

## **Solid-state Vibrational Spectroscopic Investigation of Cocrystal and Salt of Indomethacin**

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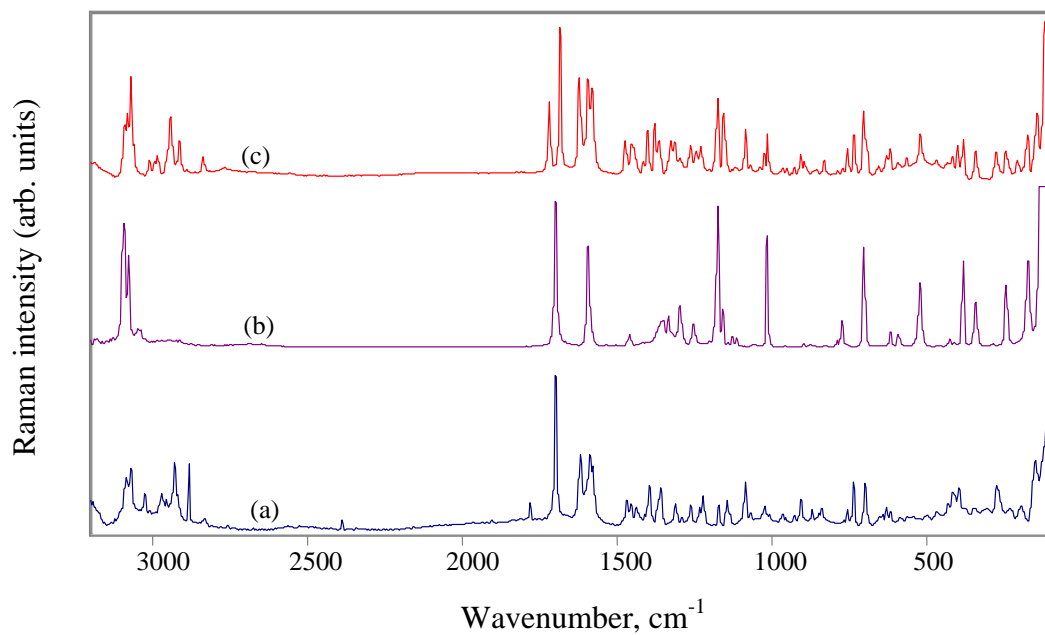


Figure I. Baseline corrected Raman spectra of (a) IND, (b) SAC and (c) IND-SAC in the region of (150-3200 cm<sup>-1</sup>)

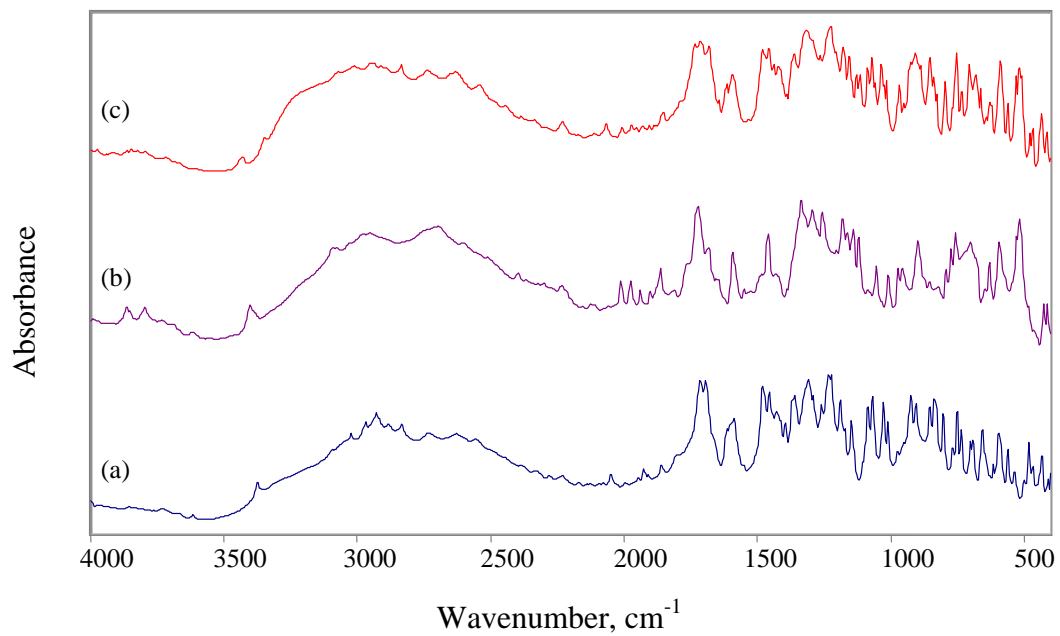


Figure II. IR spectra of (a) IND, (b) SAC and (c) IND-SAC in the region of (400-4000) cm<sup>-1</sup>)

