

IR and UV Study of Aromatic Amines Adsorbed on Aluminum Halides II; The Results on 1, 5-Naphthylenediamine, *p*-Aminobenzonitrile, and *N*-Methylaniline, with the Tables of Absorption Bands on Aniline, *p*-Toluidine, *p*-Chloroaniline, 1- and 2-Naphthylamine

By

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Summary

Infrared and ultraviolet studies were made on 1, 5-naphthylenediamine, *p*-aminobenzonitrile, and *N*-methylaniline adsorbed on aluminum chloride and bromide. The adsorption occurred by the amino- or *N*-methylamino-group. For 1, 5-naphthylenediamine adsorbed on aluminum chloride, the overall feature of the spectra was similar to 1- or 2-naphthylamine adsorbed on aluminum chloride or bromide. For adsorbed *p*-aminobenzonitrile, both the bands related to amino-group and that associated with cyano-group showed shifts, the shift of the latter being attributed to the weakening of the electron-donating ability of the amino group on adsorption. For adsorbed *N*-methylaniline, large shifts or intensity changes were observed for six bands, which are to be related to the methylamino-group. Numerical tables of IR and UV absorption bands are given for aniline, *p*-toluidine, *p*-chloroaniline, 1-naphthylamine, and 2-naphthylamine adsorbed on aluminum chloride, bromide, and iodide.

IR and UV study was made on some aromatic amines adsorbed on aluminum halides to investigate the molecular structure of the adsorbed molecules. The amines studied are the following: aniline (I), *p*-toluidine (II), *p*-chloroaniline (III), 1-naphthylamine (IV), 2-naphthylamine (V), 1, 5-naphthylenediamine (VI), *p*-aminobenzonitrile (VII), and *N*-methylaniline (VIII). Aluminum halides used are chloride (A), bromide (B), and iodide (C). UV study of IA (I adsorbed on A. Such an abbreviation is adopted hereafter.) and VIIIA,^{1,2)} IR study of IA, IB, and IC together with UV study of IB and IC,³⁾ and IR and UV study of IIA, IIB, IIIA, IIIB, IVA, IVB, VA, and VB⁴⁾ are reported previously. The present paper is divided into two parts. PART I includes the unpublished results on the systems VIA, VIIA, VIIB, VIIIA, and VIIIB. In PART II are given the numerical tables of IR and UV absorption bands on the systems IA, IB, IC, IIA, IIB, IIIA, IIIB, IVA, IVB, VA, and VB, for which only the figures of spectra were given in the previous publications (Refs. 1-4).

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PART I. The Results on 1, 5-Naphthylenediamine (VI), *p*-Aminobenzonitrile (VII), and *N*-Methylaniline (VIII)

In the preceding paper,⁴⁾ IR and UV study was made on *p*-toluidine (II), *p*-chloroaniline (III), 1-naphthylamine (IV), and 2-naphthylamine (V) adsorbed on evaporated films of aluminum chloride (A) and bromide (B), in order to obtain the information on the structure of adsorbed molecules in relation to the electron-donating abilities of these aromatic amines in comparison with aniline (I). The amines II and III were revealed to be the stronger donors than I. Naphthylamines IV and V are more stronger electron donors. 1, 5-Naphthylenediamine (VI) seems to have the largest electron-donating ability among these aromatic amines. The presence of the electron-withdrawing cyano group in *p*-aminobenzonitrile (VII) may weaken the electron-donating ability of this molecule in comparison with aniline (I). The effect of *N*-methyl group in *N*-methylaniline (VIII) on adsorption seems to be interesting. Incidentally, *N*, *N*-dimethylaniline was found not to give the adsorbed molecules, the formation of crystal violet being found in its stead.⁵⁾

Experimental. VI and VII were purified by vacuum sublimation, VIII by distillation under reduced pressure after drying with potassium hydroxide. A, B, and C were prepared from aluminum and the corresponding silver halide. The cell assembly used was provided with a quartz UV cell and an IR cell with KBr window plates. Evaporated films of A, B, or C were prepared on the inner walls of the cells, onto which amines were adsorbed. IR and UV spectra were measured on a JASCO IRA-1 (or IRA-2) and a Shimadzu MPS-50L recording spectrophotometer, respectively. All the other details of the experimental procedure were the same as those in the previous reports.^{3,4)}

Results and Discussion. Observed IR and UV spectra are shown in Figs. 1-3 in comparison with those of parent amines. Positions of IR and UV bands are given in Tables I-III.

