CHAPTER IV

RESULTS AND DISCUSSION

4.1 SAMPLE COLLECTION

Release liner samples were provided by Flex Con Company, an adhesive supplier for labels manufactured for disc drive companies. Since most release liners use the same type of siloxane, similar additives and raw materials, 8 different types of release liner and label samples (Table 4.1) from Flex Con used in this study were believed to provide good representative data.

Table 4.1 Various release liner and label samples from Flex Con used in this study

Item	Description	Vendor
1	Release liner 90 PFW	Flex Con
2	Release liner 150 Poly STH-9	Flex Con
3	Release liner Specsok-8	Flex Con
4	Release liner EX 200 Poly SC-9	Flex Con
5	Label and Release liner ST-2412014	Flex Con
6	Label and Release liner ST-2412024	Flex Con
7	Label and Release liner ST-2412034	Flex Con
8	Label and Release liner ST-2412044	Flex Con

4.2 FT-IR ANALYSIS, DHS OUTGASSING TEST, GC/MSD ANALYSIS RESULTS OF FLEX CON RELEASE LINERS AND ADHESIVE SITE FOR SILICONE CONTENT

In this study, silicone from release liners and labels adhesive site was quantified via hexane extraction and the extract was later deposited on the KRS-5 crystal then analyzed by FT-IR. In this study we used KRS-5 crystal (VATR) instead of normal cuvet liquid sample cell because the ATR method using the KRS-5 crystal has been proven to be more sensitive than normal liquid sample cell, especially at a trace level. Based on FT-IR analysis on the extracted solution, the amount of silicone could be quantified as shown in Table 4.2.

Table 4.2 Amount of silicone detected from FT-IR analysis

Repeat #	Release liner 150 Poly STH-9 (ng/cm^2)	Release liner 90 PFW (ng/cm^2)	Release liner ST-2412034 (ng/cm^2)	Release liner ST-2412014 (ng/cm^2)	Release liner Specsok-8 (ng/cm^2)	Release liner EX 200 Poly SC-9, ST-2412024, ST-2412044, Label ST-2412014, ST-2412024, ST-2412034 and ST-2412044
Rep.1	0.07	0.09	0.12	0.43	0.68	ND
Rep.2	0.07	0.09	0.12	0.41	0.55	ND
Rep.3	0.09	0.08	0.09	0.41	0.58	ND
Average	0.08	0.09	0.11	0.42	0.60	ND
Std.dev.	0.01	0.01	0.02	0.01	0.07	NA
%RSD	10.09	9.02	13.33	2.51	11.28	NA

The FT-IR results in Table 4.2 indicate that silicone from some release liner could be quantified at a low level using FT-IR. On the other

hand, silicone could not be detected from some release liners, which may indicate that these release liners are the silicone-free type release liner. At the same time silicone could not be detected on the labels adhesive site because silicone from release liner could not transfer to the adhesive on the label. There were siliconized release liners and silicone-free release liners in the pressure-sensitive adhesive manufacturing. However, the silicone-free release liners are still very expensive, thus we are using siliconized release liners. This study showed that some release liners contained silicone as in the FT-IR results for 90 PFW, 150 Poly STH-9 and Specsok-8 release liners (Figures 4.1, 4.2 and 4.3, respectively).

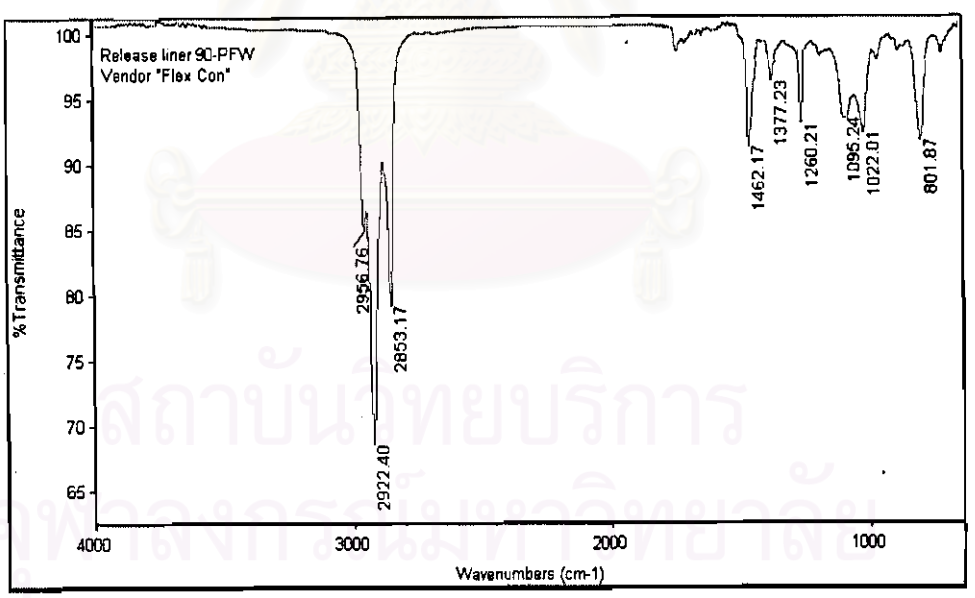

Figure 4.1. FT-IR Spectrum of 90-PFW Release Liner

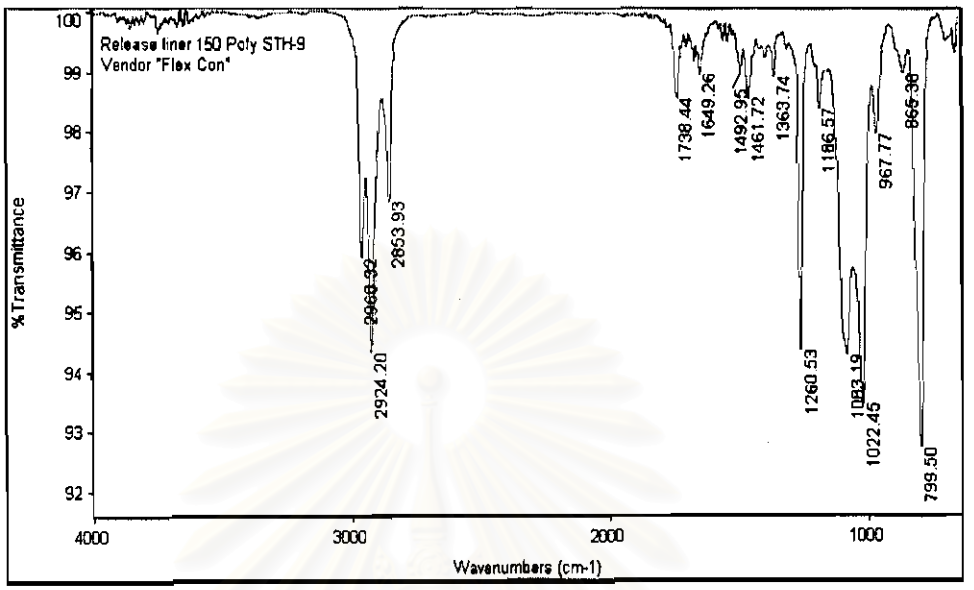

Figure 4.2. FT-IR Spectrum of 150 Poly STH-9 Release Liner

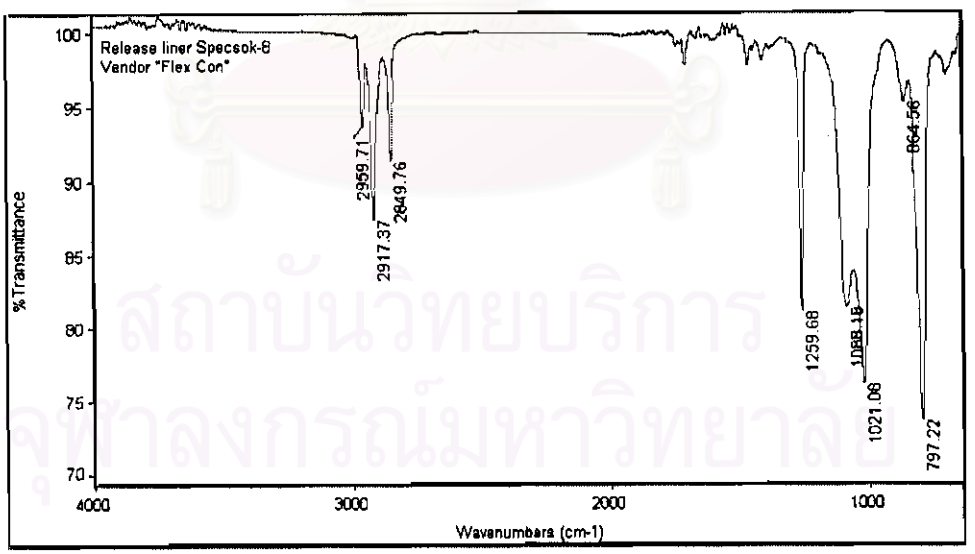

Figure 4.3. FT-IR Spectrum of Specsok-8 Release Liner

The FT-IR analysis detected long alkyl group and 0.09 ng/cm^2 silicone in 90 PFW release liner. Whereas, 0.08 ng/cm^2 of dodecamethyl

cyclohexasiloxane as well as long chain hydrocarbon could be detected from 150 Poly STH-9 release liner. And also 0.60 ng/cm^2 of silicone extracted from Specsok-8 release liner. In addition, FT-IR analysis showed very sharp peak at 2959 cm^{-1} wave number indicating high amount of alkyl group compound with silicone peak. Thus, it is likely that this release liner is coated with cyclohexylmethyl polysiloxane. Based on GC/MSD analysis on the DHS of 90 PFW release liner, the amount of detected compounds could be quantified as ng/cm^2 as hexadecane (Table 4.3 and Figure 4.4).

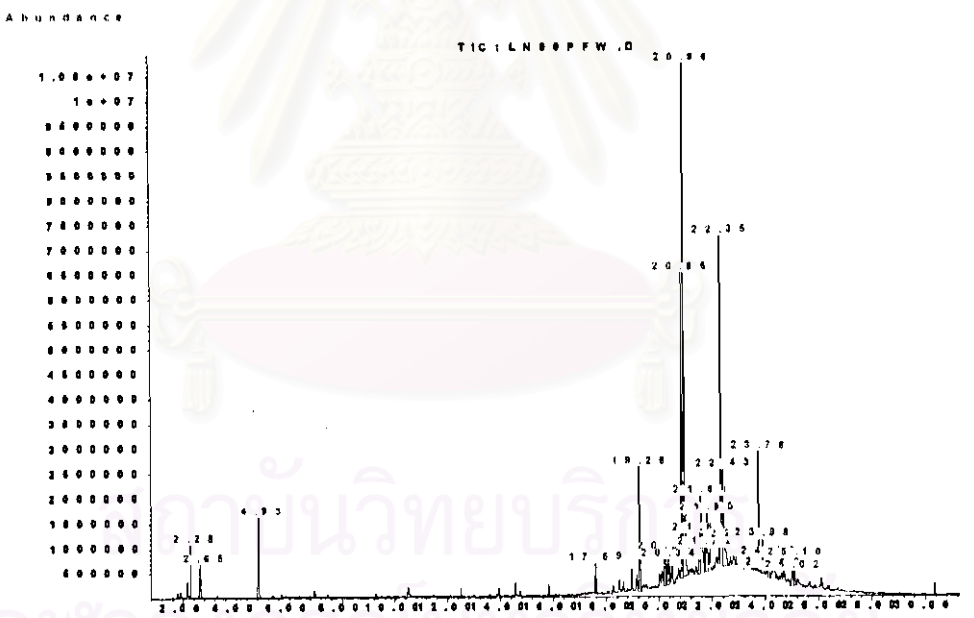

Figure 4.4. Outgassing Chromatogram of 90 PFW Release Liner

Table 4.3 shows the characteristics and amount of each compound detected in detail for the 90 PFW release liner. Total outgassed compounds were detected at 2,502 ng/cm^2.

Table 4.3 Outgassing analysis results for 90 PFW release liner from Flex Con

Description	R.T. min	Major Compound	ng/cm^2	R.T. min	Minor Compound	ng/cm^2
Release liner 90 PFW	10.50	1. 1-Hexanol, 2-ethyl-	5	5.37	1. 2, 4-dimethyl-3-pentanone,	1
	14.56	2. Octyl acrylate	5			
	18.49	3. 2, 5-bis (1,1-dimethylethyl)-Phenol	5	6.97	2. p-Xylene	3
				13.86	3. 1 (4-methylphenyl)-Ethanone,	1
	18.97	4. 2,6-bis (1,1-dimethylethyl)-2, 5-Cyclohexadiene-1, 4-dione	8	13.94	4. Dodecane	3
	20.34	5. 2,6-bis (1, 1-dimethylethyl)-4-ethyl-Phenol	21	24.29	5. 1-(7-hydroxy-5-methoxy-2, 2-dimethyl-2H-1-benzopyran-8-yl)-Ethanone	1
	20.96	6. Propanoic acid, alkyl ester	213			
	24.12	7. Isopropyl Myristate	9			
	26.11	8. Dibutyl phthalate	5			
	16.00-30.00	9. Long chain hydrocarbon	2,223			
Total outgassed			2,494			8

Based on GC/MSD analysis on the DHS of 150 Poly STH-9 release liner, the total amount of outgassed compounds were quantified to be 16 ng/cm^2 as hexadecane (Table 4.4 and Figure 4.5). This is considered to be a very low outgassing release liner as compared to the other release liners in this study. The detail characteristics and amount of each compound can be seen in Table 4.4.

