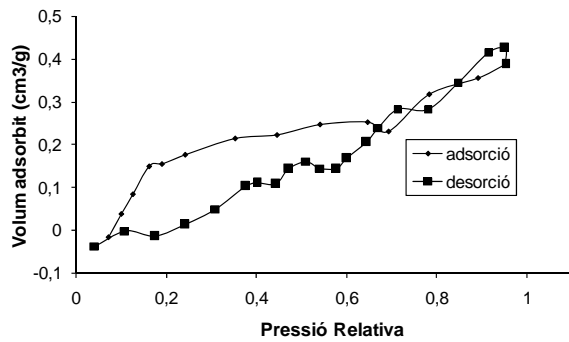


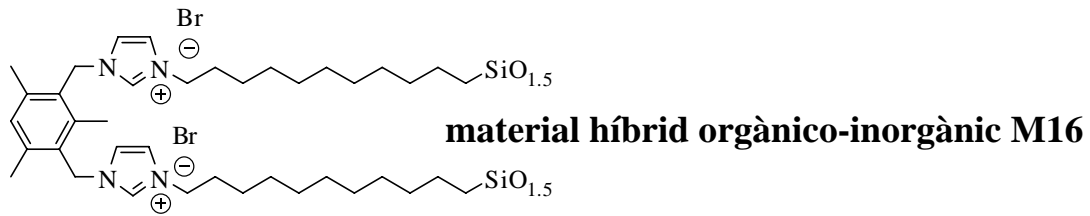
<sup>29</sup>Si-RMN (79.5 MHz, CP-MAS)



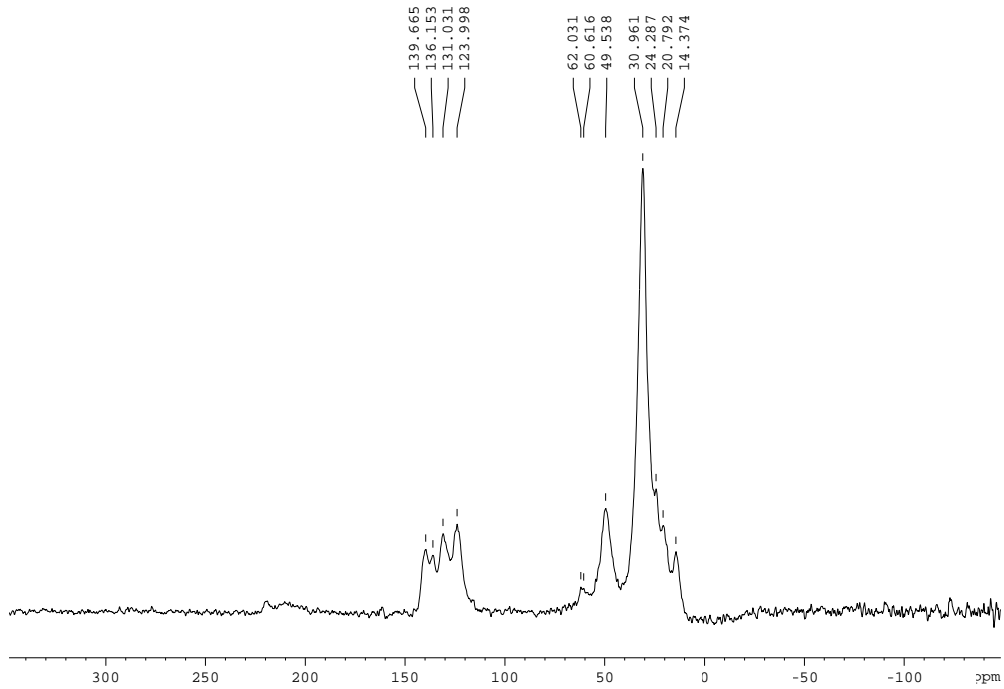
<sup>13</sup>C-RMN (100.62 MHz, CP-MAS)



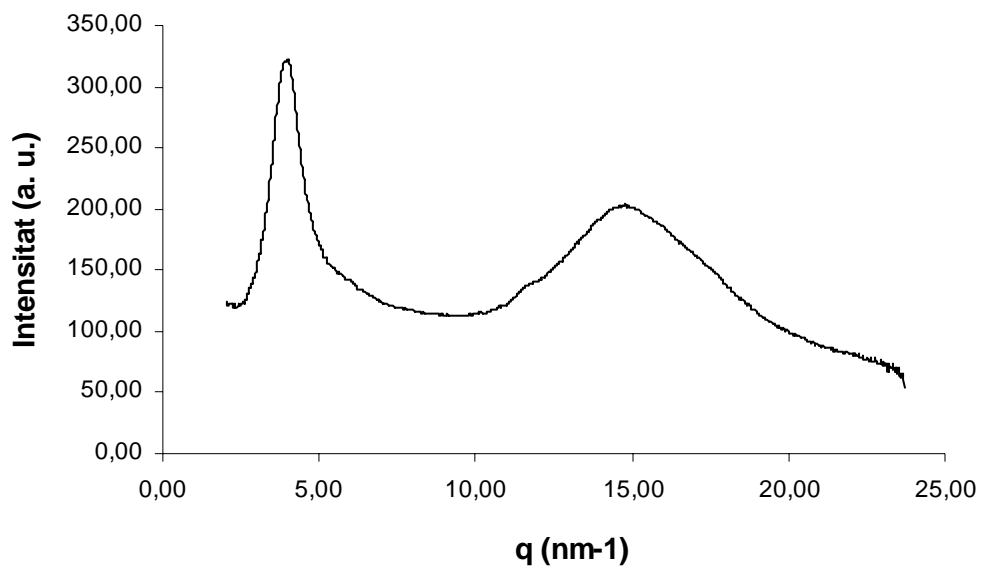
**Raigs X de pols****BET (Brunauer-Emmett-Teller)**

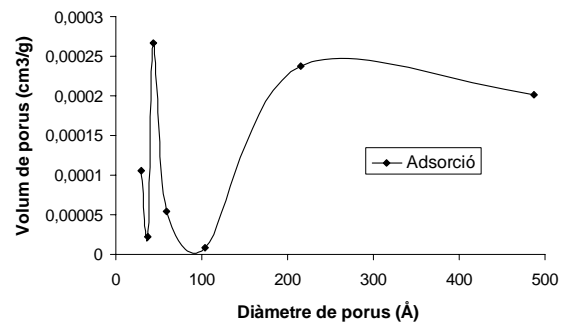
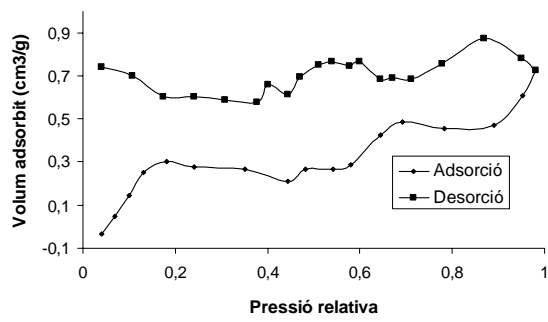


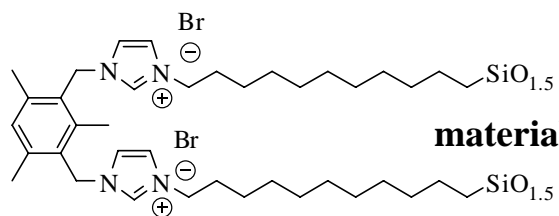
**$^{13}\text{C}$ -RMN (100.62 MHz, CP-MAS)**



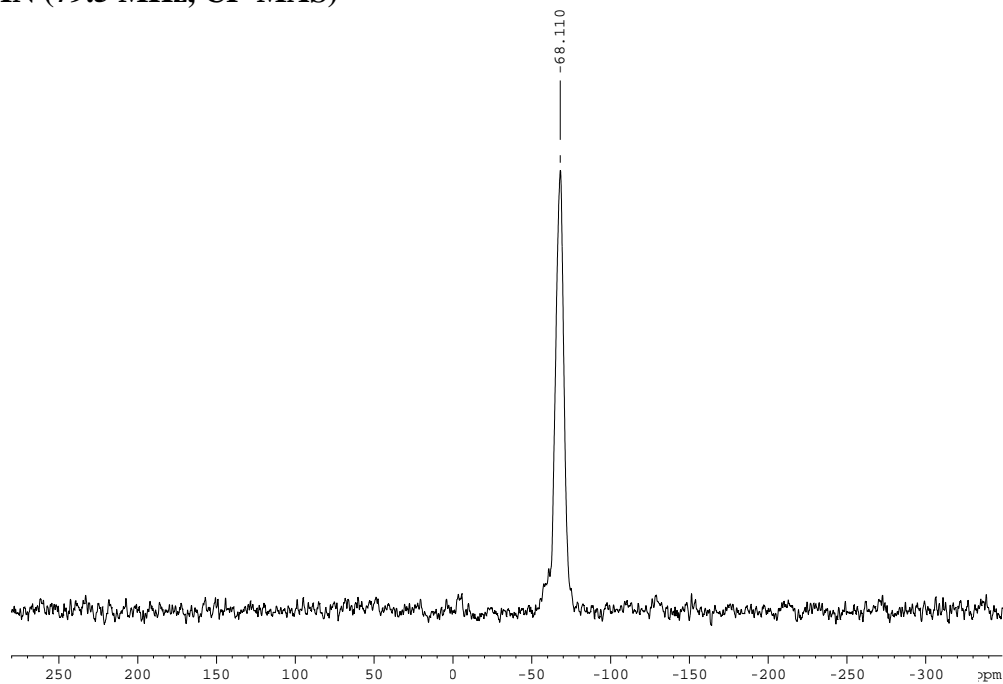
**Raigs X de pols**



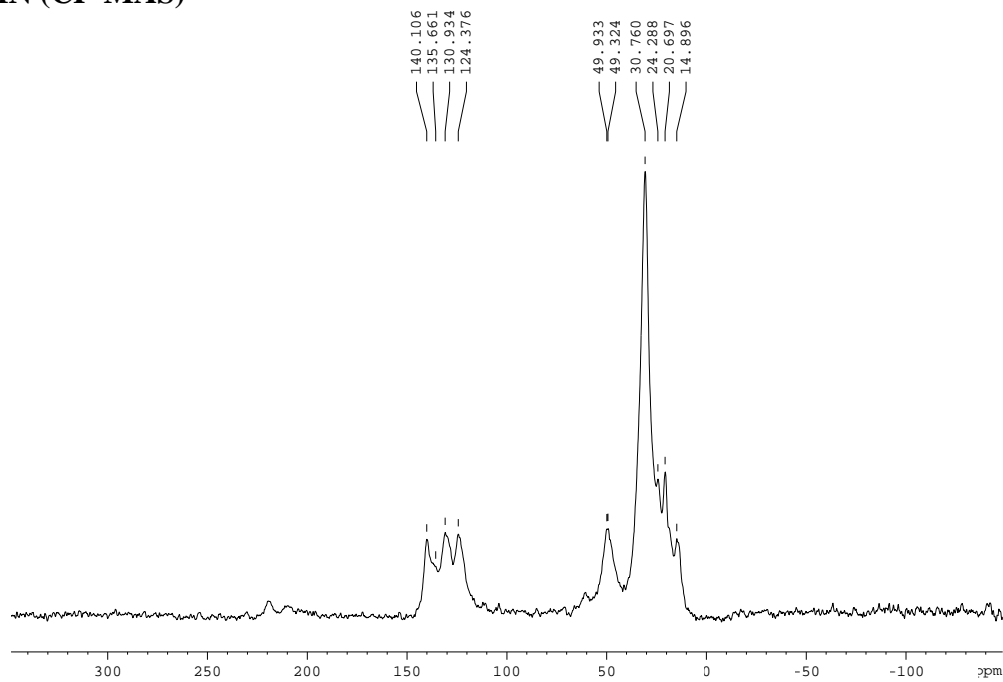
**BET (Brunauer-Emmett-Teller)**



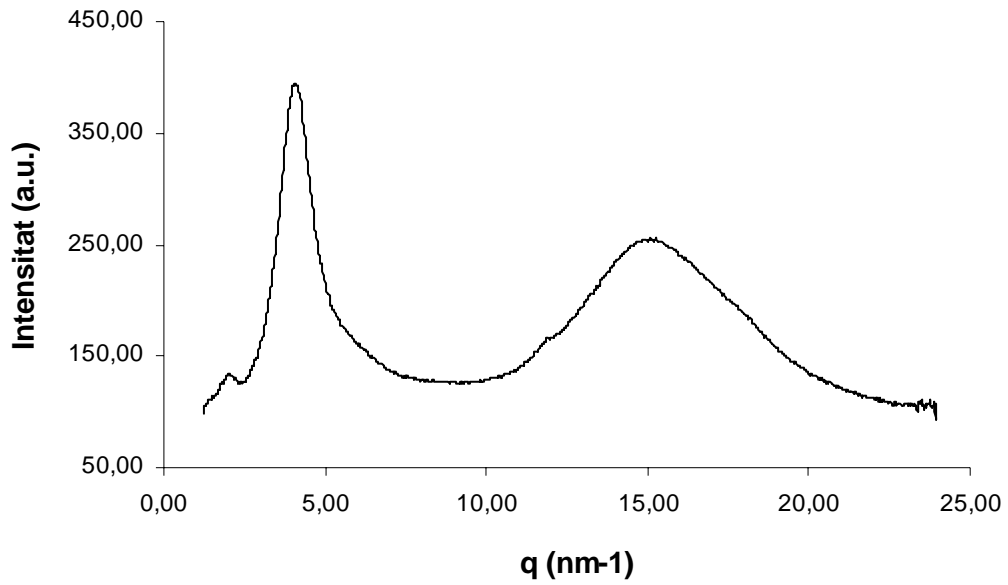
<sup>29</sup>Si-RMN (79.5 MHz, CP-MAS)



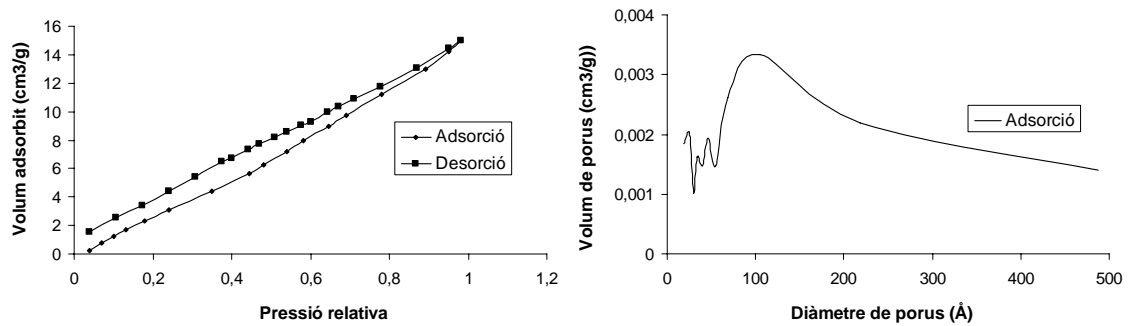
<sup>13</sup>C-RMN (CP-MAS)

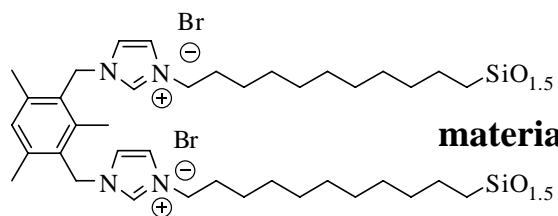


## Raigs X de pols

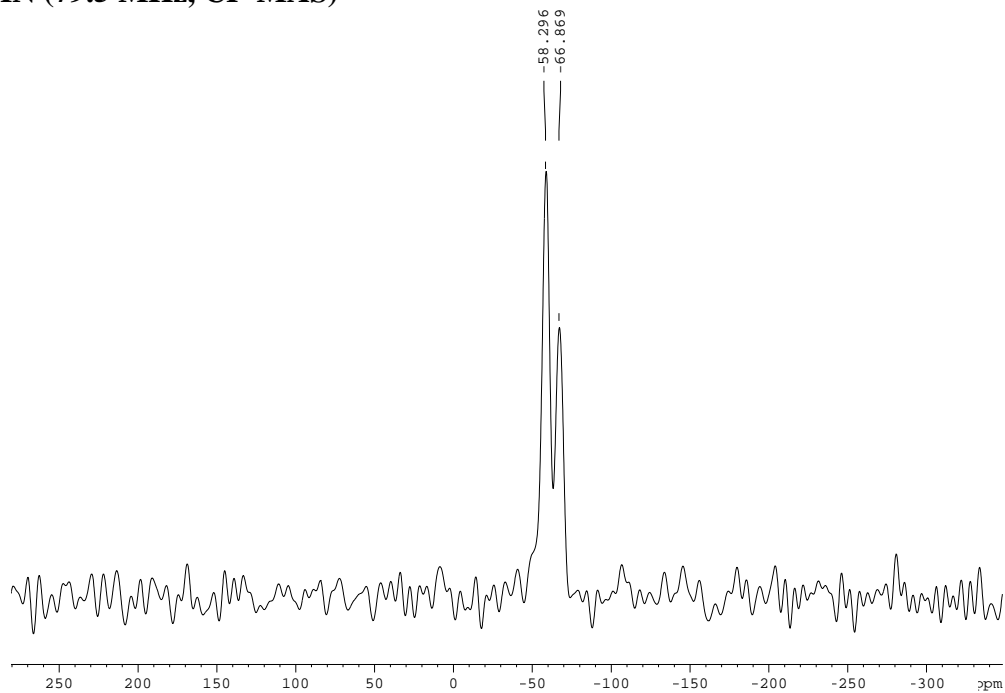


## BET (Brunauer-Emmett-Teller)

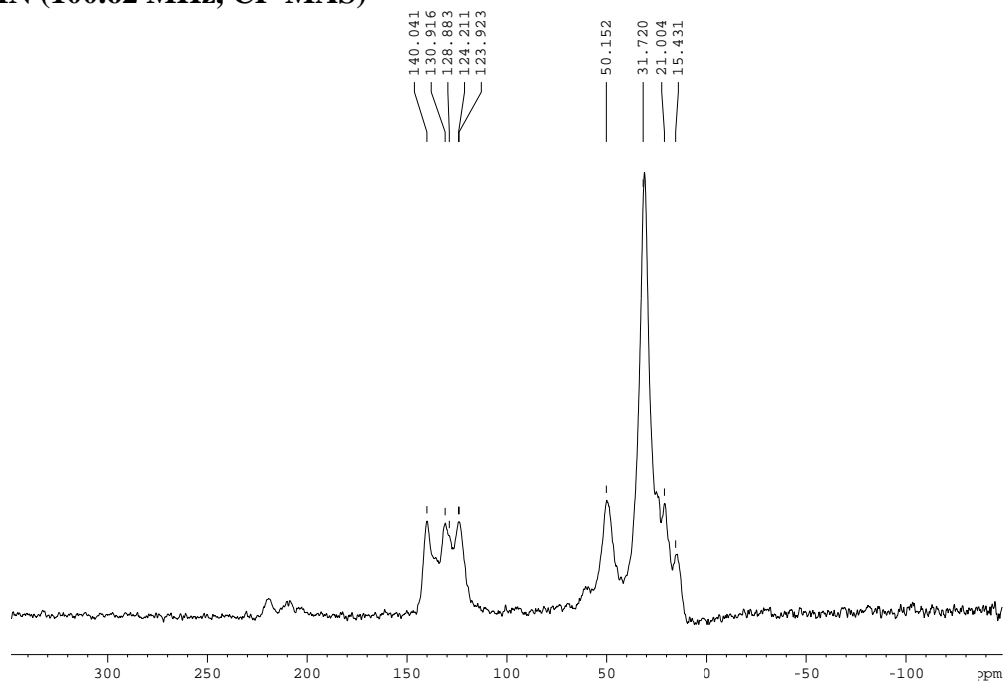




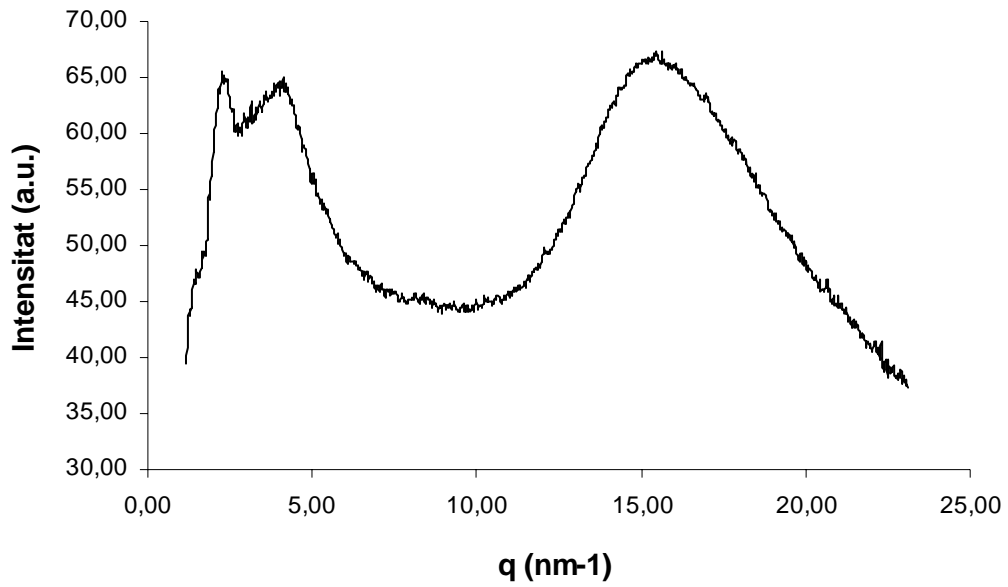
<sup>29</sup>Si-RMN (79.5 MHz, CP-MAS)