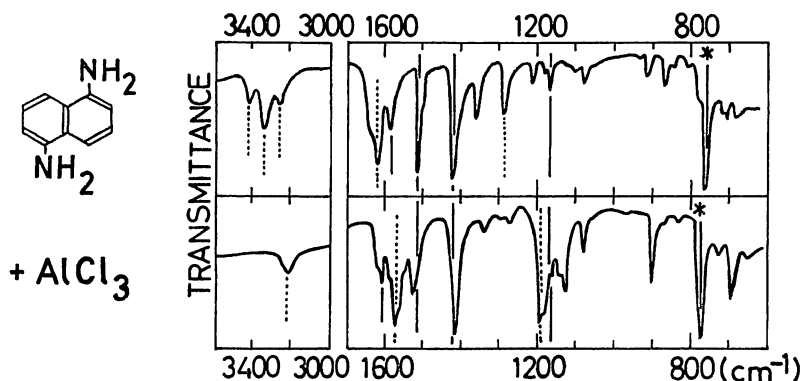


Fig. 1(a). IR spectra of 1, 5-naphthylenediamine (KBr disc) and 1, 5-naphthylenediamine adsorbed on aluminum chloride. The bands of group (a) and (b) are shown by vertical solid and dotted lines, respectively. The C-H out-of-plane bending modes are marked by asterisks.

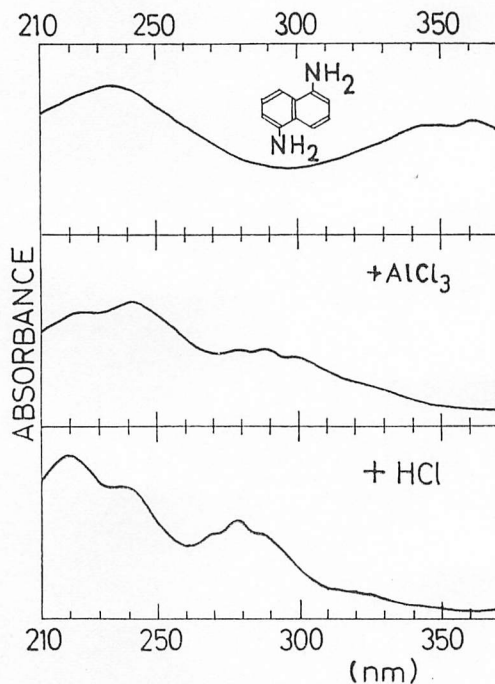


Fig. 1(b). UV spectra of 1, 5-naphthylenediamine (evaporated film) and 1, 5-naphthylenediamine adsorbed on aluminum chloride, and dissolved in hydrochloric acid.

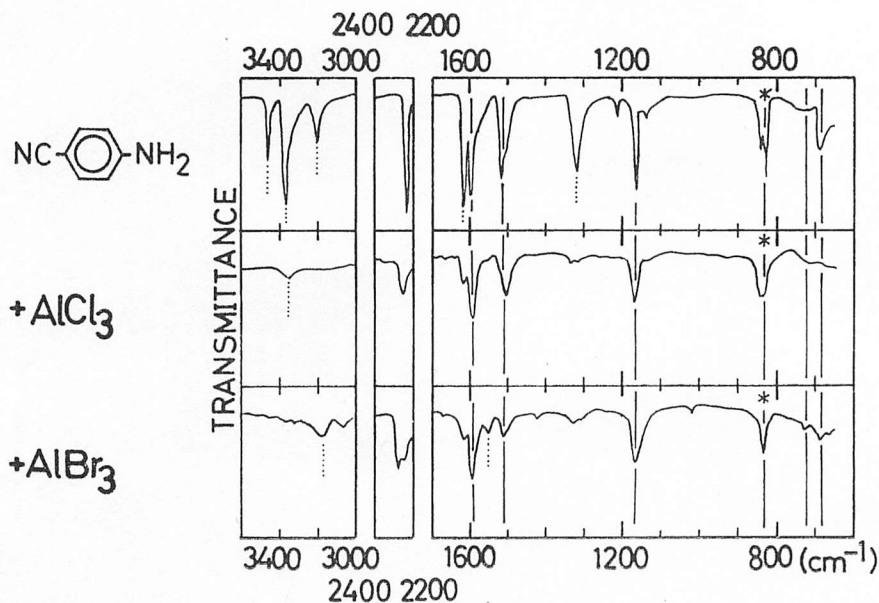


Fig. 2(a). IR spectra of *p*-aminobenzonitrile (KBr disc) and *p*-aminobenzonitrile adsorbed on aluminum chloride and on aluminum bromide. The bands related to the modes within the benzene ring and those of the amino group (C-N stretching inclusive) are shown by vertical solid and dotted lines, respectively. The C-H out-of-plane bending modes are marked by asterisks.