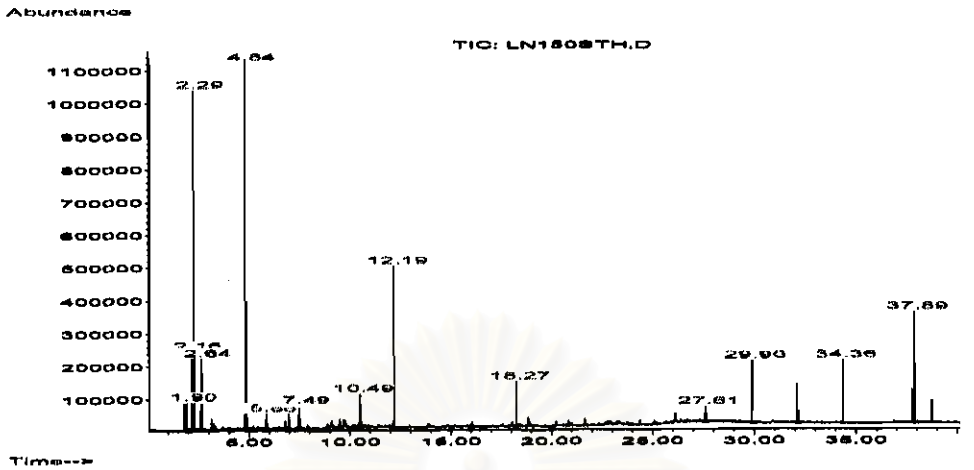

Figure 4.5. Outgassing Chromatogram of 150 Poly STH-9 Release Liner

Table 4.4 Outgassing analysis results for 150 Poly STH-9 release liner from Flex Con

Description	R.T. min	Major Compound	ng/cm^2	R.T. min	Minor Compound	ng/cm^2
Release liner	9.08	1. Benzaldehyde	1	3.25	1. Benzene	1
150 Poly	9.49	2. Phenol	1			
STH-9	9.77	3. 1, 2, 3-Trimethyl-benzene	3			
	10.49	4. 2-Ethyl hexanol	1			
	21.65	5. Benzophenone	1			
	22.77-23.33	6. 2-(1, 1-Dialkyl)- phenol	1			
	26.12	7. Dibutyl phthalate	1			
	13.87-20.84	8. Other alkane and alkene compound	6			
Total outgassed			15			1

Based on GC/MSD analysis on the DHS of Specsok-8 release liner, total outgassed compounds were detected at 152 ng/cm^2 as hexadecane, indicating very low outgassing property (Table 4.5 and Figure 4.6). Table 4.5 shows the characteristics and amount of each compound outgassed from Specsok-8 release liner.

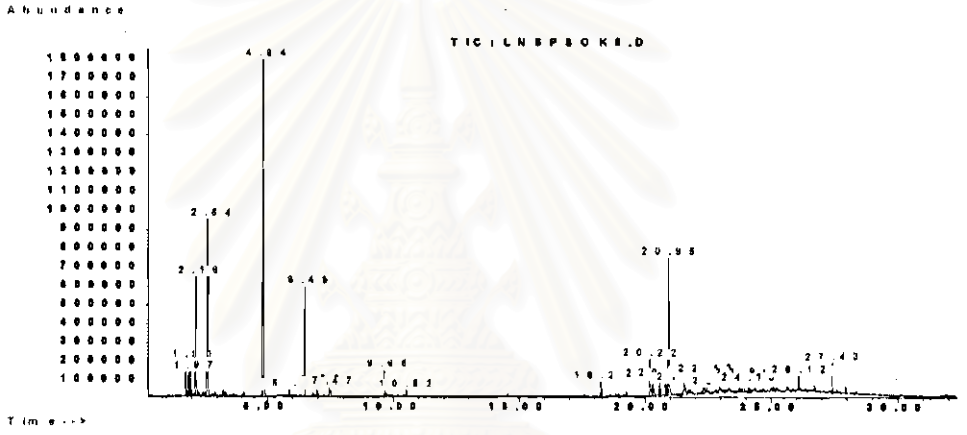

Figure 4.6. Outgassing Chromatogram of Specsok-8 Release Liner

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.5 Outgassing analysis results for Specsok-8 release liner from Flex Con

Description	R.T. min	Major Compound	ng/cm^2	R.T. min	Minor Compound	ng/cm^2
Release liner Specsok-8	10.52	1. 2-Ethyl hexanol	1	2.93	1. 2-Methyl-1-propanol	1
	20.34	2. 2, 6-Bis (1, 1-dimethylethyl)-4-ethyl- phenol	2	3.26	2. Benzene	1
				14.57	3. 2-Phenoxy-ethanol	1
	20.95	3. Propanoic acid, alkyl ester	14	22.80	4. 2, 2'-Diethyl-1, 1'-biphenyl	1
	26.12	4. (1, 2-Benzenedicarboxy-lic acid, butyl decyl ester) Phthalate ester	2	24.13	5. Isopropyl myristate	1
				25.65	6. Other Benzene derivative	1
	18.27-23.89	5. Long chain hydrocarbon	126	26.71	7. Hexanoic acid	1
Total outgassed			145			7

Results from DHS outgassing test analysis on 90 PFW, 150 Poly STH-9 and Specsok-8 release liners revealed no silicone detected because they probably contain trace amount of silicone and/or high molecular weight silicone that could not be outgassed at 85°C for 3 hrs. Only long chain hydrocarbon, 2, 6-bis (1, 1-dimethylethyl)-4-ethyl-phenol, propanoic acid, alkyl ester and 2-ethyl-1-hexanol were detected from 90 PFW release liner, while 2-ethyl-1 hexanol, cycloalkane and benzophenone were detected from 150 Poly STH-9 release liner. As for Specsok-8 release liner, long chain and branched chain hydrocarbon, phthalate ester, propanoic acid, alkyl ester and 2, 6-bis (1, 1-dimethylethyl)-4-ethyl-phenol were detected. Based on these results, it

should be safe to say that these kinds of release liner could be used in the hard disc drive production.

On the other hand, GC/MSD analysis could also be used to identify the organic compounds in the extracted solution from 90 PFW, 150 Poly STH-9 and Specsok-8 release liners using methylene chloride as the extract solvent (Figures 4.7, 4.8 and 4.9, respectively). The characteristics of each compound detected from 90 PFW, 150 Poly STH-9 and Specsok-8 release liners are shown in Tables 4.6, 4.7 and 4.8, respectively.

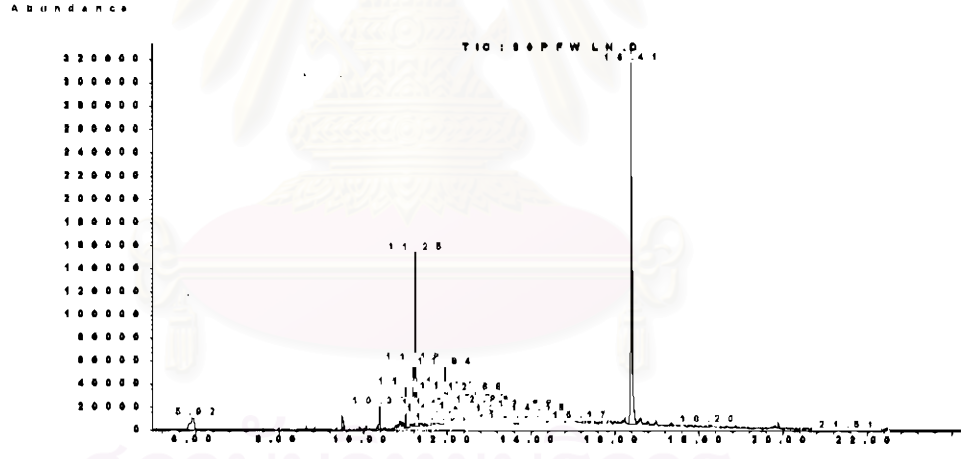

Figure 4.7. GC/MSD Chromatogram of 90 PFW Release Liner

Table 4.6 GC/MSD analysis results for 90 PFW release liner from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
Release liner 90 PFW	5.94	1. 2-Ethyl hexanol	11.73	1. 2-Butyl-1-octanol
	10.36	2. 3-Isopropoxy-1, 1, 1, 7, 7, 7-hexamethyl-3, 5, 5-tris (trimethylsiloxy) tetrasiloxane	12.74	2. 2-Ethyl-1-decanol
			13.32	3. 2-Hexyl-1-decanol
			15.89	4. Butanedioic acid, methyl-bis (1-methylpropyl) ester
	10.38	3. Tetradecane		
	11.01	4. 2, 6-bis (1, 1-dimethylethyl)-4-ethyl-phenol	16.19	5. 2-Acetylthiazole
			17.65	6. 2, 4-Dimethyl-1-decene
	11.19	5. Hexadecane	18.29	7. Other benzene derivative
	11.25	6. Propanoic acid, alkyl ester	19.07	8. 6, 6-Dimethyl-undecane
	11.56	7. 3, 6-Dimethyl-undecane		
	11.99	8. 2, 6, 11, 15-Tetramethyl-hexadecane		
	12.18	9. Isopropylbiphenyl		
	12.38	10. Pentadecane		
	12.85	11. 1,1,1,5,7,7,7-Heptamethyl-3,3-bis (trimethylsiloxy) tetrasiloxane		
	13.95	12. Heptadecane		
	14.67	13. Octadecane		
	14.74	14. Tritetracontane		
	14.97	15. Pentatriacontane		
	15.15	16. 1-Octadecene		
	15.65	17. Octadecane		
	16.41	18. 12-Octadecanoic acid, methyl ester		
	17.18	19. Octylcyclohexane		
	19.95	20. Phthalate ester		
	20.49	21. Dodecane		

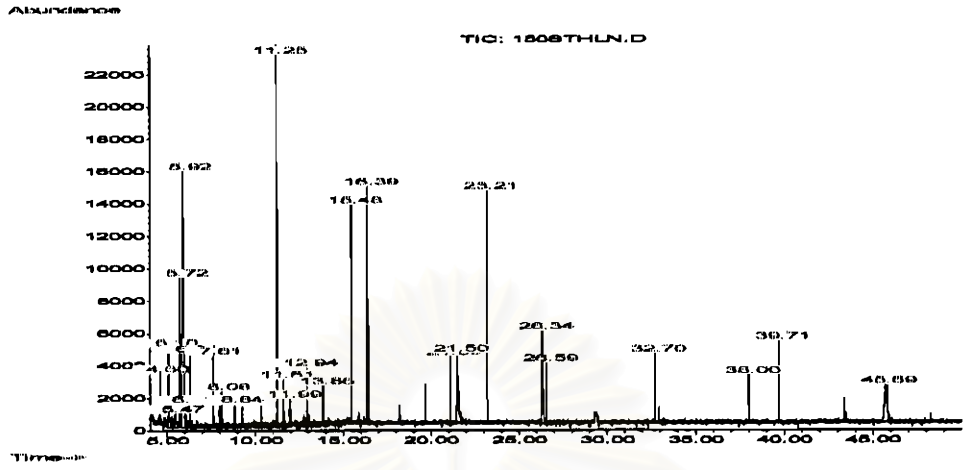

Figure 4.8. GC/MSD Chromatogram of 150 Poly STH-9 Release Liner

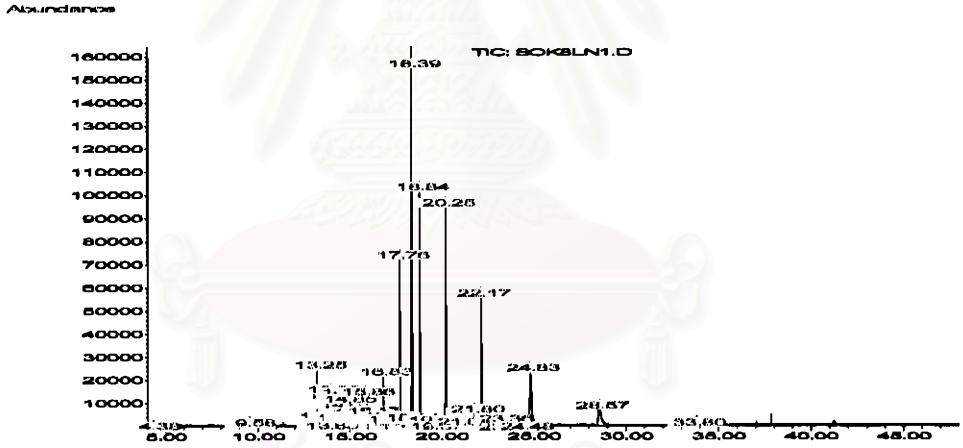

Figure 4.9. GC/MSD Chromatogram of Specsok-8 Release Liner

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.7 GC/MSD analysis results for 150 Poly STH-9 release liner from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
Release liner 150 Poly STH-9	5.10	1. 1, 4-Butanediol	9.59	1. Ethanol, 2-butoxy-
	5.72	2. 2-Fluoro-.beta.,3, 4-trihydroxy-N-isopropyl-benzeneethanamine	11.93	2. Vanillin
			12.94	3. 2-Decanal, (Z)-
	5.92	3. 2-Ethyl-1-hexanol	18.20	4. 2-Hexenal
	7.61	4. 1-(2-Propenyloxy)-2-propanol	26.59	5. Nonadecanol
	10.36	5. 3-Isopropoxy-1, 1, 1, 7, 7, 7-hexamethyl-3, 5, 5-tris (trimethylsiloxy) tetrasiloxane		
	10.83	6. Cyclohexasiloxane, dodecamethyl-		
	11.25	7. Propanoic acid, alkyl ester		
	11.61	8. Benzophenone		
	11.94	9. Long chain hydrocarbon		
	13.86	10. Phthalate ester		
	16.39	11. 10-Octadecanoic acid, methyl ester		
	21.50	12. Amide compound		
	26.34	13. Dithianone		