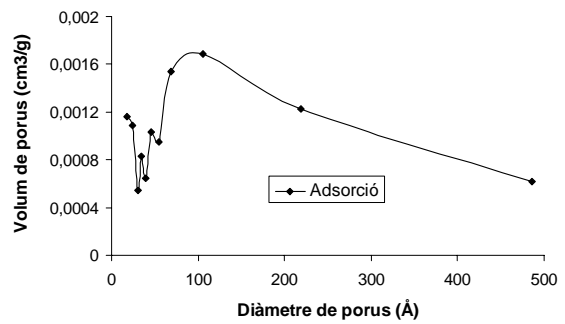
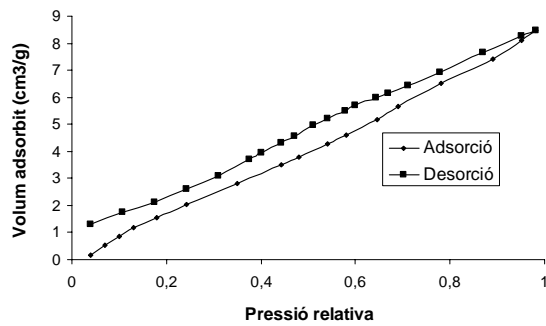
<sup>13</sup>C-RMN (100.62 MHz, CP-MAS)



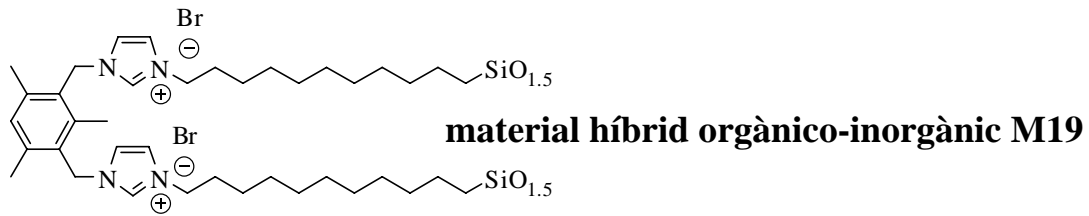
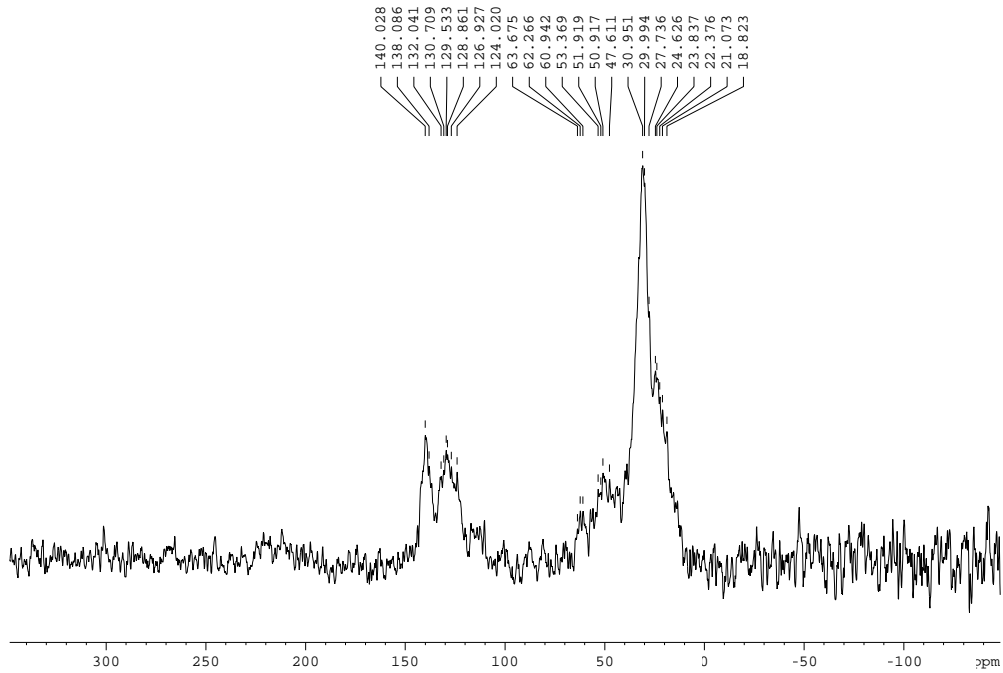
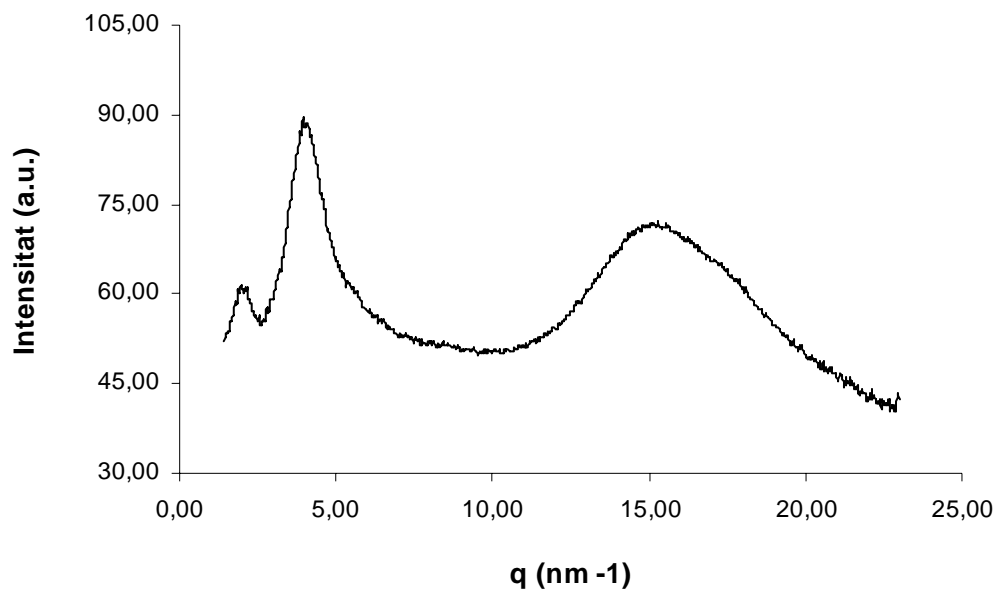
## Raigs X de pols



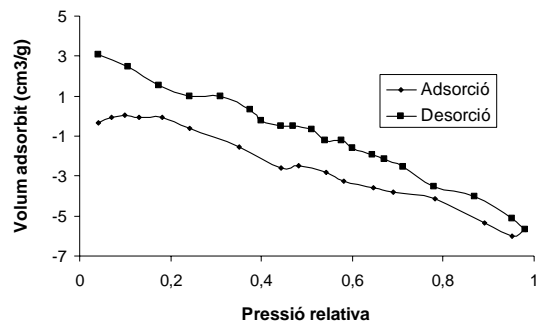
## BET (Brunauer-Emmett-Teller)

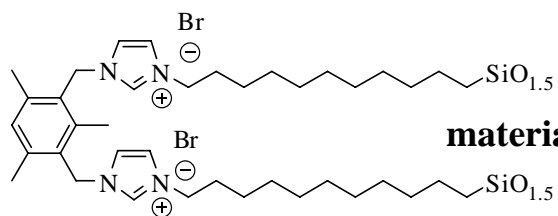




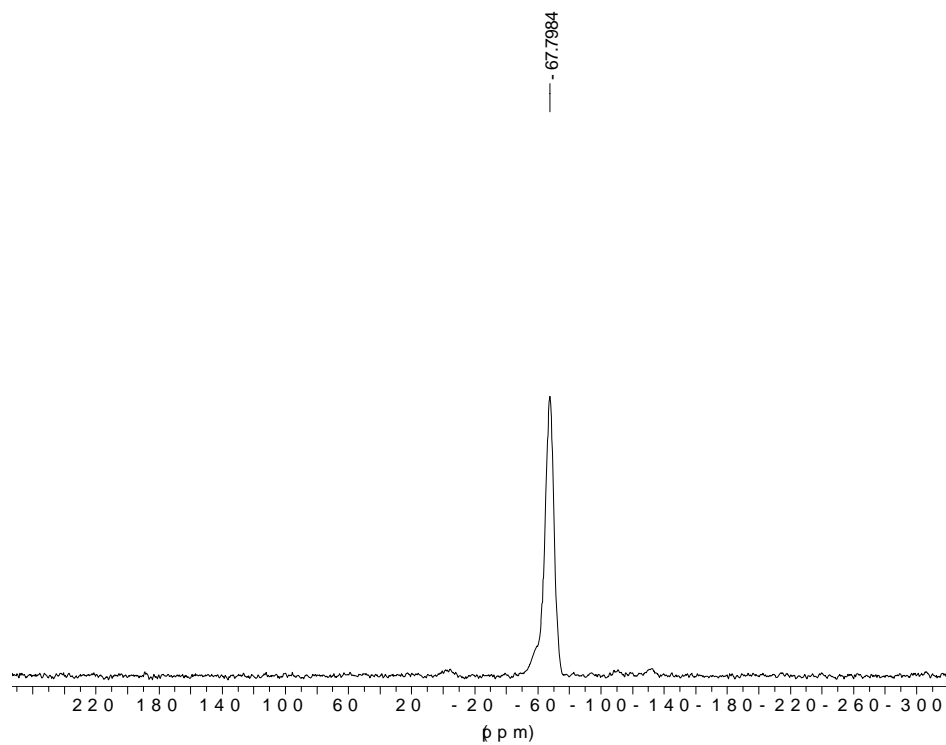
 **$^{13}\text{C}$ -RMN (100.62 MHz, CP-MAS)****Raigs X de pols**

### BET (Brunauer-Emmett-Teller)

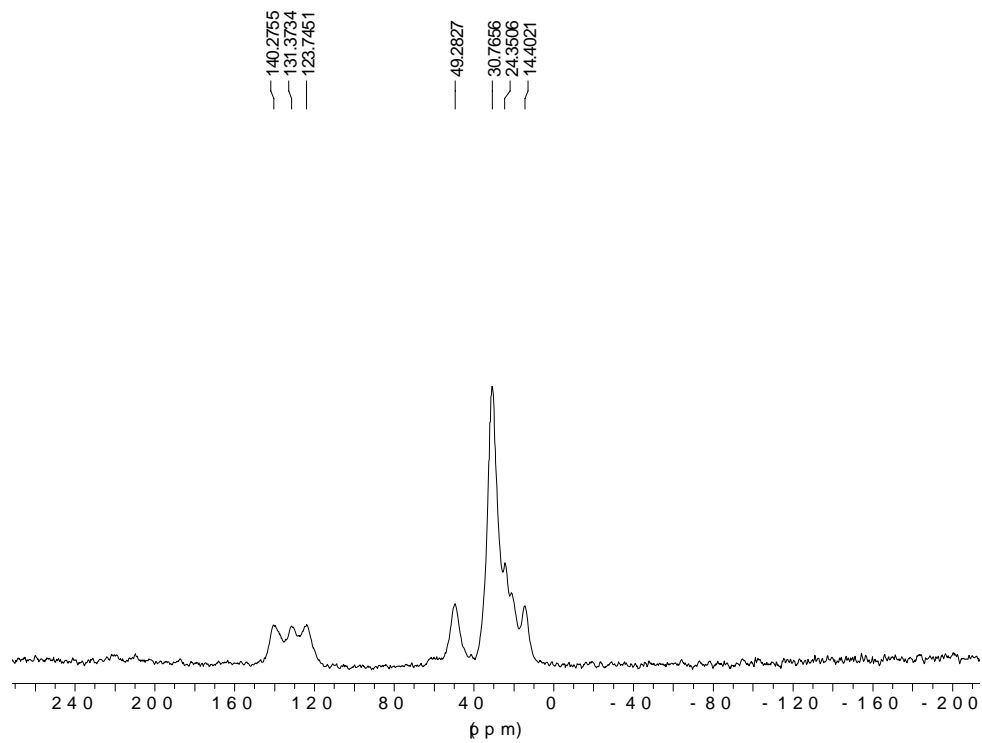




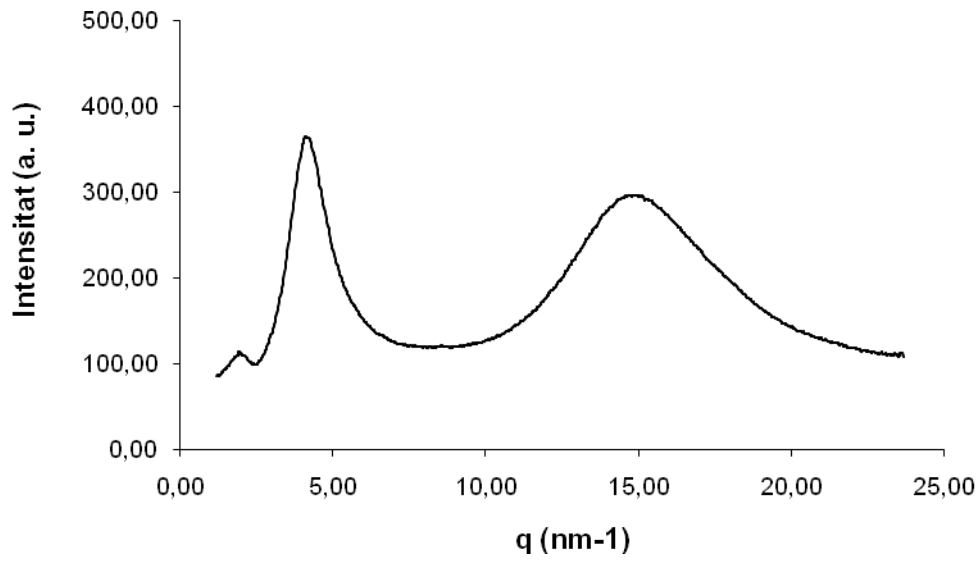
<sup>29</sup>Si-RMN (79.5 MHz, CP-MAS)



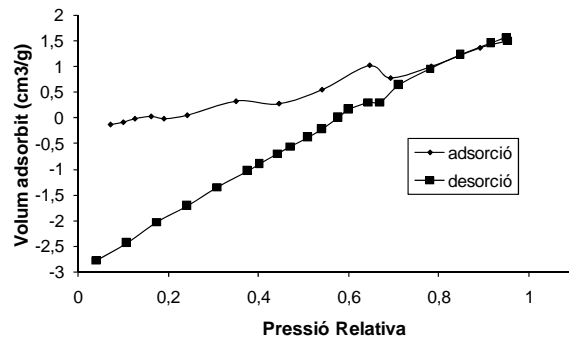
<sup>13</sup>C-RMN (100.62 MHz, CP-MAS)

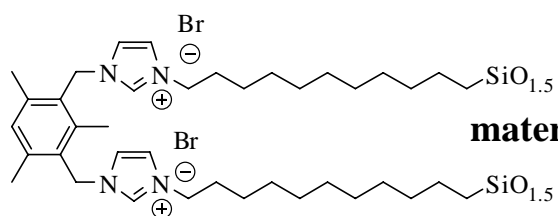
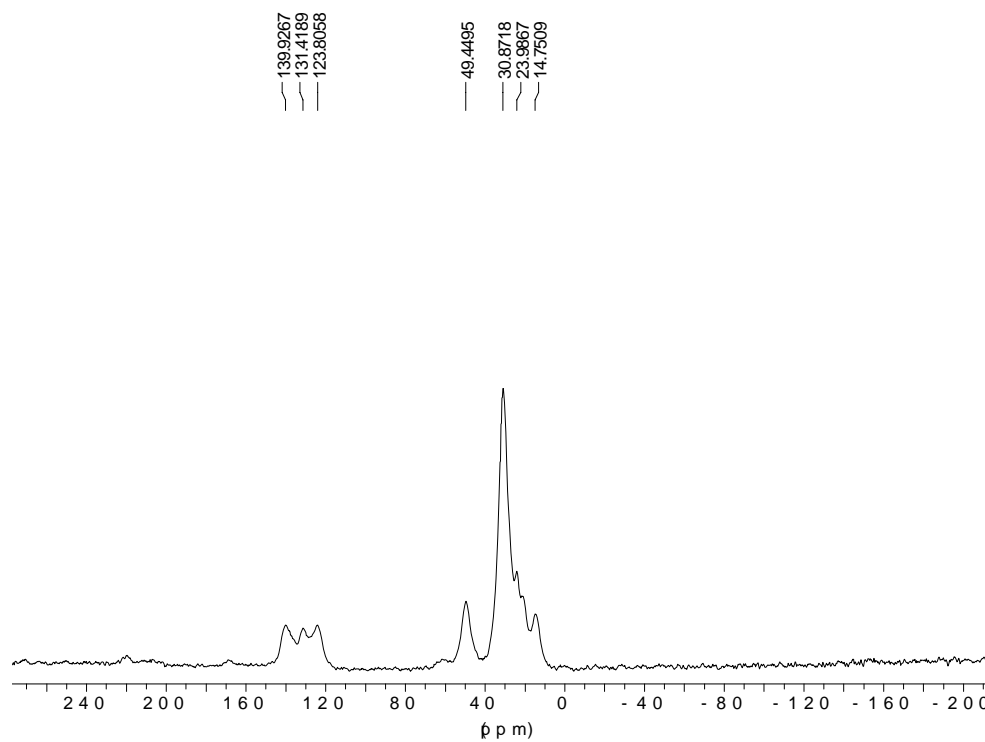
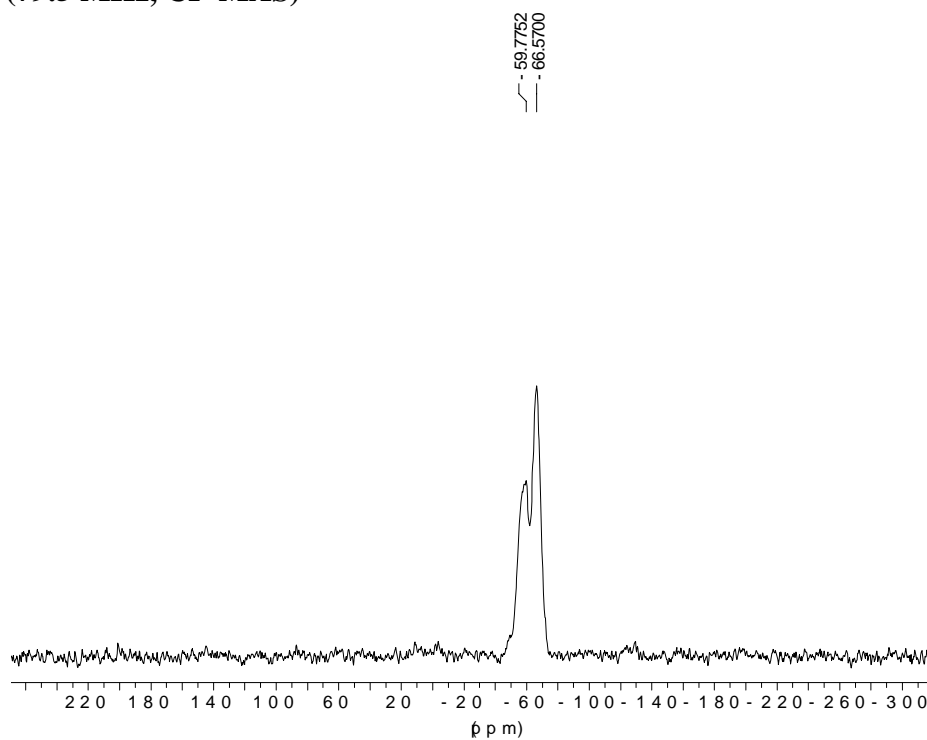


## Raigs X de pols

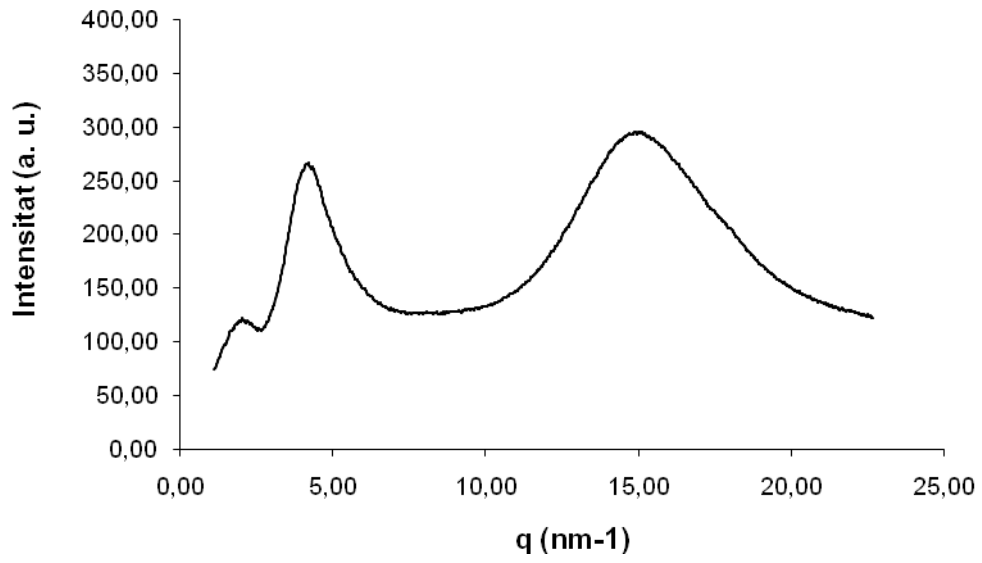


## BET (Brunauer-Emmett-Teller)

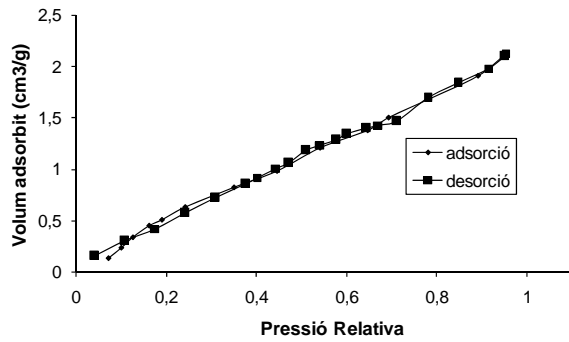


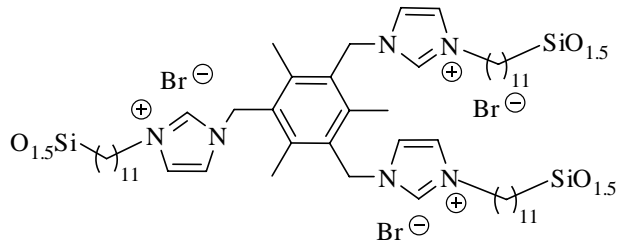
**material híbrid orgànic-inorgànic M21** **$^{13}\text{C}$ -RMN (100.62 MHz, CP-MAS)** **$^{29}\text{Si}$ -RMN (79.5 MHz, CP-MAS)**

