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## INFRARED MODES OF CHARGED SOLITONS

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**ABSTRACT** Doping level and temperature dependence (4,2K-300K) of infrared absorption spectra of  $I_2$  and  $MoCl_5$  doped polyacetylene and deuterated polyacetylene are reported within spectral range 400-2000  $cm^{-1}$ . They exhibit two absorption ranges. The 1370  $cm^{-1}$   $CH_x$  mode (1160  $cm^{-1}$  for  $CD_x$ ) is a charged soliton mode. The low frequency part (400-1000  $cm^{-1}$  for  $CH_x$ , 400-900 for  $CD_x$ ) can be analysed into resonant mode and doping species optical modes superimposed to a pinning mode.

### EXPERIMENTAL

Cis thin films (thickness about 1  $\mu m$ ) synthesized by the usual Shirakawa's method were grown on KBr pellets, then thermally isomerized at 150°C during 20 minutes.  $MoCl_5$  doping was performed in toluene and carbone disulphide solutions, iodine doping in gaseous phase.

### RESULTS

$MoCl_5$  doping results are mainly reported below. Most of iodine doping results will be published elsewhere.

Two striking features appear in the absorption spectra. Strong narrow absorption at 1370  $cm^{-1}$  (1160 for  $CD_x$ ) and a broader absorption near 870  $cm^{-1}$  with a complex structure superimposed.

### DOPING LEVEL AND TEMPERATURE DEPENDENCE

Main results are shown rather than a detailed discussion.

The intensity of the 1370  $cm^{-1}$  mode associated with the number of charged centers increases with doping

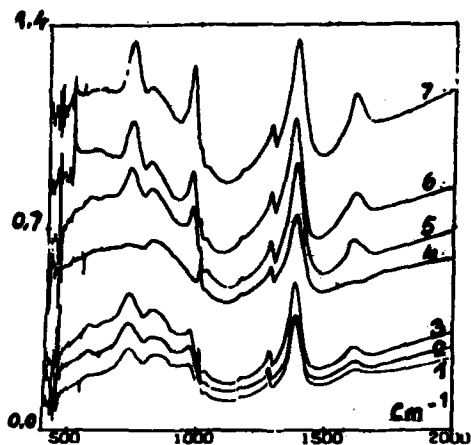


Figure 1 Absorption spectra of  $\text{MoCl}_5$  doped  $\text{CH}_x$ . 1, 2, 3, 5, 6, 7 in toluene solution. 4 in carbon disulphide solution (point that the bands at 730, 970, 1600 due to toluene solvated ion are missing).

The intensity of this mode increases with decreasing temperature  
Fig 2.

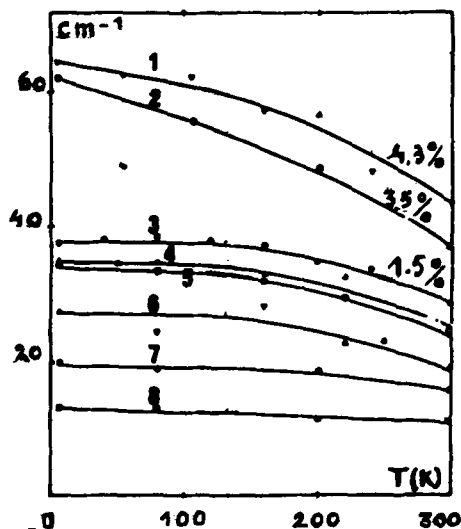


FIGURE 2 Strength variation of the  $1370\text{cm}^{-1}$  mode with temperature for different doping level. 1, 2, 3  $\text{I}_2$  doped  $\text{CH}_x$  4, 5, 6, 7, 8  $\text{Mo Cl}_5$  doped  $\text{CH}_x$