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.8 GC/MSD analysis results for Specsok-8 release liner from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
Release liner Specsok-8	10.36	1. Isopropoxy-1, 1, 1, 7, 7, 7-hexamethyl-3, 5, 5-tris (trimethylsiloxy) tetra siloxane	20.20	1. Bis (2-ethylhexyl)phthalate
			10.81	2. Cyclohexasiloxane, dodecamethyl-
			18.83	3. 1, 1, 1, 5, 7, 7, 7-Heptamethyl-3, 3-bis (trimethylsiloxy) tetrasiloxane
	11.25	2. Propanoic acid, alkyl ester		
	11.94	3. Tridecane, 4-methyl-		
	12.85	4. 1, 1, 1, 5, 7, 7, 7-Heptamethyl-3, 3-bis (trimethylsiloxy) tetrasiloxane and 3-Isopropoxy-1, 1, 1, 7, 7, 7-hexamethyl-3, 5, 5-tris (trimethylsiloxy) tetrasiloxane		
	13.86	5. Dibutyl phthalate		
	15.89	6. 1, 2-Benzenedicarboxylic acid, butyl-2-methylpropyl ester		
	16.02	7. Tetratetracontane		
	18.39	8. 15-Octadecanenoic acid, methyl ester		

The GC/MSD analysis results on 90 PFW release liner showed different types of polysiloxane, namely isopropoxy hexamethyl tris (trimethylsiloxy) tetrasiloxane and heptamethyl bis (trimethylsiloxy) tetrasiloxane. Furthermore, long chain hydrocarbon, 2, 6-bis (1, 1-dimethylethyl)-4-ethyl-phenol, propanoic acid, alkyl ester and 2-ethyl-1-hexanol were also detected as other organic compounds. Whereas,

GC/MSD analysis results on 150 Poly STH-9 release liner showed that the extracted silicone detected were dodecamethyl cyclohexasiloxane and isopropoxy hexamethyl tris (trimethylsiloxy) tetrasiloxane. Additionally, 2-ethyl-1-hexanol, benzeneethanamine, propanoic acid alkyl ester and octadecanoic acid, methyl ester were also detected. The GC/MSD analysis on Specsok-8 release liner extract showed the mixture of polysiloxane dodecamethyl cyclohexasiloxane, isopropoxy-1, 1, 1, 7, 7, 7-hexamethyl-3, 5, 5-tris (trimethylsiloxy) tetrasiloxane, and 1, 1, 1, 5, 7, 7, 7-heptamethyl-3, 3-bis (trimethylsiloxy) tretrasiloxane. Moreover, phthalate ester, propanoic acid alkyl ester and long chain hydrocarbon were also detected.

The FT-IR results in Table 4.2 show no silicone but only very long chain hydrocarbon, aromatic compound and carbonyl group detected in the hexane extract of EX200 Poly SC-9 release liner. This finding indicates that the EX200 Poly SC-9 release liner is a silicone-free release liner (Figure 4.10). Based on GC/MSD analysis on the DHS samples, only 120 ng/cm^2 of total outgassed compounds could be quantified as hexadecane (Figure 4.11 and Table 4.9). The DHS outgassing test revealed a trace level organic compounds indicating very low outgassing property of this release liner. The detected outgassed compounds were 2-ethyl-1-hexanol, phthalate ester, 2, 6-bis (1, 1-dimethylethyl)-4-ethyl-phenol, propanoic acid alkyl ester and long chain hydrocarbon detected. There was no silicone detected as it is supposed to be a silicone-free release liner. Thus it should be safe to use this kind of release liner in the hard disc drive production. Figure 4.12 and Table 4.10 shows the characteristics of each compound detected in the methylene chloride

extract of the release liner via GC/MSD analysis. The detected compounds in the extract include only propanoic acid alkyl ester, benzophenone, 2, 6-bis (1, 1-dimethylethyl)-4-ethyl-phenol, phthalate ester and long chain hydrocarbon. Again there was no silicone detected as it is supposed to be a silicone-free release liner.

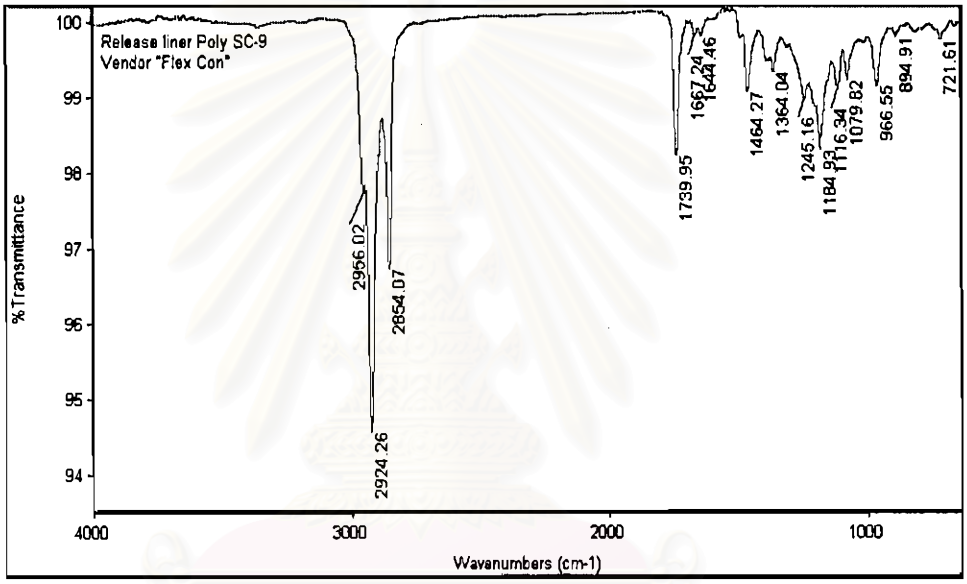

Figure 4.10. FT-IR Spectrum of EX200 Poly SC-9 Release Liner

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

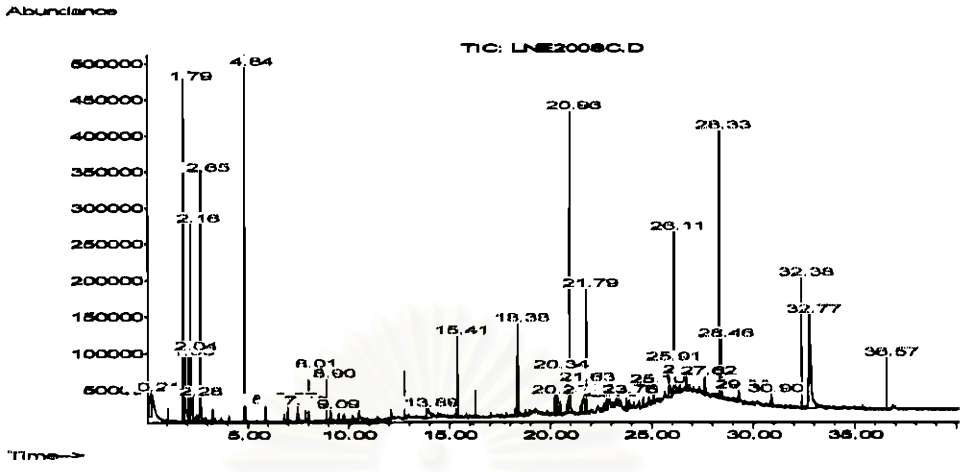

Figure 4.11. Outgassing Chromatogram of EX200 Poly SC-9 Release Liner

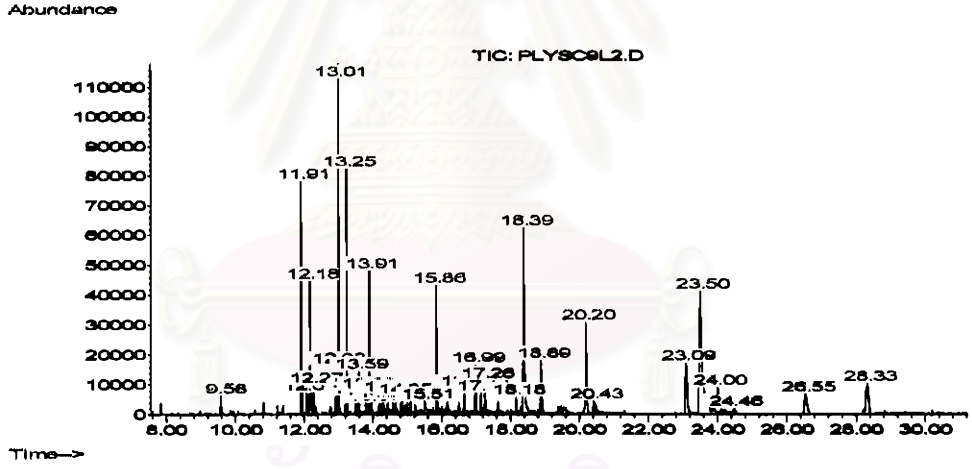

Figure 4.12. GC/MSD Chromatogram of EX200 Poly SC-9 Release Liner

Table 4.9 Outgassing analysis results for EX200 Poly SC-9 release liner from Flex Con

Description	R.T. min	Major Compound	ng/cm^2	R.T. min	Minor Compound	ng/cm^2
Release liner EX200 Poly SC-9	9.09	1. Benzaldehyde	1	13.89 & 16.01	1. Naphthalene derivative	1
	10.40	2. 2-Ethyl-1-hexanol	1			
	18.38	3. 4-(Methylthio)-benzaldehyde	3			
	20.34	4. 2, 6-Bis (1, 1-dimethylethyl)-4-ethyl-phenol	2			
	20.96	5. Propanoic acid, alkyl-ester	8			
	22.79	6. 4-Nonylphenol	1			
	22.95	7. 2-Ethoxy-benzaldehyde	1			
	23.34	8. 2-Ethyl-4, 5-dimethyl-phenol	1			
	24.87	9. Dibutyl phthalate	5			
	27.62	10. Other Benzene derivative	1			
	32.77	11. Bis (2-ethylhexyl) hexanedioic acid ester	7			
	22.00-32.40	12. Total (alkane and alkene compound)	91			
Total outgassed			119			1

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.10 GC/MSD analysis results for EX200 Poly SC-9 release liner from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
EX200 Poly SC-9	11.92	1. 4-(Methylthio)-Benzaldehyde	7.84	1. 2-Ethyl hexanol
	12.10	2. Dimethyl phthalate	9.58	2. Ethanol, 2-(2-butoxyethoxy)-
	12.18	3. Dodecanol	12.28	3. Mixture of 4-Hydroxy-3-methoxybenzyl alcohol and Benzeneacetic acid, alpha-hydroxy-
	13.02	4. 2, 6-Bis (1, 1-dimethylethyl)-4-ethyl-phenol		
	13.25	5. Propanoic acid, alkyl ester		
	13.60	6. Benzophenone	14.19	4. Isopropyl biphenyl
	13.80	7. 3, 4-Dimethoxyphenylacetone	14.26	5. 2 (3H)-Phenanthrenone, 4, 4a, 9, 10-tetrahydro-4a-methyl-
	13.91			
	17.14	8. Cyclododecane	16.99	6. Benzenebutanol
		9. 2-Propenoic acid, 3-(4-methoxyphenyl), 2-ethylhexyl ester	17.26	7. Likely to be Benzenebutanoic acid
	18.39		24.00	8. Sebacate
		10. 10-Octadecenoic acid, methyl ester	23.09	9. Unknown which has m/z = 301, 316, 119, 213
	18.89			
		11. Selenocyanic acid, p-(diethylamino) phenyl ester	24.46	10. Squalene
	20.20		26.55	11. Cyclopentadecanone
	23.50	12. Bis (2-ethylhexyl) phthalate	28.33	12. Dithianone
		13. 9-Octadecenamide, (z)-		

The FT-IR results in table 4.2 show no silicone detected from ST-2412014, ST-2412024, ST-2412034 and ST-2412044 labels likely because silicone could not transfer to the adhesive site of indicated label. Furthermore, FT-IR revealed similar FT-IR spectrum for all four labels (Figures 4.13, 4.14, 4.15 and 4.16) showing mainly terephthalate detected. Based on the GC/MSD analysis on the DHS samples of these four labels, the total outgassed compounds were 14,841 ng/cm^2 as hexadecane for ST-2412014 label, 12,346 ng/cm^2 for ST-2412024 label, 11,383 ng/ for ST-2412034 label, and 13,422 ng/cm^2 for ST-2412044

label (Tables 4.11, 4.12, 4.13 and 4.14). The DHS analysis revealed similar GC/MSD chromatograms for all labels (Figures 4.17, 4.18, 4.19 and 4.20), showing the outgassed compounds to be namely 2-ethyl-1-hexanol, branched chain hydrocarbon, acetic acid, propanoic acid, alkyl ester and ketone but no phthalate ester. This could indicate that the labels contain only phthalate ester with big molecule and high boiling point, which could not outgas at 85°C for 3 hrs. The results of the GC/MSD analysis on the methylene chloride extract of these four labels showed the same type of adhesive (Figures 4.21, 4.22, 4.23 and 4.24) with acetic acid, octyl ester, propanoic acid, alkyl ester, 2-ethyl-1-hexanol and phthalate ester (Tables 4.15, 4.16, 4.17 and 4.18).