### Raigs X de pols



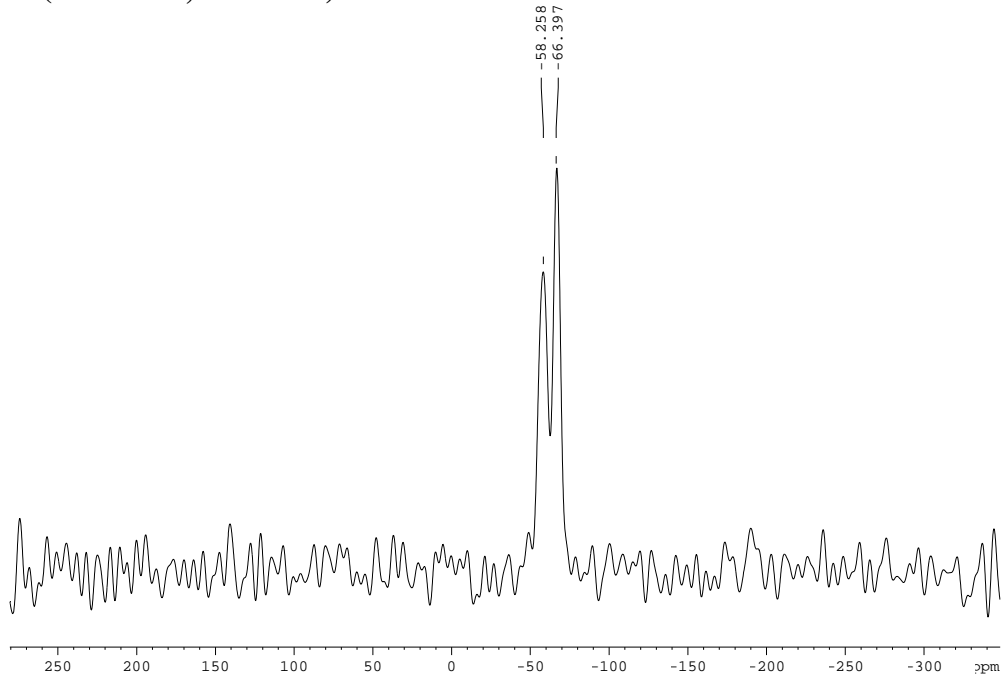
### BET (Brunauer-Emmett-Teller)



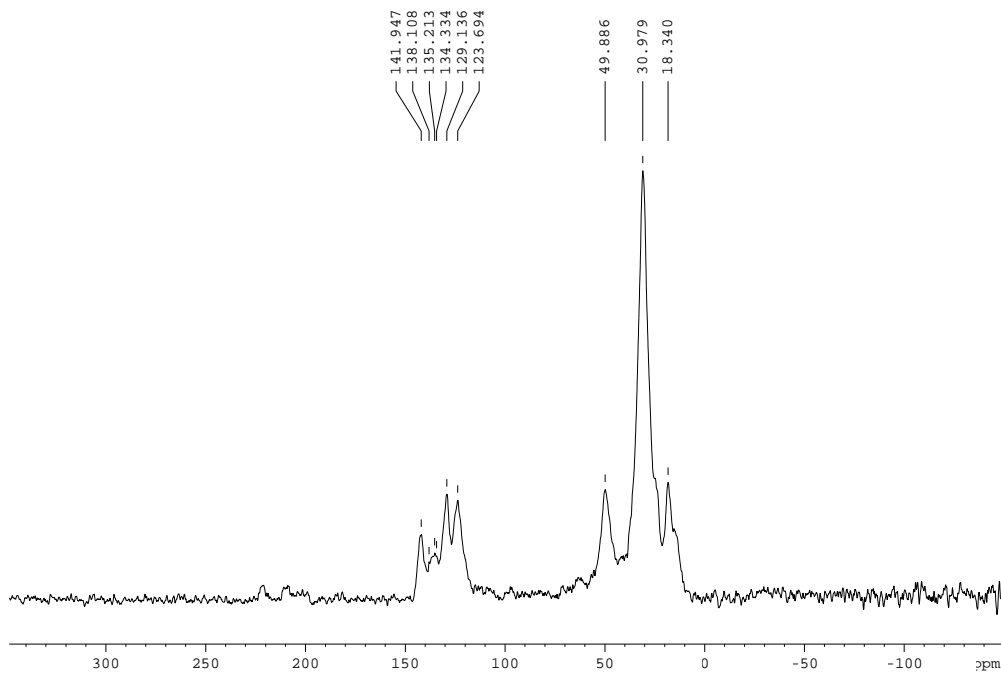


### material híbrid orgànic-inorgànic M22

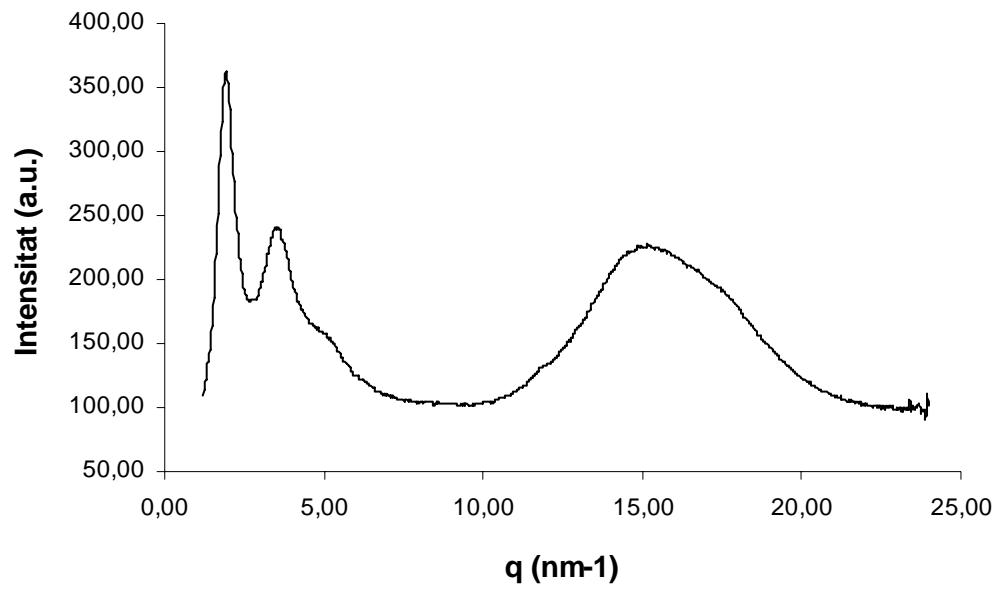
#### <sup>29</sup>Si-RMN (79.5 MHz, CP-MAS)



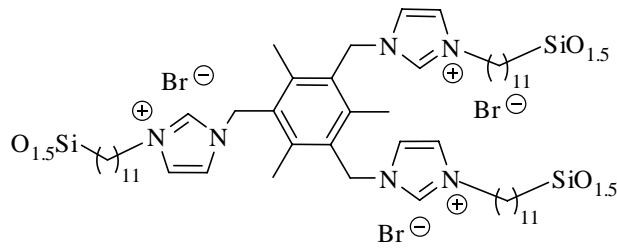
#### <sup>13</sup>C-RMN (100.62 MHz, CP-MAS)



### Raigs X de pols

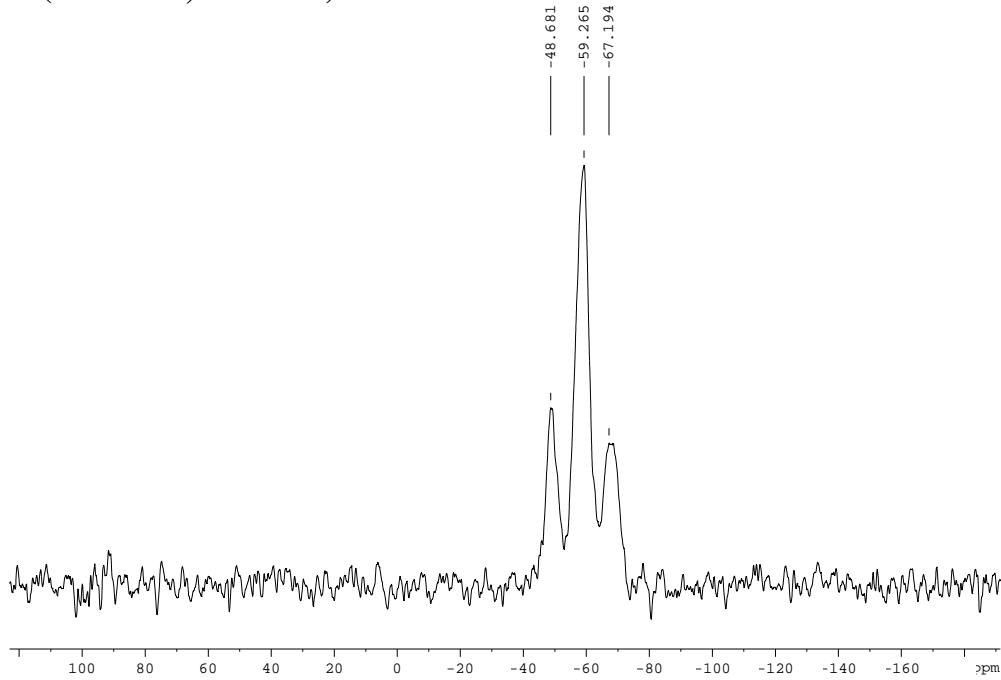




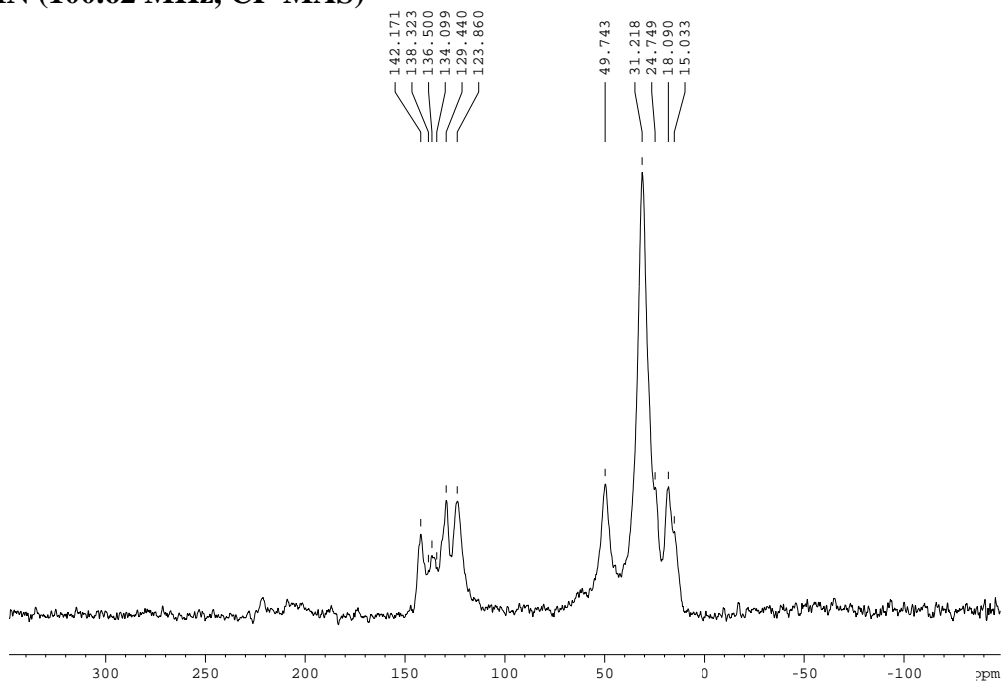


## Material híbrid orgànic-inorgànic M23

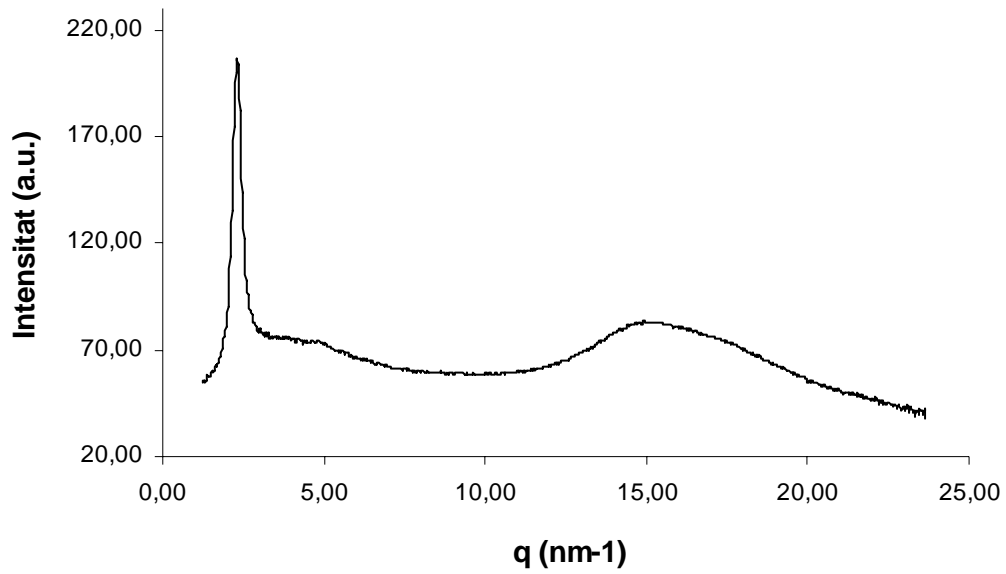
### $^{29}\text{Si}$ -RMN (79.5 MHz, CP-MAS)



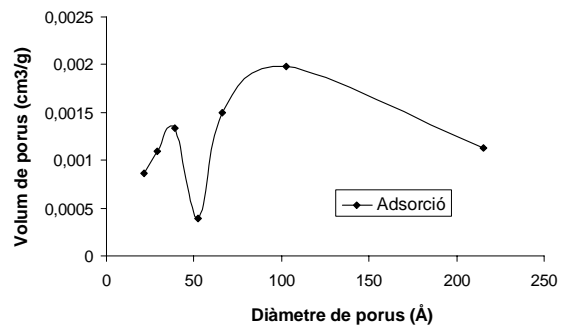
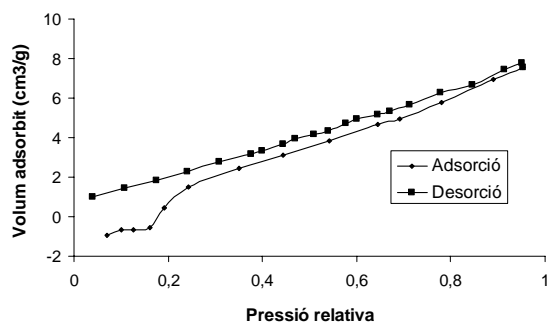
### $^{13}\text{C}$ -RMN (100.62 MHz, CP-MAS)

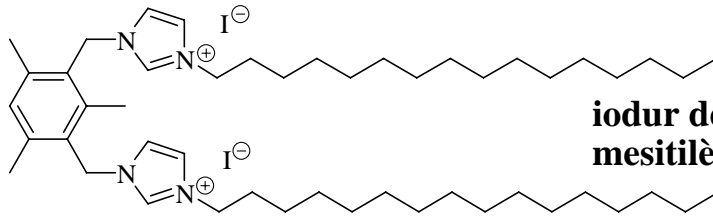


## Raigs X de pols



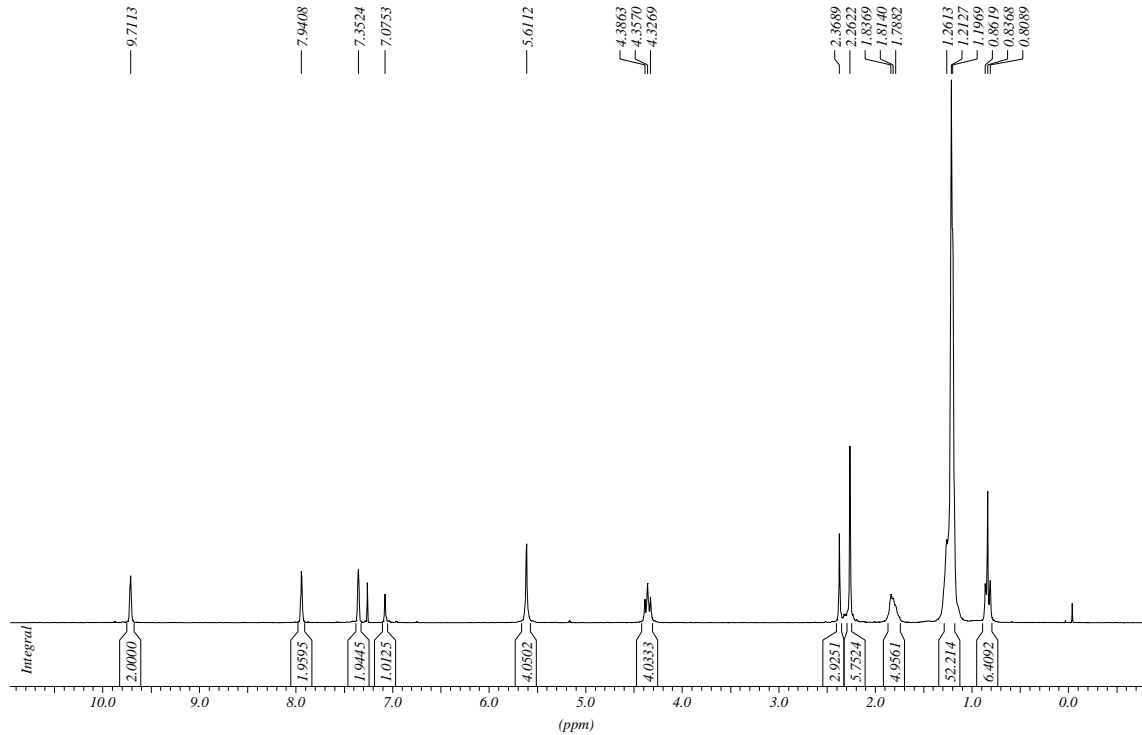
## BET (Brunauer-Emmett-Teller)



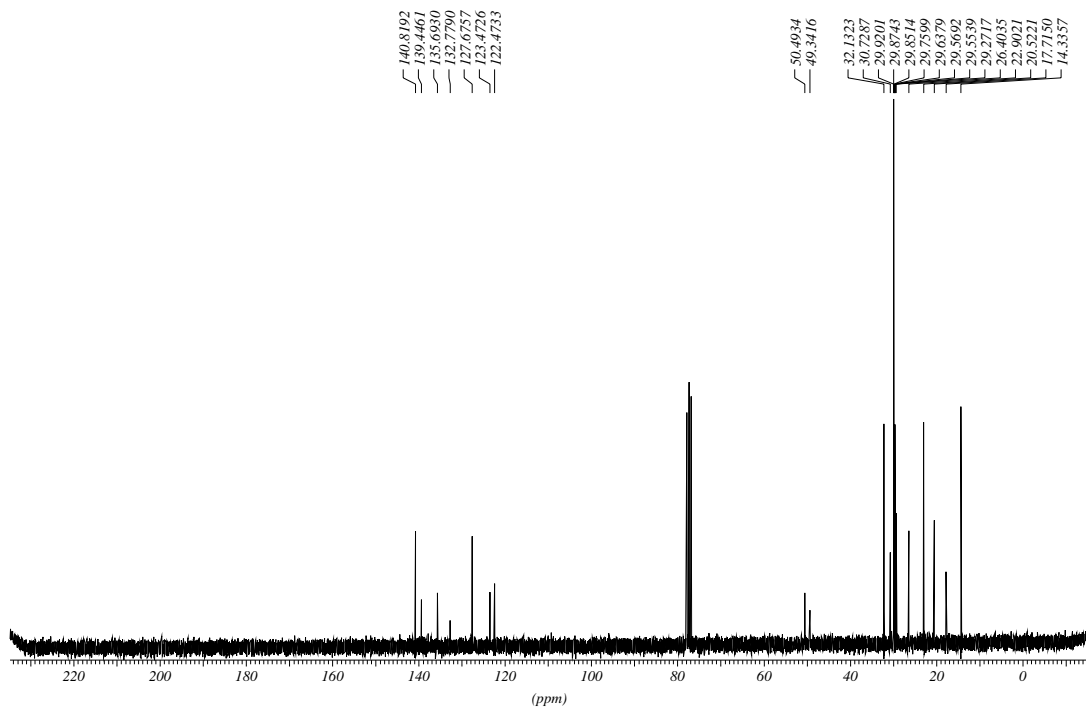


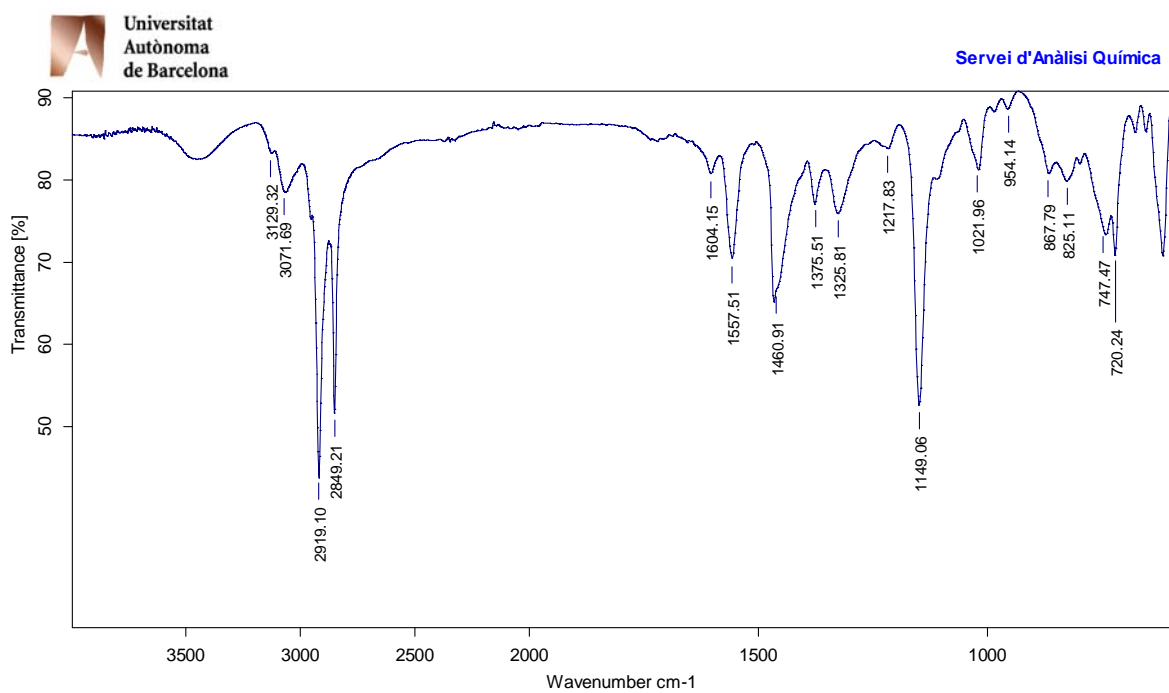
iodur de 3,3'-hexadecil-1,1'-(1,3-mesitilè)bis(metilè)imidazoli, 103a