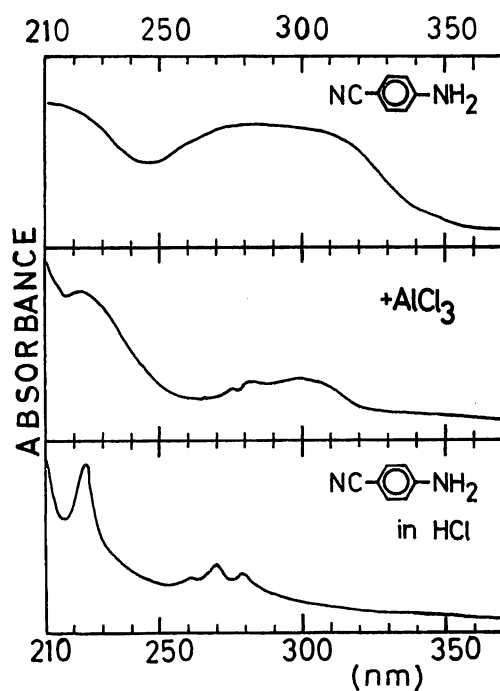


Fig. 2(b). UV spectra of *p*-aminobenzonitrile (evaporated film) and *p*-aminobenzonitrile adsorbed on aluminum chloride, and dissolved in hydrochloric acid.

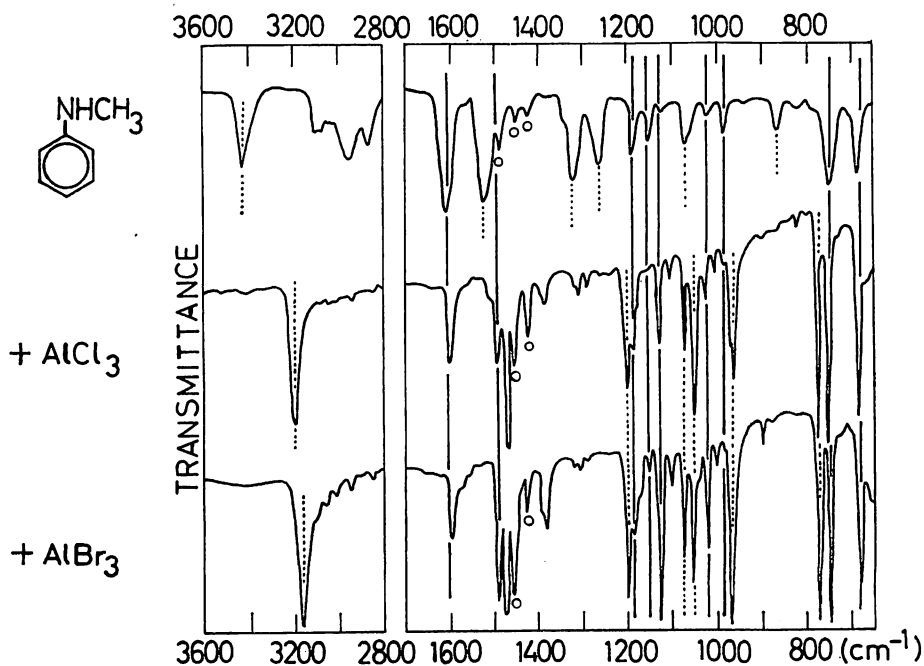


Fig. 3. IR spectra of *N*-methylaniline (liq. film) and *N*-methylaniline adsorbed on aluminum chloride and on aluminum bromide. The bands due to the modes within the benzene ring are shown by vertical solid lines, those of the methyl group by small circles. The bands with large change on adsorption are shown by vertical dotted lines.