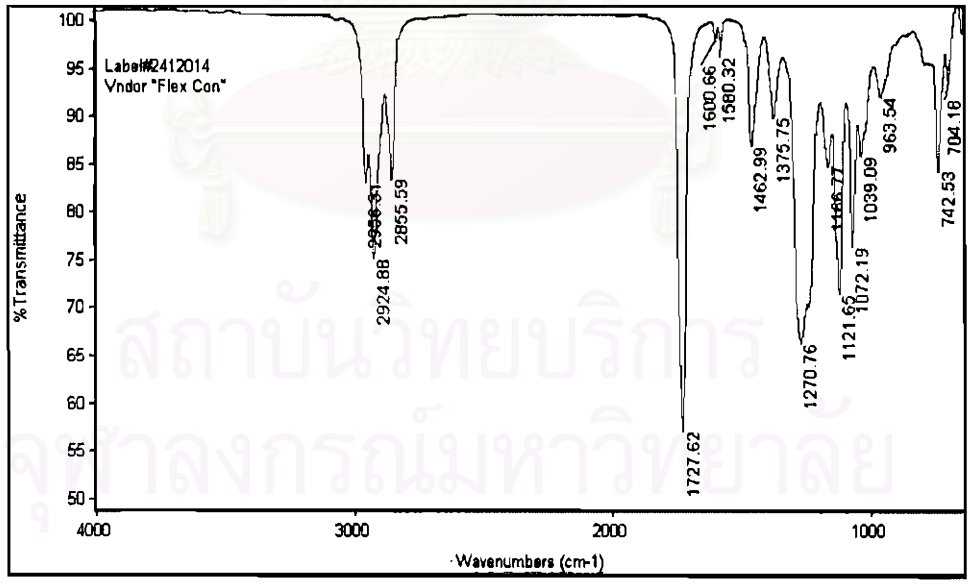

Figure 4.13. FT-IR Spectrum of ST-2412014 Label

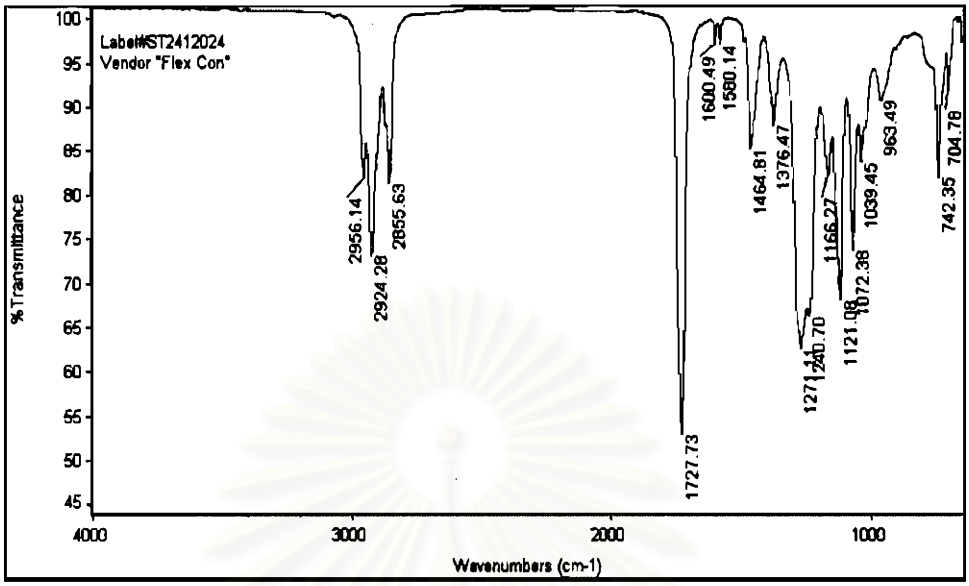

Figure 4.14. FT-IR Spectrum of ST-2412024 Label

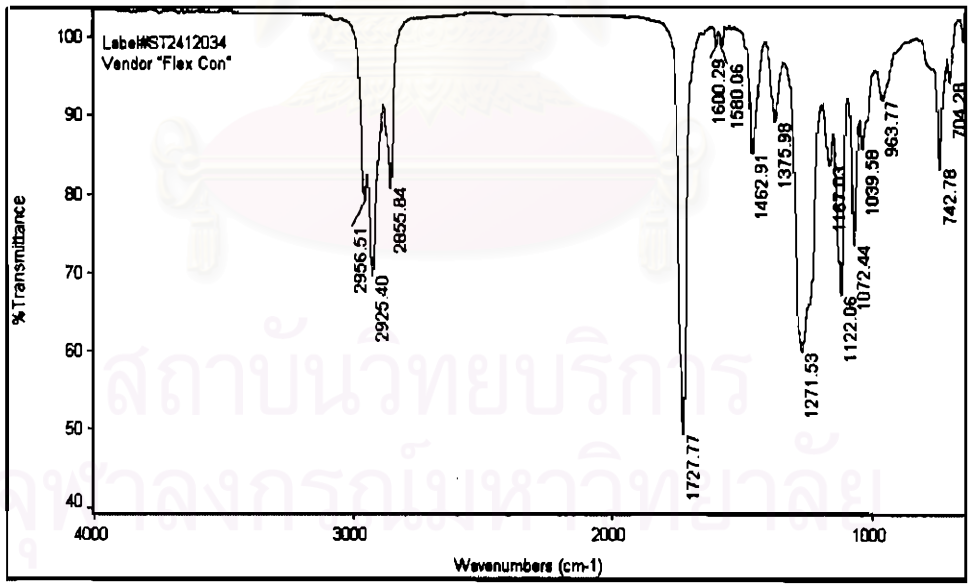

Figure 4.15. FT-IR Spectrum of ST-2412034 Label

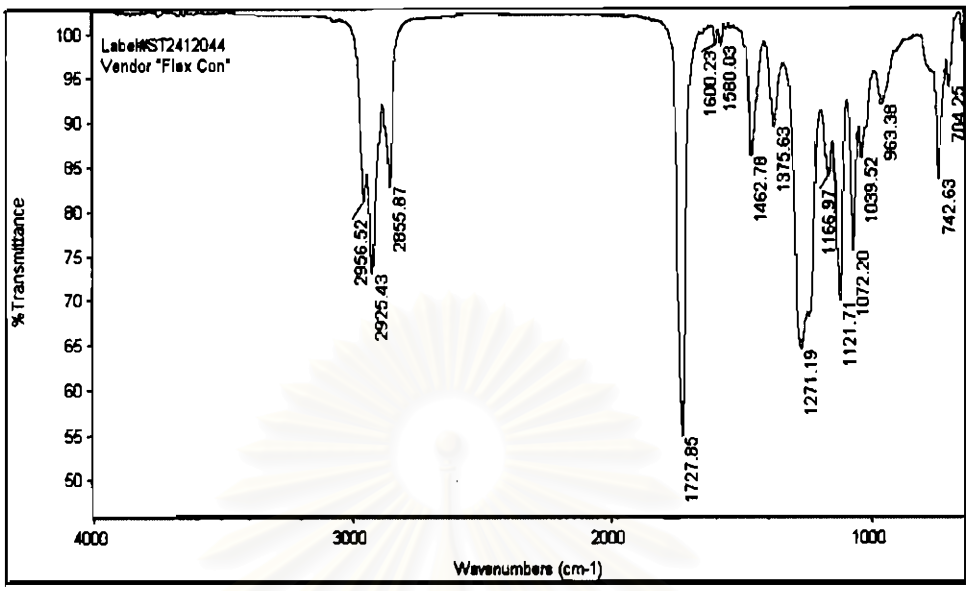

Figure 4.16. FT-IR Spectrum of ST-2412044 Label

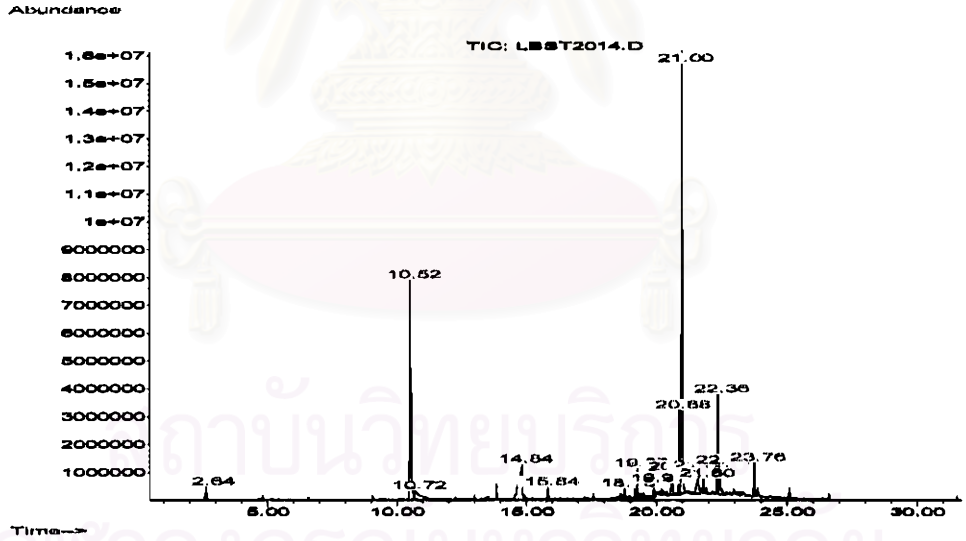

Figure 4.17. Outgassing Chromatogram of ST-2412014 Label

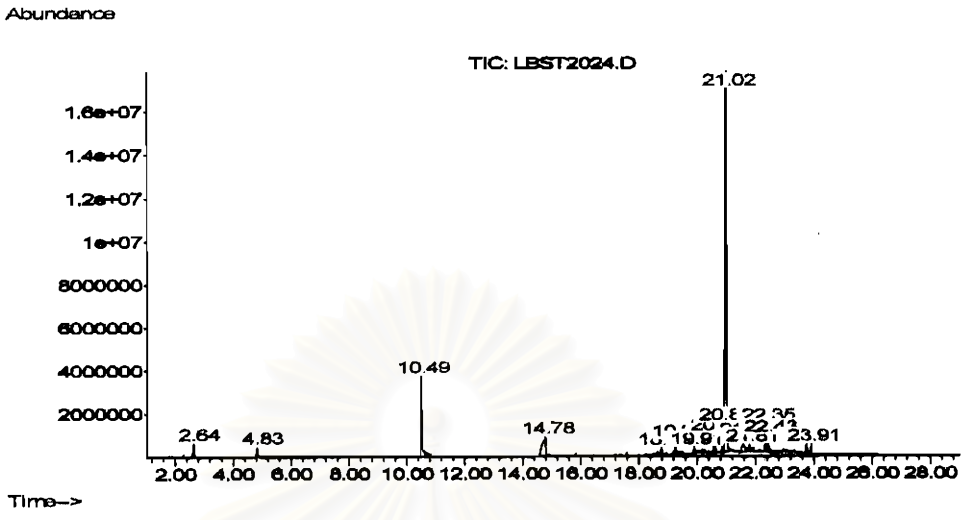

Figure 4.18. Outgassing Chromatogram of ST-2412024 Label

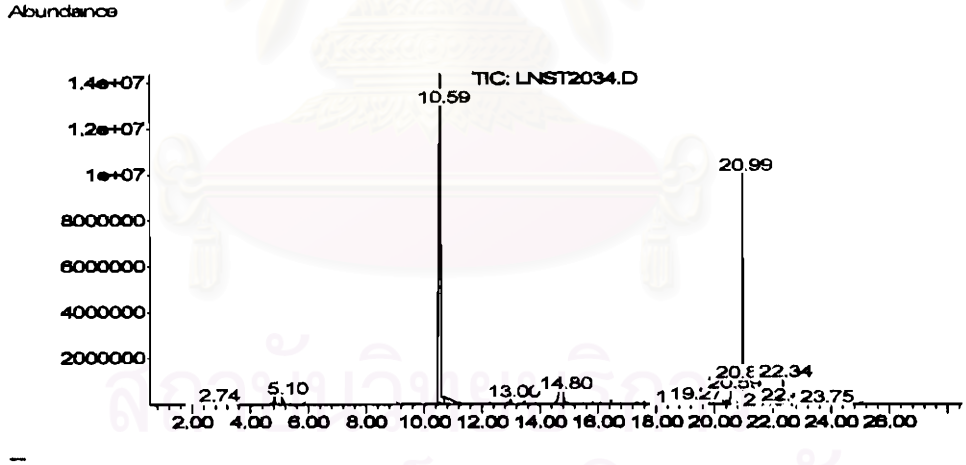

Figure 4.19. Outgassing Chromatogram of ST-2412034 Label

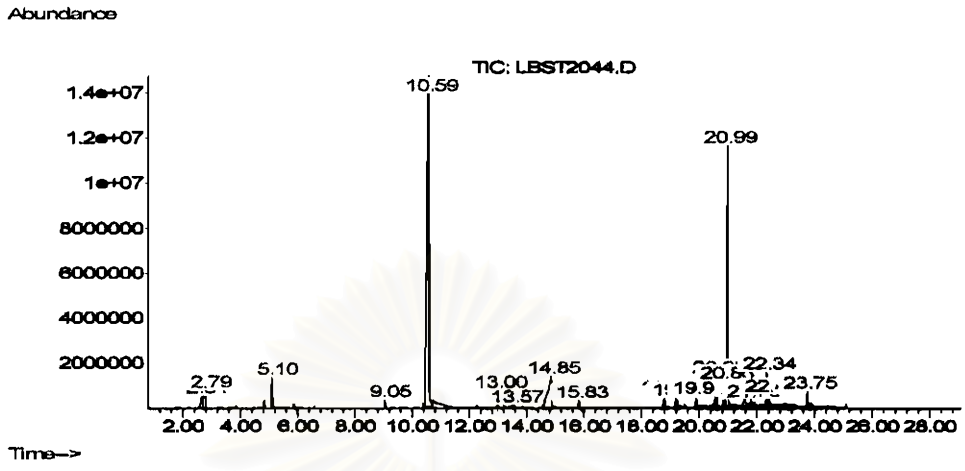

Figure 4.20. Outgassing Chromatogram of ST-2412044 Label

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.11 Outgassing analysis results for ST-2412014 Label from Flex Con