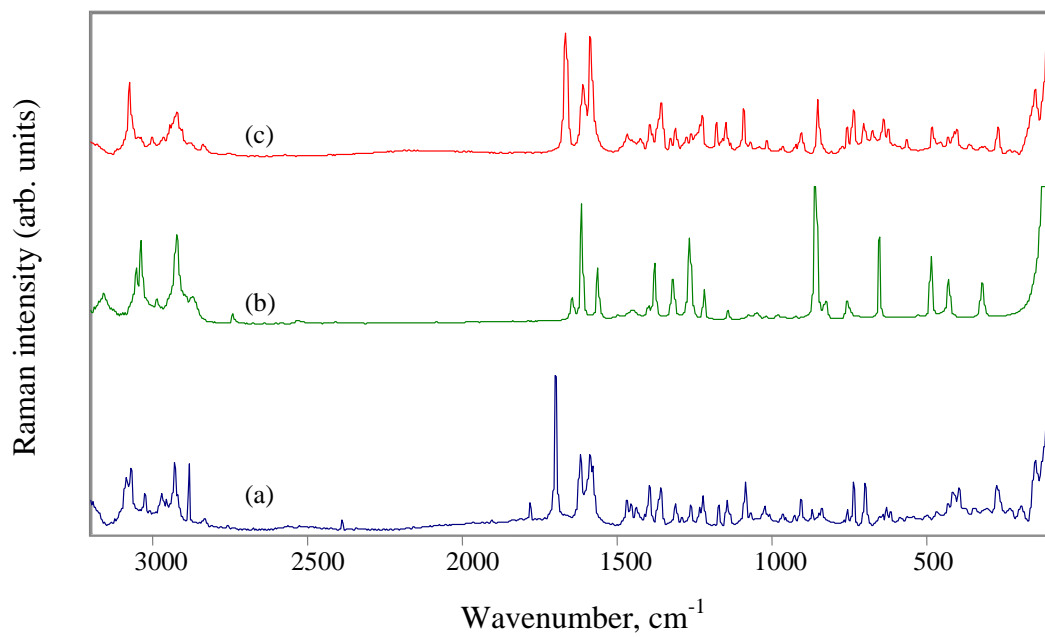


Figure III. Baseline corrected Raman spectra of (a) IND, (b) AMP and (c) IND-AMP in the region of (150-3200 cm<sup>-1</sup>)