a) 1, 5-Naphthylenediamine (VI). The classification of the IR bands of VI into (a) those associated with the modes within the naphthalene ring and (b) those related to the modes of the amino-group (C-N stretching inclusive) was made by referring to the IR spectrum of 1, 5-dimethylnaphthalene. The bands of group (a), shown by vertical solid lines in the figure, suffered little change on adsorption. Especially, the CH out-of-plane bending mode (shown by asterisks in the figure) remained essentially unchanged on adsorption. The distinct changes in the IR spectrum on adsorption was the following. The NH stretching mode ($3420\text{--}3230\text{ cm}^{-1}$) shifted to around 3220 cm^{-1} (a broad band). The band at 1632 cm^{-1} (NH_2 scissors) shifted to 1565 cm^{-1} . The band at 1290 cm^{-1} (C-N stretching) moved to 1186 cm^{-1} . The overall feature of IR bands of the system VIA is similar to those of IVA, IVB, VA, and VB. The UV spectrum of VIA also showed the feature similar to those of these systems.

b) *p*-Aminobenzonitrile (VII). The IR spectrum of VIIA showed only a small difference in comparison with that of VII, namely the small shift of the C-N stretching mode of cyano group from 2225 cm^{-1} (a sharp band) to 2240 cm^{-1} (a broad band). This spectrum will be attributed to a very weakly adsorbed species. It is known that the frequency of C-N mode of a cyano group on an aromatic ring is reduced by the presence of an electron-donating substituent like an amino-group.⁶⁾ The finding given above can be attributed to weakening of the electron-donating ability of the amino-group in this molecule on adsorption on aluminum chloride. The adsorption by the cyano group seems to be unlikely by comparison with VIIB (*vide infra*).

The IR spectrum of VIIB showed a larger difference from VII than in the case of VIIA. Although the spectrum given in the figure seems to be a superposition of that of adsorbed molecules and (a smaller portion of) free molecules, some distinct change in the spectrum on adsorption can be observed. A band at 1555 cm^{-1} appeared on adsorption at the expense of the 1620 cm^{-1} band (NH_2 scissors mode). The band at about 1300 cm^{-1} of free amine (C-N stretching mode of C-NH₂) seems to disappear on adsorption. The corresponding band of adsorbed amine is, however, difficult to locate. The 1177 cm^{-1} band (CH bending in plane) of the adsorbed amine is very broad, indicating that a broad band is superimposed on the lower frequency side of this band. This broad band superimposed can be attributed to the C-N stretching mode of C-NH₂ in the adsorbed molecule. A broad and intense band characteristic of adsorbed species was found at about 3200 cm^{-1} (NH stretching mode). These findings show clearly that the molecule is adsorbed by the amino-group, not by the cyano-group. The shift of C-N stretching mode in the cyano group to a higher frequency will be due to the reduced electron-donating ability of the amino-group on adsorption. From the spectra VIIA and VIIB, B seems to be a stronger electron-acceptor than A toward VII. The UV spectra of VIIA and VIIB showed the $^1\text{L}_b$ bands of adsorbed species, which are shifted to a shorter wavelength than in the free amine VII, in addition to the bands of free amine left in the samples used in the experiments.

c) *N*-Methylaniline (VIII). The assignments of IR bands of VIII were made after Hadzi and Skrblijak.⁷⁾ The bands due to the modes within benzene ring (shown by

vertical solid lines in the figure) and those of the methyl group (marked with small circles) remained essentially unchanged on adsorption. Large shifts or intensity changes on adsorption were observed for the bands of VIII at (in cm^{-1}) (1) 3470, (2) 1516, (3) 1319, (4) 1270, (5) 1070, and (6) 860. New bands appeared on adsorption were at (7) 3210 and 3166, (8) 1198 and 1198, (9) 1073 and 1072, (10) 1052 and 1053, (11) 963 and 968, and (12) 773 and 772, for VIIIA and VIIIB, respectively. The band (7) is undoubtedly

Table I. IR and UV spectra of adsorbed 1, 5-naphthylenediamine. Positions of bands in cm^{-1} (IR) and in nm (UV).