Description	R.T. min	Major Compound	ng/cm^2	R.T. min	Minor Compound	ng/cm^2
Label	2.64	1. Acetic acid	98	4.76	1. Propanoic acid, 2-methyl-	15
ST-2412014	9.05	2. Benzaldehyde	26	8.86	2. Aldehyde	4
	10.52	3. 2-Ethyl hexanol	2,169	9.53	3. Phenol	6
	12.99	4. 3-Methylheptyl acetate	28	10.07	4. Ethanol, 2-(2-ethoxyethoxy)-	6
	13.27	5. Ketone	266	10.26	5. 2-propanol, 1-(2-methoxypropoxy)-	5
	13.37	6. 1-O-Acetyl-exo-2, 3-O-ethylidene-.beta.-d-erythrofuranose	60	10.42	6. N, N'-methanetetraylbis-2-propanamine	5
	14.55	7. Octyl acrylate	32	12.40	7. 2-Ethyl hexanoic acid	11
	14.84	8. Acetamide, N-methyl-N-(2-propynyl)-	857	12.76	8. Acetic acid, octyl ester	10
				12.86	9. Organic acid	7
	14.93	9. 2, 6-Octadienal, 3, 7-dimethyl	27	13.63	10. 2-Acetyl-5-methylthiophene	4
				13.93	11. 2-Propanol, 1-butoxy-	9
	15.84	10. 1-Benzyl-3-pyrroline	75	15.05	12. Benzonitrile, 4-hydroxy-3-methoxy-	7
	19.21	11. Other Benzene derivative	66			
	19.51	12. Butanoic acid, 2-acetyl-3-methyl-, methyl ester	28	16.00	13. Naphthalene, 1-methyl-	6
				16.10	14. 3-(2H)-Furanone, 4-methoxy-2, 5-dimethyl-	8
	19.91	13. Biphenyl	84			
	21.00	14. Propanoic acid, alkyl ester	3,326	16.29	15. 7-Oxabicyclo (4.1.0)heptan-1-ol, acetate	17
	22.81	15. 1, 1'-Biphenyl, 2, 2'-diethyl-	23	16.58	16. 1, 3, 5-tris (1-methylethyl) Benzene	8
	26.61	16. Benzenamine, N, N, 2-trimethyl-	37	17.25	17. Ethenylmethyl-benzene	12
				18.26	18. 2-Propanone, 1-4-hydroxy-3methoxyphenyl)-	11
	16.50-28.00	17. Total alkane and alkene compound	7,466			
				26.12	19. Pthalate ester	7
				26.37	20. 2H, 8H-Benzo (1, 2-b: 3, 4-b;) dipyran-2-one, 6-methoxy-8, 8-dimethyl-	15
Total outgassed			14,668			173

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.12 Outgassing analysis results for ST-2412024 Label from Flex Con

Description	R.T. min	Major Compound	ng/cm^2	R.T. min	Minor Compound	ng/cm^2
Label	2.64	1. Acetic acid	136		None	
ST-2412024	10.50	2. 2-Ethyl hexanol	731			
	14.56	3. Octylacrylate	11			
	14.79	4. N-methyl-N-(2-propynyl)-Acetamide	533			
	15.83	5. 1-Benzyl-3-pyrroline	24			
	18.79	6. 4, 6-Nonanedione	76			
	19.20	7. Phenol, 4-propyl-	24			
	19.91	8. Bibenzyl	61			
	20.60	9. 5-Hepten-2-one	234			
	21.02	10. Propanoic acid, alkyl ester	4,411			
	18.00-26.00	11. Other alkane	6,105			
Total outgassed			12,346			

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.13 Outgassing analysis results for ST-2412034 Label from Flex Con

Description	R.T. min	Major Compound	ng/cm^2	R.T. min	Minor Compound	ng/cm^2
Label	2.74	1. Acetic acid	157	4.75	1. 2-Methyl-propanoic	12
ST-2412034	5.10	2. 2, 4-Pentanedione	142		acid	
	10.59	3. 2-Ethyl hexanol	4,820	5.89	2. Methyl isobutyl	24
	13.00	4. 2-Ethylhexyl ester	112		ketone	
		acetic acid		9.06	3. Benzaldehyde	12
	14.56	5. Octyl acrylate	20	10.14	4. 2-(2-Ethoxyethoxy)-	6
	14.80	6. N-methyl-N-(2-	582		ethanol	
		propynyl)-acetamide		10.42	5. Other Ketone	55
	18.79	7. 4, 6-Nonanedione	100	13.85	6. 3, 4-Dimethoxy-	10
	19.20	8. Benzenemethana-	40		phenol	
		mine, .alpha.-2, 5, 7-		15.83	7. 5-phenyl-2-Pentenal	12
		octatrienyl-N-propyl-		16.09	8. 4-Methoxy-2, 5-	9
		and			dimethyl-3(2H)-	
		Ethanonediphenyl			furanone	
	19.92	9. Bibenzyl	36	16.46	9. DL-Valine, N-aceyl-,	24
	20.59	10. 5-Hepten-2-one	239		methyl ester amine	
	20.99	11. Propanoic acid, alkyl	1,741	19.51	10. 4-Methyl-3-hexanol	16
		ester			acetate	
	18.00-	12. Total hydrocarbon	3,205	24.48	11. 1H-Cyclopa(b)	9
	26.00				naphthalene, 1a, 2, 7,	
					7a-tetrahydro-	
Total			11,194			189
outgassed						

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.14 Outgassing analysis results for ST-2412044 Label from Flex Con

Description	R.T. min	Major Compound	ng/cm^2	R.T. min	Minor Compound	ng/cm^2
Label ST-2412044	2.79	1. Acetic acid	390	4.78	1. 2-Methyl-propanoic acid	19
	5.10	2. 2, 4-Pentanedione	208			
	9.05	3. Benzaldehyde	57	12.28	2. Other Ketone	51
	10.40	4. N,N'-methanetetraylbis-2-Propanamine	31	19.51	3. 4-Methyl-morphorine	24
	10.59	5. 2-Ethyl-1-hexanol	5,594	20.49	4. 2, 6-Bis (1, 1-dimethylethyl) 4-ethyl-phenol	24
	13.00	6. 2-Ethylhexyl ester acetic acid	126			
	13.57	7. Butanoic acid, 3-oxo-, methyl ester	40			
	14.85	8. N-methyl-N-(2-propynyl)-acetamide	778			
	15.83	9. 1-Benzyl-3-pyrroline	52			
	18.79	10. 4, 6-Nonanedione	121			
	19.20	11. N, N-dimethyl-4-methyl-benzenamine	68			
	19.91	12. Bibenzyl	90			
	20.60	13. 5-Hepten-2-one	317			
	20.99	14. Propanoic acid, alkyl ester	1,971			
	18.00-28.00	15. Other alkane	3,461			
Total outgassed			13,304			118