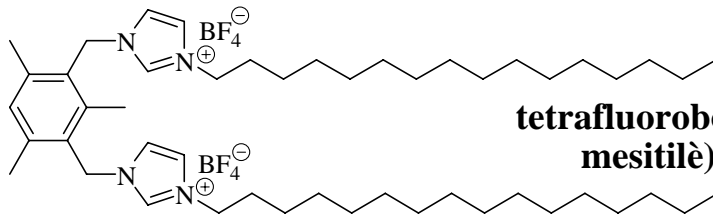
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

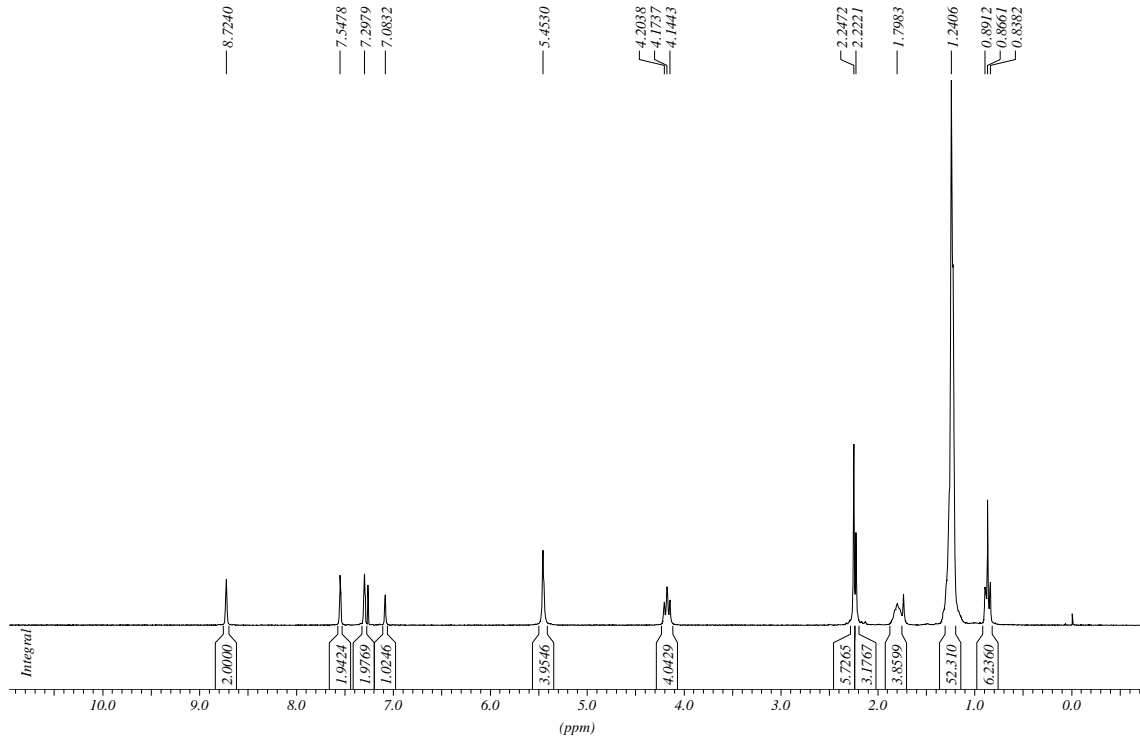


IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

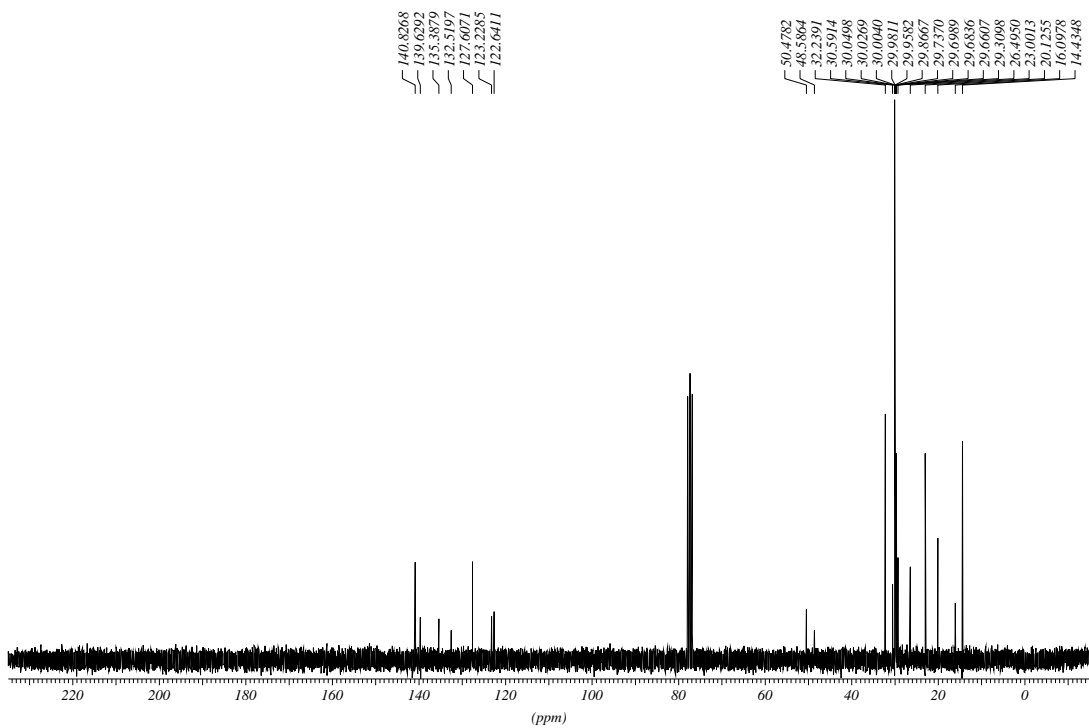


**tetrafluoroborat de 3,3'-hexadecil-1,1'-(1,3-mesitilè)bis(metilè)imidazoli, 103b**

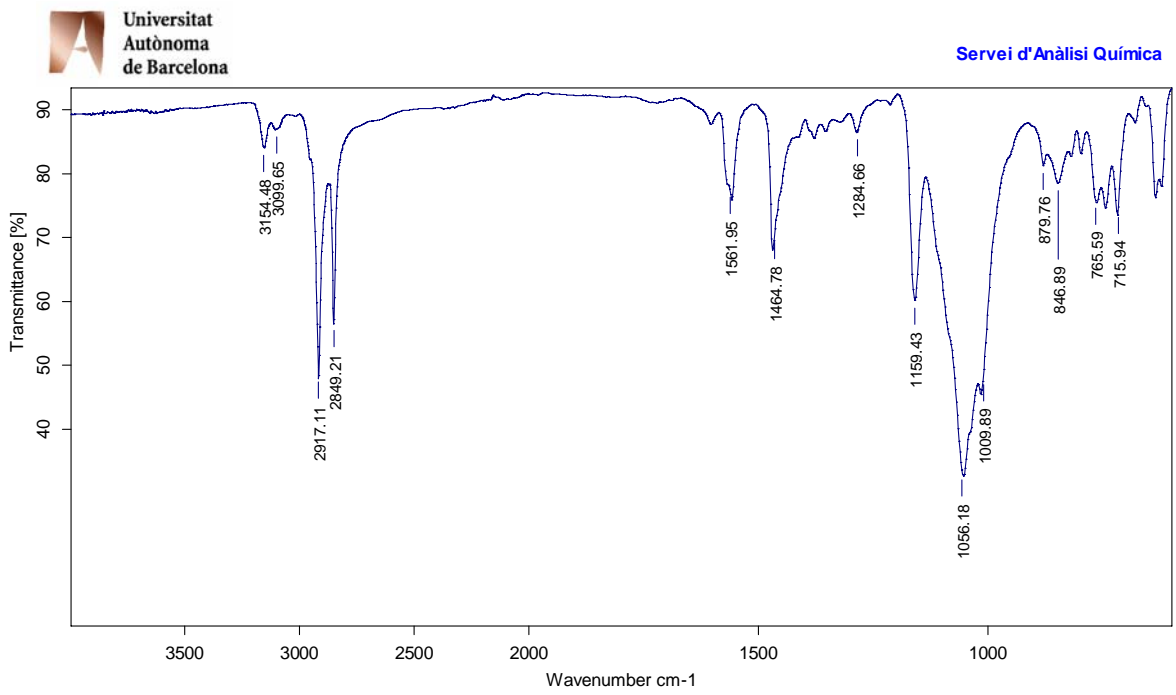
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)

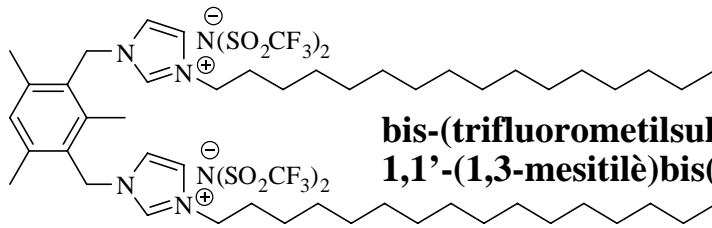


$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

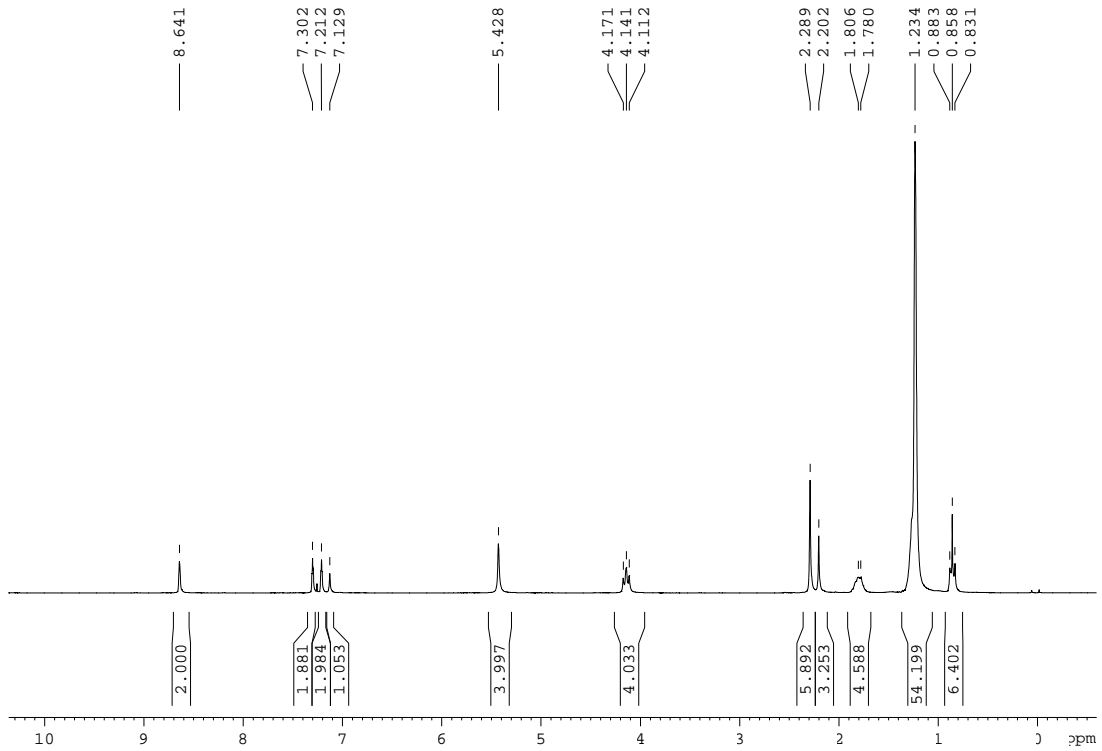


IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

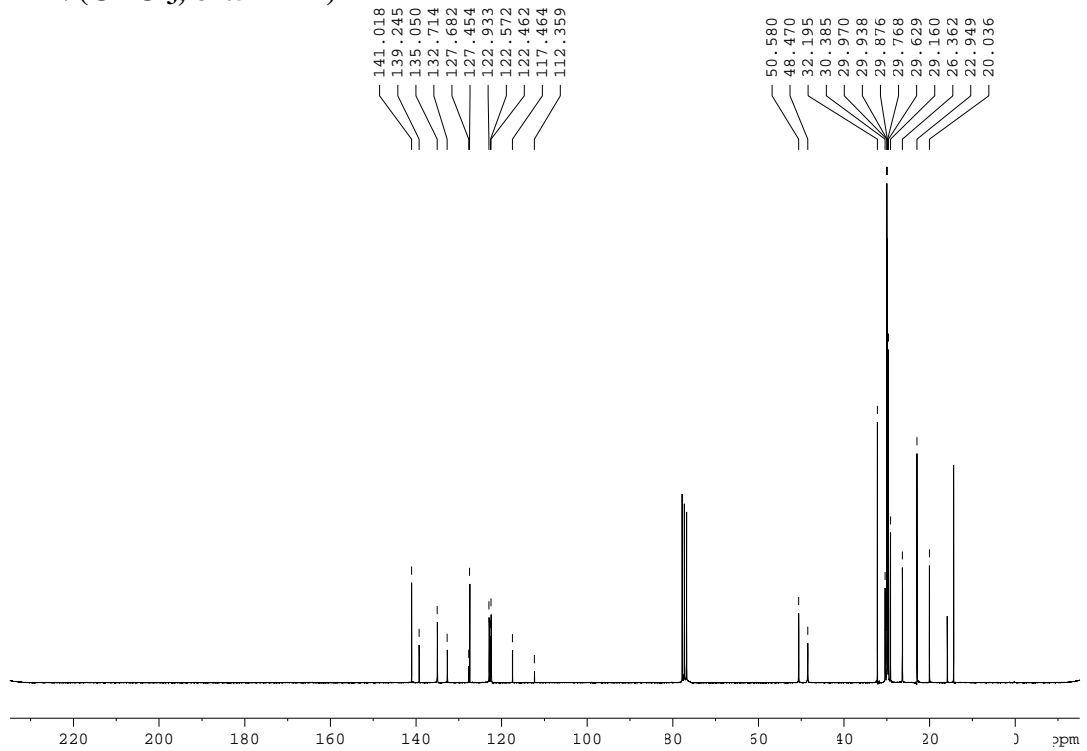




$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)

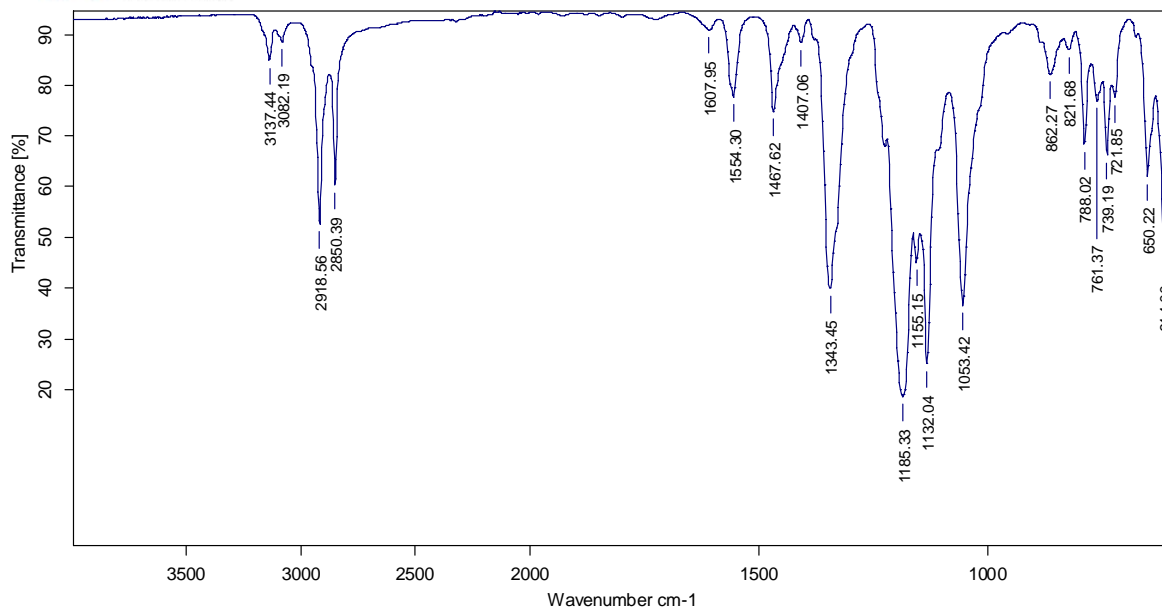


$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

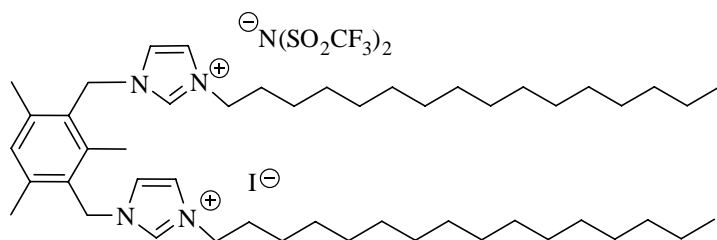
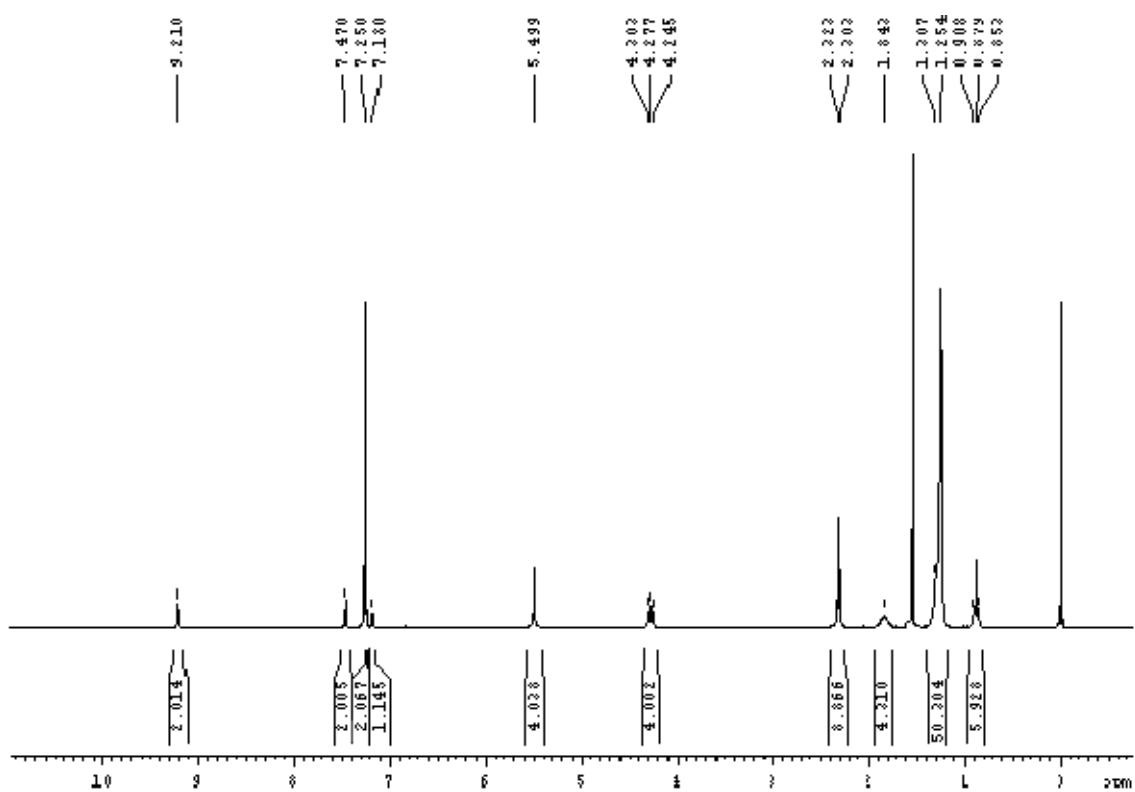