<i>IR Spectra</i>				
1, 5-naphthyl- enediamine(VI) evaporated film	1, 5-naphthyl- enediamine adsorbed on aluminum chloride (VIA)	1, 5-naphthyl- enediamine adsorbed on aluminum bromide (VIB)	Assignment*	
3440 m			} NH str.	
3360 s	3220 s br.			
3250 m				
3040 w			CH str.	
1632 s			NH ₂ bend.	
1590 s	1608 m		ν_{12} (1589)	
	1565 s		NH ₂ bend. (ads.)	
1522 s	1518 m		ν_{30} (1509)	
1432 s	1410 s		ν_{28} (1455), ν_4 (1450)	
1367 m			ν_{21} (1372)	
	1331 w			
1290 m	1290 w		C-N str.	
	1260 w		ν_{14} (1259)	
1210 w				
	1186 s		C-N str. (ads.)	
1170 m	1176 s		ν_{22} (1186)	
	1138 w		ν_{23} (1135)	
	1122 w		ν_{15} (1116)	
1065 m	1076 w			
930 m			ν_{32} (935)	
875 m	890 m			
764 s	774 s		CH bend. o. p. (3 adj. H)	
	730 w			
	685 m			
<i>UV Spectra</i>				
VI	VIA	VIB	VI+HCl	Assign.
242	242	230	220	¹ B _b
	277	274	269	
	288	283	278	¹ L _a
	300	292	287	
(350				CT
368				

* The modes within naphthalene ring (ν_1 's) are numbered after Scherer's assignment of naphthalene (J. R. Scherer, *J. Chem. Phys.*, **36**, 3308 (1962)). The positions of corresponding bands in naphthalene are given in parentheses.

the band (1) (NH stretching) shifted to a lower frequency. The band (4) was attributed to the mode mainly due to $C_{\text{arom}}-\text{N}$ stretching.⁷⁾ Considering the shift of 1272 cm^{-1} band of I (C-N stretching) to 1140 (in IA) and 1201 (in IB) cm^{-1} , the band (8) can be assigned to the $C_{\text{arom}}-\text{N}$ stretching mode in VIIIA and VIIIB. Little can be said on the assignments of the bands (9), (10), (11), and (12) and their relations to the bands (2), (3), (5), and (6) in the free amine.⁸⁾ These bands may be related to two NH deformation modes (parallel and perpendicular to CNC plane), $C_{\text{aliph}}-\text{N}$ stretching mode and CH_3 rocking mode. The UV spectrum of VIIIA¹⁾ and that of VIIIB show the feature drawing

Table II. IR and UV spectra of adsorbed *p*-aminobenzonitrile. Positions of bands in cm^{-1} (IR) and in nm (UV).

IR Spectra				
<i>p</i> -Aminobenzonitrile (VII); evaporated film	<i>p</i> -Aminobenzonitrile adsorbed on aluminum chloride (VIIA)	<i>p</i> -Aminobenzonitrile adsorbed on aluminum bromide (VIIB)	Assignment	
3480 s	3480 m	3470 w	} NH str.	
3364 s	3380 ms	3360 w		
3200 w	3220 m	3176 m br.		
		3100 m	CH str.	
2216 s	2256 s	2270 s	$\text{C}\equiv\text{N}$ str.	
		2240 sh		
1620 s	1620 s	1620 m	NH_2 bend.	
1600 s	1598 s	1598 s	ring str.	
		1560 m	NH_2 bend. (ads.)	
1512 s	1510 m	1510 w	ring def.	
		1500 w		
	1321 m	1430 w		
1313 s	1232 w	1328 w		
		1300 vw	C-N str.	
1208 w				
1170 s	1170 s	1166 s	CH bend. in plane (+ C-N str. *)	
1132 w				
		1012 vw		
837 m				
825 m	826 m	828 m	CH bend. out of plane (2 adj. H)	
	730 w	730 m	CH bend. out of plane	
690 m		682 w	ring def. out of plane	
UV Spectra				
VII	VIIA	VIIIB	VII+HCl	Assign.
<210	227		225	$^1\text{L}_a$
	273		264	
	280		271	$^1\text{L}_b$
	288		278	
290 broad	310 sh**			CT

* See text.

** The band of excess amine present.

nearer to the spectrum of ethylbenzene. This finding can be attributed to the weakening of the electron-donating ability of methylamino-group on adsorption on aluminum halides.

Table III. IR and UV spectra of adsorbed *N*-methylaniline. Positions of bands in cm^{-1} (IR) and in nm (UV).