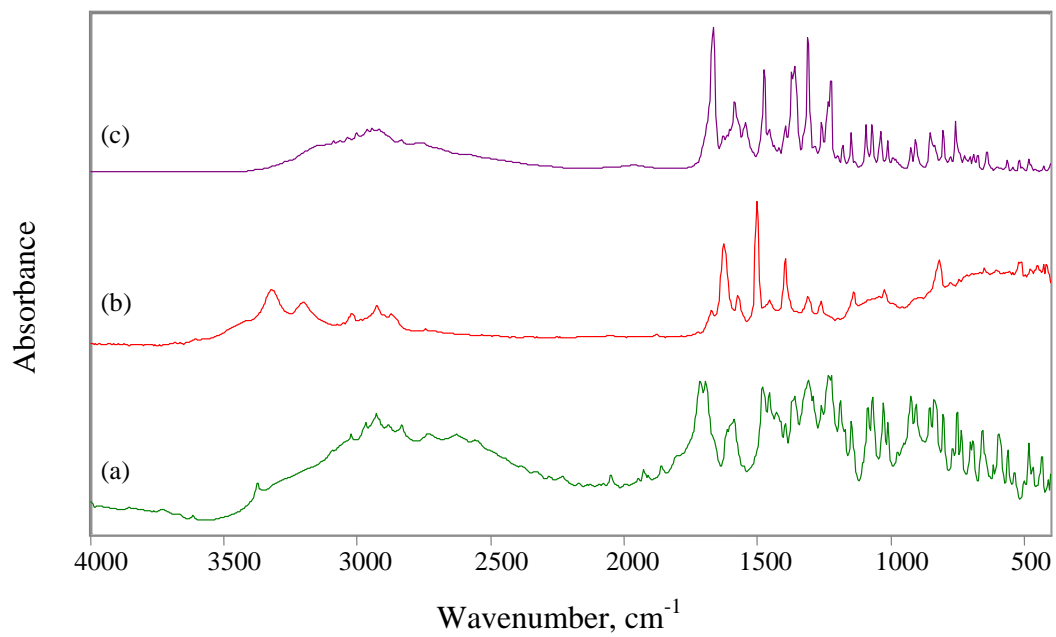


Figure IV. IR spectra of (a) IND, (b) AMP and (c) IND-AMP in the region of (400-4000 cm<sup>-1</sup>)

Table I. Vibrational wavenumbers of IND, IND-SAC and SAC

IND		IND-SAC		SAC		Proposed Assignment
IR	Raman	IR	Raman	IR	Raman	
		3430 mw		3402 mw		$\nu(\text{NH})$
3370 w		3346 w				$\nu(\text{OH})$
	3084 ms		3088 ms		3091 s	$\nu(\text{CH})$
			3078 ms		3076 m	$\nu(\text{CH})$
	3067 ms		3067 s			$\nu(\text{CH})$
			3062 m,sh			$\nu(\text{CH})$
					3040 w,br	$\nu_{\text{as}}(\text{CH}_2)$
	3024 mw					$\nu_{\text{as}}(\text{CH}_2)$
			3009 mw			$\nu(\text{CH}_2)$
			2987 mw,sh			$\nu(\text{C}=\text{CH})$
	2973 w,sh		2980 m			combination: $\nu(\text{CH})$ and $\nu(\text{OH})$
	2966 mw					combination: $\nu(\text{CH})$ and $\nu(\text{OH})$
	2953 w		2946 m,sh			combination: $\nu(\text{CH})$ and $\nu(\text{OH})$
	2928 s		2940 ms			$\nu(\text{CH}_3)$
	2918 m,sh		2912 m			C-C ring modes
	2880 s					combination: (C=O) in-plane and C-C ring modes
	2832 w		2832 m			combination: (C=O) in-plane and C-C ring modes
	1782 w					
		1736 s		1720 s		$\nu(\text{C}=\text{O})$
1713 s		1710 s	1717 s			$\nu(\text{C}=\text{O})$ of the carboxylic acid dimer
1691 s	1698 s			1696 ms,sh	1698 s	$\nu(\text{C}=\text{O})$
		1682 s	1684 vs			$\nu(\text{C}=\text{O})$
		1644 mw		1644 m,sh		$\nu(\text{C}=\text{O})$
1613 ms,sh	1620 s	1613 ms	1622 s	1628 w,sh		$\nu(\text{C}=\text{C})$
1592 ms,sh	1590 s	1592 ms	1594 s	1592 ms	1594 s	$\nu(\text{C}-\text{C})_{\text{ring}}$

Table I. Vibrational wavenumbers of IND, IND-SAC and SAC (cont.)