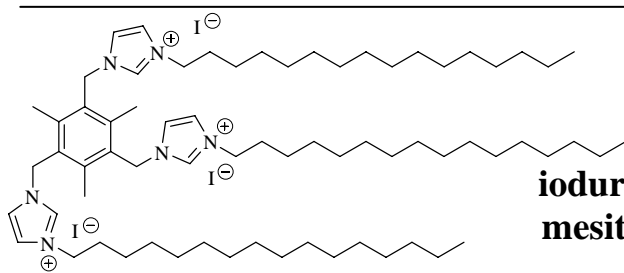
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)Universitat  
Autònoma  
de Barcelona

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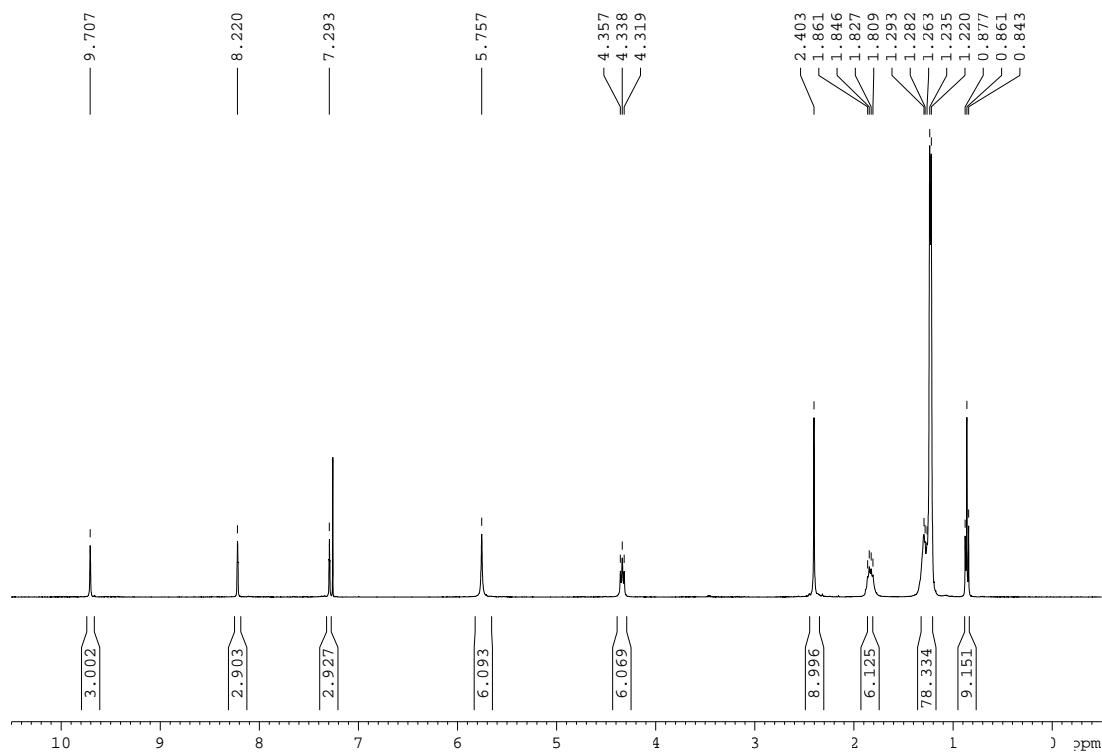


 **$^1\text{H}$ -RMN ( $\text{CDCl}_3$ , 250 MHz)**

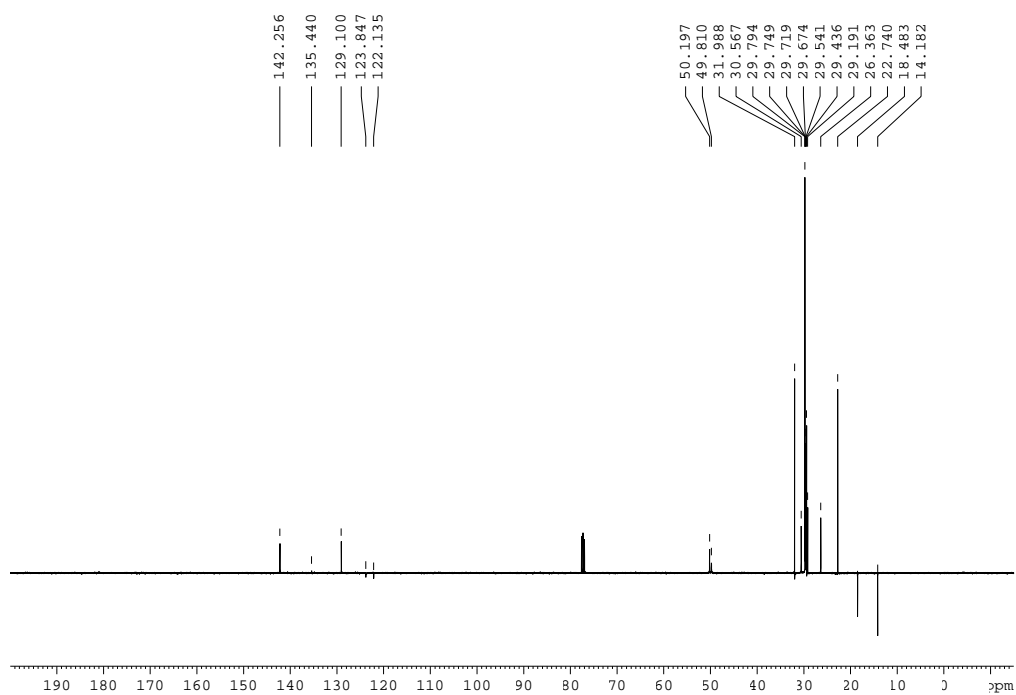


iodur de 3,3',3''-hexadecil-1,1',1''-(1,3,5-mesitilè)tris(metilè)imidazoli, 104a

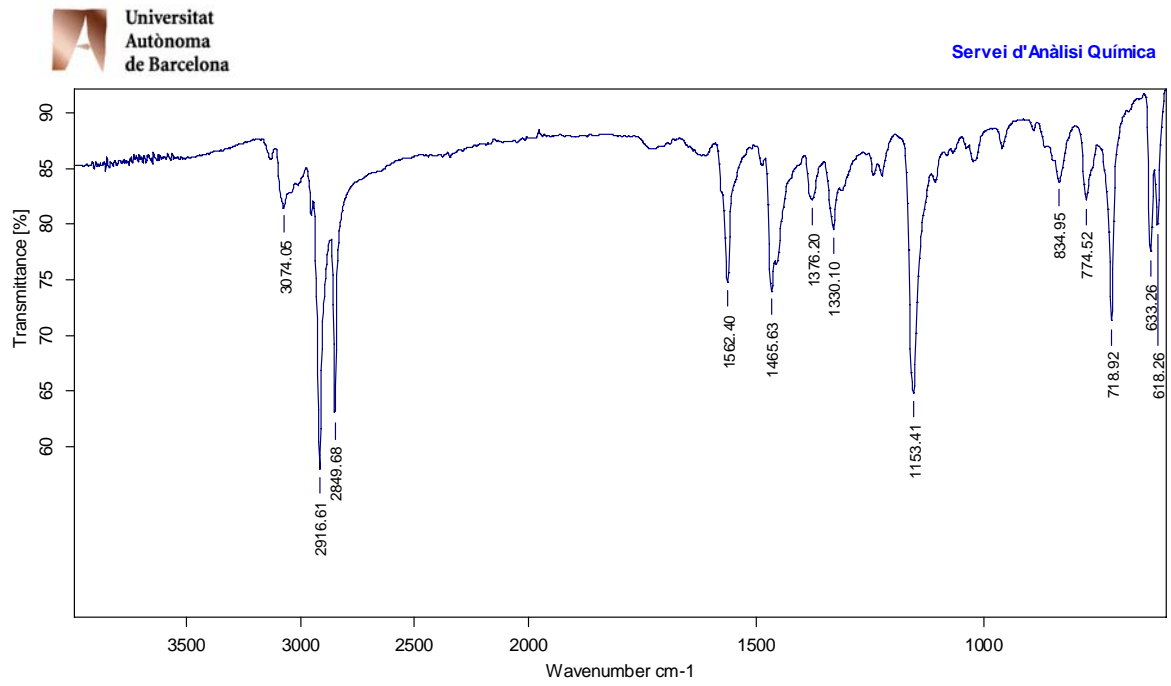
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 400 MHz)

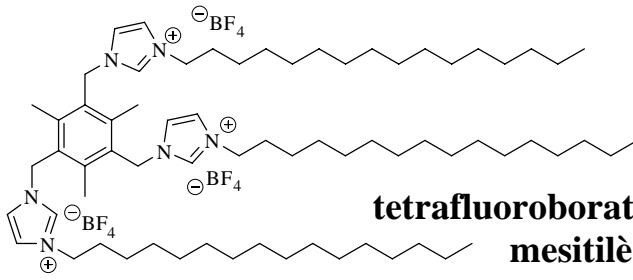


$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 100 MHz)



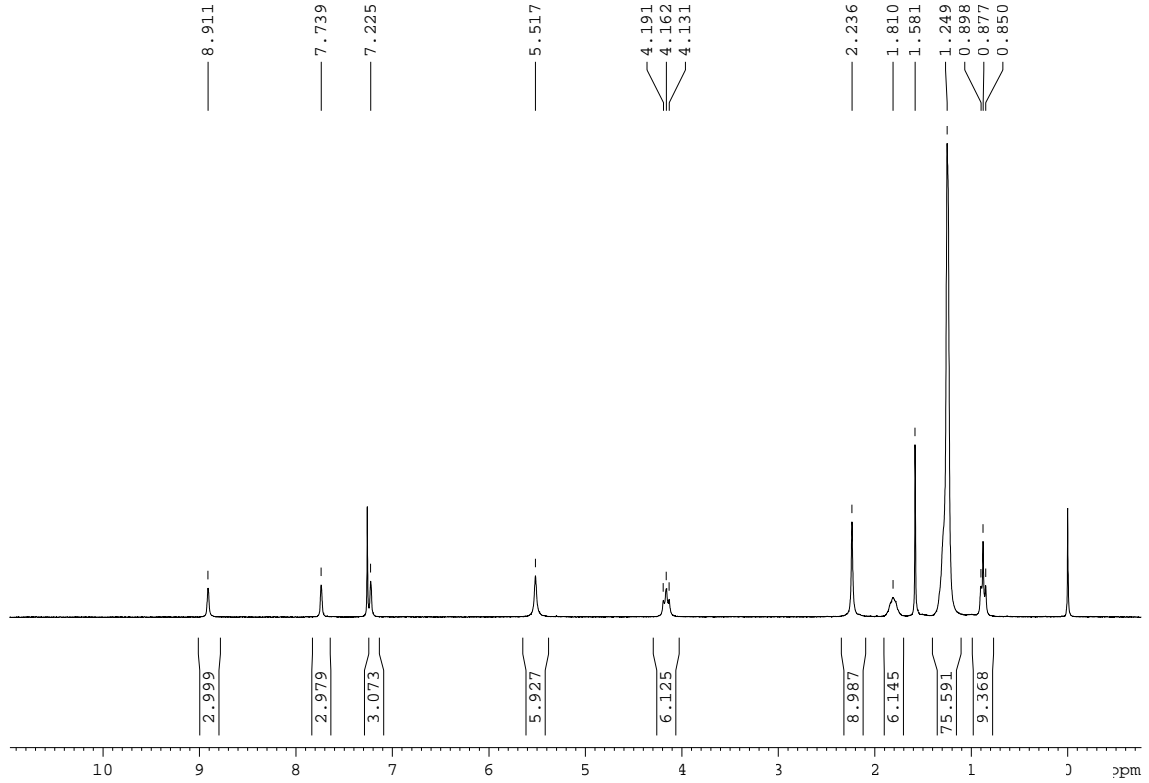
# IR $\nu$ ( $\text{cm}^{-1}$ ) (ATR)



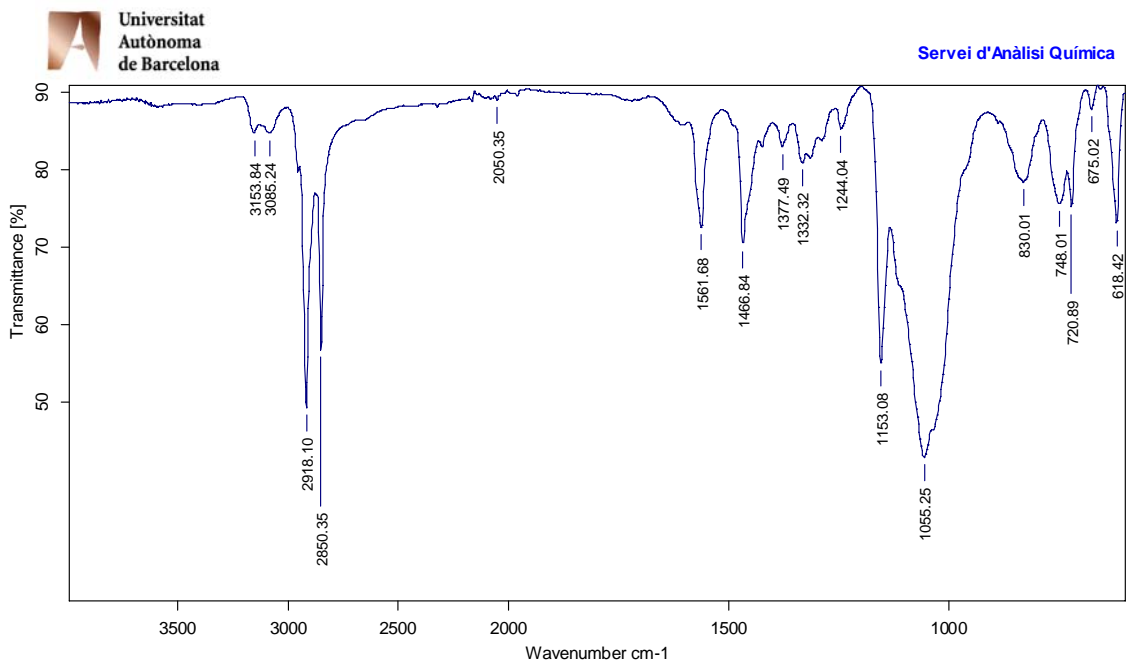


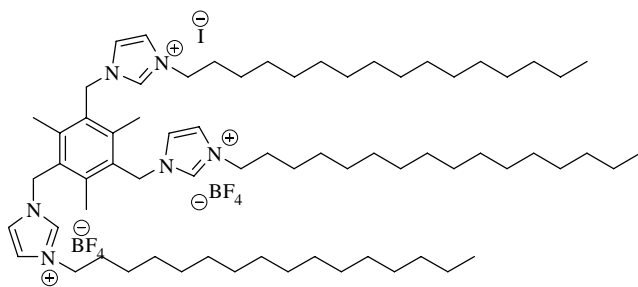
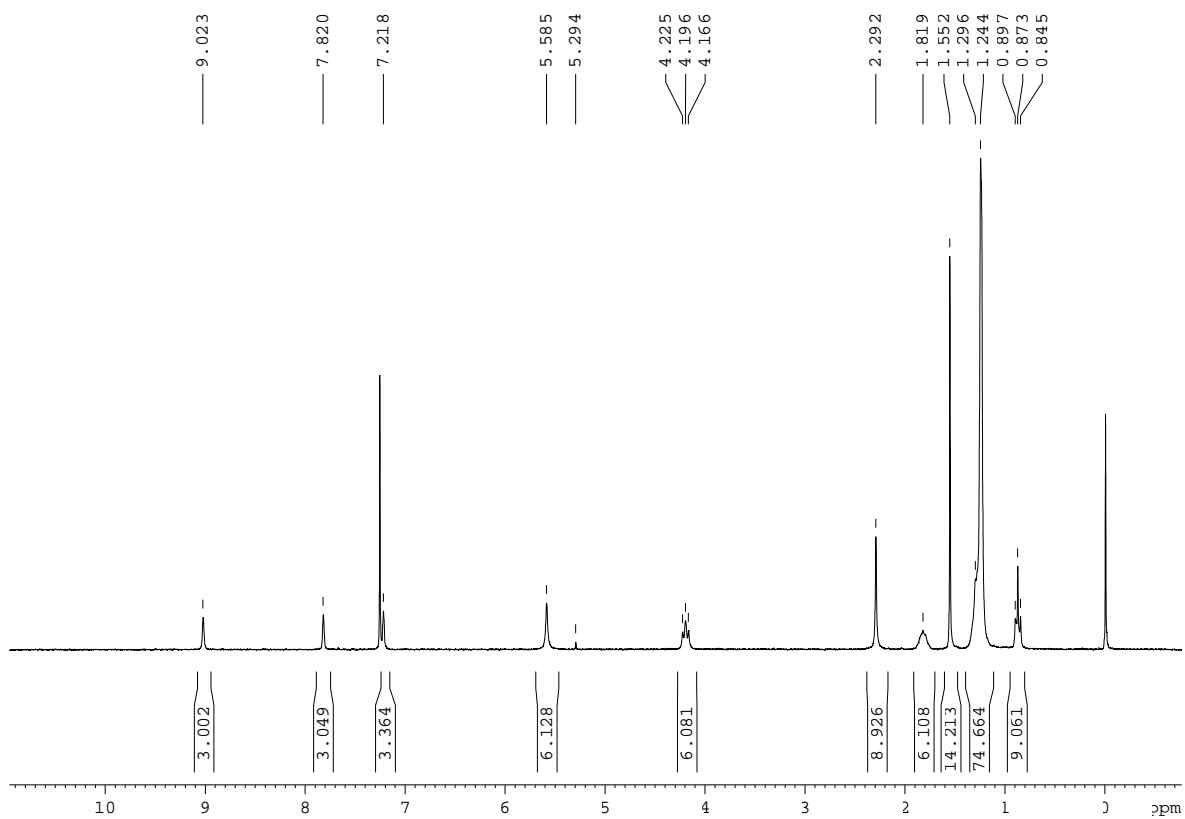
tetrafluoroborat de 3,3',3''-hexadecil-1,1',1''-(1,3,5-mesitilè)tris(metilè)imidazoli, 104b

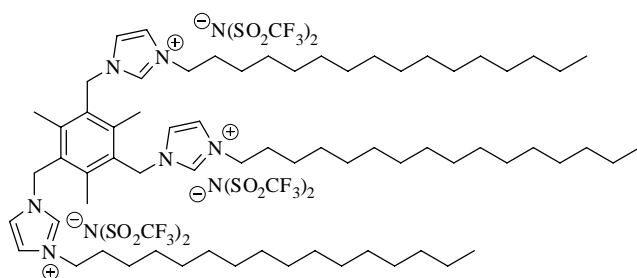
$^1\text{H}$ -RMN ( $\text{CDCl}_3$ , 250 MHz)



IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)

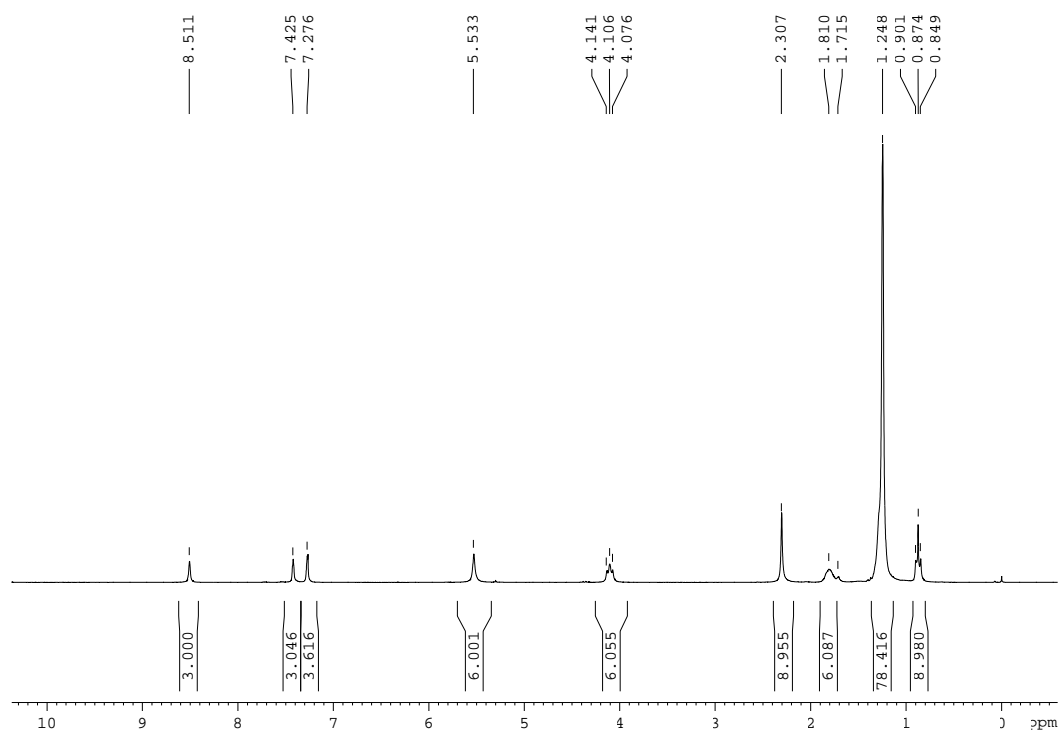


 $^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)