<i>IR Spectra*</i>			
<i>N</i> -Methylaniline (VIII); evaporated film	<i>N</i> -Methylaniline adsorbed on aluminum chloride (VIII A)	<i>N</i> -Methylaniline adsorbed on aluminum bromide (VIII B)	Assignment
3470 (1)			NH str.
	3210 s	3166 s (7)	NH str.
3150			CH str. (arom.)
2970			CH str.
2830			CH str.
1608 s	1603 m	1593 m	ring str.
1516 s (2)	1493 m	1491 s	ring str. or NH def.
1486 m	1473 s	1470 s	} NCH ₃ def.
1459 w	1453 m	1458 s	
1430 w	1423 w	1421 w	
	1383 w	1379 m	?
1319 m (3)			?
1270 m (4)			} C _{arom} -N str.
	1198 s	1198 s (8)	
1180 m	1187 sh	1186 sh	CH bend. in plane
1150 m		1150 w	CH bend. in plane
1125 w	1128 m	1126 s	CH bend. in plane
	1103 w		
		1096 w	
1070 m (5)	1073 m	1072 m (9)	?
	1052 s	1053 m (10)	?
1023 w	1025 w	1022 m	CH bend. in plane
	1003 w		
		999 w	
990 m			ring breath.
	963 s	968 s (11)	?
	900 vw	898 w	
860 m (6)			?
	773 s	772 s (12)	?
749 m	753 s	747 s	CH bend. out of pl.
690 m	683 s	680 s	ring bend. out of pl.
<i>UV Spectra¹⁾</i>			
197			¹ L _a
238	210		
		249	¹ L _b
	254	253	
	258	260	
	264	266	
283			CT

* See text for the numbers in parentheses.

**PART II. Tables of IR and UV Absorption Bands on Aniline (I),
p-Toluidine (II), *p*-Chloroaniline (III), 1-Naphthylamine (IV)
 and 2-Naphthylamine (V) Adsorbed on Aluminum Halides**

Table IV. IR spectra of adsorbed aniline-h₇. Positions of bands in cm⁻¹.

Aniline-h ₇ (C ₆ H ₅ NH ₂)	Aniline-h ₇ ads. on aluminum chloride	Aniline-h ₇ ads. on aluminum bromide	Aniline-h ₇ ads. on aluminum iodide	Aniline-h ₇ ads. on gallium chloride	Assignment*
3436 s	3282 s	3238 s		3246 sh	NH str. (a)
3360 s	3238 s	3190 s	3124 s	3204 s	NH str. (a)
3222 m	3122 m	3094 m	3000 s br.	3110 m	NH str. (a)
3074 m	3075 sh			3048 m	CH str. (n)
3034 m	3040 m				CH str. (n)
1617 s					NH ₂ bend. (c)
1599 s	1601 s	1599 s	1590 s	1595 s	ring str. (p)
	1572 s	1559 s	1545 s	1562 s	NH ₂ bend. (c) (ads.)
1498 s	1495 s	1493 s	1485 s	1490 s	ring str. (p)
1466 m	1468 m	1468 m	1460 m	1465 m	ring str. (p)
			1370 w br.		
	1342 vw	1340 w			
		1320 vw			
1308 m					CH bend. i. p. (q)
1272 s					C-N str. (f)
			1276 m		
	1250 br.			1250 w br.	
	1217 w				
		1201 s	1164 s	1195 s	C-N str. (f) (ads.)
1172 ms		1174 s		1169 s	CH bend. i. p. (q)
1148 w				1140 sh	CH bend. i. p. (q)
	1140 s				C-N str. (f)
1118 w					CH bend. i. p. (q)
		1095 vw	1090 vw		
1050 w	1070 m	1071 m	1064 m	1067 m	NH ₂ tw. (i)
1026 mw	1027 m	1026 m	1019 m	1023 m	CH bend. i. p. (q)
996 mw	1001 vw	1000 vw			ring str. (p)
		960 vw			
878 m	900 m	900 m	882 w br.	899 m	CH bend. o. p. (s)
826 w sh					CH bend. o. p. (s)
810 vw sh	799 m	789 m	781 m	791 m	NH ₂ rock. (j)
750 s	752 s	751 s	742 s	753 s	CH bend. o. p. (s)
			730 w		
686 s	687 s	683 s	676 s	682 s	ring def. o. p. (u)
670 sh	655 m	660 sh			NH ₂ wag. (l)
615 vw	612 m	612 m			ring def. i. p. (u)
		577 m			
524 w	544 m	541 m			ring def. i. p. (u)
503	523 vw				ring def. o. p. (u)
	503 sh				
	483 s				AlCl ₃ skeletal (v)
	468 s				
		400 vs			AlBr ₃ skeletal (v)

* The notation in Ref. 1 is given in parentheses.

Table V. IR and UV spectra of adsorbed *p*-toluidine. Positions of bands in cm^{-1} (IR) and in nm (UV).