IND		IND-SAC		SAC		Proposed Assignment
IR	Raman	IR	Raman	IR	Raman	
	1579 s		1579 s			$\nu(\text{C-C})_{\text{ring}}$
1548 w,sh				1548 w		$\delta(\text{CCC})$
1479 s	1466 m	1479 s	1472 m	1479 mw,sh	1466 w	$\delta(\text{CCH})$
1455 s	1456 m	1455 s	1456 m,br	1459 s	1456 w	$\nu(\text{C-C})_{\text{ring}}$
1437 ms,sh	1440 mw	1437 ms		1437m,sh,br		$\delta(\text{CH})$
1420 m,br	1412 vw	1420 m,br	1412 w			$\nu(\text{C-N})$
		1405 m,sh	1401 m			$\delta(\text{O-H})$
1394 mw	1396 ms	1394 w		1394 w		$\nu(\text{C-N})$
			1378 m			$\delta(\text{CH}_3)$
1364 ms,br	1365 m,sh	1364 ms,br	1365 m	1364 m,sh	1365 mw,br	$\delta(\text{CH}_2)$
	1359 ms					$\delta(\text{CH}_2)$
			1333 mw,sh		1333 mw	$\nu(\text{CC})$
			1326 m		1326 w,sh	$\nu(\text{CC})$
1319 s,br		1319 s,br				in-plane $\delta(\text{CH})$
	1311 m		1313 m			in-plane $\delta(\text{CH})$
1289 ms,sh	1287 vw	1294 ms,sh	1296 w	1294 ms	1296 mw	in-plane $\delta(\text{COOH})$
		1278 w,sh		1278 ms,sh		$\nu_{\text{as}}(\text{SO}_2)$
1260 mw	1261 m	1264 w	1261 mw		1253 w	in-plane $\delta(\text{C=O})$
1232 s	1234 m	1232 mw,sh	1242 mw			$\nu(\text{C-OH})$
1223 s	1219 ms	1223 s	1226 mw			in-plane $\delta(\text{CH})$
		1203 m,sh		1203 w		
1189 ms						$\delta(\text{CH}_2)$ wagging mode
1178 m,sh	1171 m	1178 ms	1174 s	1178 ms	1174 s	$\delta(\text{CH})$ rocking mode
		1157 ms	1157 ms	1162 m	1156 mw	$\nu(\text{SO}_2)$ and $\delta(\text{CSN})$
1148 ms	1147 ms	1146 mw,sh				$\delta(\text{CH})$ twisting mode

Table I. Vibrational wavenumbers of IND, IND-SAC and SAC (cont.)

IND		IND-SAC		SAC		Proposed Assignment
IR	Raman	IR	Raman	IR	Raman	
1137 mw,sh	1137 mw,sh			1137 m		in-plane $\delta(\text{CH})$
		1129 m			1127 w	$\nu(\text{CC})$
		1118 m	1115 w	1118 m	1115 w	$\nu(\text{C-N})$
1107 w,sh		1107 vw,sh				in-plane $\delta(\text{CC})$
1087 s	1089 s	1087 ms	1089 ms	1087 vw		$\delta(\text{CCC})$
1068 s	1068 w	1071 s	1071 w			$\delta(\text{CH})$ rocking mode
		1058 m,sh		1058 m		$\nu(\text{C-S})$
		1036 s	1042 w	1036 w,sh		$\delta(\text{CH})$
1028 s	1030 w,sh	1028 m,sh	1025 mw			$\nu(\text{C-OH})$
1015 ms	1020 mw	1016 ms	1016 ms		1016 ms	$\delta(\text{CCC})$
	1005 w	1011 mw,sh				$\nu_{\text{as}}(\text{C-OH})$
974 vw,sh		974 w,sh	972 w,sh	974 m		out-of-plane $\delta(\text{CH})$
	969 mw	968 ms	969 w			out-of-plane $\delta(\text{CH})$
950 vw,sh	954 w	950 w	953 w	950 m		$\delta(\text{C-C-C})$
927 s	930 mw	927 ms,sh	927 w			out-of-plane $\delta(\text{COOH})$
		910 s	910 mw			out-of-plane $\delta(\text{C=O})$
906 ms	907 ms	906 ms,sh				
		898 ms,sh	894 w	898 ms		
	871 mw	885 ms,sh	885 vw,sh	885 mw,sh		
854 ms	850 w	854 s	860 w,br	854 vw		
835 ms	835 vw	835 ms	835 vw,sh			out-of-plane $\delta(\text{CH})_{\text{ring}}$
		828 m	828 w	828 vw		out-of-plane $\delta(\text{CH})_{\text{ring}}$
801 ms		797 ms				$\delta(\text{C-H})$ rocking mode
		793 ms,sh	789 vw	793 mw	789 vw	$\delta(\text{C-H})$ rocking mode
769 w	766 vw	769 mw,sh	774 vw	774 mw	774 mw	out-of-plane $\delta(\text{CH})_{\text{ring}}$



Table I. Vibrational wavenumbers of IND, IND-SAC and SAC (cont.)