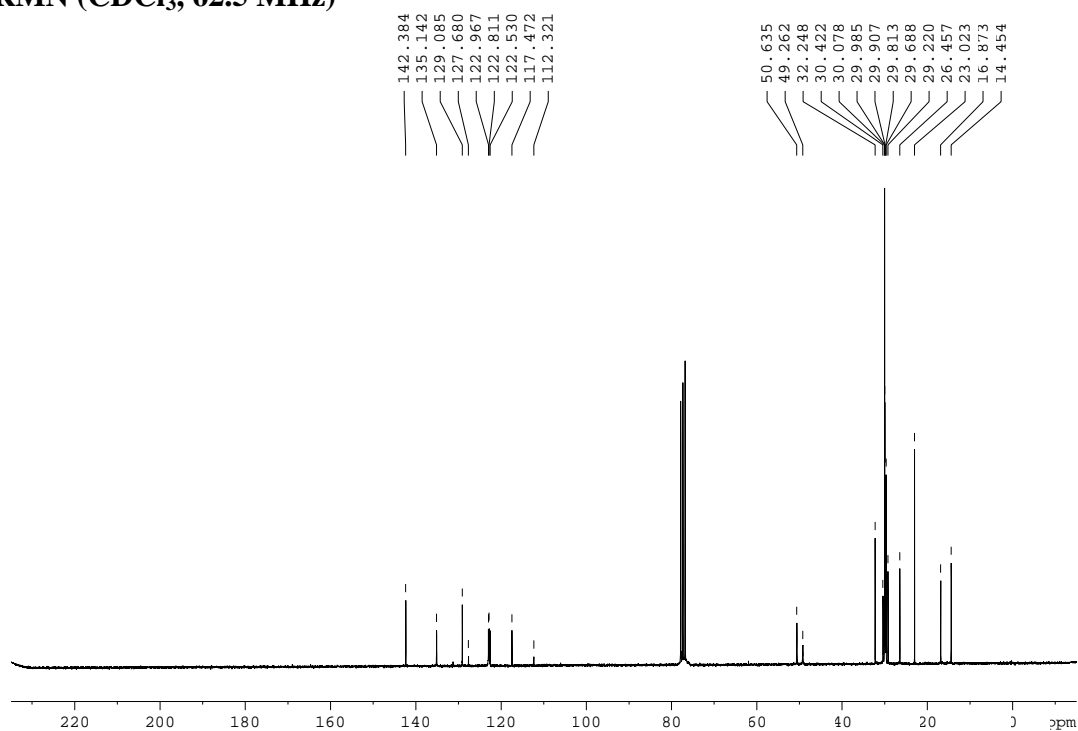


bis-(trifluorometilsulfonil)amidur de  
3,3',3''-hexadecil-1,1',1''-(1,3,5-  
mesitilè)tris(metilè)imidazoli, 104c

$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



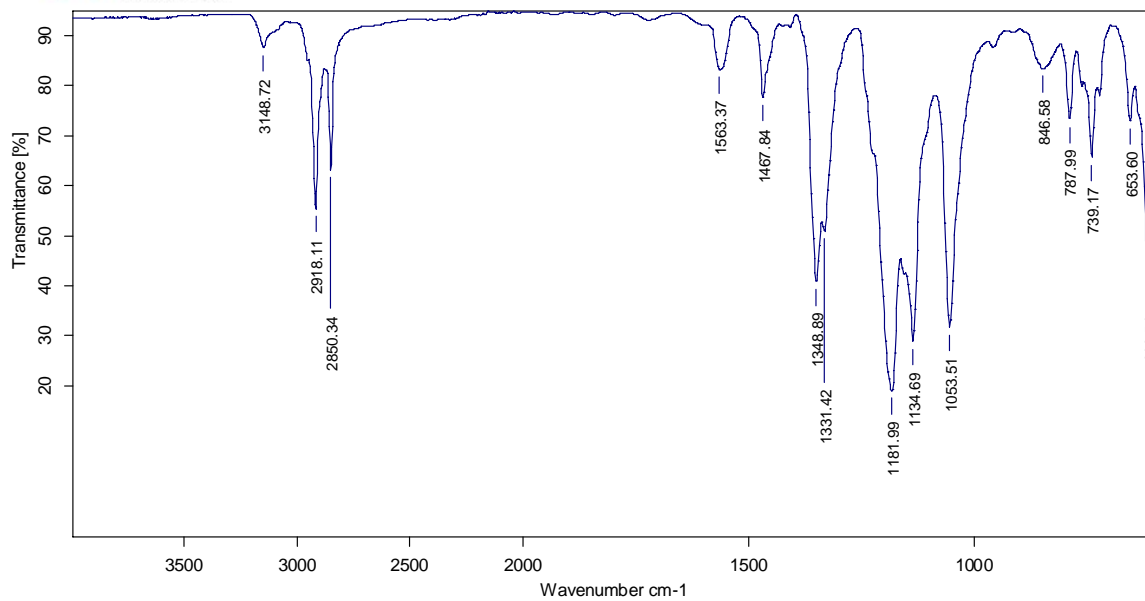
$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

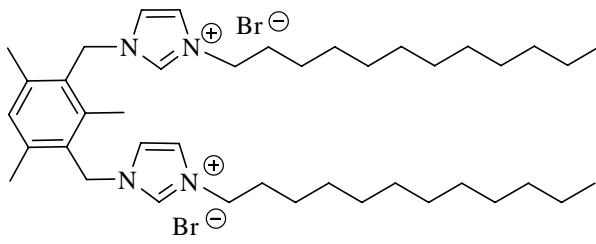


IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)



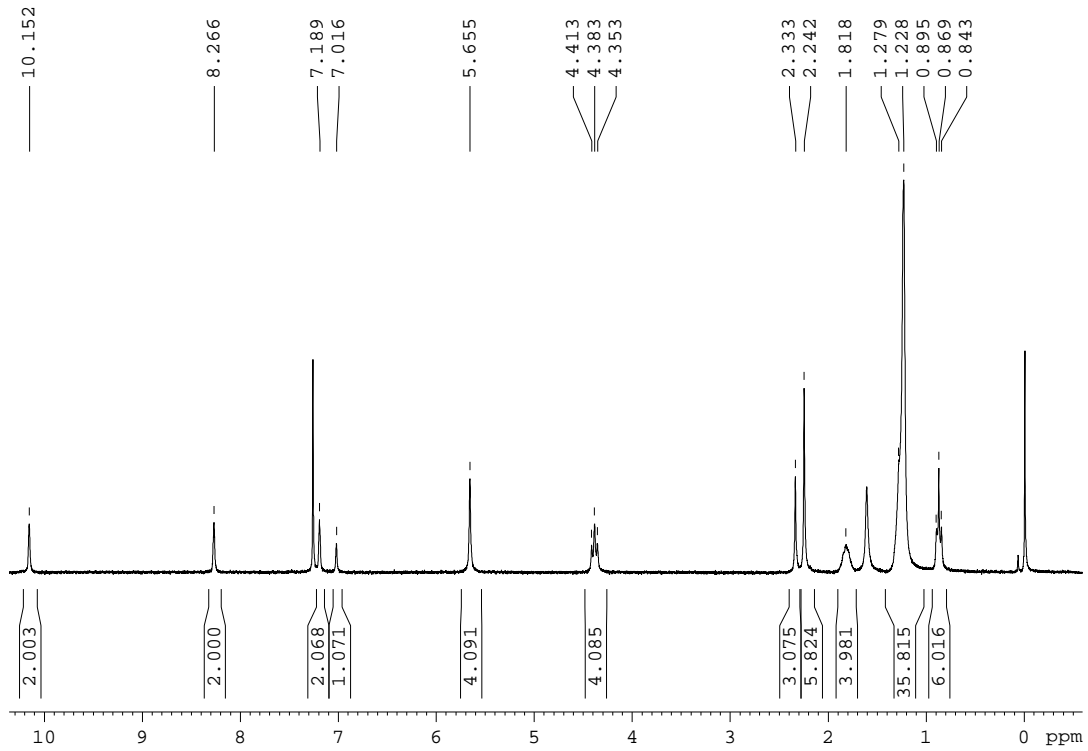
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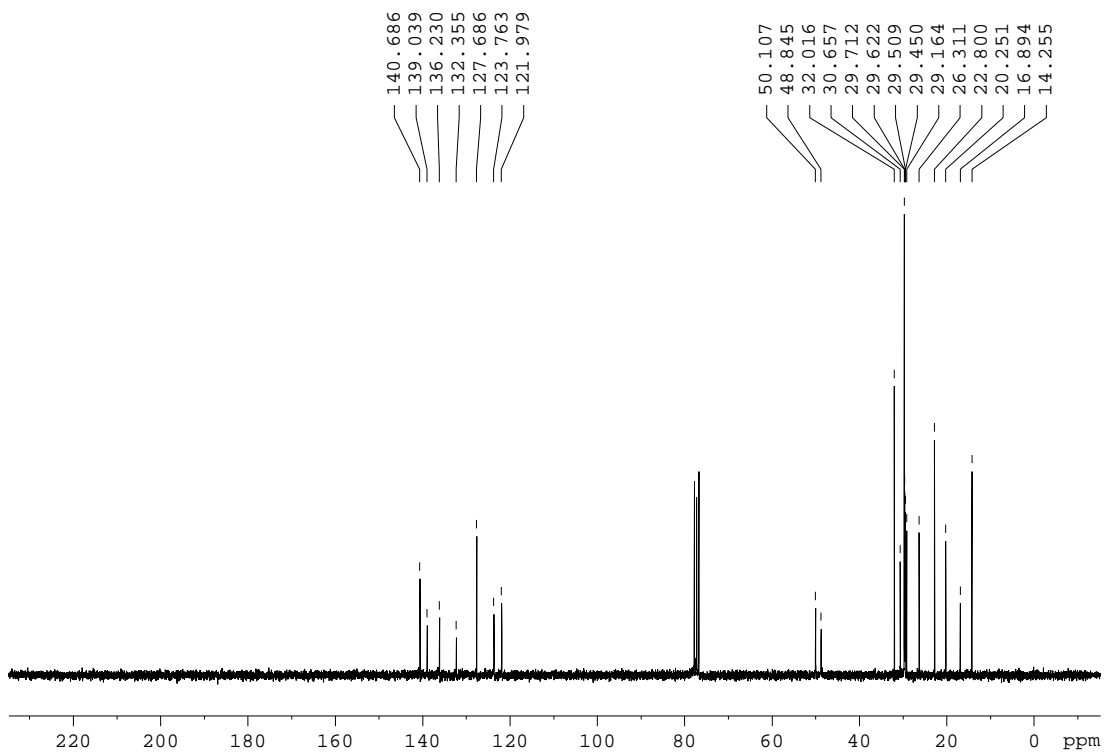


bromur de 3,3'-dodecil-1,1'-(1,3-mesitilè)bis(metilè)imidazoli, 105

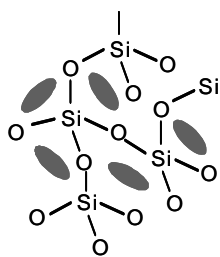
$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



$^{13}\text{C-RMN}$  ( $\text{CDCl}_3$ , 62.5 MHz)

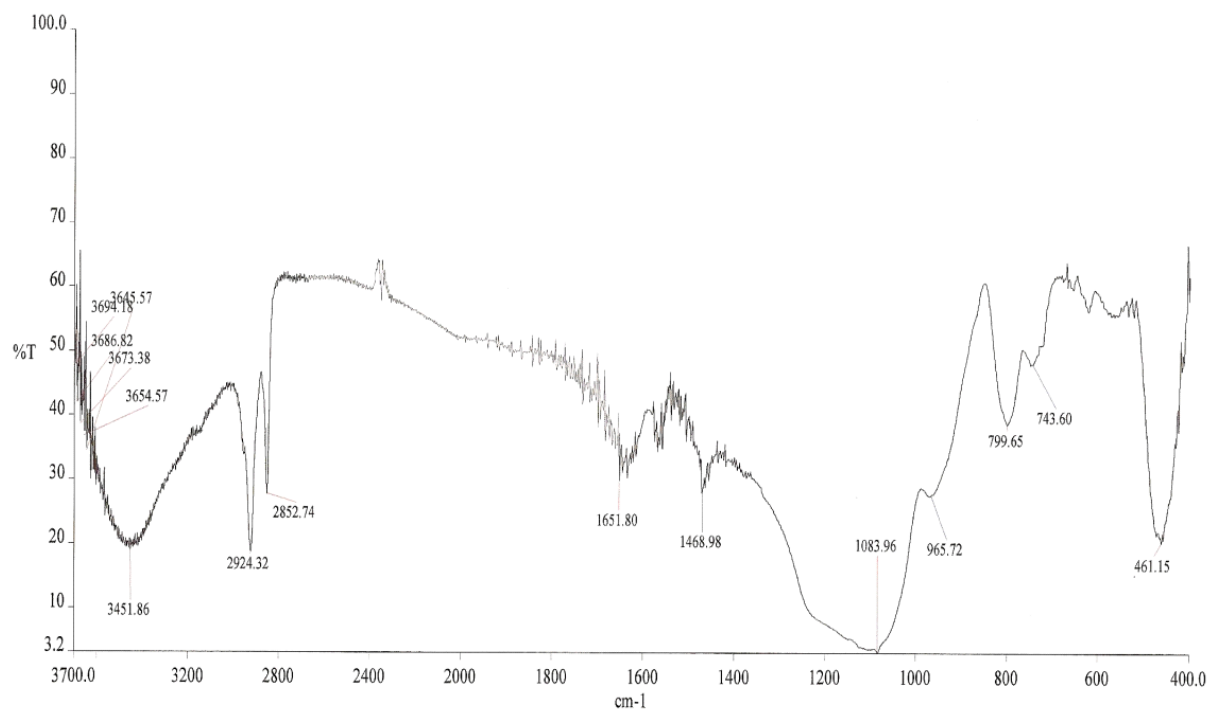




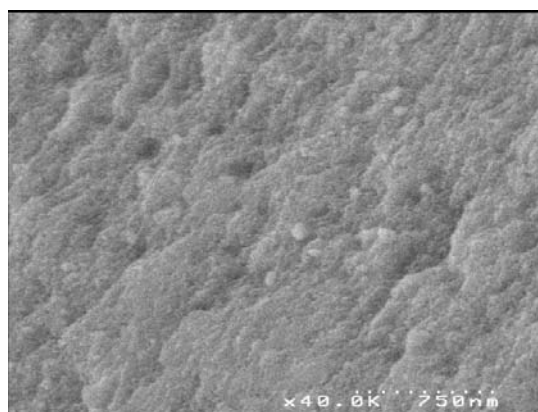
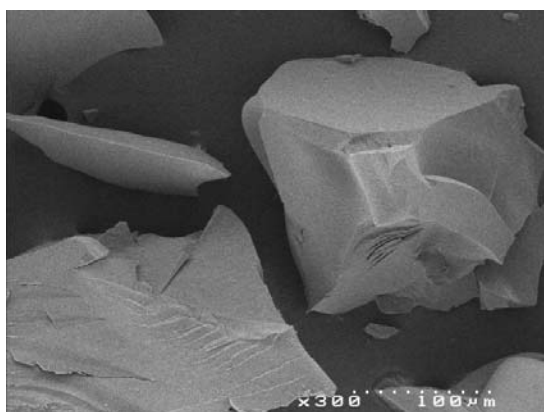


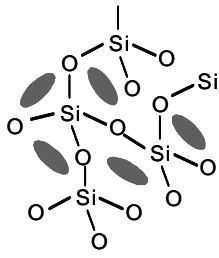
## material híbrid orgànic-inorgànic tipus I M24

IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)



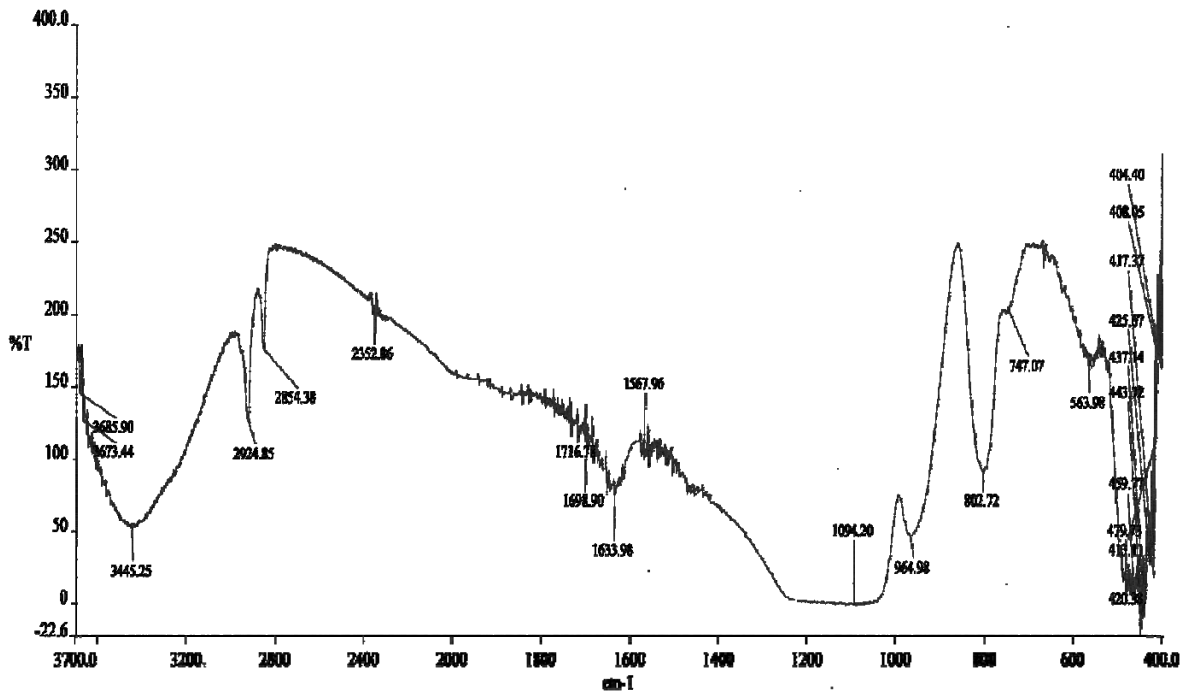
SEM



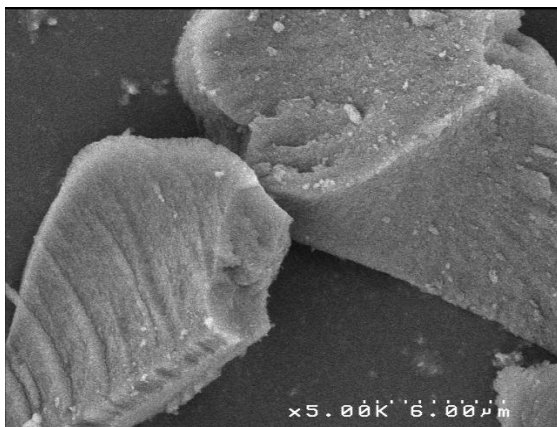


material híbrid orgànic-inorgànic tipus I M24ext

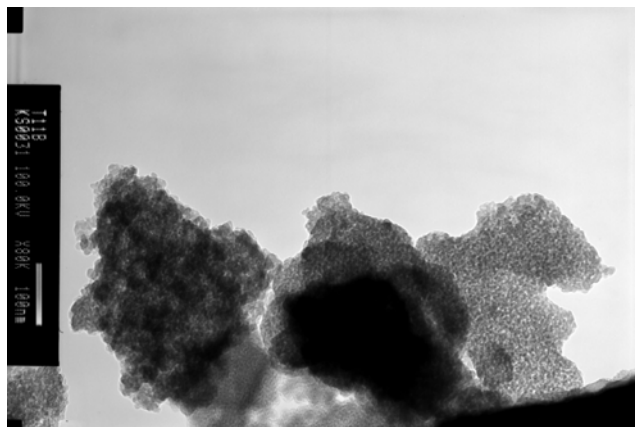
IR  $\nu$  (cm<sup>-1</sup>) (KBr)