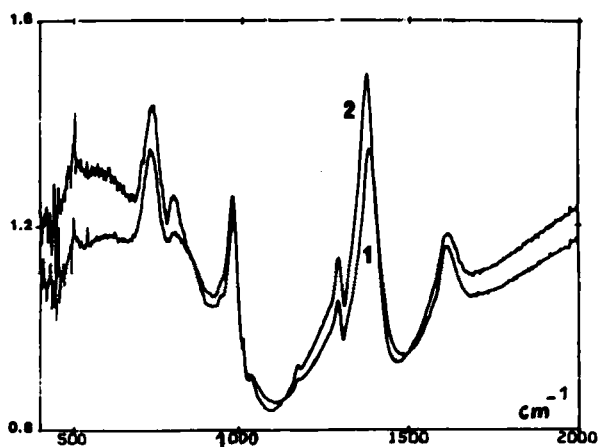


FIGURE 3 Absorption spectra of  $\text{MoCl}_5$  doped  $\text{CH}_x$  in toluène solution : 1 (300K). 2 (4,2K)

. The broad band (bandwidth  $\sim 200\text{cm}^{-1}$ ) strongly dependent of dopant concentration (Fig 1) and temperature (Fig 3,4) is the pinning mode of charged solitons.

. Frequencies are shifted towards low energies.

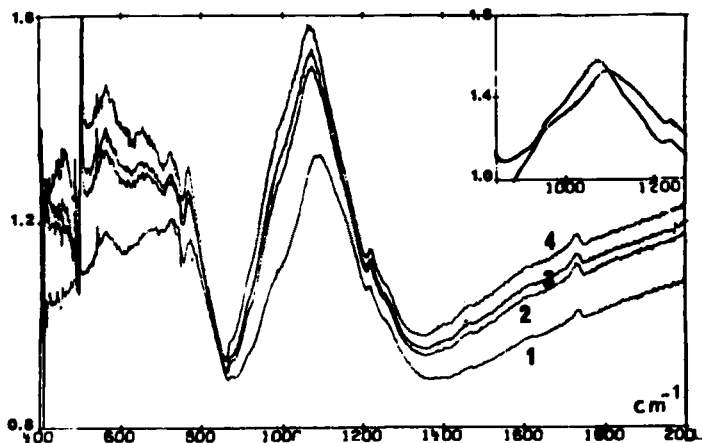


FIGURE 4 Evolution of  $1370\text{cm}^{-1}$ , and low frequency modes of  $\text{MoCl}_5$  doped  $\text{CD}_x$  in carbene disulphide solution 1 (300K); 2 (220K); 3 (160K) 4 (4,2K)

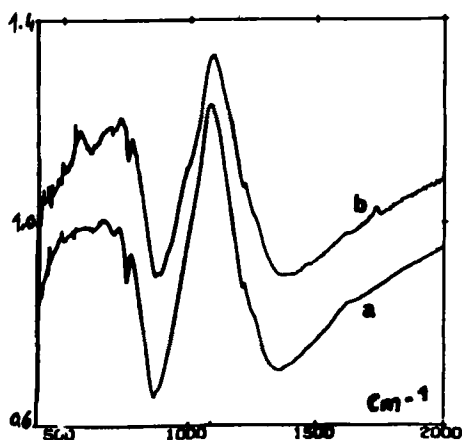


FIGURE 5 Absorption spectra of doped  $CD_x$  a: with Iodine b: with  $MoCl_5$  in toluene solution

The superimposed structure can be analysed into: localised or resonant modes of the chain ( $730-820cm^{-1}$ )

. Internal modes of dopant species ( $906-570cm^{-1}$ ) or solvated ion

( $977cm^{-1}$ ) Fig 5. Similar results were obtained with iodine doping (Fig 6)

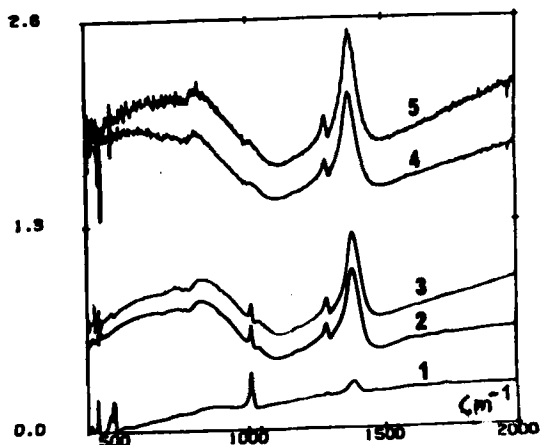


FIGURE 6 Absorption spectra of Iodine doped  $CH_x$  (2,3,4, 5) 1 undoped trans sample.