<i>IR Spectra</i>				
<i>p</i> -toluidine (II) evaporated film	<i>p</i> -toluidine adsorbed on aluminum chloride (with excess amine) (IIA(e))	<i>p</i> -toluidine adsorbed on aluminum chloride (IIA(0))	<i>p</i> -toluidine adsorbed on aluminum bromide (IIB)	Assignment
3420 m				NH str.
3345 s	3290 m	3240 sh		NH str.
3275 w	3230 m	3200 s	3200 s	NH str.
3220 w				
3020 m			3000 w	CH str.
2920 m				CH str.
1620 s				NH ₂ bend.
1580 m	1575 m			ring str.
	1560 w	1560 m	1560 m	NH ₂ bend. (ads.)
			1540 w	
	1518 m			
1510 s	1510 m	1510 m	1510 m	ring str.
1380 vw	1382 w	1380 vw	1380 vw	
1323 vw				ring str.
1277 s				C-N str.
1265 s				
	1220 w	1218 w	1200 w	
		1187 s	1182 s	C-N str. (ads.)
1174 m	1182 w	1180 s	1174 s	CH bend. i. p.
	1164 s			
	1150 s			C-N str. (ads.)
	1130 m			
1120 w	1110 w	1120 vw	1120 w	CH bend. i. p.
			1105 w	
1040 w	1040 vw	1040 vw	1040 w	CH ₃ rock.
	1022 w	1021 w	1020 w	CH bend. i. p.
	821 s		830 w	
810 s	818 s	818 s	808 s	CH bend. o. p.*
	762 w	760 vw	760 w	
	745 w	738 w	734 w	CH bend. o. p.
	680 s	690 m	680 m	ring def. o. p.
	665 s			
<i>UV Spectra</i>				
232				¹ L _a
260 sh		260	260 sh	
	270	267	267	¹ L _b
	277	273	274	
	289			
290	293 **	295 sh**		CT
	296			
	300			

* 2 adjacent H

** The band of excess amine present

Table VI. IR and UV spectra of adsorbed *p*-chloroaniline. Positions of bands in cm^{-1} (IR) and in nm (UV).

IR Spectra				
<i>p</i> -chloro-aniline (III) evaporated film	<i>p</i> -chloro-aniline adsorbed on aluminum chloride (with excess amine) (IIIA(e))	<i>p</i> -chloro-aniline adsorbed on aluminum chloride (IIIA(0))	<i>p</i> -chloro-aniline adsorbed on aluminum bromide (IIIB)	Assignment
3480 m				} NH str.
3390 m	3285 m	3235 m		
	3240 m	3205 s	3195 s	
	3145 w	3110 w	3105 w	CH str.
	1620 vw			NH ₂ bend.
1614 s				
	1608 vw			
	1580 m	1564 s	1565 s	NH ₂ bend. (ads.) ring def.
1500 s	1498 s	1495 s	1495 s	
1490 s				C-N str.
1435 vw	1432 w	1430 m	1427 m	
1289 s				
	1220 w	1218 w	1203 w	C-N str. (ads.) CH bend. i. p.
		1188 s	1175 s	
1180 m				
	1167 m			C-N str. (ads.)
	1142 s			
	1134 m			
1116 w		1119 w	1117 m	CH bend. i. p.
1090 s	1099 s	1099 s	1100 s	C-Cl str.
	1019 m	1018 m	1017 m	CH bend. i. p.
1004 w				ring def.
825 m	826 s	826 s	822 s	CH bend. o. p.*
817 m				ring def. o. p.
			770 w	
	682 m	698 m	700 m	
UV Spectra				
235				¹ L _a
		248		¹ L _b
		255		
265 sh		263	263	
	272	270	269	
	278	277	277	
300	295 sh**			CT

* 2 adjacent H

** The band of excess amine present

Table VII. IR and UV spectra of adsorbed 1-naphthylamine. Positions of bands in cm^{-1} (IR) and in nm (UV).