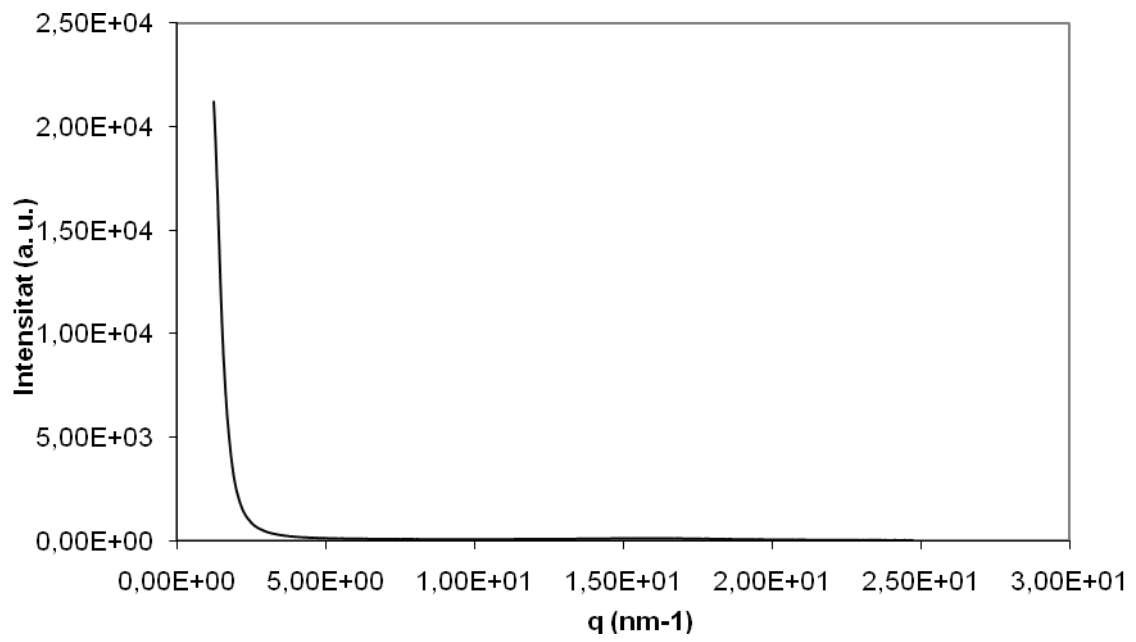
SEM

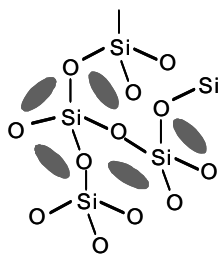


TEM



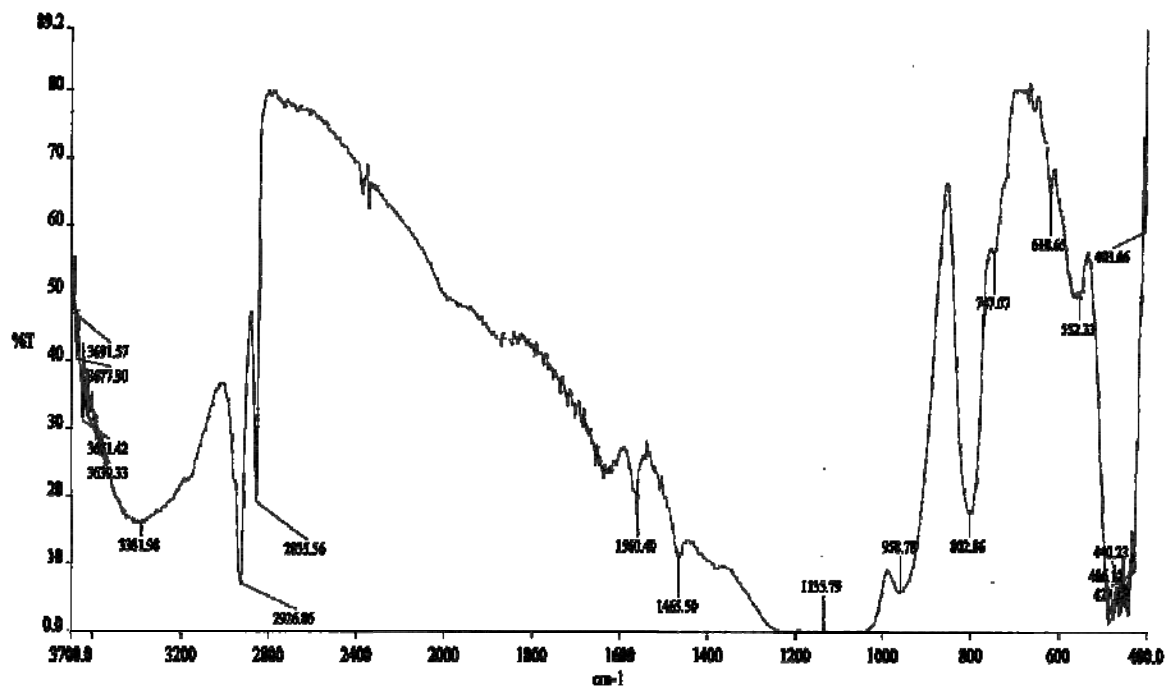
**Raigs X de pols**

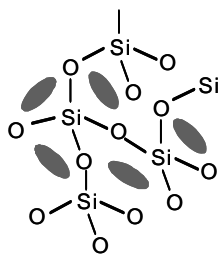
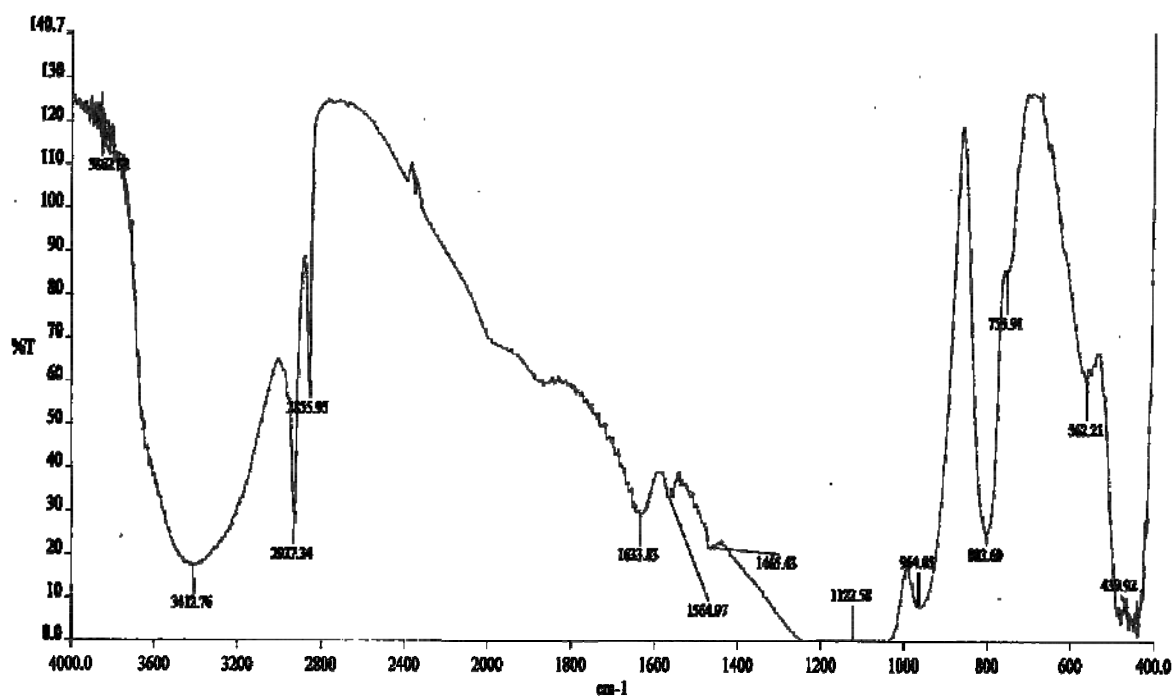




## material híbrid orgànic-inorgànic tipus I M25

IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)

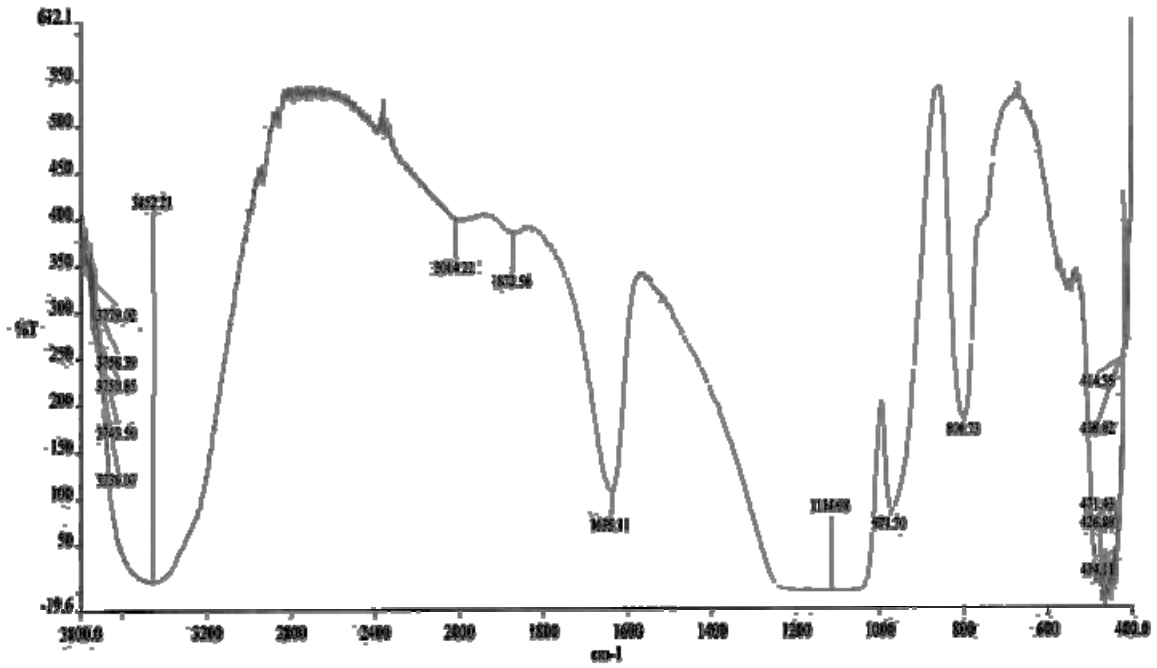


**material híbrid orgànic-inorgànic tipus I M25ext**IR  $\nu$  ( $\text{cm}^{-1}$ ) (KBr)

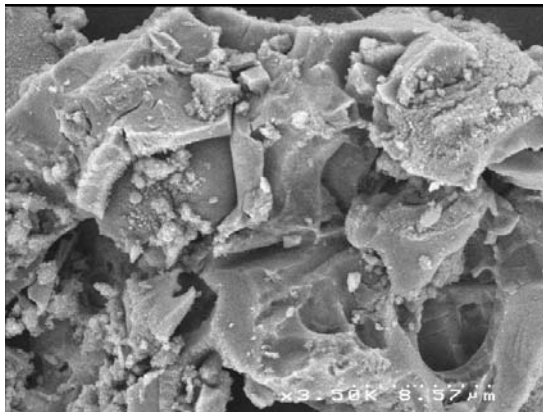
SiO<sub>2</sub>

material M26

IR v (cm<sup>-1</sup>) (KBr)



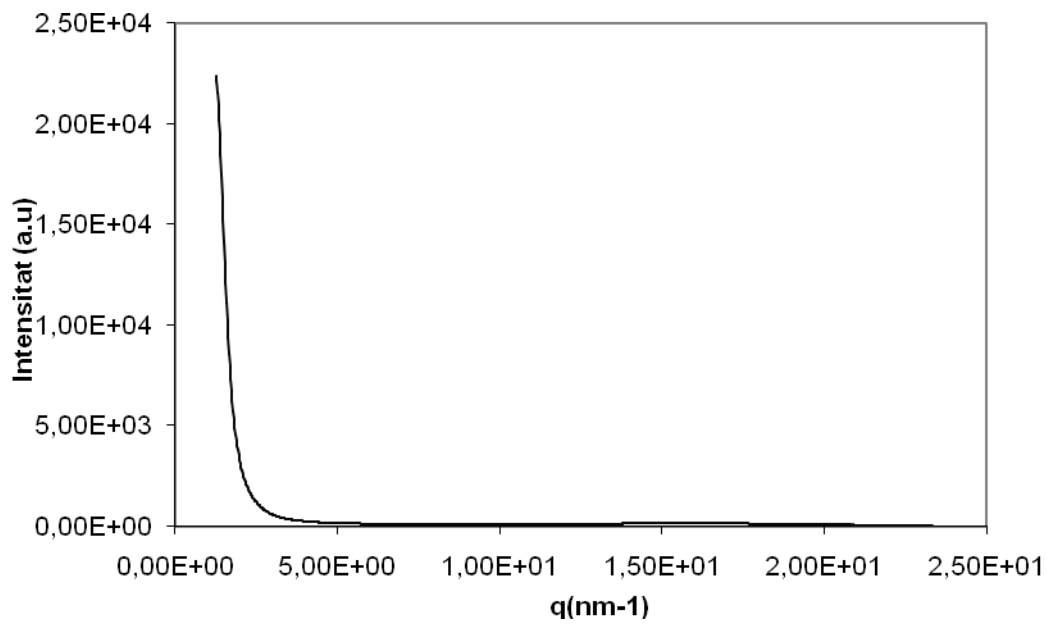
SEM



TEM



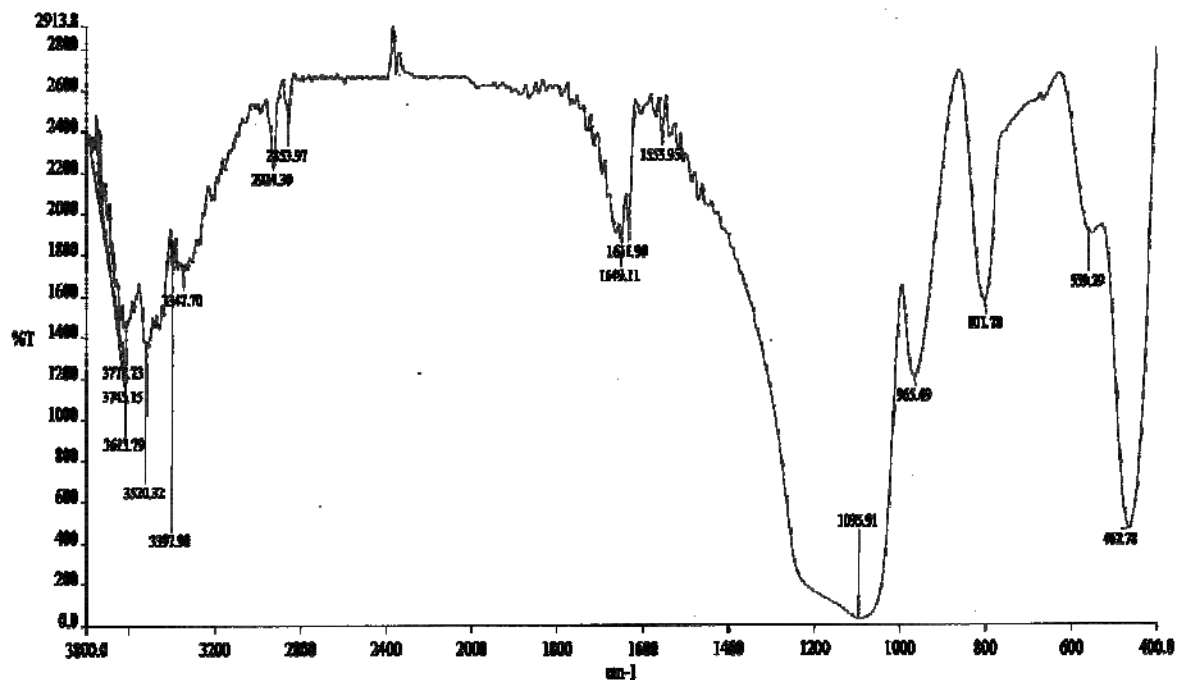
**Raigs X de pols**



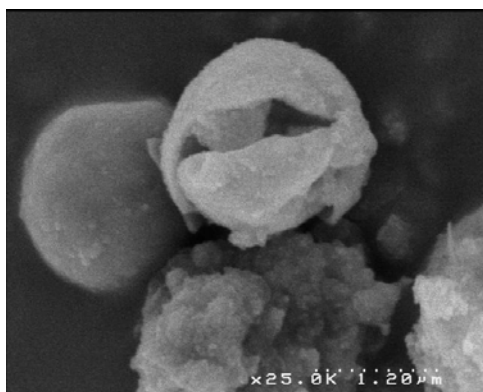
SiO<sub>2</sub>

material M27

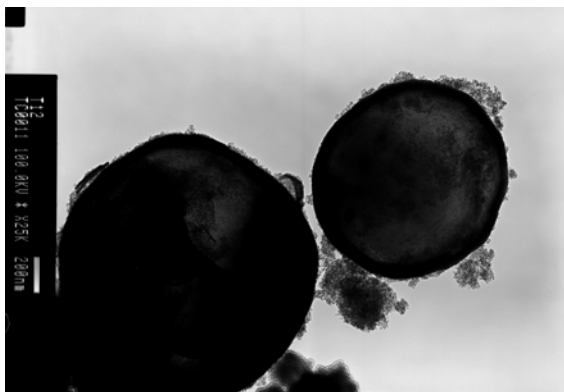
IR v (cm<sup>-1</sup>) (KBr)



SEM

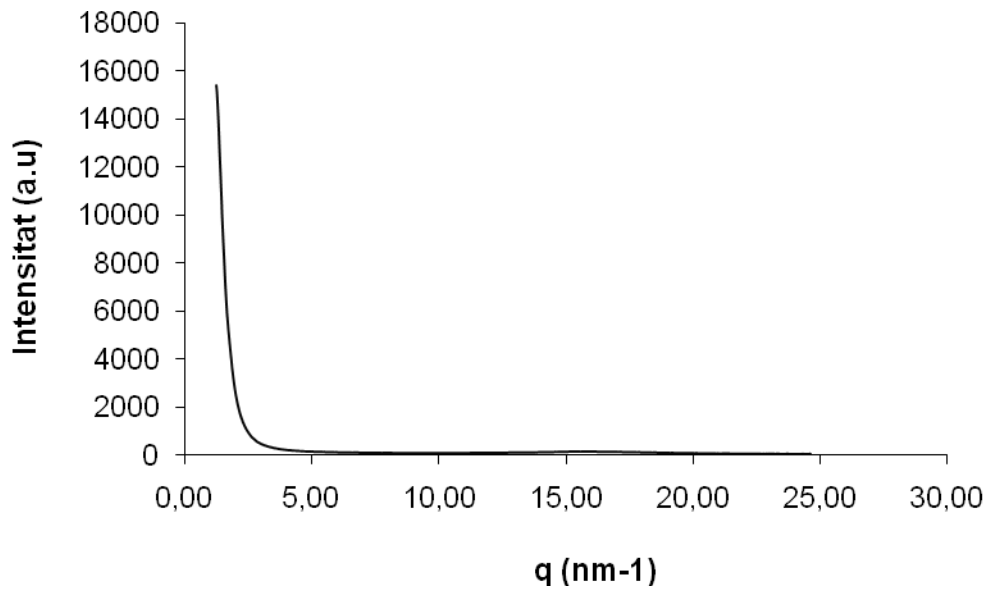


TEM

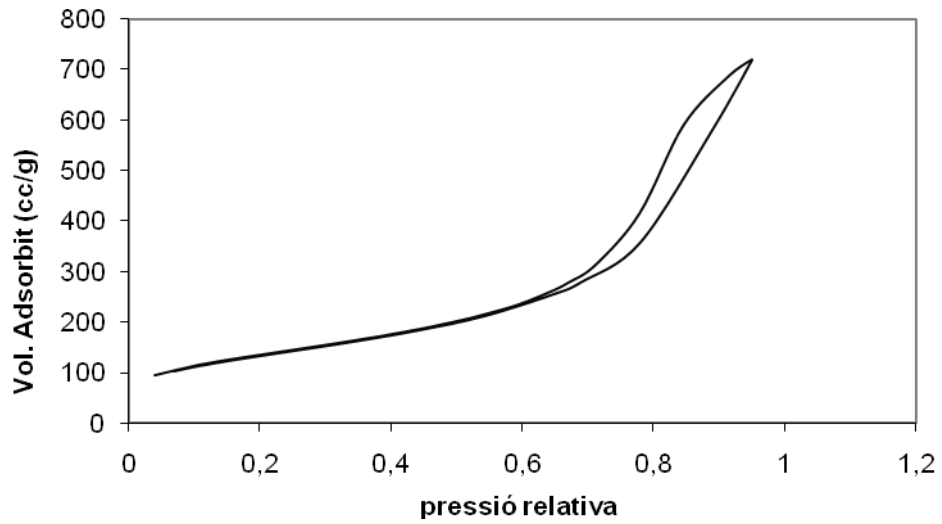




### Raigs X de pols



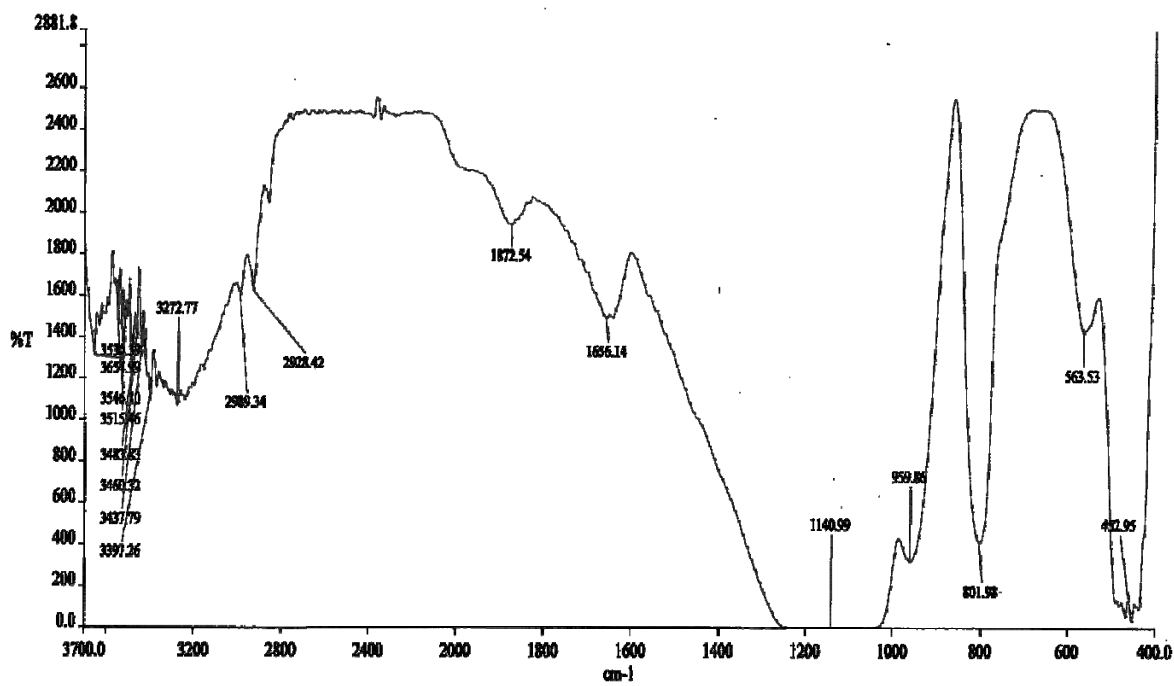
### BET (Brunauer-Emmett-Teller)