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

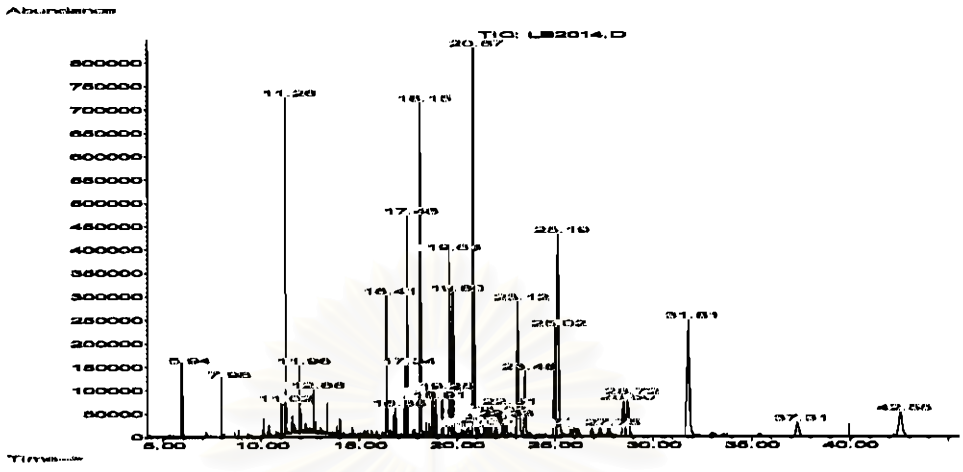

Figure 4.21. GC/MSD Chromatogram of ST-2412014 Label

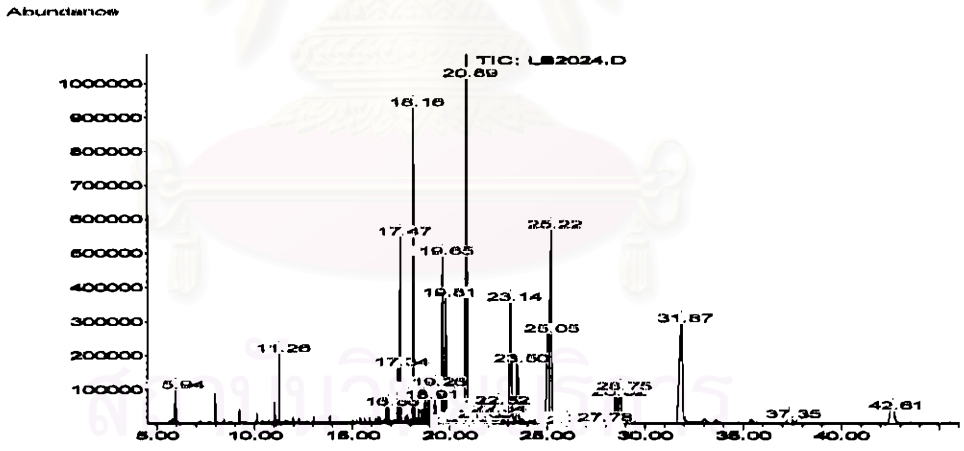

Figure 4.22. GC/MSD Chromatogram of ST-2412024 Label

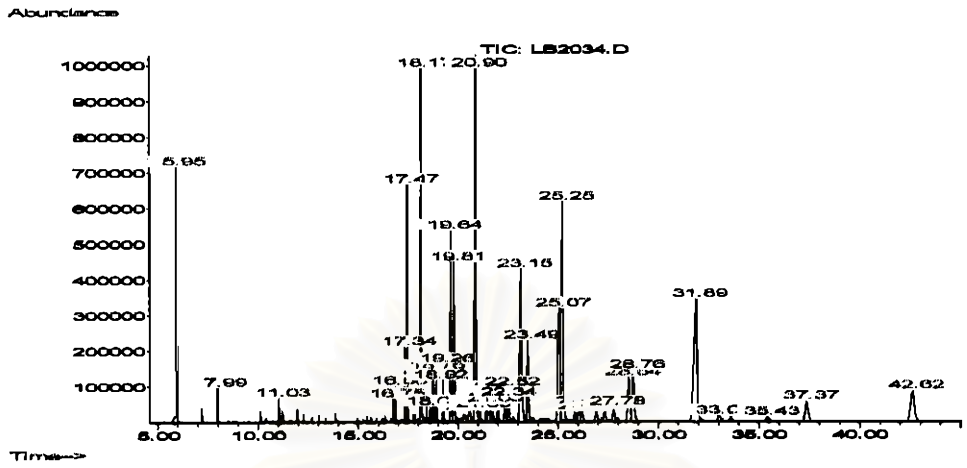

Figure 4.23. GC/MSD Chromatogram of ST-2412034 Label

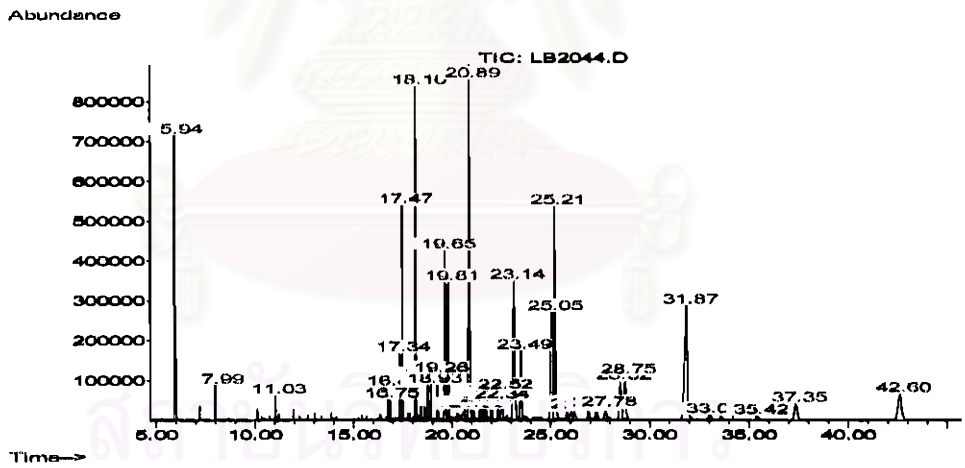

Figure 4.24. GC/MSD Chromatogram of ST-2412044 Label

Table 4.15 GC/MSD analysis results for ST-2412014 Label from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
Label ST-2412014	5.94	1. 2-Ethyl hexanol	9.31	1. 1-Butanol, 2, 3-dimethyl
	7.20	2. Acetic acid, octyl ester	10.34	2. 3, 5-diethoxy-1, 1, 1, 7, 7, 7-Tetrasiloxane
	7.98	3. Pentane, 2-methyl-		
	11.26	4. Propanoic acid, alkyl ester	10.73	3. Bibenzyl
	16.41	5. Oleic acid	11.13	4. Eicosane
	18.15	6. 1, 2-Benzenedicarboxylic acid, diheptyl ester	11.19	5. Hexadecane
	18.29	7. Didodecyl phthalate	11.96	6. Heptadecane
	33.01	8. 1, 2-Benzenedicarboxylic acid, butylmethylnonyl ester	12.28	7. Tetratetracontane
	18.60-28.72	9. 1, 2-Benzenedicarboxylic acid, butyl 2 ethylhexyl ester	13.87	8. 9, 12, 15-Octadecatrienoic acid, ethyl ester
	31.81	10. 1, 2-Benzenedicarboxylic acid, decyl octyl ester		

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.16 GC/MSD analysis results for ST-2412024 Label from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
Label	5.94	1. 2-Ethyl hexanol	7.20	1. 1-Butanol, 2-ethyl-
ST-2412024	7.98	2. Pentane, 2-methyl-	8.66	2. Toluene
	11.02	3. Acetic acid, octyl ester	8.84	3. Silicone
	11.26	4. Propanoic acid, alkyl ester	9.24	4. Benzene, 2, 4-diisocyanato-1-methyl-
	17.13-22.76	5. 1, 2-Benzenedicarboxylic acid, diheptyl ester	10.12	5. 4, 6-Nonanedione
	23.14	6. Di-n-octyl phthalate	10.50	6. 1, 3-Dioxolane, 2, 2, 4-trimethyl-
	25.22	7. Didodecyl phthalate	10.74	7. Bibenzyl
	28.75-31.87	8. 1, 2-Benzenedicarboxylic acid, butyl 8 methylnonyl ester	11.19	8. Eicosane
			11.57	9. Octadecane, 6-methyl-
	33.03-35.42	9. 1, 2-Benzenedicarboxylic acid, butyl 2 ethylhexyl ester	11.84	10. 3-Buten-2-one, 3-methyl-
			11.96	11. Decane, 2-methyl-
	37.35-42.61	10. 1, 2-Benzenedicarboxylic acid, decyl octyl ester	12.27	12. Dodecane, 1-isocyanato-
			13.04	13. Naphthalene, 1, 2-dihydro-3-methyl-
			13.87	14. Other ester compound
			15.04	15. Trimethadione
			15.42	16. Benzenemethanamine, N-(1, 1-dimethylethyl)-
			16.20	17. Isothiazole, trimethyl-
			16.41	18. 15-Octadecanoic acid, methyl ester

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.17 GC/MSD analysis results for ST-2412034 Label from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
Label	5.94	1. 2-Ethyl hexanol	7.20	1. 1-Butanol, 2-ethyl-
ST-2412034	7.98	2. Pentane, 2-methyl-	8.66	2. Toluene
	11.02	3. Acetic acid, octyl ester	8.84	3. Silicone
	11.26	4. Propanoic acid, alkyl ester	9.24	4. Benzene, 2, 4-diisocyanato-1-methyl-
	17.13-22.76	5. Oleic acid 6. 1, 2-Benzenedicarboxylic acid, diheptyl ester	10.12 10.50	5. 4, 6-Nonanedione 6. 1, 3-Dioxolane, 2, 2, 4-trimethyl-
	23.14	7. Di-n-octyl phthalate	10.74	7. Bibenzyl
	25.22	8. Didodecyl phthalate	11.19	8. Eicosane
	28.75-31.87	9. 1, 2-Benzenedicarboxylic acid, butyl 8 methylnonyl ester	11.57 11.84 11.96	9. Octadecane, 6-methyl- 10. 3-Buten-2-one, 3-methyl- 11. Decane, 2-methyl-
	33.03-35.42	10. 1, 2-Benzenedicarboxylic acid, butyl 2 ethylhexyl ester	12.27 13.04	12. Dodecane, 1-isocyanato- 13. Naphthalene, 1, 2-dihydro-3-methyl-
	37.35-42.61	11. 1, 2-Benzenedicarboxylic acid, decyl octyl ester	13.87 15.04 15.42 16.20 16.41	14. Other ester compound 15. Trimethadione 16. Benzenemethanamine, N-(1, 1-dimethylethyl)- 17. Isothiazole, trimethyl- 18. 15-Octadecanoic acid, methyl ester

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.18 GC/MSD analysis results for ST-2412044 Label from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
Label	5.94	1. 2-Ethyl hexanol	7.20	1. 1-Butanol, 2-ethyl-
ST-2412044	7.98	2. Pentane, 2-methyl-	8.66	2. Toluene
	11.02	3. Acetic acid, octyl ester	8.84	3. Silicone
	11.26	4. Propanoic acid, alkyl ester	9.24	4. Benzene, 2, 4-diisocyanato-1-methyl-
	17.13-22.76	5. Oleic acid		
		6. 1, 2-Benzenedicarboxylic acid, diheptyl ester	10.12	5. 4, 6-Nonanedione
			10.50	6. 1, 3-Dioxolane, 2, 2, 4-trimethyl-
	23.14	7. Di-n-octyl phthalate	10.74	7. Bibenzyl
	25.22	8. Didodecyl phthalate	11.19	8. Eicosane
	28.75-31.87	9. 1, 2-Benzenedicarboxylic acid, butyl 8 methylnonyl ester	11.57	9. Octadecane, 6-methyl-
			11.84	10. 3-Buten-2-one, 3-methyl-
			11.96	11. Decane, 2-methyl-
	33.03-35.42	10. 1, 2-Benzenedicarboxylic acid, butyl 2 ethylhexyl ester	12.27	12. Dodecane, 1-isocyanato-
			13.04	13. Naphthalene, 1, 2-dihydro-3-methyl-
	37.35-42.61	11. 1, 2-Benzenedicarboxylic acid, decyl octyl ester	13.87	14. Other ester compound
			15.04	15. Trimethadione
			15.42	16. Benzenemethanamine, N-(1, 1-dimethylethyl)-
			16.20	17. Isothiazole, trimethyl-
			16.41	18. 15-Octadecanoic acid, methyl ester

The FT-IR analysis results in Table 4.2 show 0.42 ng/cm^2 of silicone compound being dodecamethyl cyclohexasiloxane was extracted from the ST-2412014 release liner. In addition, 1-ethylpropyl octanoate mixed together with pentadecane were also detecetd (Figure 4.25). As for the ST-2412034 release liner, the amount of 0.11 ng/cm^2 octanoate polysiloxane could be extracted (Figure 4.26).

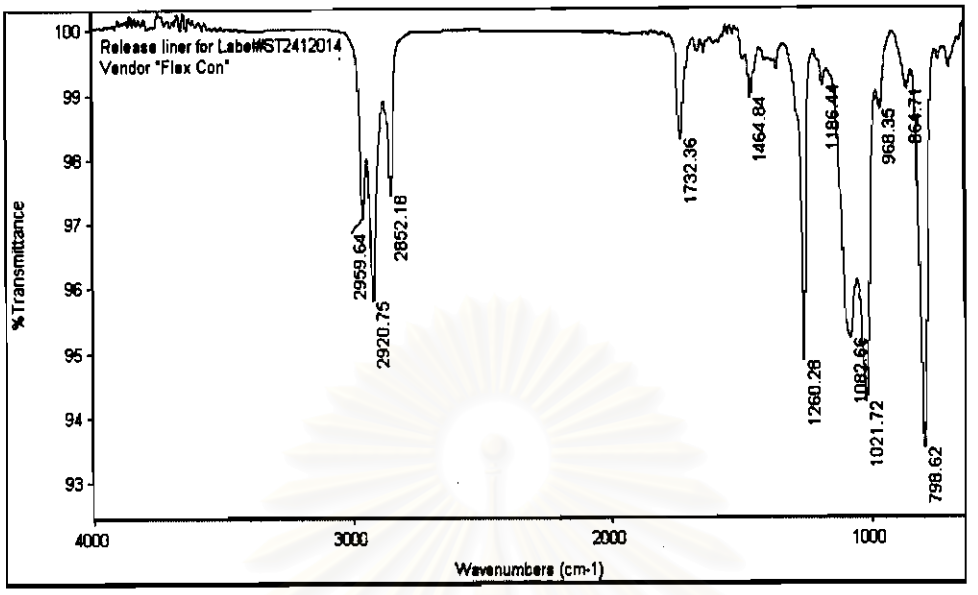

Figure 4.25. FT-IR Spectrum of ST-2412014 Release Liner

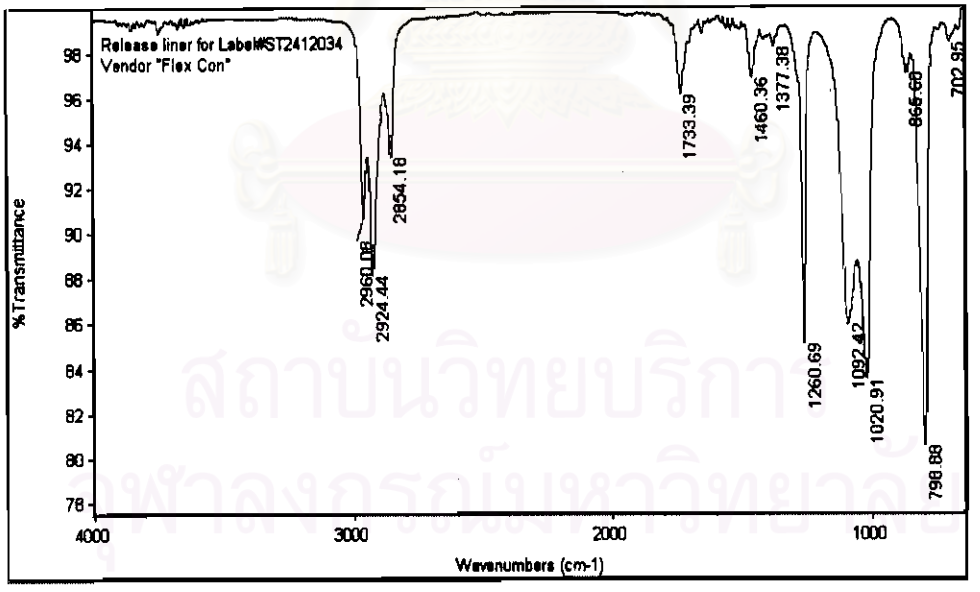

Figure 4.26. FT-IR Spectrum of ST-2412034 Release Liner

Based on GC/MSD analysis on the DHS ST-2412014 release liner sample, the total outgassed compounds were accounted for 295 ng/cm^2 as

hexadecane (Table 4.19 and Figure 4.27). In addition, the DHS result of ST-2412034 release liner sample, the total outgassed compounds were also accounted for 155 ng/cm^2 as hexadecane (Table 4.20 and Figure 4.28) indicating low outgassing property of ST-2412014 and ST-2412034 release liners. However, no silicone could be detected in the DHS outgassing test on ST-2412014 release liner, which could indicate that high molecular weight silicone is used in this release liner coating material. Whereas, DHS outgassing test on ST-2412034 release liner revealed acetic acid, 2-ethyl hexanol, decamethyl cyclopentasiloxane, dodecamethyl cyclohexasiloxane and isopropoxy-1, 1, 1, 7, 7, 7-hexamethyl-3, 5, 5-tris (trimethylsiloxy) tetrasiloxane.