<i>IR Spectra</i>				
1-naphthylamine (IV); evaporated film	1-naphthylamine adsorbed on aluminum chloride (IVA)	1-naphthylamine adsorbed on aluminum bromide (IVB)	Assignment*	
3420 m	3240 m	3240 m	} NH str.	
3356 s	3180 s	3180 s		
3236 m	3110 m	3090 m		
3048 m	3050 m	3050 sh	CH str.	
1620 s			NH ₂ bend.	
1574 s	1601 m	1601 m	ν_{12} (1589)	
	1565 s	1559 s	NH ₂ bend. (ads.)	
	1530 m			
1513 s	1512 m	1511 m	ν_{20} (1509)	
1458 s	1450 w	1450 w	ν_{29} (1455), ν_4 (1450)	
1406 s	1399 s	1398 s	ν_{13} (1393)	
1376 s			ν_5 (1380), ν_{21} (1372)	
1290 s			C-N str.	
	1267 w	1268 w	ν_{14} (1259)	
1250 vwsh	1240 vw	1242 w	ν_{30} (1246)	
		1220 sh		
	1200 s	1190 s	C-N str. (ads.)	
1177 w			ν_{22} (1186)	
1163 w	1160 w	1160 m	ν_6 (1172)	
	1131 w	1140 sh	ν_{28} (1135)	
1090 m	1075 m	1075 m	ν_{15} (1116), ν_{31} (1116)	
		1030 w		
1013 m	1007 m	1010 m	ν_7 (1004), ν_{24} (1000)	
958 w	960 vw	968 w	ν_{32} (935)	
	951 vw	950 w		
		898 w		
878 w	860 w	863 w		
858 w	850 w br.	850 w		
790 s	790 s	790 s	CH bend. o. p. (3 adj. H)	
770 s	765 s	758 s	CH bend. o. p. (4 adj. H)	
	730 w	727 vw		
	707 w	710 m		
	675 m	670 m		
<i>UV Spectra</i>				
IV	IVA	IVB	IV+HCl	Assign.
242	220	226	220	¹ B ₀
	(275	(264	(260	¹ L _a
	287	278	268	
	295	287	278	
		298	285	
334				CT

* The modes within naphthalene ring (ν_i 's) are numbered after Scherer's assignment of naphthalene (J. R. Scherer, *J. Chem. Phys.*, **36**, 3308 (1962)). The positions of corresponding bands in naphthalene are given in parentheses.

Table VIII. IR and UV spectra of adsorbed 2-naphthylamine. Positions of bands in cm^{-1} (IR) and in nm (UV).

<i>IR Spectra</i>				
2-naphthylamine (V); evaporated film	2-naphthylamine adsorbed on aluminum chloride (VA)	2-naphthylamine adsorbed on aluminum bromide (VB)	Assignment*	
3450 m		3236 sh	} NH str.	
3360 s	3205 s	3176 s		
3270 m		3086 m		
3040 m			CH str.	
1630 s			NH ₂ bend.	
1601 m	1603 w		ν_{12} (1589)	
	1557 s	1557 s	NH ₂ bend. (ads.)	
	1538 w	1541 w	ν_3 (1568)	
		1517 m		
1512 s	1503 m	1508 m	ν_{20} (1509)	
1475 w	1470 m	1473 w	ν_{20} (1455)	
1450 w		1455 w	ν_4 (1450)	
1385 w			ν_{13} (1393)	
1360 w	1370 w	1372 w	ν_{21} (1372)	
		1330 vw		
1280 m			C-N str.	
1265 w	1266 vw	1268 vw	ν_{14} (1259)	
		1253 vw	ν_{30} (1246)	
1223 m	1220 vw			
	1198 s	1189 s	C-N str. (ads.)	
1183 m			ν_{22} (1186)	
	1156 w	1157 m	ν_6 (1172)	
1145 w	1140 w	1143 w	ν_{23} (1135)	
1125 w	1118 w	1120 w	ν_{15} (1116)	
1020 w			ν_{24} (1000)	
957 m	953 m	955 w	ν_{32} (935)	
880 w	880 m	887 m		
855 s	855 m	853 m	CH bend. o. p. (isol. H)	
814 s	808 s	808 m	CH bend. o. p. (2 adj. H)	
742 s	752 m	746 m	CH bend. o. p. (4 adj. H)	
	738 w			
710 m		708 w		
	679 s	680 m		
<i>UV Spectra</i>				
V	VA	VB	V+HCl	Assign.
241	220	230	220	¹ B _b
	272	273	267	
294	282	284	275	¹ L _a
	292	295	283	
	300 w sh	300 w sh	302	¹ L _b
346				CT

* The modes within naphthalene ring (ν_i 's) are numbered after Scherer's assignment of naphthalene (J. R. Scherer, *J. Chem. Phys.*, **36**, 3308 (1962)). The positions of corresponding bands in naphthalene are given in parentheses.

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