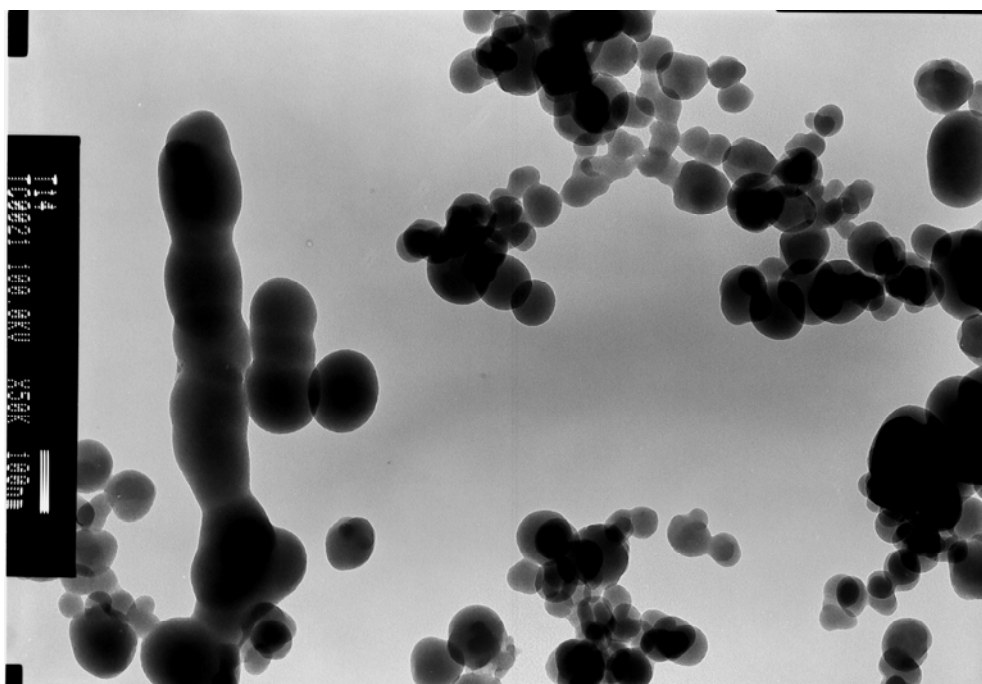
SiO<sub>2</sub>

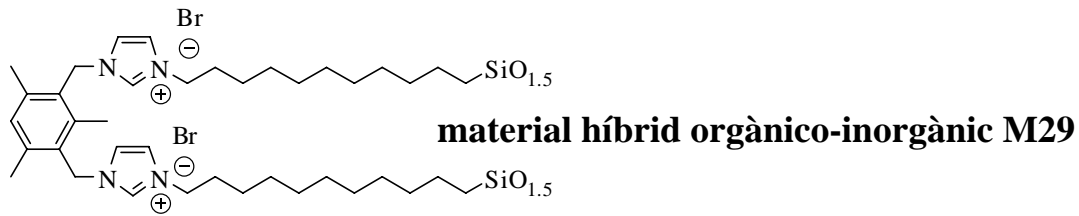
material M28

IR v (cm<sup>-1</sup>) (KBr)

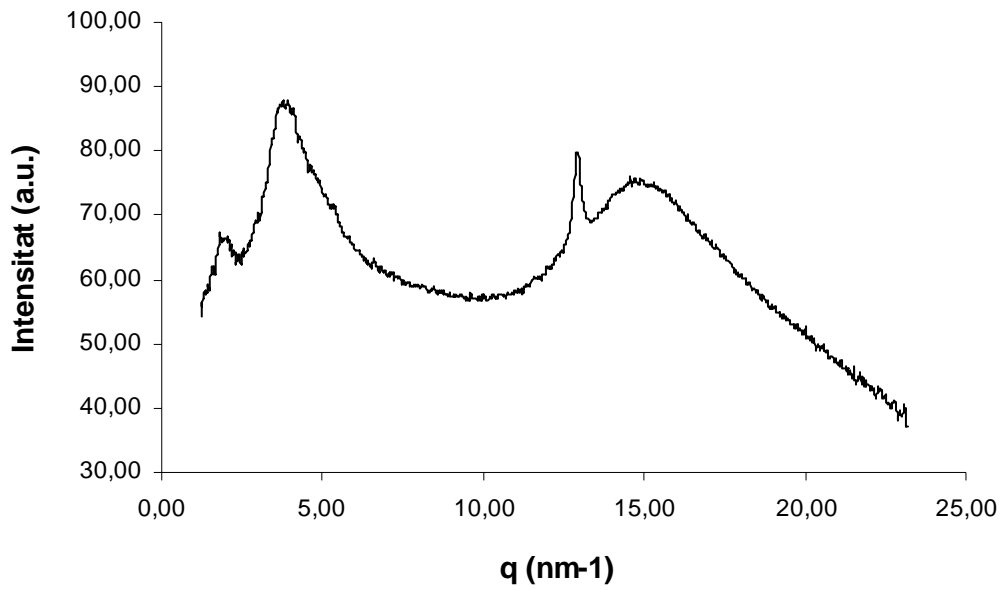


TEM

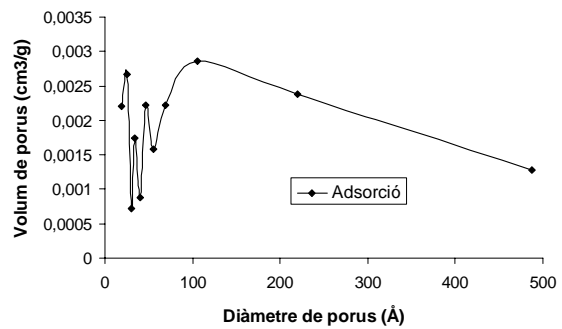
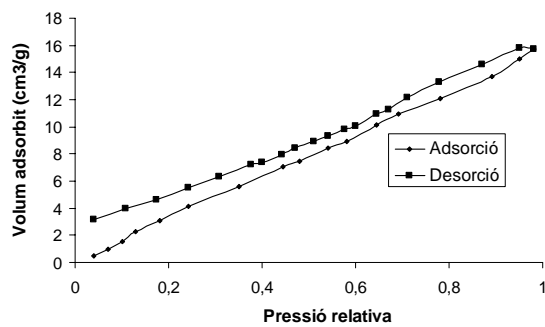


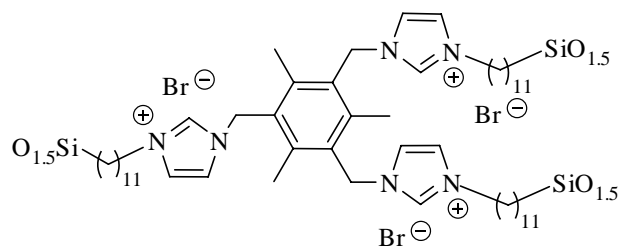


### Raigs X de pols



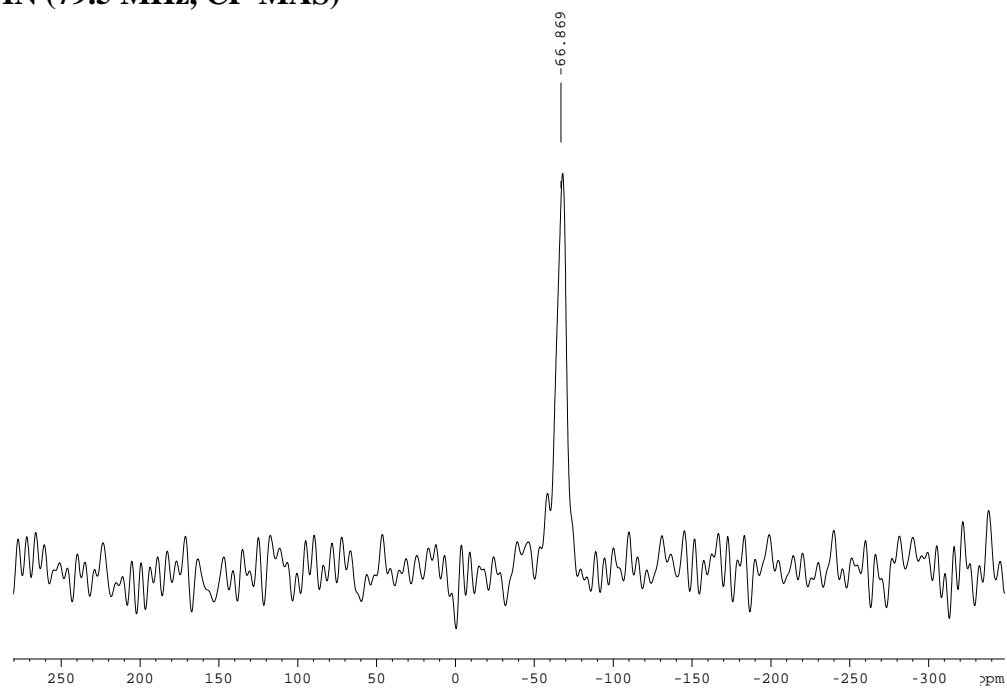
### BET (Brunauer-Emmett-Teller)



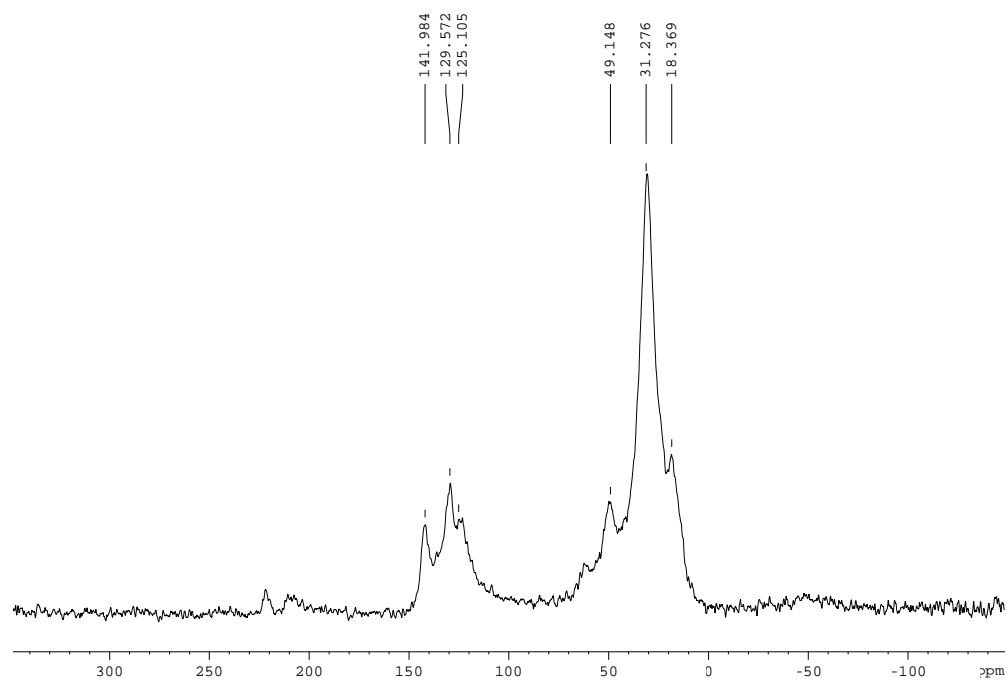


**material híbrid orgànic-inorgànic  
M30**

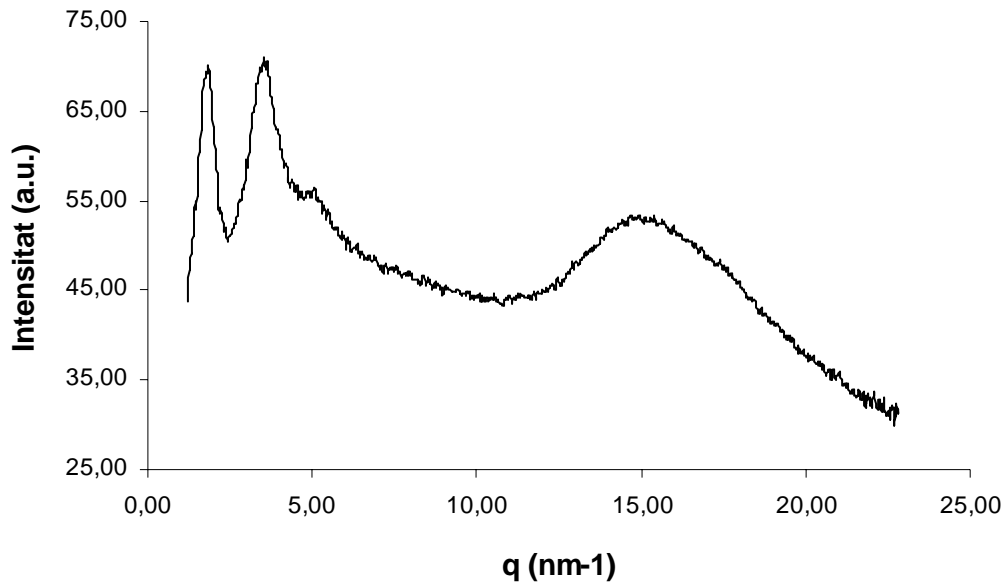
**$^{29}\text{Si}$ -RMN (79.5 MHz, CP-MAS)**



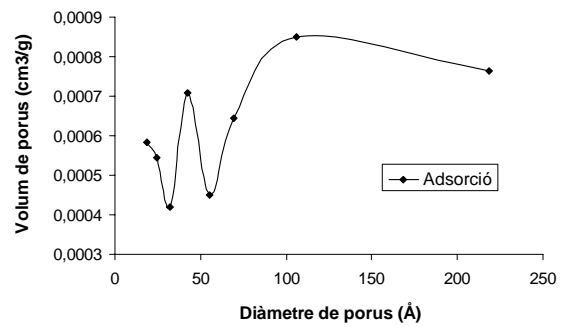
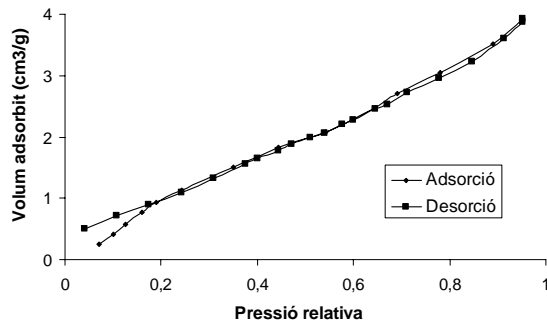
**$^{13}\text{C}$ -RMN (100.62 MHz, CP-MAS)**

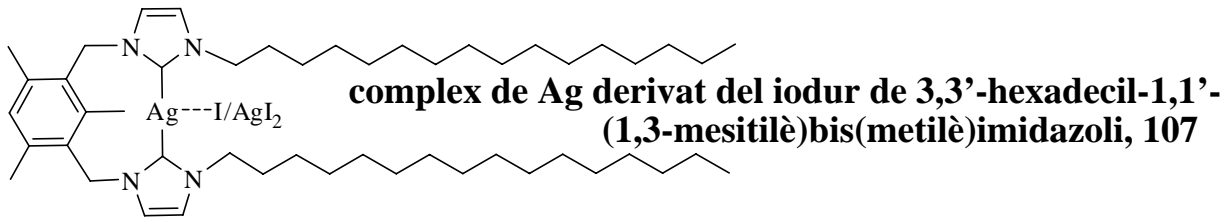


## Raigs X de pols

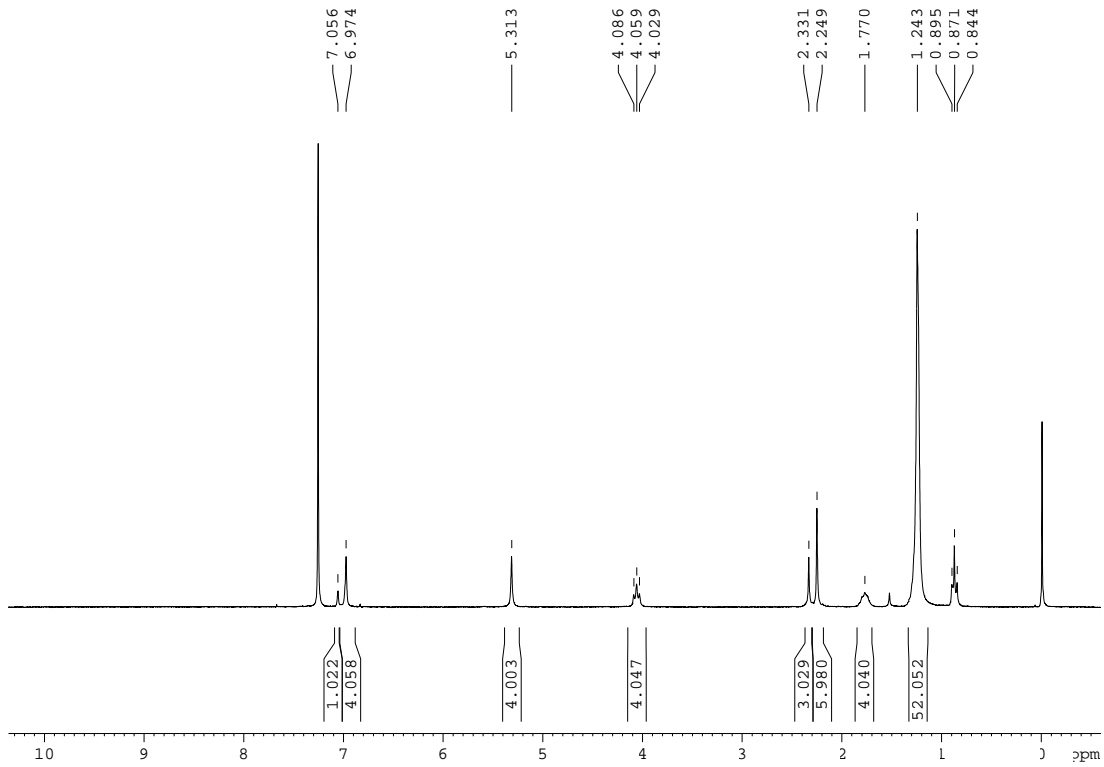


## BET (Brunauer-Emmett-Teller)

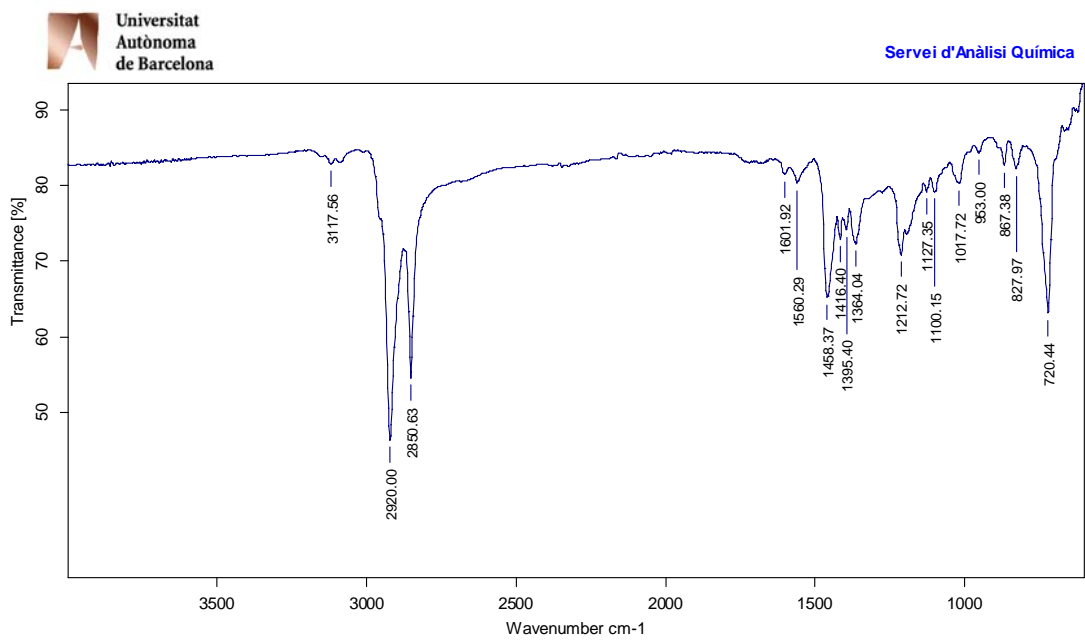




$^1\text{H-RMN}$  ( $\text{CDCl}_3$ , 250 MHz)



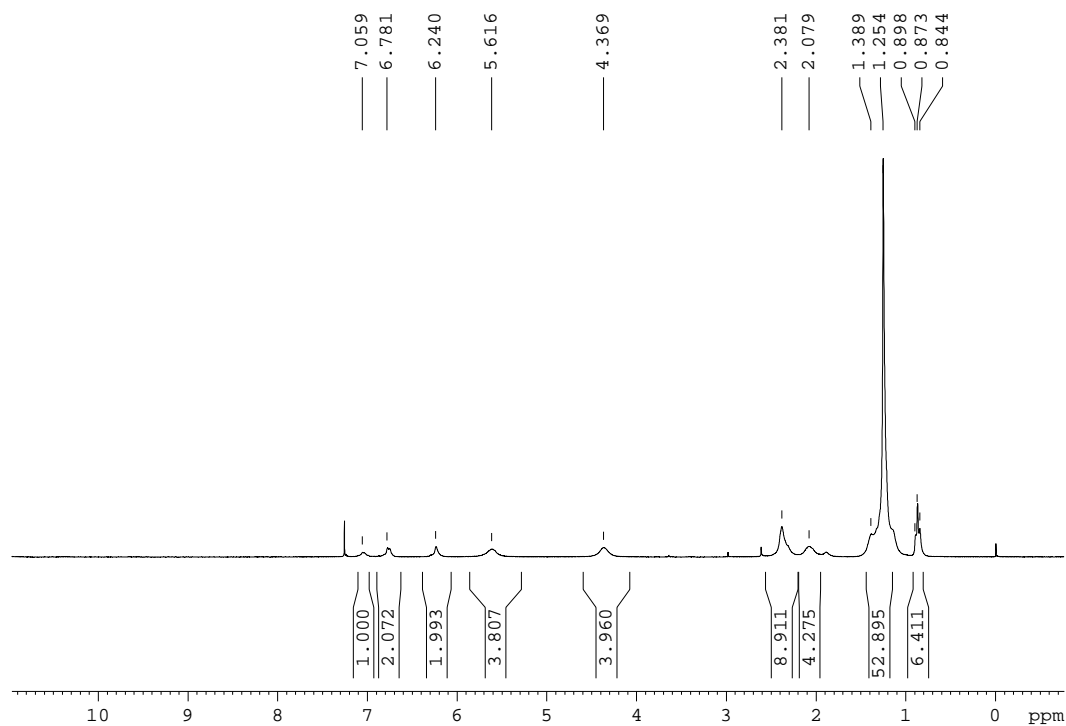
IR  $\nu$  ( $\text{cm}^{-1}$ ) (ATR)





**complex de Pd derivat del iodur de 3,3'-hexadecil-1,1'-  
(1,3-mesitilè)bis(metilè)imidazoli, 106**

**$^1\text{H}$ -RMN (CDCl<sub>3</sub>, 250 MHz)**



**$^{13}\text{C}$ -RMN (CDCl<sub>3</sub>, 62.5 MHz)**