IND		IND-SAC		SAC		Proposed Assignment
IR	Raman	IR	Raman	IR	Raman	
753 ms	753 mw	757 ms	755 mw	757 mw		ring torsion
	738 s	737 mw	738 mw			out-of-plane $\delta(\text{COOH})$
				716 m,br		$\nu(\text{CC})$
701 m	702 s	701 ms	702 m	701 m	702 m	ring torsion
691 m		681 m	697 m,sh	691m,sh,br		ring torsion
657 ms	653 w	664 m	658 w			out-of-plane $\delta(\text{C-H})$
649 m,sh	641 w	642 vw		649 vw		out-of-plane $\delta(\text{C-H})$
629 vw	629 mw	629 mw,br	629 w	629 m		in-plane ring deformation mode
615 w	617 mw		617 mw		617 w	$\delta(\text{CCC})_{\text{ring}}$
596 m,br		596 m,sh	593 w		593 w	$\delta(\text{CCC})_{\text{ring}}$
		591 s		591 ms		$\delta(\text{SO}_2)$
	586 w	578 mw,sh		578 w,sh		
563 m	562 w	563 m	566 w			in-plane $\delta(\text{CCN})$
537 mw	543 w			537 w,sh		$\delta(\text{CCC})$
		529 s	523 mw	529 ms	523 mw	$\delta(\text{CNS})$
	520 vw	517 s		517 s		out-of-plane $\delta(\text{CC})$
		512 s,sh				out-of-plane $\delta(\text{CC})$
496 w,sh	499 w			491 w,sh		in-plane $\delta(\text{CC})_{\text{chain}}$
483 ms	480 vw	483 mw				ring torsion
469 mw	469 w	469 mw	469 w	469 w,sh		ring torsion
432 m	430 w	432 m	432 w	428 mw	430 vw	out-of-plane $\delta(\text{CCC})$
413 w	418 ms	413 mw	418 w	413 mw		out-of-plane $\delta(\text{CCC})$
	399 ms		399 mw			ring deformation
			384 mw		384 m	ring deformation
	351 w		344 mw		344 mw	ring deformation

Table I. Vibrational wavenumbers of IND, IND-SAC and SAC (cont.)

IND		IND-SAC		SAC		Proposed Assignment
IR	Raman	IR	Raman	IR	Raman	
	308 w					
	269 s		276 mw			(CH <sub>3</sub> )τ
	230 mw		243 mw		243 mw	skeletal deformation
	196 m		206 w			skeletal deformation
			174 m		174 m	skeletal deformation
	147 s		147 m			skeletal deformation
					135 ms	
			121 s		121 s	

br, m, s, sh, w and v stand for broad, medium, strong, shoulder, weak and very, respectively and  $\nu$ ,  $\delta$  and  $\tau$  stand for stretching, deformation and torsional respectively.

Table II. Vibrational wavenumbers of IND, AMP-IND and AMP

IND		AMP-IND		AMP		Proposed Assignment
IR	Raman	IR	Raman	IR	Raman	
				3388 s,sh		hydrogen-bonded $\nu_{as}(\text{NH}_2)$
3370 w						$\nu(\text{OH})$
				3318 s,br		hydrogen-bonded $\nu_{as}(\text{NH}_2)$
				3200 m		hydrogen-bonded $\nu_{as}(\text{NH}_2)$
					3157 m	hydrogen-bonded $\nu_{as}(\text{NH}_2)$
			3112 vw			$\nu(\text{NH}^+)$
	3084 ms		3072 s	3074 vw		$\nu(\text{CH})$
	3067 ms		3064 m,sh	3052 vw	3050 ms	$\nu(\text{CH})$
			3040 mw,br		3035 s	$\nu(\text{CH})$
	3024 mw			3017 mw		$\nu(\text{CH})$
			3001 mw			$\nu(\text{CH})$
	2973 w,sh				2981 w	$\nu_{as}(\text{CH}_3)$
	2966 mw		2963 mw			$\nu(\text{CH})$
	2953 w		2943 m		2939 w,sh	$\nu_{as}(\text{CH}_3)$
	2928 s			2927 mw		$\nu(\text{CH}_3)$
	2918 m,sh		2920 ms		2920 s	$\nu_{as}(\text{CH}_3)$
			2903 m	2898 vw,sh		$\nu(\text{CH}_3)$
	2880 s		2877 mw,br	2870 w	2870 mw	$\nu(\text{CH}_3)$
						$\nu(\text{CH}_3)$
	2832 w		2834 mw			combination: (C=O) in-plane and C-C ring modes
			2748 vw,br		2738 w	
	1782 w					
1713 s						$\nu(\text{C}=\text{O})$ of the carboxylic acid dimer
1691 s	1698 s					Benzoyl $\nu(\text{C}=\text{O})$
		1665 vs	1665 vs			Benzoyl $\nu(\text{C}=\text{O})$

Table II. Vibrational wavenumbers of IND, AMP-IND and AMP (cont.)

IND		AMP-IND		AMP		Proposed Assignment
IR	Raman	IR	Raman	IR	Raman	
					1645 mw	$\delta(\text{NH}_2)$ and $\nu(\text{C}=\text{C})$
1613 ms,sh	1620 s	1628 w		1623 s,br	1613 s	$\nu(\text{C}=\text{C})$
			1611 s			$\nu(\text{COO}^-)$
1592 ms,sh	1590 s	1588 m	1588 vs			$\nu(\text{C}-\text{C})_{\text{ring}}$
					1563 m	$\delta(\text{NH}_2)$ and $\nu(\text{C}=\text{C})$
	1579 s	1572 w,sh		1572 mw		$\nu(\text{C}-\text{C})_{\text{ring}}$
1548 w,sh						$\delta(\text{CCC})$
				1501 vs		$\delta(\text{CH}_3)$
		1483 mw,sh				$\delta(\text{NH}^+)$
1479 s		1474 ms	1475 vw,sh			$\delta(\text{CCH})$
	1466 m		1465 w			$\delta(\text{CCH})$
1455 s	1456 m	1454 w		1454 vw	1450 w,br	$\nu(\text{C}-\text{C})_{\text{ring}}$
1437 ms,sh	1440 mw	1434 w				$\delta(\text{CH})$
1420 m,br	1412 vw	1417 w	1426 w			$\nu(\text{C}-\text{N})$
1394 mw	1396 ms	1399 w,sh	1396 mw	1394 ms	1398 w	$\nu(\text{C}-\text{N})$
					1377 ms	$\delta(\text{CH}_3)$
		1370 ms				$\nu_{\text{as}}(\text{COO}^-)$
1364 ms,br	1365 m,sh					$\delta(\text{CH}_2)$
	1359 ms	1358 ms	1357 m			$\delta(\text{CH}_2)$
1319 s,br		1322 w,sh	1329 w		1321 m	in-plane $\delta(\text{CH})$
	1311 m	1310 s	1310 mw	1310 w		in-plane $\delta(\text{CH})$
1289 ms,sh	1287 vw	1287 w,sh				$\nu(\text{C}-\text{C})$
			1275 w			$\nu(\text{COO}^-)$
1260 mw	1261 m	1261 mw	1260 vw	1261 w	1265 ms	$\delta(\text{C}-\text{N})$
1232 s	1234 m					$\nu(\text{C}-\text{C H}_3)$

Table II. Vibrational wavenumbers of IND, AMP-IND and AMP (cont.)

IND		AMP-IND		AMP		Proposed Assignment
IR	Raman	IR	Raman	IR	Raman	
		1232 s				in-plane $\delta$ (COO <sup>-</sup> )
			1226 mw			in-plane $\delta$ (COO <sup>-</sup> )
1223 s	1219 ms	1223 s			1220 mw	in-plane $\delta$ (CH)
1189 ms		1198 vw				$\delta$ (CH <sub>2</sub> ) wagging mode
1178 m,sh	1171 m	1178 mw	1178 mw			$\delta$ (CH) rocking mode
			1155 w,sh			$\delta$ (NH <sub>2</sub> ) rocking mode
1148 ms	1147 ms	1149 m	1148 mw			$\delta$ (CH) twisting mode
1137 mw,sh	1137 mw,sh	1139 w,sh	1133 vw,sh	1139 mw	1142 w	in-plane $\delta$ (CH)
1107 w,sh						in-plane $\delta$ (CC)
1087 s	1089 s	1092 ms	1090 m			$\delta$ (CCC)
1068 s	1068 w	1070 ms	1071 vw			$\delta$ (CH) rocking mode
		1040 m	1041 vw		1050 vw	in-plane $\delta$ (CC) and $\delta$ (NH <sub>2</sub> ) rocking mode
1028 s	1030 w,sh					$\nu$ (C-OH)
1015 ms	1020 mw	1014 m	1018 w	1023 mw		$\delta$ (CCC)
	1005 w					$\nu_{as}$ (C-OH)
		990 w		992 vw,br		Ring breathing
		983 w,sh			981 vw	Ring breathing
974 vw,sh			970 vw,sh			out-of-plane $\delta$ (CH)
	969 mw		963 vw			out-of-plane $\delta$ (CH)
950 vw,sh	954 w			956 vw		$\delta$ (C-C-C)
927 s	930 mw	927 m	927 w			in-plane $\delta$ (C-C-C)
906 ms	907 ms	909 ms				
		904 m,sh	904 mw			out-of-plane $\delta$ (COO <sup>-</sup> )
	871 mw					
854 ms	850 w	851 ms	850 ms	851 w,sh	860 vs	out-of-plane $\delta$ (CH)
835 ms	835 vw	837 m,sh		827 ms,sh	826 w	out-of-plane $\delta$ (CH) <sub>ring</sub>

Table II. Vibrational wavenumbers of IND, AMP-IND and AMP (cont.)

IND		AMP-IND		AMP		Proposed Assignment
IR	Raman	IR	Raman	IR	Raman	
801 ms		804 ms	806 vw	817 ms		$\delta(\text{C-H})$ rocking mode
769 w	766 vw	776 w	775 vw	776 vw		out-of-plane $\delta(\text{CH})_{\text{ring}}$
753 ms	753 mw	758 s	757 mw		758 mw	ring torsion
		751 mw,sh		744 w		out-of-plane $\delta(\text{CH})$
	738 s		735 m			in-plane $\delta(\text{C-C-C})$
		722 w		715 vw,br		in-plane $\delta(\text{C-C-C})$
701 m	702 s	703 w	701 mw			ring torsion
691 m		689 mw				$\delta(\text{COO}^-)$
		675 mw	676 w			$\delta(\text{COO}^-)$
657 ms	653 w			651 w	654 ms	out-of-plane $\delta(\text{C-H})$
649 m,sh	641 w	640 mw	640 mw			out-of-plane $\delta(\text{C-H})$
629 vw	629 mw		623 w			in-plane ring deformation mode
615 w	617 mw					$\delta(\text{CCC})_{\text{ring}}$
596 m,br		600 vw	600 vw	600 vw		$\delta(\text{CCC})_{\text{ring}}$
	586 w	587 vw	585 vw			
563 m	562 w	565 mw	565 w			in-plane $\delta(\text{CCN})$
537 mw	543 w	543 w		543 vw		$\delta(\text{CCC})$
	520 vw	518 mw		518 m,br	522 vw	out-of-plane $\delta(\text{CNC})$
496 w,sh	499 w	509 w,sh		496 vw		in-plane $\delta(\text{CC})_{\text{chain}}$
483 ms	480 vw	482 mw	482 mw		488 m	ring torsion
		478 w,sh		478 w,br		NH <sub>2</sub> wagging
469 mw	469 w	459 vw	456 w	459 w,sh		ring torsion
432 m	430 w	428 w	430 w	428 mw	430 mw	out-of-plane $\delta(\text{CCC})$
413 w	418 ms		415 mw	416 mw		out-of-plane $\delta(\text{CCC})$
				412 mw		out-of-plane $\delta(\text{C-NH}_2)$
	399 ms		404 mw			ring deformation

Table II. Vibrational wavenumbers of IND, AMP-IND and AMP (cont.)

IND		AMP-IND		AMP		Proposed Assignment
IR	Raman	IR	Raman	IR	Raman	
	351 w		362 w			ring deformation
			322 vw		323 mw	out-of-plane $\delta(\text{C-NH}_2)$ and $\delta(\text{C-CH}_3)$
	308 w		309 vw			
	269 s		272 m			$(\text{CH}_3)\tau$
	230 mw		232 vw			skeletal deformation
	196 m		211 vw			skeletal deformation
	147 s		146 s			skeletal deformation

br, m, s, sh, w and v stand for broad, medium, strong, shoulder, weak and very, respectively and  $\nu$ ,  $\delta$  and  $\tau$  stand for stretching, deformation and torsional respectively.