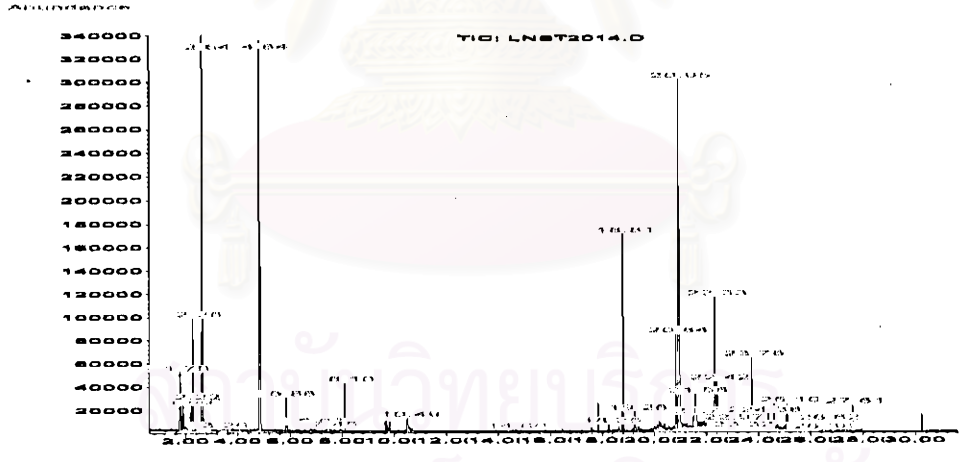

Figure 4.27. Outgassing Chromatogram of ST-2412014 Release Liner

Table 4.19 Outgassing analysis results for ST-2412014 release liner from Flex Con

Description	R.T. min	Major Compound	ng/cm^2	R.T. min	Minor Compound	ng/cm^2
Release liner ST-2412014	10.49	1. 2-Ethyl hexanol	3	14.60	1. Other alcohol	2
	20.95	2. Propanoic acid , alkyl ester	52	26.13	2. Phthalate ester	1
	26.62	3. N, N-2-trimethyl-benzenamine	3			
	27.61	4. Crinan-1-ol, methoxy-(1.alpha.)-	3			
	18.00-28.00	5. Total hydrocarbon	231			
Total outgassed			292			3

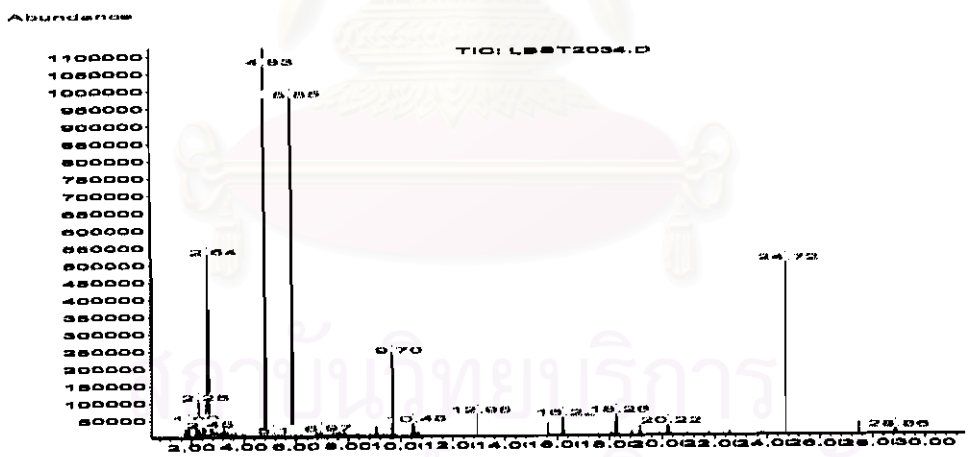

Figure 4.28. Outgassing Chromatogram of ST-2412034 Release Liner

Table 4.20 Outgassing analysis results for ST-2412034 Release liner from Flex Con

Description	R.T. min	Major compound	ng/cm^2	R.T. min	Minor Compound	ng/cm^2
Release liner ST-2412034	2.62	1. Acetic acid	53	2.45	1. Trimethyl silanol	8
	5.14	2. Pentanedione	6	2.80	2. Ethyl acetate	3
	9.07	3. Benzaldehyde	5	3.13	3. 1, 3-Dioxolane, 2-methyl-	1
	10.48	4. 2-Ethyl-1-hexanol	10			
	12.05	5. Decamethyl-cyclopentasiloxane	11	3.25	4. Benzene	4
				3.36	5. Alcohol	2
	16.22	6. Dodecamethyl cyclohexasiloxane	10	7.50	6. 1, 2-Dimethyl benzene	3
	18.26-18.85	7. Other alkane 8. Isopropoxy-1, 1, 1, 7, 7, 7-hexamethyl-3, 5, 5-tris (trimethylsiloxy) tetrasiloxane	4	7.64	7. 5-Methyl-3-hexen-2-one	2
	19.17		8	7.84	8. 2-Butoxy-ethanol	2
				9.48	9. Phenol	1
				10.69	10. Benzyl alcohol	1
				18.07	11. 2-Cyclohexen-1-one, 3-(1, 3-butadienyl)-2, 4, 4, 5-tetramethyl-	1
		9. Butyl hexadecanoate				
	28.86		20			
Total outgassed			127			28

Upon GC/MSD analysis, the characteristics of each compound detected in the methylene chloride extract of the ST-2412014 and ST-2412034 release liners are shown in Tables 4.21 and 4.22 and Figures 4.29 and 4.30, respectively. GC/MSD detected the mixture of silicone, namely dodecamethyl cyclohexasiloxane, isopropoxy-1, 1, 1, 7, 7, 7-hexamethyl-3, 5, 5-tris (trimethylsiloxy) tetrasiloxane and 1, 1, 1, 5, 7, 7, 7-heptamethyl-3, 3-bis (trimethylsiloxy) tretrasiloxane on both release liners. Furthermore, ethyl hexanol, propanoic acid alkyl ester, long chain hydrocarbon and phthalate ester were also detected in ST-2412014

release liner, while only 2-ethyl-1-hexanol and phthalate ester were detected from ST-2412034 release liner.

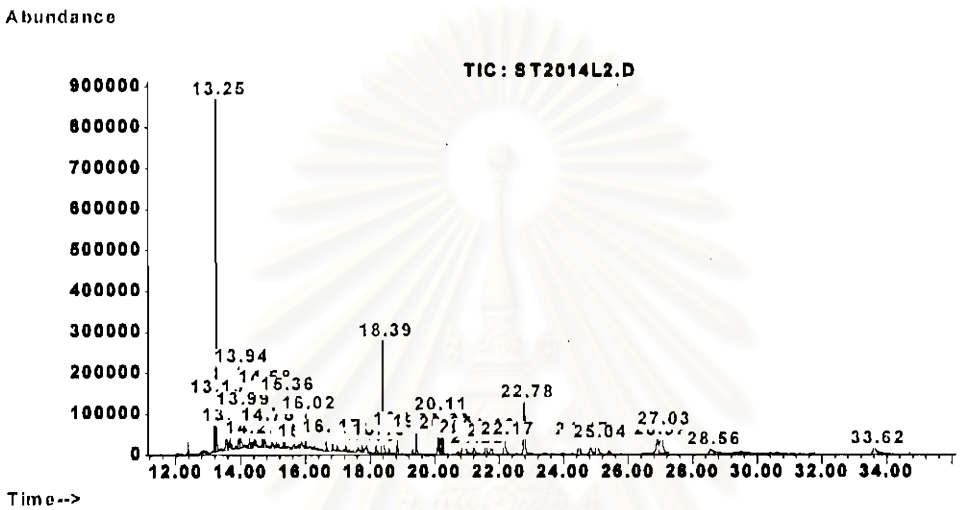

Figure 4.29. GC/MSD Chromatogram of ST-2412014 Release Liner

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.21 GC/MSD analysis results for ST-2412014 release liner from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
Release liner ST-2412014	7.85	1. Ethyl hexanol	18.39	12. Oxacyclohexadecan -2-one
	10.83	2. Dodecamethyl cyclohexasiloxane		
	12.38	3. Pentadecane		
	13.19	4. Hexadecane		
	13.24	5. Propanoic acid, alkyl ester		
	13.56	6. Squalene		
	13.94	7. Heptadecane		
	13.99	8. Pentadecane, 2, 6, 10, 14-tetramethyl-		
	14.68	9. Octadecane		
	14.75	10. Octacosane		
	15.36	11. Nonadecane		
	16.02	12. Eicosane		
	16.64	13. Tritetracontane		
	17.65	14. 1, 2-Benzenedicarboxylic acid, dicyclohexyl ester		
	17.76	15. Likely to be 1, 1, 1, 5, 7, 7, 7-Heptamethyl-3, 3-bis(trimethylsiloxy) tetrasiloxane		
	18.19	16. 1-Ethylpropyl octanoate		
	18.84	17. 1, 1, 1, 5, 7, 7, 7-Heptamethyl-3, 3-bis (trimethylsiloxy)tetrasiloxane and 3-Isopropoxy-1, 1, 1, 7, 7, 7-hexamethyl-3, 5, 5-tris (trimethylsiloxy) tetrasiloxane		
	19.31-20.11	18. 1, 2-Benzenedicarboxylic acid, diheptyl ester		
	20.20	19. Bis(2-ethylhexyl)phthalate		
	20.73	20. Didodecyl phthalate		
	21.22	21. Phthalate ester		
	21.60	22. 1, 2-Benzenedicarboxylic acid, butyl 2-ethylhexyl ester		
	22.78	23. Other phthalate ester		

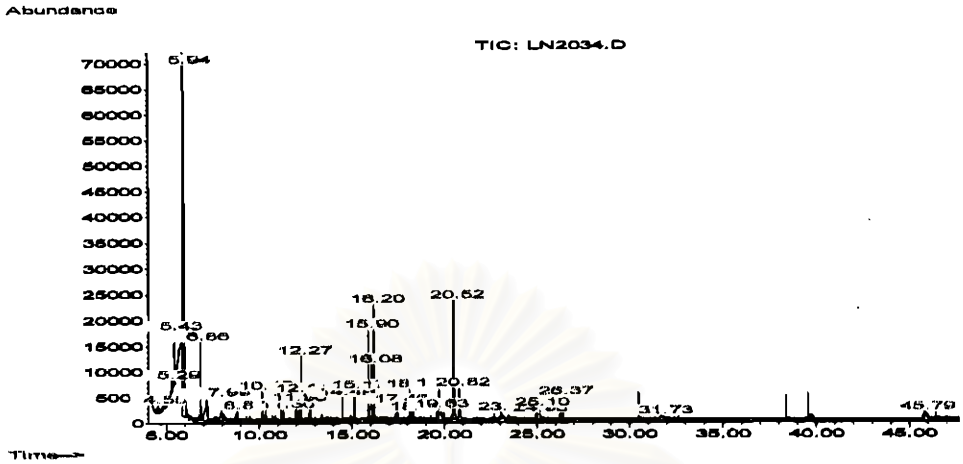

Figure 4.30. GC/MSD Chromatogram of ST-2412034 Release Liner

Table 4.22 GC/MSD analysis results for ST-2412034 release liner from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
Release liner ST-2412034	5.47	1. 2-Ethyl-1-hexanol	20.82	1. Phthalate ester
	7.20	2. 2, 4, 6-Trimethyl-1-nonene	26.38	2. Dithianone
	7.98	3. 2-Ethyl-4-pentenal		
	8.84	4. Silicone compound trace level		
	11.20	5. 3-Methyl-hexane		
	11.96	6. Undecane		
	11.99	7. Decanal		
	12.14	8. Benzoic acid, phenyl ester		
	12.23	9. 2, 7-Dimethyl-octane		
	12.27	10. 6-Heptyltetrahydro-2H-pyran-2-one		
	16.20	11. 2-Acetyl thiazole		
	17.46	12. Phthalate ester		
	18.13	13. 1, 2-Benzenedicarboxylic acid, diheptyl ester		
	20.52	14. 5-Methyl-tridecane		

The FT-IR analysis results in Table 4.2 show no silicone detected from ST-2412024 and ST-2412044 release liners. These findings indicate that the ST-2412024 and ST-2412044 release liners are silicone-free release liners (Figures 4.31 and 4.32). FT-IR analysis on ST-2412024 release liner revealed only di-n-octyl phthalate (Figure 4.31), while only aromatic compound and carbonyl compounds could be detected on ST-2412044 release liner (Figure 4.32).

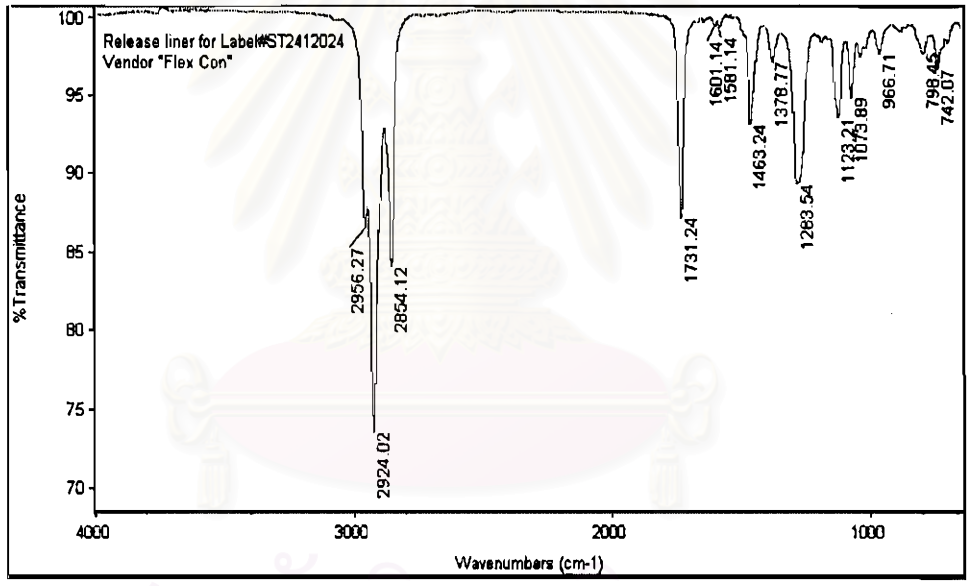

Figure 4.31 FT-IR Spectrum of ST-2412024 Release Liner

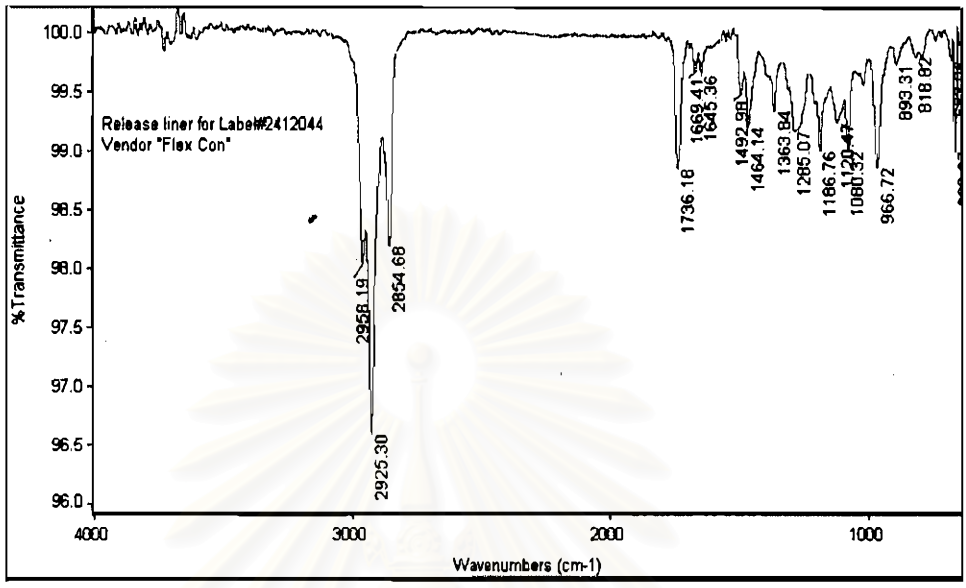

Figure 4.32. FT-IR Spectrum of ST-2412044 Release Liner

Based on GC/MSD analysis on the DHS on ST-2412024 and ST-2412044 release liners, only 7,710 ng/cm^2 and 91 ng/cm^2 respectively of total outgassed compounds could be quantified as hexadecane (Tables 4.23 and 4.24; and Figures 4.33 and 4.34). DHS outgassing test results revealed very low outgassing property of ST-2412044 release liner. The outgassed compounds from ST-2412024 release liner were 2-ethyl hexanol, long chain hydrocarbon with branched chain hydrocarbon and propanoic acid, alkyl ester; while acetic acid, ketone, benzaldehyde, 2-ethyl-1-hexanol, benzyl alcohol and cycloalkane were detected from ST-2012044 outgassing. There was no silicone detected from both release liners as they are supposed to be silicone-free release liners. Therefore, these labels should be safe to use in the hard disc drive production. The GC/MSD analysis on the methylene chloride extract of these label release liners showed phthalate ester, propanoic acid alkyl ester, long

chain hydrocarbon mixed with branched chain hydrocarbon from ST-2412024 release liner (Figure 4.35 and Table 4.25). As for ST-2412044 release liner, phthalate ester, benzaldehyde, 2-ethyl-1-hexanol, ketone and isocyanato octadecane could be extracted from (Figure 4.36 and Table 4.26). Again there were no silicone detected as they are supposed to be silicone-free release liners.

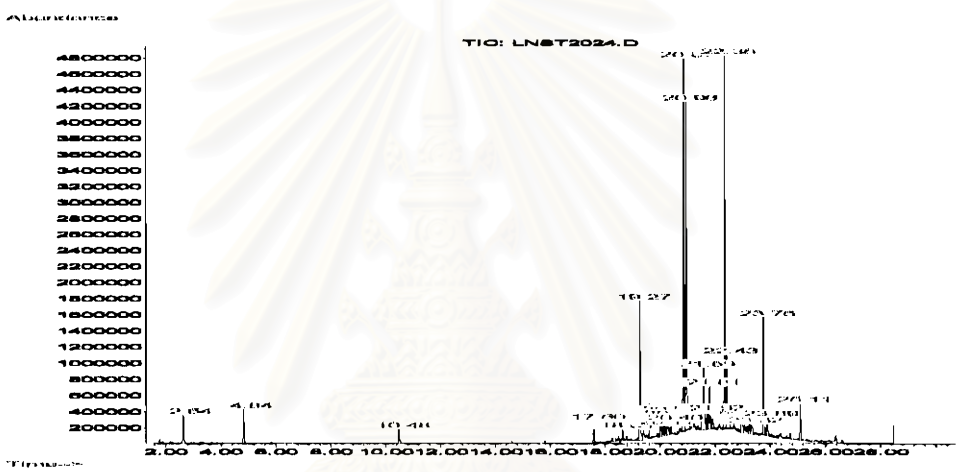

Figure 4.33. Outgassing Chromatogram of ST-2412024 Release Liner

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table 4.23 Outgassing analysis results for ST-2412024 Release liner from Flex Con

Description	R.T. min	Major Compound	ng/cm^2	R.T. min	Minor Compound	ng/cm^2
Release liner ST-2412024	10.48	1. 2-Ethyl hexanol	38	19.92	1. Bibenzyl	8
	20.96	2. Propanoic acid, alkyl ester	684	24.38	2. 2, 4, 6-Tris (1, 1-dimethylethyl)-phenol	10
	16.50-28.00	3. Other alkane	6,970			
Total outgassed			7,692			18

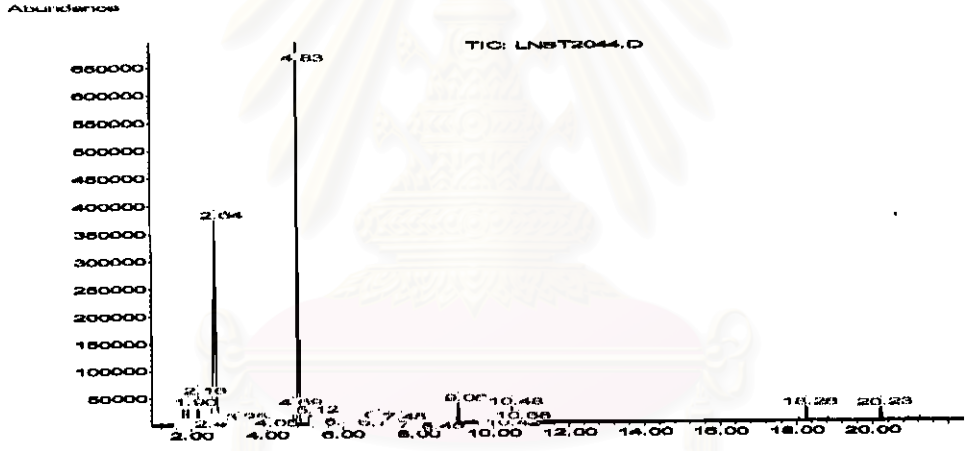

Figure 4.34. Outgassing Chromatogram of ST-2412044 Release Liner

Table 4.24 outgassing analysis results for ST-2412044 Release liner from Flex Con

Description	R.T. min	Major Compound	ng/cm^2	R.T. min	Minority compound	ng/cm^2
Release liner	2.62	1. Acetic acid	51		None	
ST-2412044	5.12	2. 2, 4-Pentanedione	7			
	9.06	3. Benzaldehyde	9			
	10.48	4. 2-Ethyl-1-hexanol	8			
	10.68	5. Benzyl alcohol	4			
	18.26	6. Other alkane	12			
Total outgassed			91			

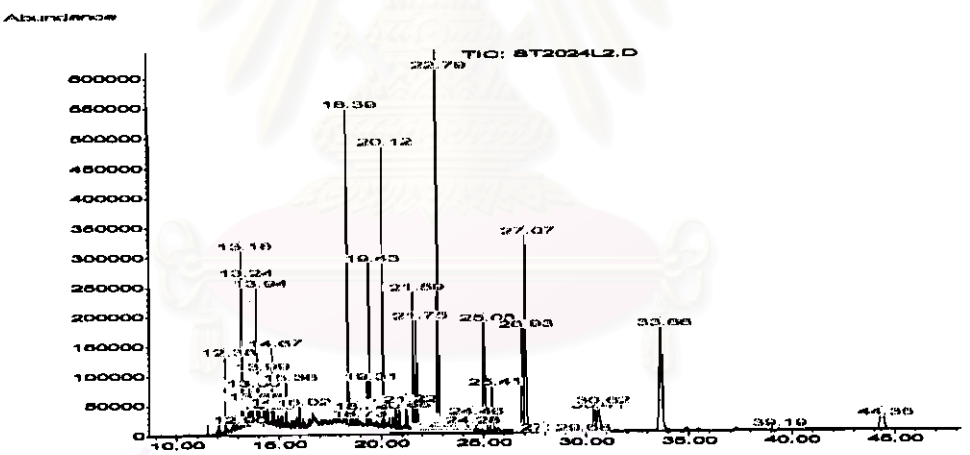

Figure 4.35. GC/MSD Chromatogram of ST-2412024 Release Liner

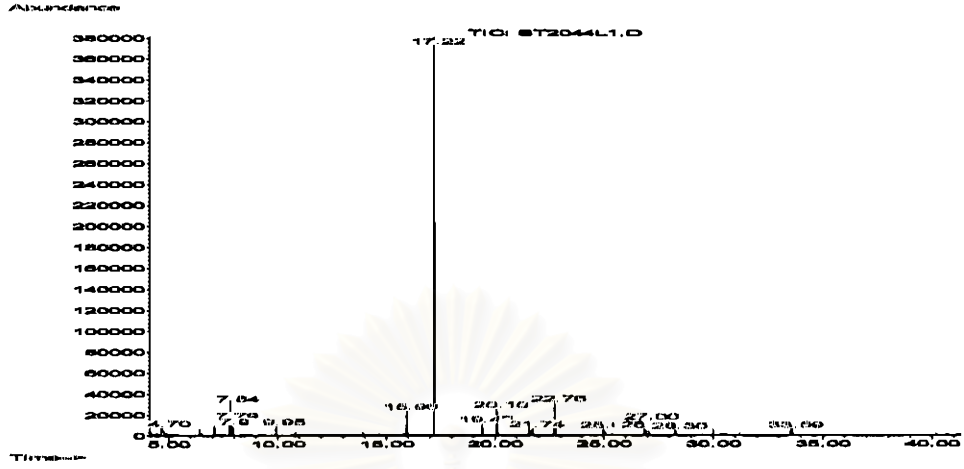

Figure 4.36. GC/MSD Chromatogram of ST-2412044 Release Liner

Table 4.25 GC/MSD analysis results for ST-2412024 release liner from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
Release liner ST-2412024	11.53	1. Tetradecane	7.80	1. 4-Pentenal, 2-ethyl-
	12.38	2. Pentadecane	12.07	2. Eicosane
	13.19	3. Hexadecane	12.87	3. N-Nonyl cyclohexane
	13.24	4. Propanoic acid, alkyl ester	12.96	4. Tetratriacontane
	13.94	5. Heptadecane	13.57	5. Pentatriacontane
	13.99	6. Pentadecane, 2, 6, 10, 14-tetramethyl-	13.68	6. Cyclohexane, decyl-
			16.00	7. 2H, 8H-Benzo(1, 2-b:3, 4-b') dipyran-2-one, 6-methoxy-8, 8-dimethyl-
	14.26	7. Pentadecane		
	14.67	8. Octadecane		
	14.74	9. Hexadecane, 2, 6, 10, 14-tetramethyl-	18.39	8. Ethyl oleate
			19.31	9. 1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl)ester
	15.36	10. Nonadecane		
	18.57	11. Octadecanoic acid, octadecyl ester	25.41	10. Bis (2-methoxyethyl)phthalate
			27.73, 27.94 and 28.11	11. 1, 2-Benzenedicarboxylic acid, bis(8-methyl nonyl)ester
	18.73	12. 1, 2-Benzenedicarboxylic acid, diheptyl ester		
	18.83	13. 1, 2-Benzenedicarboxylic acid, butyl-8-methylnonyl ester		
	21.75	14. Di-n-Octyl phthalate		

Table 4.26 GC/MSD analysis results for ST-2412044 release liner from Flex Con

Description	R.T. min	Major Compound	R.T. min	Additive Compound
Release liner ST-2412044	4.69	1. 2, 4-Pentanedione	28.31	1. Dithianone
	7.09	2. Benzaldehyde		
	7.79	3. Cyclohexane, 1, 1, 2-trimethyl-		
	7.84	4. 2-Ethyl hexanol		
	17.22	5. 1-Isocyanato-dodecane		
	19.42	6. 1, 2-Benzenedicarboxylic acid, diheptyl ester		
	21.57	7. 1, 2-Benzenedicarboxylic acid, butyl cyclohexyl ester		

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย