DOCKET NO. **SA-516**

EXHIBIT NO. **20C**

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

FIRE AND EXPLOSION GROUPS FACTUAL REPORT
Appendix III
(Tests and Study)
(81 pages)

TWA FLIGHT 800 ACCIDENT INVESTIGATION

FIRE AND EXPLOSION

APPENDIX III

(TESTS AND STUDY)

APPENDIX III

TESTS AND ANALYSIS RESULTS

Item #	Description of Analysis
1.	Fuel Sample taken July 11, 1996 in Athens, Greece. Certificate of Quality Analysis
2.	Reference Samples Labeled MMB-1, MB-2, MB-3, MB-4, MB-5, and MB-6 Kennedy Space Center, Florida (May 19, 1997)
3.	Gasper Tubing Sample # 1 from the Environmental Control System Kennedy Space Center, Florida (June 3, 1997)
4.	Gasper Tubing Samples # 2 from the Environmental Control System Kennedy Space Center, Florida (June 4, 1997)
5.	Seat Samples and Adhesive Reference Material Analysis Kennedy Space Center, Florida (June 24, 1997)
6.	Reports Pending for the following:

1. Description of Material embedded in CWT upper skin sealant.
2. Other Fuel Samples.
3. Various Soot Sample Analysis.

Swab Test taken March 6, 1997
for National Transportation Safety Board by Frank McGill (ASI)

1. Vile Test # 1 Blank with only gauze.
2. Vile Test # 2 Blank with gauze and alcohol.
3. Vile Test #3 Sta. 191F Body section 44 Access Doors and Panels.
4. Vile Test #4 Sta 191N Air Cond. Pack Door
5. Vile Test #5 Sta. 192H Right Air Cond. Door
6. Vile Test #6 Inside of #24 Krueger Flap on Right Wing aft of #4 Engine.
7. Vile Test #7 LF 55B- Left Fuselage Internal Surface.
8. Vile Test #8 LF 55C- Left Fuselage Internal Surface.

Samples taken 11/1/96

1. Blank (dry)
2. Blank (w/isopropyl)
3. Aft face of front spar near upper chord outboard of LBL 106 stiffener (swabbed)
4. Inboard web of front spar stiffener at LBL 106, approximately 18" below upper chord (scraped)
5. Upper surface of top skin near front spar at LBL 83 (scraped)
6. Upper surface of top skin (part CW129) between SWB#2 and SWB#3 near LBL 83 (scraped)
7. Forward face of midspar near lower chord at RBL 50 (swabbed)
8. Wire insulation at cannon plug attached to part LF16B (cut from rear spar); plug marked "center tank F/Q spar disconnect plug" (swabbed)
9. Outboard face of left side web of keel beam approximately 12" forward of SWB#1(swabbed)

RESIDUE SAMPLING DONE ON December 12, 1996

NO. 1—Rt side of Keel beam forward of trim air tube
No. 2 --inside of trim air tube on right side of keel beam
No. 3---outside of trim air tube clamp on right side
No. 4 –right side of keel beam just aft of break between RF-14A and RF-14B
No. 5 –Solid scraping from top inside surface of CW 504
No. 6—alcohol blank
No. 7—LF 12B Aft lower corner of passenger door
No. 8—RF 7—Aft upper corner of passenger door area
No. 9—RF 7—Between windows at about STA 920

MOBIL-SHELL-ERO

ΠΕΤΡΟΛΑ ΕΛΛΑΣ Α.Ε.Β.Ε.
ΔΙΥΛΙΣΤΗΡΙΟ ΕΛΕΥΣΙΝΑΣ

PETROLA HELLAS S.A.
ELEFSIS REFINERY

ΔΕΛΤΙΟ ΑΝΑΛΥΣΕΩΣ
CERTIFICATE OF QUALITY
(BATCH Nº 44)

ΗΜΕΡ. DATE 11-7-96
Νο 1258

ΚΑΥΣΙΜΑ ΑΕΡΟΠΟΡΙΑΣ - AVIATION TURBINE FUEL

ΠΡΟΙΟΝ PRODUCT JET A-1

ΔΕΞΑΜΕΝΕΣ SHORE TANKS TK-204

(1) page 1

LOADED ON THE TRUCKS No:

ΔΕΞΑΜΕΝΗ Νº 3

PROPERTIES	Method ASTM/IP	Results
Density at 15 °C kg/m3	D-1298	799,7
APPEARANCE visual		Clear Bright
COMPOSITION		
Total acidity mg KOH/gr	IP-354	0,003
Aromatics % vol.	D-1319	17,0
Olefins % vol.	D-1319	0,5
Sulphur total % mass	D-1266	
or - - % mass	D-4294	0,23
Sulphur, Mercaptan, % mass	D-3227	0,0015
VOLATILITY		
Distillation °C	D- 86	
I.B.P.		150
10 % Vol.		173
20 % Vol.		181
50 % Vol.		198
90 % Vol.		234
End point		250
Residue % Vol.		0,8
Loss % Vol.		0,5
Flash point (Abel) °C	IP-170	
Flash point (Tag) °C.	D- 56	45
FLUIDITY		
Freezing point °C	D-2386	-49
Viscosity - 20 °C, cst	D- 445	5,0

PROPERTIES	Method ASTM/IP	Results
COMBUSTION		
Specific Energy		
Net, MG/Kg	D-4809	43,2
or Aniline Gravity	D- 611	
Product	D-1298	
Smoke Point, mm	D-1322	26
or Naphthalenes % vol	D-1840	
and Smoke point	D-1322	
CORROSION		
Corrosion, copper classification	D- 130	1a
Corrosion Silver, classification	IP-227	ZERO
STABILITY (JFTOT) (control temperature 260° C)		
Thermal stability		
a-Filter pressure differential mm Hg.	D-3241	ZERO
b - Tube Deposit Rating (visual)	ZERO N.A.	NO PEACOCK - NORMAL
CONTAMINANTS		
Existent Gum mg/100ml	D- 381	1,5
Water reaction	D-1094	1b/2
Water Separometer index (without STADIS 450)	D-3948	92
Electrical conductivity Perm at c	D-2624	100
ADDITIVES		
Static Dissipator add. STADIS 450 ml		98

1. This product is not Hydrotreated and Copper Sweetened.
2. This product meets joint fuelling system check list latest issue ( ) and addendum No..... which embodies the following Specifications.
   a. DERD 2494
   b. IATA Guidance material, Kerosine type fuel

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Vol II 11/12

16/8/96

(2)

ΛΑ ΔΙΥΛΙΣΤΗΡΙΑ ΑΣΠΡΟΠΥΡΓΟΥ Α.Ε.
HELENIC ASPROPYRGOS REFINERY S.A.
ΧΗΜΕΙΟΝ - LABORATORY

ΔΕΞΑΜΕΝΗ Nº 3

ΕΚΘΕΣΗ ΑΝΑΛΥΣΕΩΣ — LABORATORY REPORT

JA-1 JET FUEL — JA-1

ΑΡΙΘΜΟΣ ΕΚΘΕΣΕΩΣ: 104 — REPORT NO:
ΗΜΕΡΟΜΗΝΙΑ: 5/07/96 — DATE:
ΑΡΙΘ.ΔΕΞΑΜΕΝΗΣ P-2813 — TANK NO.

ΠΥΚΝΟΤΗΤΑ ΣΕ 15°C,KG/L DENSITY AT 15°C ,KG/L	0.8005	ΑΠΩΛΕΙΕΣ ΑΠΟΣΤΑΞΗΣ,% ΚΟ DISTILLATION LOSS,% VOL	1.0
ΕΜΦΑΝΙΣΗ APPEARANCE	B/C	ΣΗΜΕΙΟ ΑΝΑΦΛΕΞΗΣ,TAG,°C FLASH POINT,TAG,°C	47
ΟΞΥΤΗΤΑ,MG KOH/G ACIDITY,MG KOH/G	0.008	ΣΗΜΕΙΟ ΨΥΞΗΣ,°C FREEZING POINT,°C	-51
ΑΡΩΜΑΤΙΚΑ,% Κ.Ο AROMATICS,% V/V	18	ΙΞΩΔΕΣ ΣΕ -20°C,CST VISCOSITY AT -20°C,CST	4
ΟΛΕΦΙΝΕΣ,% ΚΟ OLEFINS,% V/V	0.6	ΚΑΤ.ΘΕΡΜΟΓ.ΔΥΝΑΜΗ.MJ/KG NET HEAT OF COMBUS.,MJ/KG	43.231
Ο,% Κ.Β SULFUR,% M/M	0.26	ΣΗΜΕΙΟ ΑΙΘΑΛΙΣΜΟΥ,ΜΜ SMOKE POINT,MM	25
ΘΕΙΟ ΜΕΡΚΑΠΤΑΝΩΝ,% Κ.Β MERCAPTAN SULFUR,% M/M	0.0018	ΝΑΦΘΑΛΕΝΙΑ,% Κ.Ο NAPHTALENES,% V/V	
ΔΟΚΙΜΗ DOCTOR DOCTOR TEST		ΔΙΑΒΡΩΣΗ ΧΑΛΚΟΥ,ASTM N° COPPER STRIP CORROSION,N°	1A
ΑΠΟΣΤΑΞΗ ΑΡΧ.ΣΗΜ.,°C INITIAL BOILING POINT ,°C	150	ΔΙΑΒΡΩΣΗ ΑΡΓΥΡΟΥ, ASTM N° CORROSION SILVER,N°	0
10% Κ.Ο ΣΥΜΠΥΚΝΩΜΑ,°C 10% VOL RECOVERED ,°C	154	JFTOT:ΠΤΩΣΗ ΠΙΕΣΗΣ,ΜΜ ΗG JFTOT:PRES.DROP,MM HG	0
20% Κ.Ο ΣΥΜΠΥΚΝΩΜΑ,°C 20% VOL RECOVERED ,°C	159	JFTOT:ΟΠΤΙΚΗ ΕΚΤΙΜΗΣΗ ΔΙΑΓΡΑΜΜΑ JFTOT:TUBE RATING VISUAL	0
50% Κ.Ο ΣΥΜΠΥΚΝΩΜΑ ,°C 50% VOL RECOVERED, °C	[illegible]	JFTOT:"P" Η "A" ΑΠΟΘΕΣΕΙΣ JFTOT:"P"OR"A"DEPOSITS	NO
90% Κ.Ο ΣΥΜΠΥΚΝΩΜΑ.°C 90% VOL RECOVERED ,°C	231	ΚΟΜ. ΟΥΣΙΕΣ,MG/100ML GUM EXISTENT,MG/100ML	2.6
ΑΠΟΣΤΑΞΗ ΤΕΛ.ΣΗΜ.,°C FINAL BOILING POINT,°C	261	W.R-INTERFACE RATING WR-INTERFACE RATING	1
ΥΠΟΛΕΙΜΜΑ ΑΠΟΣΤΑΞΗΣ,% Κ.Ο DISTILLATION RESIDUE,%VOL	1.1	WSIM (W/O SDA,CI) WSIM (W/O SDA,CI)	94

Ο ΠΡΟΪΣΤΑΜΕΝΟΣ ΤΟΥ ΧΗΜΕΙΟΥ THE CHIEF CHEMIST

ΔΗΜΟΚΡΑΤΙΑ

ΙΔ. ΒΑΡΟΣ Γ'ΧΗΜ. 0,8016

Ι. ΓΑΓΑΙΑΣ

a/a Adami

7

19/1:

ΔΕΞΑΜΕΝΗ ΝΟ 3

Α ΔΙΥΛΙΣΤΗΡΙΑ ΑΣΠΡΟΠΥΡΓΟΥ Α.Ε.
C ASPROPYRGOS REFINERY S.A.
ΧΗΜΕΙΟΝ - LABORATORY

ΔΕΞΑΜΕΝΗ ΑΝΑΛΥΣΕΩΣ — JA-1 JET FUEL
LABORATORY REPORT — JA-1

ΑΡΙΘ.ΔΕΞΑΜΕΝΗΣ F-87118
TANK NO.

ΗΜΕΡΟΜΗΝΙΑ 2/07/96
DATE:

ΑΡ.ΔΕΛΤΙΟΥ: 48
REPORT NO:

ΠΥΚΝΟΤΗΤΑ ΣΕ 15°C,ΚΓ/Λ DENSITY AT 15°C ,KG/L	0.7999	ΑΠΩΛΕΙΕΣ ΑΠΟΣΤΑΓΗΣ,% ΚΟ DISTILLATION LOSS,% VOL	1.0
ΕΜΦΑΝΙΣΗ APPEARANCE	C/B	ΣΗΜΕΙΟ ΑΝΑΦΛΕΞΗΣ,ΤΑΒ,°C FLASH POINT,TAG,°C	44
ΟΞΥΤΗΤΑ,ΜΓ ΚΟΗ/Γ ACIDITY,MG KOH/G	0.012	ΣΗΜΕΙΟ ΨΥΞΗΣ,°C FREEZING POINT,°C	-51
ΑΡΩΜΑΤΙΚΑ,% Κ.Ο AROMATICS,% V/V	16	ΙΞΩΔΗΣ ΣΕ -20°C,CST VISCOSITY AT -20°C,CST	4
ΘΕΡΜΑΝΣΗ,% ΚΟ HEAT,% V/V	0.6	ΚΑΤ.ΘΕΡΜΟΤ.ΔΥΝΑΜΗ,ΜΖ/ΚΓ NET HEAT OF COMBUS.,MJ/KG	43.200
ΘΕΙΟ,% Κ.Β SULFUR,% M/M	0.26	ΣΗΜΕΙΟ ΑΙΘΑΛΙΣΜΟΥ,ΜΜ SMOKE POINT,MM	26
ΘΕΙΟ ΜΕΡΚΑΠΤΑΝΩΝ,% Κ.Β MERCAPTAN SULFUR,% M/M	0.0015	ΝΑΦΘΑΛΕΝΙΑ,% Κ.Ο NAPHTALENES,% V/V	
ΔΟΚΙΜΗ DOCTOR DOCTOR TEST		ΔΙΑΒΡΩΣΗ ΧΑΛΚΟΥ,ASTM Ν° COPPER STRIP CORROSION,N°	1A
ΑΡΧΙΚΗ ΑΠΟΣΤΑΓΗ,°C INITIAL BOILING POINT ,°C	154	ΔΙΑΒΡΩΣΗ ΑΡΓΥΡΟΥ, ASTM Ν° CORROSION SILVER,N°	0
10% Κ.Ο ΣΥΛΛΕΧΘΗΚΕ,°C 10% VOL RECOVERED ,°C	181	JFTOT:ΠΤΩΣΗ ΠΙΕΣΗΣ,ΜΜ ΗΟ JFTOT:PRES.DROP,MM HG	5
20% Κ.Ο ΣΥΛΛΕΧΘΗΚΕ,°C 20% VOL RECOVERED ,°C	197	JFTOT:ΟΠΤΙΚΗ ΕΚΤΙΜ.ΣΩΛΗΝΑ JFTOT:TUBE RATING VISUAL	NO
50% Κ.Ο ΣΥΛΛΕΧΘΗΚΕ,°C 50% VOL RECOVERED ,°C	[illegible]	JFTOT:"P" Η "TA" ΑΠΟΘΕΣΕΙΣ JFTOT:"P"OR"A"DEPOSITS	2.8
90% Κ.Ο ΣΥΛΛΕΧΘΗΚΕ,°C 90% VOL RECOVERED ,°C	234	ΚΟΗ. ΟΥΣΙΕΣ,ΜΓ/100ΜΛ GUM EXISTENT,MG/100ML	1
ΑΠΟΣΤΑΓΗ ΤΕΛ.ΣΗΜ.,°C FINAL BOILING POINT,°C	250	W.S-INTERFACE RATING WS-INTERFACE RATING	1
ΥΠΟΛ.ΑΠΟΣΤΑΓΗΣ,% Κ.Ο DISTILLATION RESIDUE,%VOL	1.1	WSIM (W O &DA,CI) WSIM (W O &DA,CI)	96

Ο ΠΡΟΪΣΤΑΜΕΝΟΣ ΤΟΥ ΧΗΜΕΙΟΥ:

ΔΙΕΥΘΥΝΤΗΣ ΧΗΜΕΙΟΥ

C.Δ. ΒΑΡΟΣ Γ.Χ.

Ε.Κ.Ο. Α.Β. ΑΘΑΝΑΣΙΑΔΗΣ Δ.Ο.

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(A)

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ΕΛΛΗΝΙΚΑ ΚΑΥΣΙΜΑ - ΟΡΥΚΤΕΛΑΙΑ
ΑΝΩΝΥΜΗ ΒΙΟΜΗΧΑΝΙΚΗ & ΕΜΠΟΡΙΚΗ ΕΤΑΙΡΙΑ
ΧΗΜΕΙΟ ΣΚΑΡΑΜΑΓΚΑ
ΠΑΛΑΙΟΚΑ 1 - ΣΚΑΡΑΜΑΓΚΑΣ 124 62
ΤΗΛ. 6572 980

ΔΕΛΤΙΟ ΑΝΑΛΥΣΗΣ ΑΕΡΟΠΟΡΙΚΟΥ ΚΑΥΣΙΜΟΥ

Α/Α ΔΕΙΓΜΑΤΟΣ: 336 ΠΡΟΕΛΕΥΣΗ ΔΕΙΓΜΑΤΟΣ: ΣΚΑΡΑΜΑΓΚΑΣ

ΕΙΔΟΣ : JET A1 ΗΜΕΡΟΜΗΝΙΑ ΠΑΡΑΛΑΒΗΣ: 9/7/96

ΔΕΞΑΜΕΝΗ Νο 3 (Νο 7) ΔΕΞ.

ΒΑΡ: 9/7/96

ΕΛΕΓΧΟΙ		ΜΕΘΟΔΟΙ ΑΝΑΛΥΣΗΣ	ΑΠΟΤΕΛΕΣΜΑΤΑ
Appearance		Visual	B/C
Density at 15°C	(gr/ml)	ASTM D - 1298	0,8008
Distillation		ASTM D - 86	
IBP	(°C)		
10% Recovered	(°C)		
20% "	(°C)		
50% "	(°C)		
90% "	(°C)		
F.B.P.	(°C)		
Residue/Loss	(%Vol)		
Flash Point TAG	(°C)	ASTM D - 56	46,0
Freezing Point	(°C)	ASTM D - 2386	-51,5
Water Reaction		ASTM D - 1094	1
WSIM		ASTM D - 3948	77
Existent Gum	(mg/100ml)	ASTM D - 381	1,6
Copper Corrosion	(2h,100°C)	ASTM D - 130	1a
Conductivity	(pS/m)	ASTM D - 2624	117 (29°C)

ΠΑΡΑΤΗΡΗΣΕΙΣ

ΤΟ ΠΡΟΪΟΝ..... ΕΙΝΑΙ ΣΥΜΦΩΝΟ ΜΕ ΤΗΝ DEF STAN 91 - 91/1

ΣΚΑΡΑΜΑΓΚΑΣ 9/7/96

Ο ΧΗΜΙΚΟΣ Γ. ΜΠΟΥΡΟΣ

ΓΙΑ ΤΟΝ ΠΕΛΑΤΗ

9

(B)

ΕΛΛΗΝΙΚΑ ΚΑΥΣΙΜΑ - ΟΡΥΚΤΕΛΑΙΑ
ΑΝΩΝΥΜΗ ΒΙΟΜΗΧΑΝΙΚΗ & ΕΜΠΟΡΙΚΗ ΕΤΑΙΡΙΑ
ΧΗΜΕΙΟ ΣΚΑΡΑΜΑΓΚΑ
ΠΑΛΑΙΑ 1 - ΣΚΑΡΑΜΑΓΚΑΣ 124 62
ΤΗΛ. 55 72 000

ΔΕΛΤΙΟ ΑΝΑΛΥΣΗΣ ΑΕΡΟΠΟΡΙΚΟΥ ΚΑΥΣΙΜΟΥ

Α/Α ΔΕΙΓΜΑΤΟΣ: 342 ΠΡΟΕΛΕΥΣΗ ΔΕΙΓΜΑΤΟΣ: ΣΚΑΡΑΜΑΓΚΑ
ΕΙΔΟΣ : Jet A1 ΗΜΕΡΟΜΗΝΙΑ ΠΑΡΑΛΑΒΗΣ: 11/7/96
Def. (D"93)

ΔΕΞΑΜΕΝΗ Νο3 ΒΑΠ: 10/7/96

ΕΛΕΓΧΟΙ		ΜΕΘΟΔΟΙ ΑΝΑΛΥΣΗΣ	ΑΠΟΤΕΛΕΣΜΑΤΑ
Appearance		Visual	Clr
Density at 15°C	(gr/ml)	ASTM D - 1298	0,8004
Distillation		ASTM D - 86	
IBP	(°C)		
10% Recovered	(°C)		
20% "	(°C)		
50% "	(°C)		
90% "	(°C)		
F.B.P.	(°C)		
Residue/Loss	(%Vol)		
Flash Point TAG	(°C)	ASTM D - 56	41,0
Freezing Point	(°C)	ASTM D - 2386	-51,5
Water Reaction		ASTM D - 1094	1
WSIM		ASTM D - 9845	79
Existent Gum	(mg/100ml)	ASTM D - 381	1,6
Copper Corrosion	(2h,100°C)	ASTM D - 130	1a
Conductivity	(pS/m)	ASTM D - 2624	85 (29°C)

ΠΑΡΑΤΗΡΗΣΕΙΣ:

ΤΟ ΠΡΟΪΟΝ..... ΕΙΝΑΙ ΣΥΜΦΩΝΟ ΜΕ ΤΗΝ DEF STAN 91 - 91/1

ΣΚΑΡΑΜΑΓΚΑΣ 11/7/96 Ο ΧΗΜΙΚΟΣ Ε. [illegible]

ΓΙΑ ΤΟΝ ΠΕΛΑΤΗ

10

Δεξ. 5

(4)

Α ΒΥΤΑΙΟΠΗΡΙΑ ΑΕΡΟΠΟΥΡΓΟΥ Α.Ε.
C AEROPYRGOU REFINERY S.A.
ΧΗΜΕΙΟΝ • LABORATORY

ΔΕΛΤΙΟΝ ΑΝΑΛΥΣΕΩΣ JA-1 JET FUEL
LABORATORY REPORT JA-1

ΑΡΙΘ.ΔΕΞΑΜΕΝΗΣ F-8819 TANK NO.
ΗΜΕΡΟΜΗΝΙΑ 5/08/96 DATE:
ΑΡΙΘ.ΔΕΛΤΙΟΥ: 127 REPORT NO:

ΠΥΚΝΟΤΗΤΑ ΣΕ 15°C,KG/L DENSITY AT 15°C ,KG/L	0.8013	ΑΠΩΛΕΙΕΣ ΑΠΟΣΤΑΣΕΩΣ,% ΚΟ DISTILLATION LOSS,% VOL	1.0
ΦΩΤΑΥΓΕΙΑ FLUORESCENCE	Η/C	ΣΗΜΕΙΟ ΑΝΑΦΛΕΞΕΩΣ,ΤΑΒ,°C FLASH POINT,TAG,°C	47
ΣΥΣΤΑΣ.ΝΟ ΚΟΚ/G CETANE NO KOK/G	0.011	ΣΗΜΕΙΟ ΨΥΞΕΩΣ,°C FREEZING POINT,°C	-52
ΟΛΕΦΙΝΑ,% Κ.Ο OLEFINS,% V/V	16	ΙΞΩΔΕΣ ΣΕ -20°C,CST VISCOSITY AT -20°C,CST	4
ΑΡΩΜΑΤΙΚΑ,% Κ.Ο AROMATICS,% V/V	0.4	ΚΑΤ.ΘΕΡΜΟΤ.ΔΥΝΑΜΗΣ,ΜJ/ΚG NET HEAT OF COMBUS.,MJ/KG	42.106
ΘΕΙΟ,% Κ.Β SULFUR,% M/M	0.29	ΣΗΜΕΙΟ ΑΙΘΑΛΑΙΣΜΟΥ,ΜΜ SMOKE POINT,MM	24
ΘΕΙΟ ΜΕΡΚΑΠΤΑΝΩΝ,% Κ.Β MERCAPTAN SULFUR,% M/M	0.0015	ΝΑΦΘΑΛΗΝΙΑ,% Κ.Ο NAPHTALENES,% V/V	
ΔΟΚΙΜΗ ΔΟCTOR DOCTOR TEST		ΔΙΑΒΡΩΣΗ ΧΑΛΚΟΥ,ΛΩΡΙΣ Η° COPPER STRIP CORROSION,N°	1A
ΑΠΟΣΤΑΣΗ ΑΡΧ.ΣΗΜ.,°C INITIAL BOILING POINT,°C	155	ΔΙΑΒΡΩΣΗ ΑΡΓΥΡΟΥ, ΛΩΡΙΣ Η° CORROSION SILVER,N°	0
10% Κ.Ο ΣΥΜΠΥΚΝΩΘΗΚΑ,°C 10% VOL RECOVERED,°C	166	JFTOT:ΠΤΩΣΗ ΠΙΕΣΕΩΣ,ΜΜ ΗG JFTOT:PRES.DROP,MM HG	0
20% Κ.Ο ΣΥΜΠΥΚΝΩΘΗΚΑ,°C 20% VOL RECOVERED,°C	190	JFTOT,ΟΠΤΙΚΗ ΕΚΤΙΜΗΣΗ ΣΩΛΗΝΑ JFTOT:TUBE RATING VISUAL	0
40% Κ.Ο ΣΥΜΠΥΚΝΩΘΗΚΑ,°C 50% VOL RECOVERED,°C	202	JFTOT:"F" Η "A" ΑΝΘΕΚΘΕΣΕΙΣ JFTOT:"F"OR"A"DEPOSITS	NO
90% Κ.Ο ΣΥΜΠΥΚΝΩΘΗΚΑ,°C 90% VOL RECOVERED,°C	229	ΚΟΜ. ΟΥΛΕΣ,ΜG/100ML GUM EXISTENT,MG/100ML	2.9
ΑΠΟΣΤΑΣΗ ΤΕΛ.ΣΗΜ.,°C FINAL BOILING POINT,°C	248	W.R-INTERFACE RATING WR-INTERFACE RATING	1
ΚΑΤΑΛΟΙΠΟ,% Κ.Ο DISTILLATION RESIDUE,%VOL	1.2	WSIM (W/O SDA,CI) WSIM (W/O SDA,CI)	86

Ο ΒΡΟΙΣΤΑΜΕΝΟΣ ΤΟΥ ΧΗΜΕΙΟΥ THE CHIEF CHEMIST

Ι. ΓΑΓΑΛΑΣ

0,8015

11

Mobil

ΠΕΤΡΟΛΑ ΕΛΛΑΣ Α.Ε.Β.Ε.
ΔΙΥΛΙΣΤΗΡΙΟ ΕΛΕΥΣΙΝΑΣ

PETROLA HELLAS S.A.
ELEFSIS REFINERY

ΔΕΛΤΙΟ ΑΝΑΛΥΣΕΩΣ
CERTIFICATE OF QUALITY
(BATCH N° 5)

DATE 12-8-96
No 1474

ΒΕ. 5

ΚΑΥΣΙΜΑ ΑΕΡΟΠΟΡΙΑΣ - AVIATION TURBINE FUEL

ΠΡΟΪΟΝ PRODUCT JET A-1

ΔΕΞΑΜΕΝΕΣ SHORE TANKS 7Κ - 204

(5)

LOADED ON THE TRUCKS No:

PROPERTIES	Method ASTM/IP	Results
Density at 15 °C kg/m3	D-1298	800,6
APPEARANCE visual		Clear Bright
COMPOSITION		
Total acidity mg KOH/gr	IP-354	0,003
Aromatics % vol.	D-1319	12,0
Olefins % vol.	D-1319	0,5
Sulphur total % mass	D-1266	
or " " % mass	D-4294	0,23
Sulphur, Mercaptan, % mass	D-3227	0,0009
VOLATILITY		
Distillation °C	D- 86	
I. B. P.		154
10 % Vol.		185
20 % Vol.		193
50 % Vol.		204
90 % Vol.		234
End point		251
Residue % Vol.		0,8
Loss % Vol.		0,5
Flash point (Abel) °C	IP-170	
Flash point (Tag) °C	D- 56	45
FLUIDITY		
Freezing point °C	D-2386	-49,0
Viscosity -20 °C, cSt	D- 445	5,8

PROPERTIES	Method ASTM / IP	Results
COMBUSTION		
Specific Energy Net, MG/Kg	D-4809	43,2
or Aniline Gravity	D- 611	
Product	D-1298	
Smoke Point mm	D-1322	26
or Naphthalenes % vol	D-1840	
and Smoke point	D-1322	
CORROSION		
Corrosion, copper classification	D- 130	1a
Corrosion, Silver, classification	IP- 227	ZERO
STABILITY (JFTOT) (control temperature 260° C)		
Thermal stability a-Filter pressure differential mm Hg.	D-3241	ZERO
b - Tube Deposit Rating (visual)		ZERO, NO PEACOCK OR ABNORMAL COLOUR DEPOSITS
CONTAMINANTS		
Existent Gum mg/100ml	D- 381	1,5
Water reaction	D-1094	1b/2
Water Separometer index (without ~~inhibitor~~)	D-3948	92
Electrical conductivity Pa/m at c	D-2624	140
ADDITIVES Static Dissipator add. ~~mg/l~~ mg/l		0,8

1. This product is not Hydrotreated and Copper Sweetened.
2. This product meets joint fuelling system check list latest issue (16) and addendum No..... (ISSUED JUNE '96) which embodies the following Specifications.
   a- DERD 2494
   b- IATA Guidance material, Kerosine type fuel
   c- ASTM D-1655, Kerosine type Jet A-1

12

DATE : 5

6

DIL (HELLAS)
TH [illegible] S.A
THEODORI GREECE

No : 471
DATE : 4/8/96

LABORATORY QUALITY CERTIFICATE
JET A-1

: JET - A1		
NATION : SHELL PERAMA		
R : NEMEA	TANK : 787	
	RESULTS	METHODS
ITY AT 15 DEG C. Kg/M3	793.8	ASTM D-1298
1 POINT DEG C	40	IP-170
OSITY AT -20 DEG C.CST	3.8	ASTM D-445
ZING POINT DEG C	-47.0	ASTM D-2386
L SULFUR % WT	0.17	ASTM D-4294
ERCAPTAN SULFUR % WT	0.0016	ASTM D-3227
/ CONTENT %WT	14.0	ASTM D-3701
MATICS % VOL	14.1	ASTM D-1319
FINS % VOL	0.3	ASTM D-1319
TILLATION IBP DEG C OVERED 10 % VOL DEG C OVERED 20 % VOL DEG C OVERED 50 % VOL DEG C OVERED 90 % VOL DEG C DEG C OSS/LOSS	145 164 178 198 238 258 1.0/1.0	ASTM D-86
CIFIC ENERGY .NET MJ/KG	43.30	ASTM D-3338
KE POINT mm	25	ASTM D-5323
ROSION COPPER STRIP.2HRS AT 100 DEG C	1a	ASTM D-130
VER CORROSION.4HRS AT 50 DEG C	0	IP 227
STENT GUM mgr/100 ml	3	ASTM D-381
TAL ACID NUMBER mgr KOH/gr	0.005	ASTM D-3242
DROPROCESSED FUEL IN BATCH % VOL	NIL	
TER SEPARATION INDEX MODIFIED	92	ASTM D-3948
TER REACTION: INTERFACE RATING	1b/2	ASTM D-1094
ERMAL STABILITY (JFTOT) TEMP 260oC LTER PRESSURE.mmHg/TUBE DEPOSIT RATING PEACOCK OR ABNORMAL COLOR DEPOSITES	0/L1	ASTM D-3241
ICAL CONDUCTIVITY PS/M AT 36 DEG oC	190	ASTM D-2624
TATIC DISSIPATOR MG/L	0.45	

PPEARANCE: CLEAR, BRIGHT AND FREE FROM SOLID MATTER AND UNDISSOLVED WATER
T AMBIENT TEMPERATURE

onducted by

Approved by

13

ΥΠ' ΟΨΙΝ: κ. Ηρ. Τουρνάτζη 11ο όροφο

ρογα

Δt= 5

ΕΛΛΗΝΙΚΑ ΚΑΥΣΙΜΑ - ΟΡΥΚΤΕΛΑΙΑ
ΑΝΩΝΥΜΗ ΒΙΟΜΗΧΑΝΙΚΗ & ΕΜΠΟΡΙΚΗ ΕΤΑΙΡΙΑ
ΧΗΜΕΙΟ ΣΚΑΡΑΜΑΓΚΑ
ΠΑΛΑΣΚΑ 1 - ΣΚΑΡΑΜΑΓΚΑΣ 124 62
ΤΗΛ. 5572960

ΔΕΛΤΙΟ ΑΝΑΛΥΣΗΣ ΑΕΡΟΠΟΡΙΚΟΥ ΚΑΥΣΙΜΟΥ

Α/Α ΔΕΙΓΜΑΤΟΣ: 419 ΠΡΟΕΛΕΥΣΗ ΔΕΙΓΜΑΤΟΣ: ΑΕΡΟΔΡΟΜΙΟ

ΕΙΔΟΣ: Jet A1 ΗΜΕΡΟΜΗΝΙΑ ΠΑΡΑΛΑΒΗΣ: 6/8/96

Δεξ. (Νο 15)

Β.Ν. 5/8/96

ΕΛΕΓΧΟΙ		ΜΕΘΟΔΟΙ ΑΝΑΛΥΣΗΣ	ΑΠΟΤΕΛΕΣΜΑΤΑ
Appearance		Visual	B/C
Density at 15°C	(gr/ml)	ASTM D - 1298	0.8010
Distillation		ASTM D - 86	
IBP	(°C)		
10% Recovered	(°C)		
20% "	(°C)		
50% "	(°C)		
90% "	(°C)		
F.B.P.	(°C)		
Residue/Loss	(%Vol)		
Flash Point TAG	(°C)	ASTM D - 56	46,5
Freezing Point	(°C)	ASTM D - 2386	-52,0
Water Reaction		ASTM D - 1094	1
WSIM		ASTM D - 3948	89
Existent Gum	(mg/100ml)	ASTM D - 381	1,6
Copper Corrosion	(2h, 100°C)	ASTM D - 130	1a
Conductivity	(pS/m)	ASTM D - 2624	77 (21°C)

ΠΑΡΑΤΗΡΗΣΕΙΣ:

ΤΟ ΠΡΟΪΟΝ......... ΕΙΝΑΙ ΣΥΜΦΩΝΟ ΜΕ ΤΗΝ DEF STAN 91 - 91/1

ΣΚΑΡΑΜΑΓΚΑΣ 6/8/96

Ο ΧΗΜΙΚΟΣ Σ. Μπεκυρος

14

ΥΠ ΟΨΙΝ κ.. Ηρ Τουρνατζή
11ο φαξ
ΔΕΞ. 5

ΕΛΛΗΝΙΚΑ ΚΑΥΣΙΜΑ - ΟΡΥΚΤΕΛΑΙΑ
ΑΝΩΝΥΜΗ ΒΙΟΜΗΧΑΝΙΚΗ & ΕΜΠΟΡΙΚΗ ΕΤΑΙΡΙΑ
ΧΗΜΕΙΟ ΣΚΑΡΑΜΑΓΚΑ
ΠΑΛΑΙΟΚΑ 1 - ΣΚΑΡΑΜΑΓΚΑΣ 124 62
ΤΗΛ. 55 72 980

ΔΕΛΤΙΟ ΑΝΑΛΥΣΗΣ ΑΕΡΟΠΟΡΙΚΟΥ ΚΑΥΣΙΜΟΥ

ΑΑ ΔΕΙΓΜΑΤΟΣ: 419 ΠΡΟΕΛΕΥΣΗ ΔΕΙΓΜΑΤΟΣ: ΑΣΠΡΟΠΥΡΓΟΣ
ΕΙΔΟΣ : Jet A1 ΗΜΕΡΟΜΗΝΙΑ ΠΑΡΑΛΑΒΗΣ: 6/8/96
ΔΕΞ. (Ν° 15)

B.V. 5/8/96

ΕΛΕΓΧΟΙ	ΜΕΘΟΔΟΙ ΑΝΑΛΥΣΗΣ	ΑΠΟΤΕΛΕΣΜΑΤΑ
Appearance	Visual	B/C
Density at 15°C (gr/ml)	ASTM D - 1298	0.8010
Distillation	ASTM D - 86	
IBP (°C)		
10% Recovered (°C)		
20% " (°C)		
50% " (°C)		
90% " (°C)		
F.B.P. (°C)		
Residue/Loss (%Vol)		
Flash Point Tag (°C)	ASTM D - 56	46,5
Freezing Point (°C)	ASTM D - 2386	-52,0
Water Reaction	ASTM D - 1094	1
WSIM	ASTM D - 3948	98
Existent Gum (mg/100ml)	ASTM D - 381	1,6
Copper Corrosion (2h, 100°C)	ASTM D - 130	1a
Conductivity (pS/m)	ASTM D - 2624	37 (21°C)

ΠΑΡΑΤΗΡΗΣΕΙΣ:

ΤΟ ΠΡΟΪΟΝ..... ΕΙΝΑΙ ΣΥΜΦΩΝΟ ΜΕ ΤΗΝ DEF STAN 91 - 91/1

ΣΚΑΡΑΜΑΓΚΑΣ 6/8/96 Ο ΧΗΜΙΚΟΣ Χ. ΛΙΠΕΣΙΥΡΟΣ

ΓΙΑ ΤΟΝ ΠΕΛΑΤΗ

15

.ΔΕ.5

E

HELLAS A.E
Oil and Chemicals company
PERAMA LABORATORY

RECERTIFICATION TEST REPORT - SHELL JET-A1

ANALYSIS BULLETIN No	1622	INSTALLATION :	
REPORT No	95/96	DEPOT-AIRPORT	PERAMA
TANK No	15	BATCH No	PERA/15/163/96
Product drawn from tanks of M/T	MEDEA	Date sample drawn	05/08/96
Quantity received (MT)	1900		
REFINERY/LOADING PORT	KOH	Sample was drawn by mr	A.ECONOMOU
QUALITY certificate of refinery	671/4-8-96	Date received at laboratory	05/08/96
Quantity before receipt (MT)	3250		
Last batch	PERA/15/163/96		

This report relates only to the samples tested and does notguarantee the bulk of material to be of equal quality

PROPERTIES		RESULTS	SPECS	TEST METHODS
Appearance		B/C	Clear/bright	Visually
Water,sediment,suspended matter		NIL	NIL	Visually
Colour SAYBOLT		+19	Report	ASTM D 156
tillation				ASTM D 86
Initial Boiling Point	°C	145	Report	
Fuel Recovered 10% vol	°C	170	205 max	
-"- 20% vol	°C	178	Report	
-"- 50% vol	°C	198	Report	
-"- 90% vol	°C	240	Report	
Final Boiling Point (E.P.)	°C	258	300 max	
Residue	% vol	1.0	1.5 max	
Loss	% vol	1.0	1.5 max	
Flash Point- ABEL	°C	0	38 min	IP 170
or Flash point -SETAFLASH	°C		35 min	ASTM D 3828
Density at 15 °C	Kg/lt	0.7943	0,775/0,840	ASTM D 1298
Freezing Point	°C	-47.5	-47 max	ASTM D 2386
Copper corrosion,rating		1a	1 max	ASTM D 130
Silver corrosion,rating		0	1 max	IP 227
Existent Gum(steam Jet)mgr/100ml		2.9	7,0 max	ASTM D 381
Water Reaction				ASTM D 1094
Interface rating		1b	1 b max	
Additional Tests				
Conductivity	PS/m	150	50/450	ASTM D 2624
	at °C	24		

REMARKS-Results comply with the requirements of AFQUOS Joint Fuelling System 'Check List' specification for JET-A1 ISSUE 15-JUN-95 for the properties tested above

DATE 05/08/96 SIGNED BY A ECONOMOU

1 Water 'NIL' is referred to the water of the sample tested, and does not mean release of the respective tank. Release of the shore tank after the settling period and retesting for water is the responsibility of the depot supervisor.

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NASA
DIRECTOR OF LOGISTICS OPERATIONS
MATERIALS SCIENCE DIVISION
MATERIALS AND CHEMICAL ANALYSIS BRANCH
LO-MSD-1C
KENNEDY SPACE CENTER, FLORIDA 32899

May 19, 1997

REPORT 97-1C0089

SUBJECT: National Transportation Safety Board (NTSB) Reference Samples

REQUESTER: Dr. Merritt M. Birky/NTSB/(202) 314-6503

RELATED DOCUMENTATION: Report 97-1C0063
Report 97-1C0064

INVESTIGATOR: C. Bassett/LO-MSD-1C

CONTRIBUTORS: Stan Young/LO-MSD-1C
Sandy Loucks/LO-MSD-1C
Stephen Huff/LO-MSD-2E

1.0 FOREWORD

Samples were submitted by the NTSB as reference materials for the on-going investigation of TWA's flight #800 accident. During the course of the analysis, results as they developed were verbally communicated to the requester, followed up with documentation in a preliminary narrative report provided via "E-mail".

2.0 SAMPLE DESCRIPTION

Integral to the ongoing investigation of TWA's flight #800, samples labeled MMB-1, MB-2, MB-3, MB-4, MB-5 and MB-6 were submitted for analysis and use as reference materials to compare with the debris characterized and discussed in related documentation. The scale used for all photo documentation is in millimeters.

3.0 CHEMICAL ANALYSIS AND RESULTS

3.1 The initial step was to characterize each sample provided. This was accomplished using Fourier Transform Infrared (FTIR) microscope spectroscopy, polarized light microscopy and Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM/EDS).

3.2 Two samples were provided in the bag labeled MMB-1 (foam and duct material). The foam material was largely organic in appearance and had two distinctively colored sides. One side was light orange/brown and the other was a much darker orange/brown color. Cursory observation suggested an inorganic presence. Subsequently, elemental analysis was conducted.

3.2.1 The foam material (Figure 1) was identified by FTIR as a polyurethane based substance. The spectra is shown in Figure 2. Elemental analysis by EDS of the lighter side of the foam (Figure 3) indicated the material was high in carbon and oxygen with trace amounts of sodium, magnesium, aluminum, silicon, sulfur, chlorine and nickel present. The EDS overview analysis of the darker side (Figure 4) was found to contain high concentrations of carbon and oxygen. The concentrations of sodium and chlorine (probably in the form of salts) were higher in the darker side of the foam material than in the lighter side. Finally, trace amounts of magnesium, aluminum, silicon, phosphorous and sulfur were also found.

3.2.2 Initial examination of the duct debris (Figure 5) by optical microscopy, indicated the material consisted of translucent fibers which were predominately inorganic and a binder which was an organic based material. The IR analysis identified the major component of the binder as a flame retardant polyester resin (Figure 6). The fibers were examined by elemental analysis.

3.2.3 Transparent glass fibers at the ends of the fiber clusters could be clearly observed by polarized light microscopy (Figures 7 and 8). An EDS analysis (Figure 9) of the clear glass fiber shows high concentrations of oxygen, aluminum, silicon and calcium, with trace amounts of sodium, chlorine, titanium and iron present. Figure 10 shows the glass fibers as red, the binder or coating material as green, and areas of high sodium and chlorine as blue.

3.2.4 An opaque coating covered these fibers. Flakes of the opaque coating were removed from the fibers and analyzed using SEM/EDS. An EDS analysis (Figure 11) of the coating material (green as seen in Figure 10) indicates high concentrations of chlorine, carbon and oxygen with some calcium, aluminum and silicon present.

3.2.5 Figure 12 shows a secondary electron view of the binder material with several of the glass fibers that remain attached to the binder.

3.2.6 Figure 13 is a multi-window scan of the sample shown in Figures 7 and 8. This includes a small duplicate image of the same area (upper left) and eight color dot-map images that show where in Figure 10, the elements carbon, oxygen, sodium, aluminum, silicon, sulfur, chlorine and calcium are located.

3.3 The orange floor material provided in the sample bag labeled MB-2 (Figure 14) was identified by FTIR as a phenoxy resin based substance such as a molding compound. The IR spectrum for the resin is provided in Figure 15.

3.4 The orange colored material from the honeycomb structure of the large exterior duct sample was provided in the bag labeled MB-3 (Figure 16). This material was identified by FTIR as a phenol aldehyde resin, also much like a molding compound. The IR spectrum for the resin is provided in Figure 17. The green material from the base of the sample (Figure 18) is an epoxy resin, the IR spectrum of which is shown in Figure 19.

3.5 The red fiber as seen in Figure 20 is from the fabric of seat #21-5 and was provided in the sample bag labeled MB-4. The red fiber, the spectrum of which can be seen in Figure 21, is much like Azlon (a manufactured fiber in which the fiber-forming substance is composed of a regenerated naturally occurring protein) and is discussed in 97-1C0063.

3.6 The blue fiber as seen in Figure 22 is from the fabric of seat #20-4 and was provided in the sample bag labeled MB-5. The blue fiber, the spectrum of which can be seen in Figure 23, is similar to Azlon.

3.7 Several items were analyzed from the sample bag labeled MB-6, which contained floor carpet from blow out panel cover #62-75231354 (Figure 24). The red fabric is seen in Figure 25 and is the same as presented in 3.5 above. The gray fiber from the carpet material is a polyamide material much like the Nylon™6 series. The IR spectrum is provided in Figure 26.

4.0 CONCLUSIONS

4.1 The foam material of sample MMB-1 was identified as a polyurethane product and could very plausibly be the source of the dark material. This polyurethane was previously identified in the samples from report 97-1C0063 and report 97-1C0064. Whether the previously discussed dark material is the degraded form of a polyurethane foam or other polyurethane product could not be determined by this analysis.

4.2 The discolored (red and blue) fabric of the reference material (Samples MB-4 and MB-5 respectively) could plausibly have been the source of the Azlon material identified and discussed in 97-1C0063 and 97-1C0064.

4.3 The translucent blue-gray material of MB-6 was identified as a polyamide material much like the Nylon™ 6 series and could plausibly have been one of the sources of the polyamide presence of 97-1C0063 and 97-1C0064.

4.4 There is no indication that any of the reference materials examined in these analyses, served as the source of the surfactant coated polyester which was discussed in report 97-1C0064, the dull white material also discussed in that report, nor is there evidence to indicate any of the reference materials served as the source of the nitrate presence in MB-1 and MB-2.

INVESTIGATOR: _____

Charles W. Bassett/407-867-9618

Figure 1: Foam Material from MMB-1

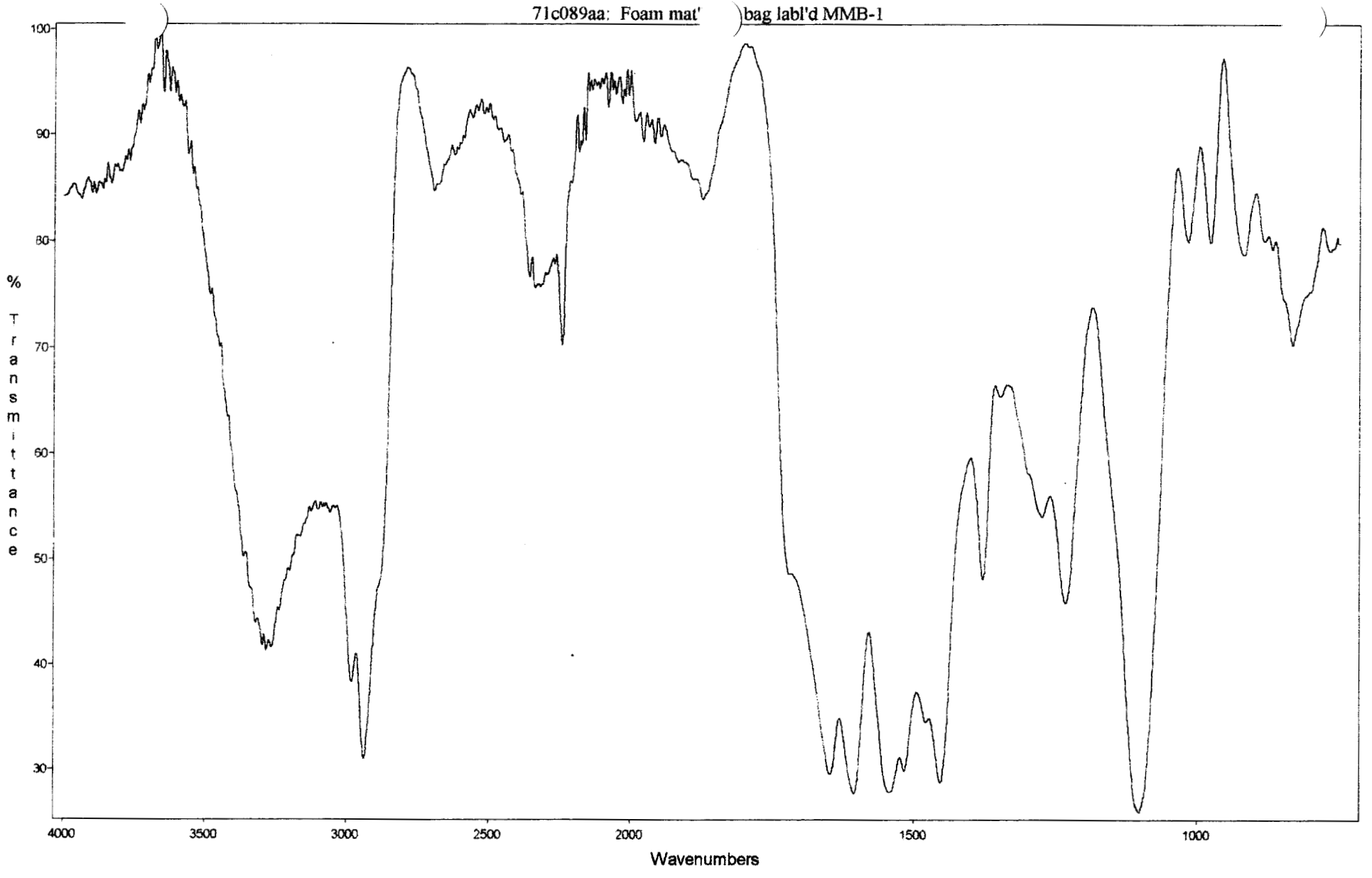

FIGURE 2. FOAM MATERIAL

22

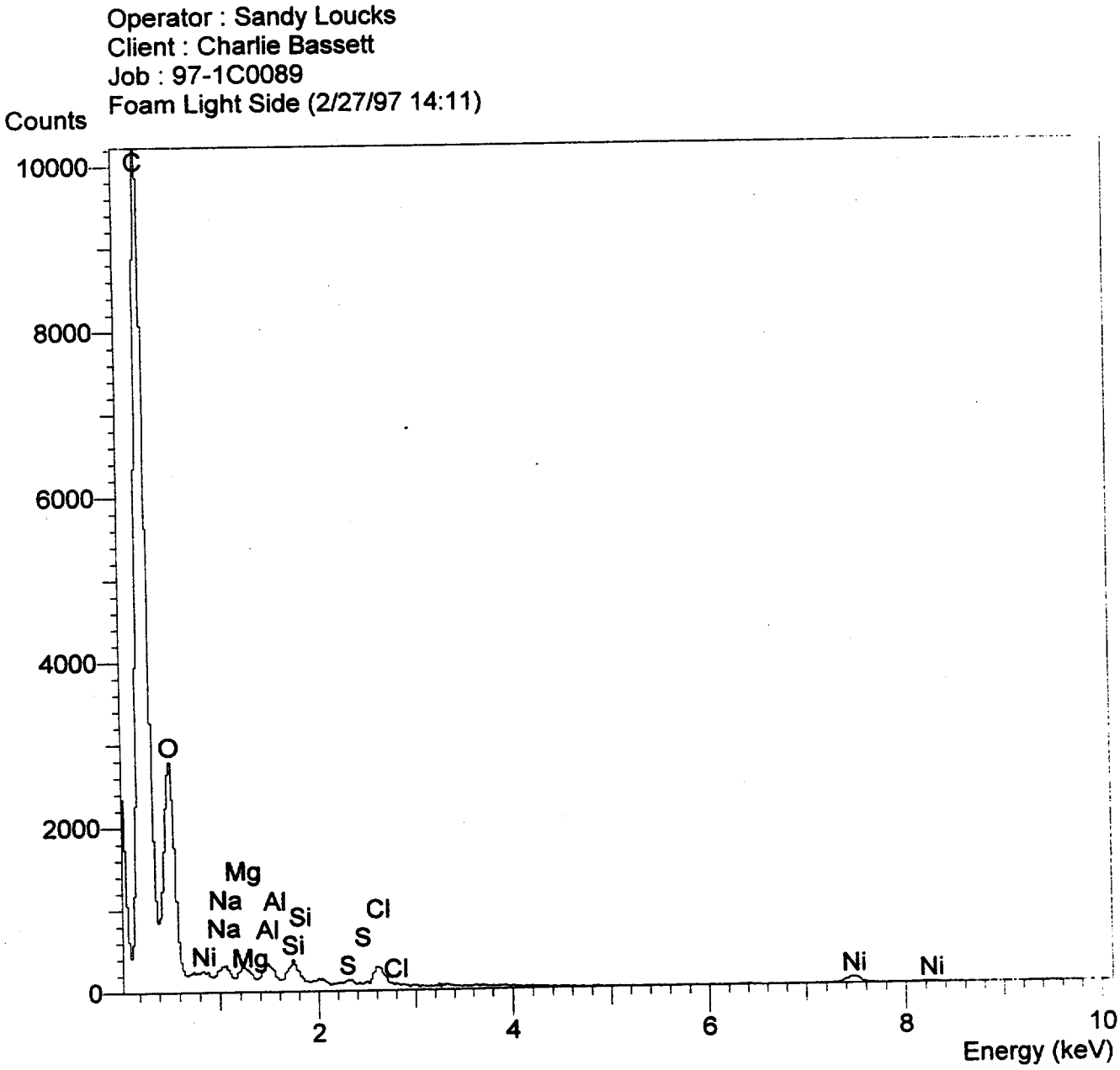

FIGURE 3. LIGHTER SIDE

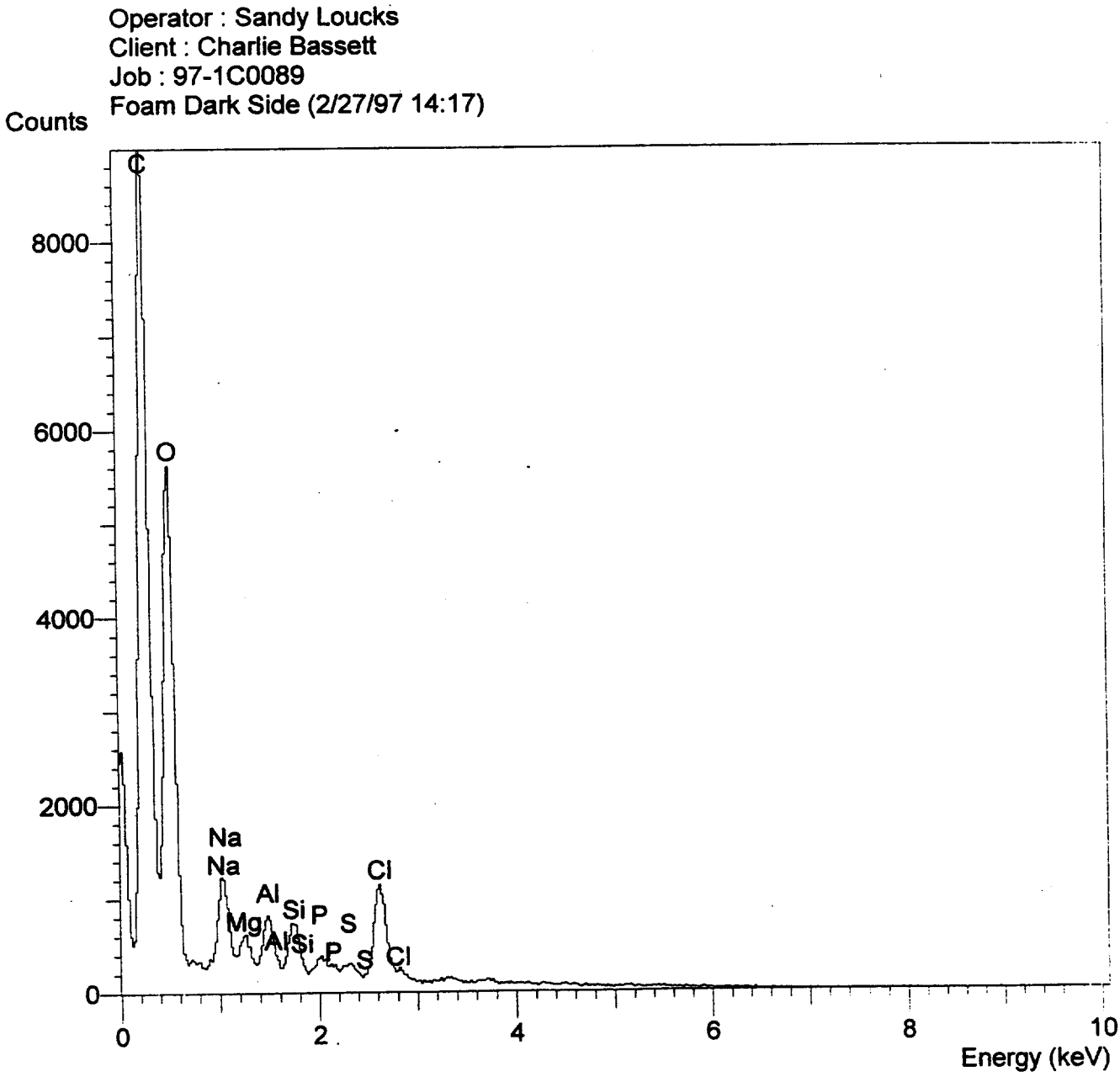

FIGURE 4. DARKER SIDE

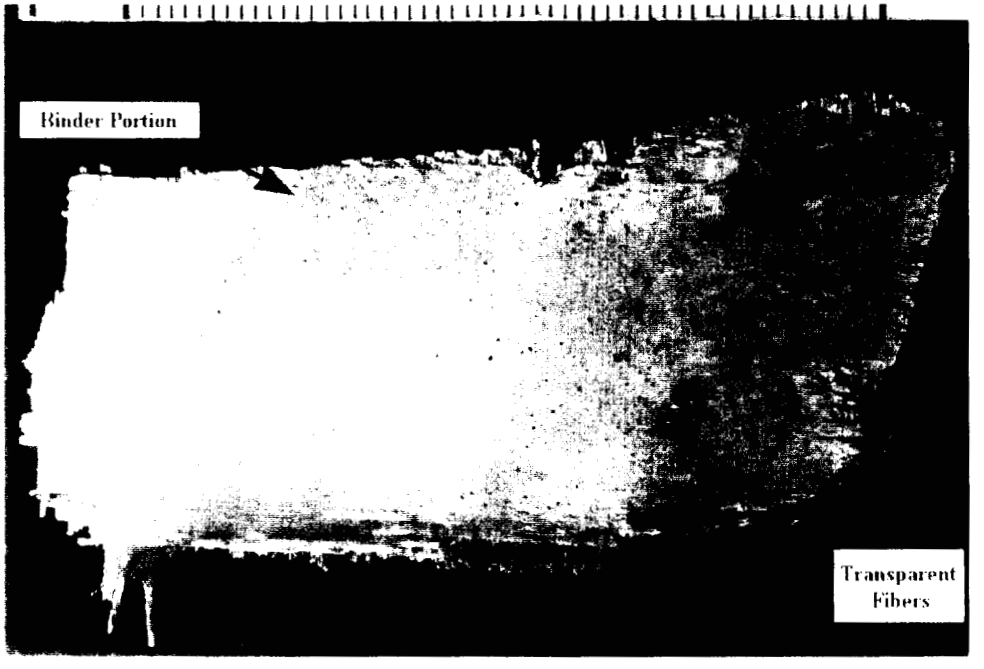

Figure 5: Duct Material from MMB-1

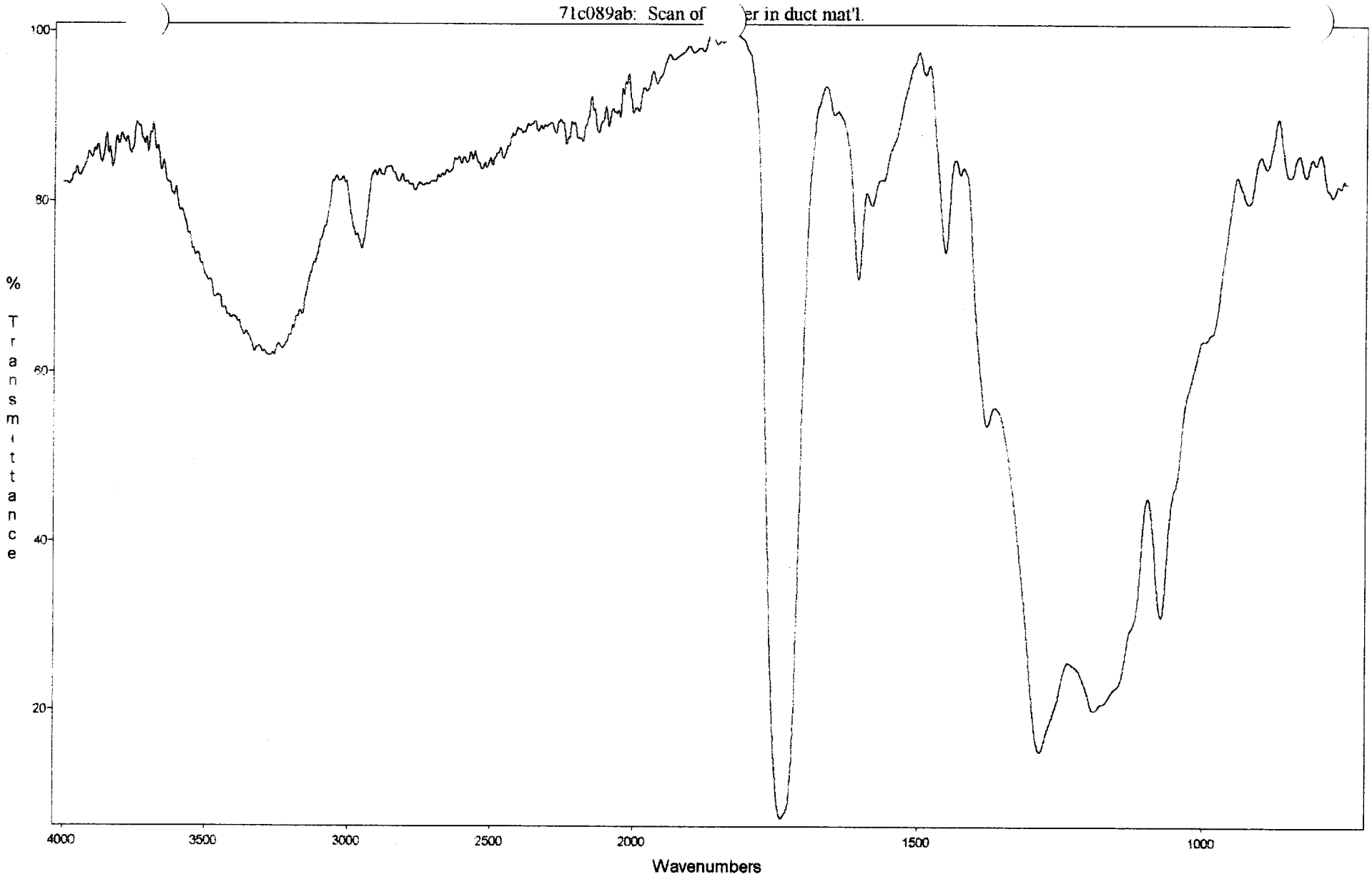

FIGURE 6. BINDER MATERIAL

FIGURE 7.

90X

POLARIZED LIGHT MICROSCOPE VIEWS OF A GLASS FIBER FROM DUCT (TWA-800)

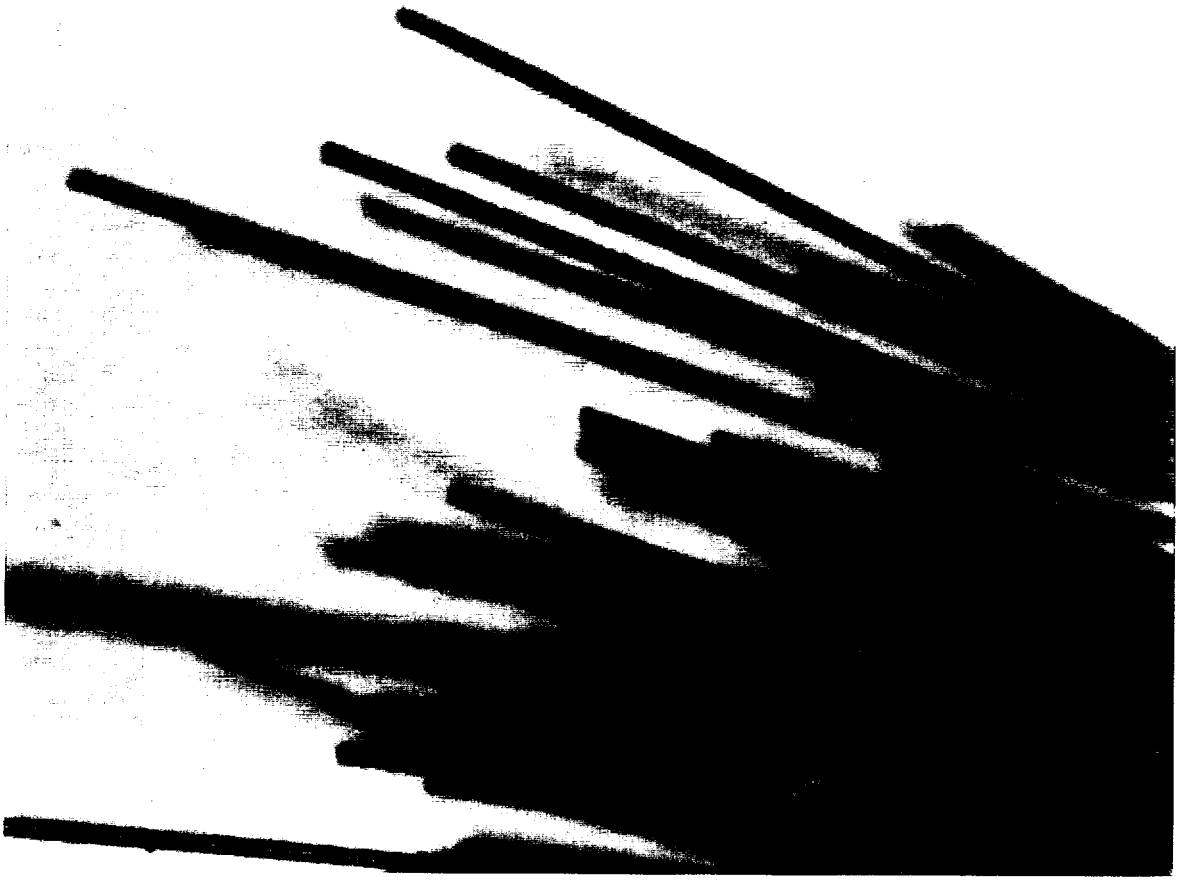

FIGURE 8.

360X

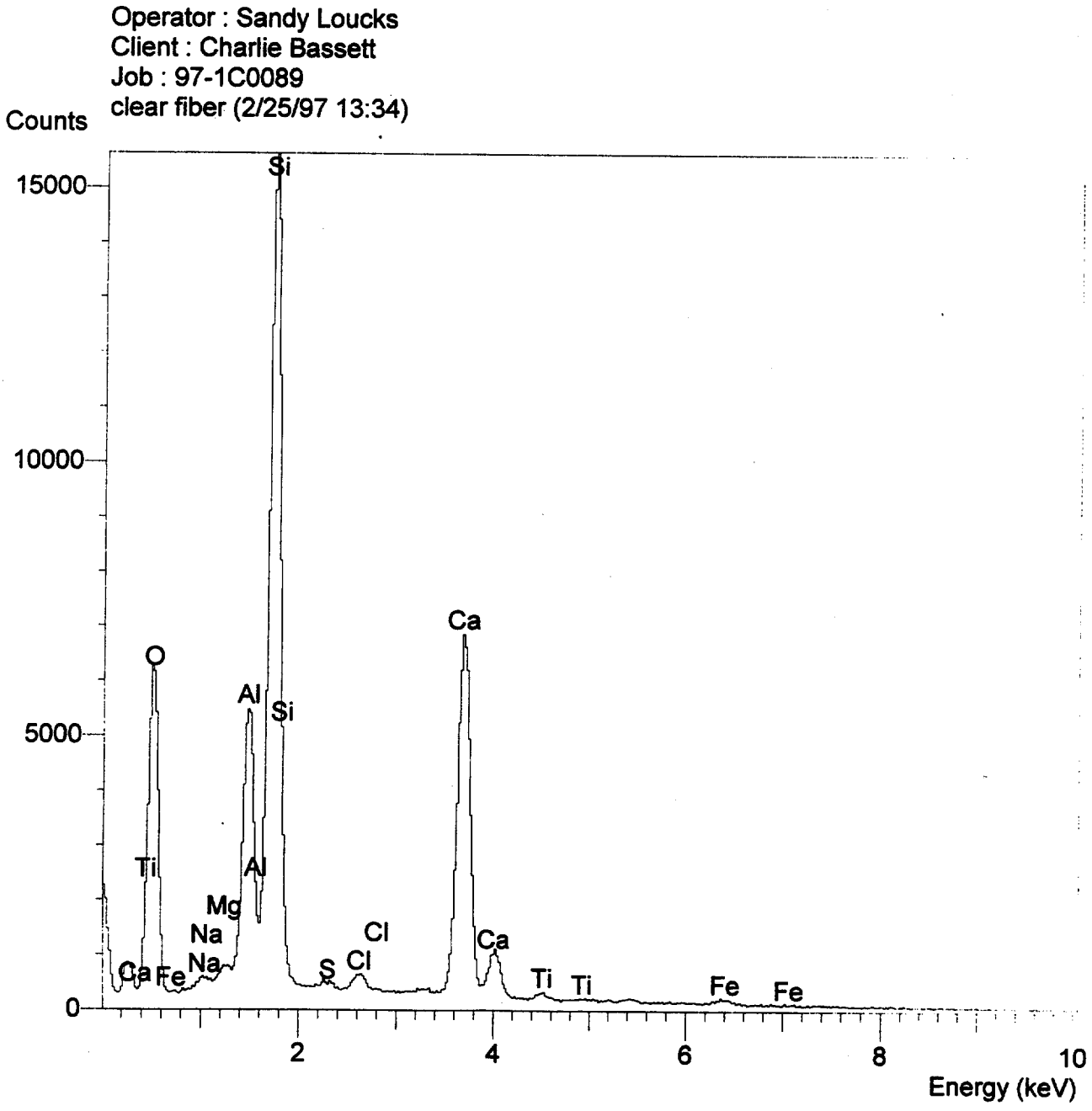

FIGURE 9. CLEAR FIBER

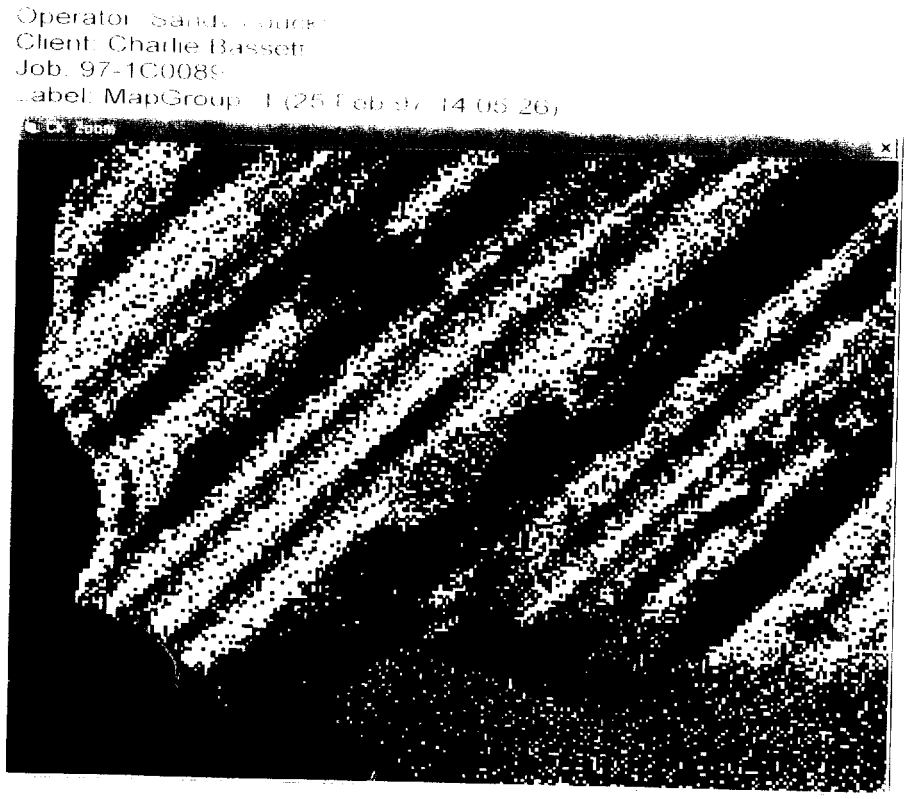

FIGURE 10 COMPOSITE ELEMENTAL VIEW OF BINDER AND GLASS MATERIAL

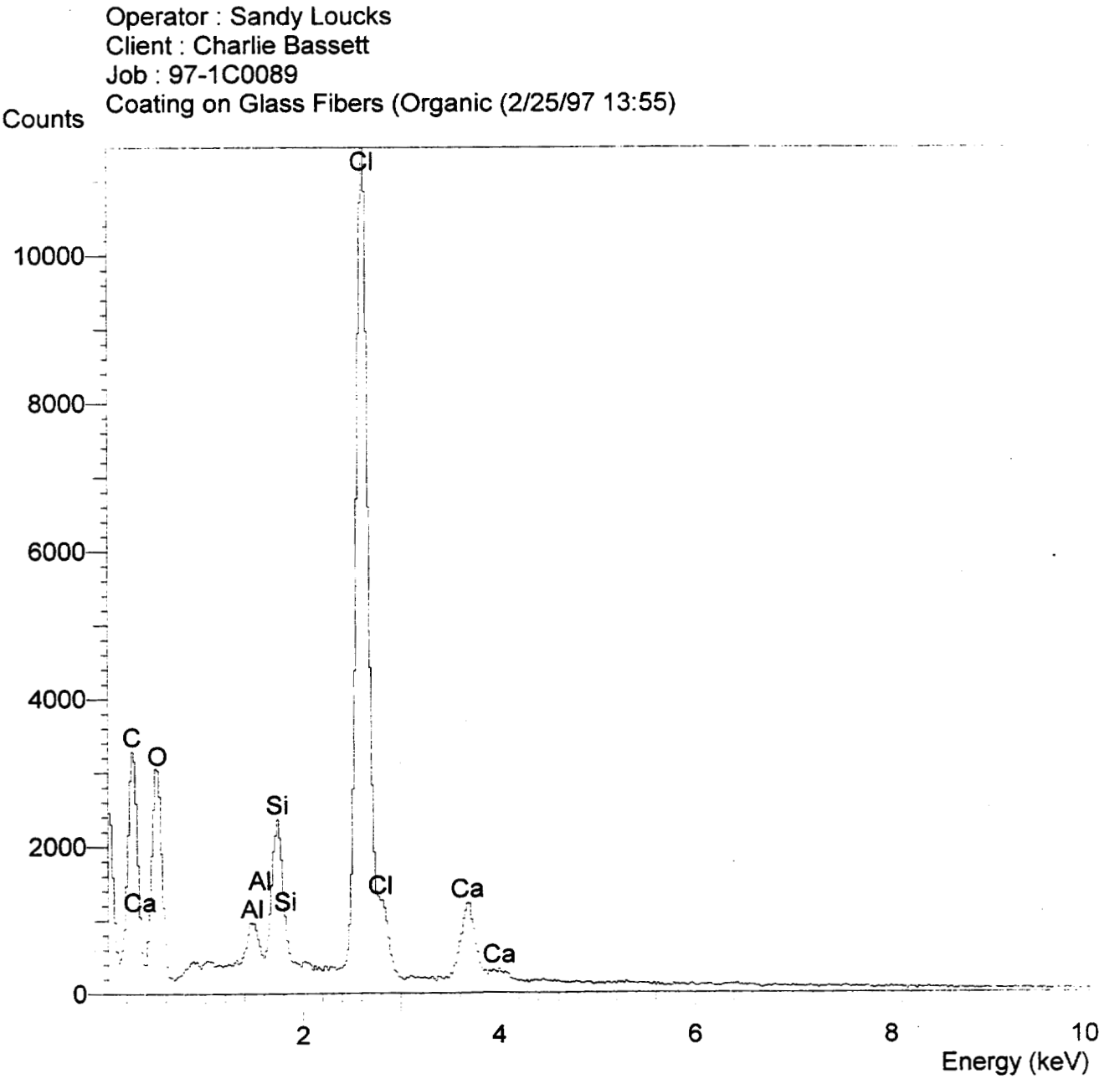

FIGURE 11. COATING ON FIBERS

FIGURE 12. SEM SECONDARY ELECTRON VIEW OF FIBER AND BINDER TAKEN FROM DUCT MATERIAL.

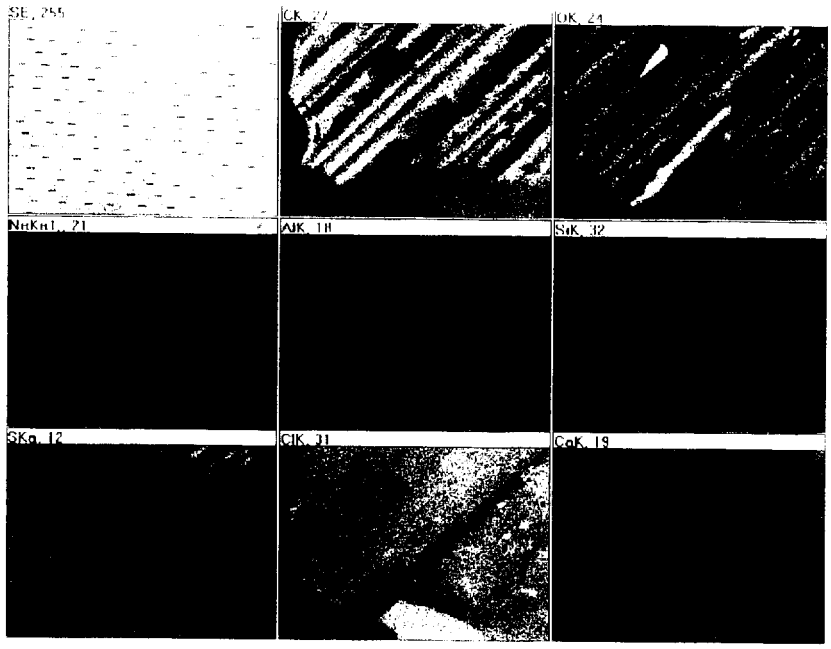

FIGURE 13 ELEMENTAL DOT MAP IMAGES OF FIBER AND BINDER TAKEN FROM DUCT MATERIAL

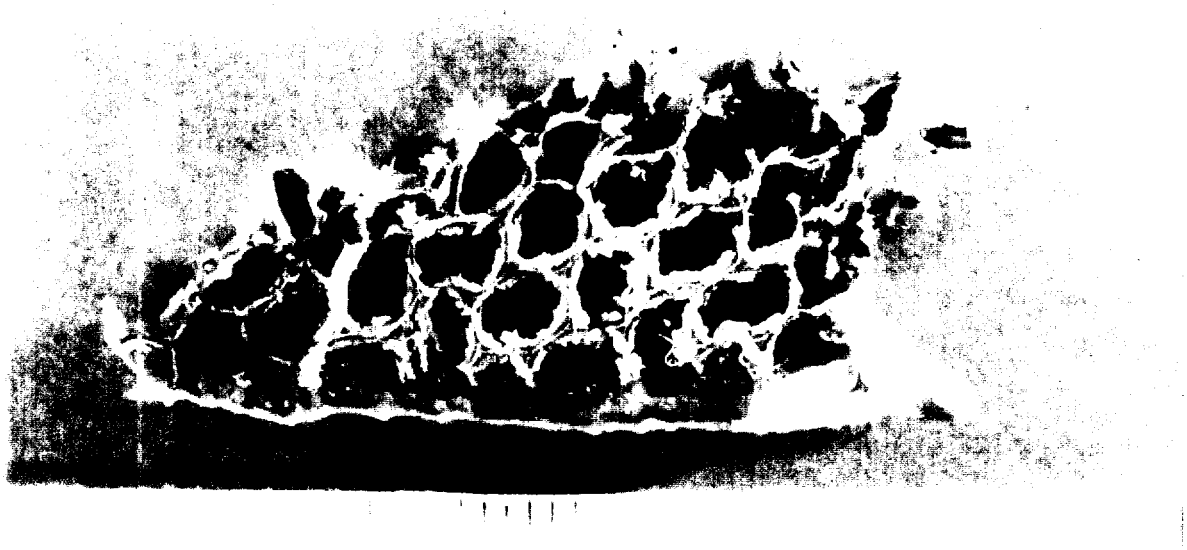

Figure 14: Orange Floor Material from MB-2

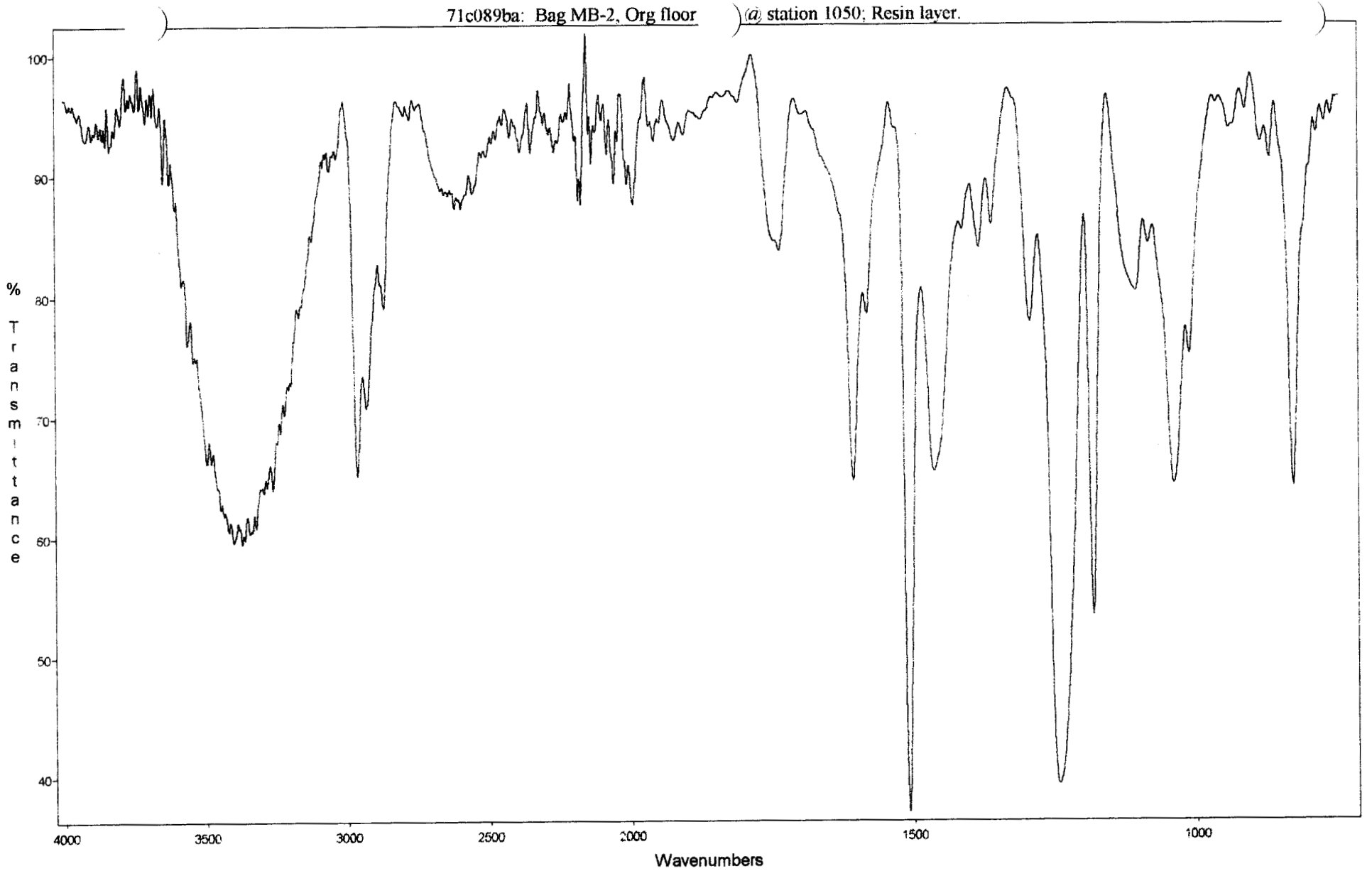

FIGURE 15. ORANGE FLOOR MATERIAL AT STATION 1050.

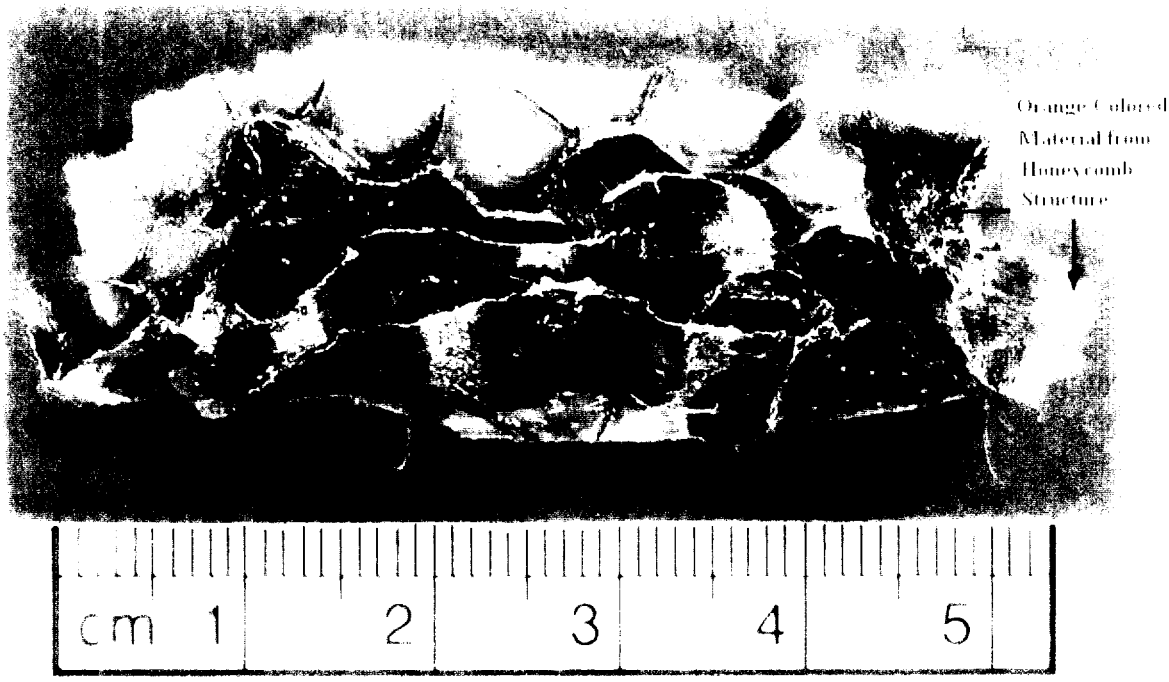

Figure 16: Material from Large Exterior Duct. MB 3

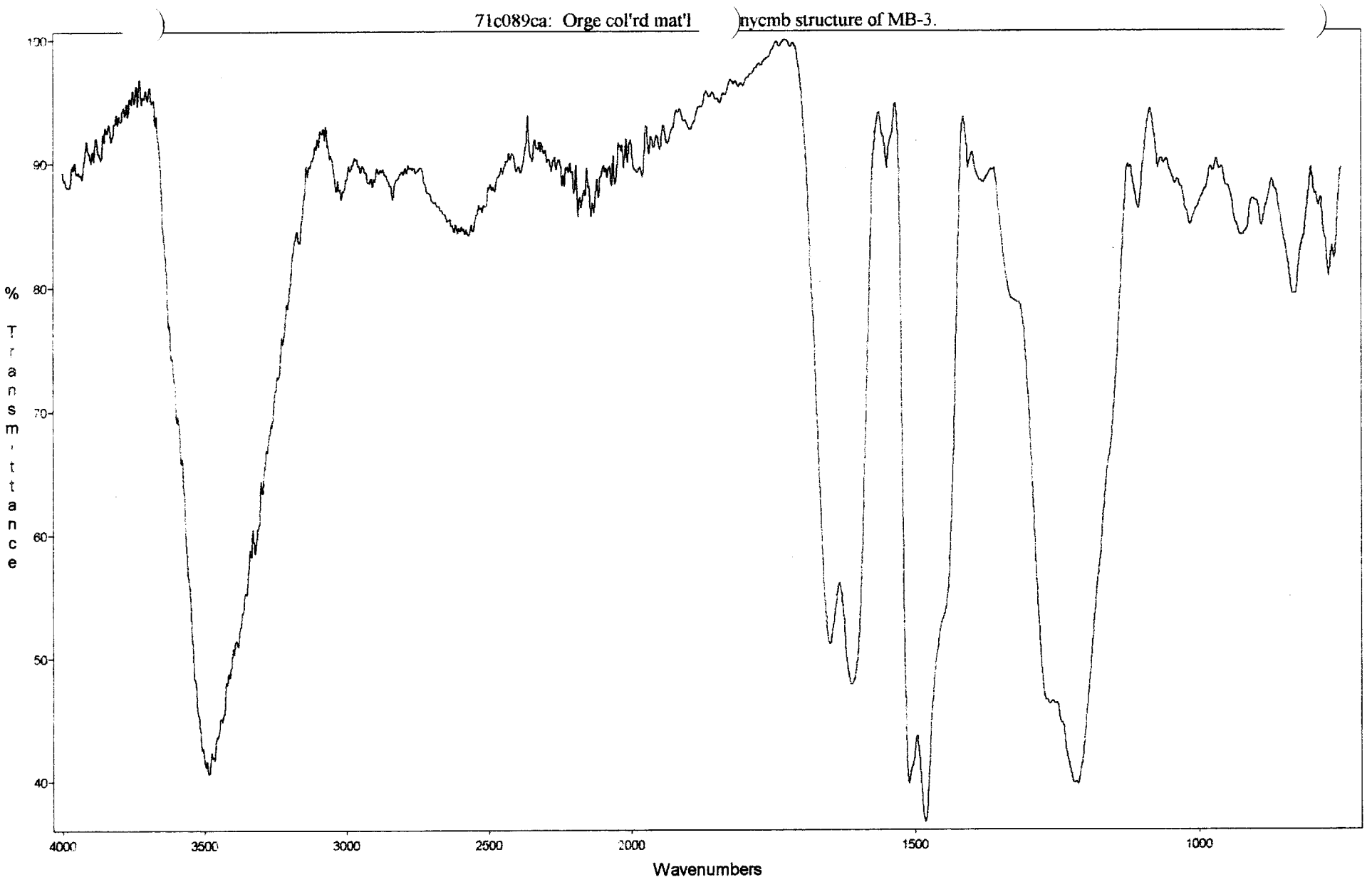

FIGURE 17. ORANGE COLORED MATERIAL FROM "HONEYCOMB" STRUCTURE.

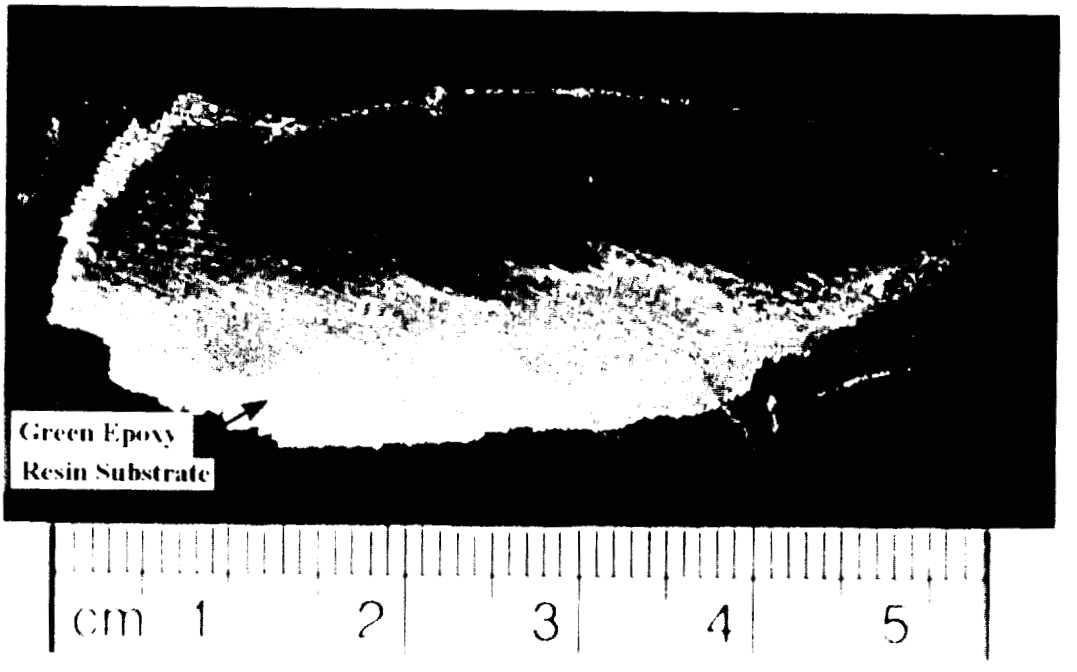

Figure 18: Green Surface Layer of MB-3

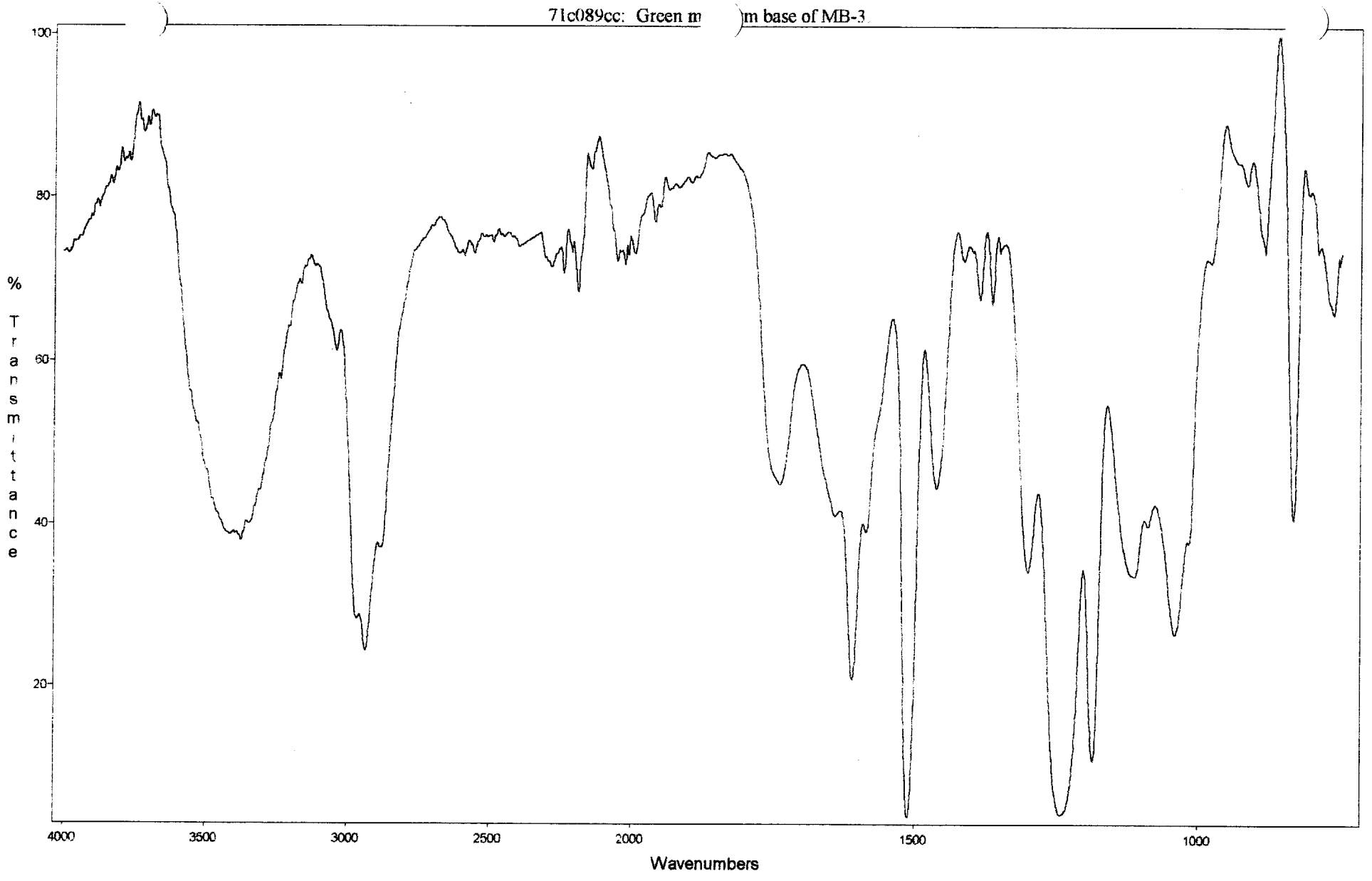

FIGURE 19. GREEN EPOXY RESIN.

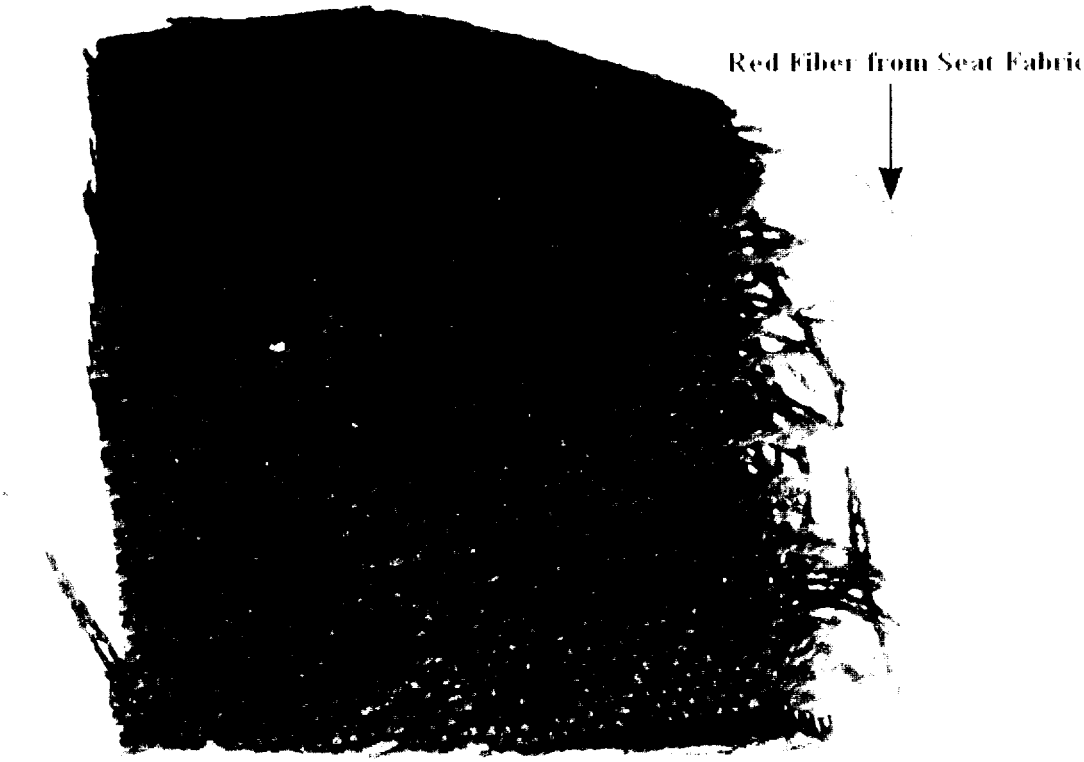

Figure 20: Fabric of Seat #21-5; MB-4

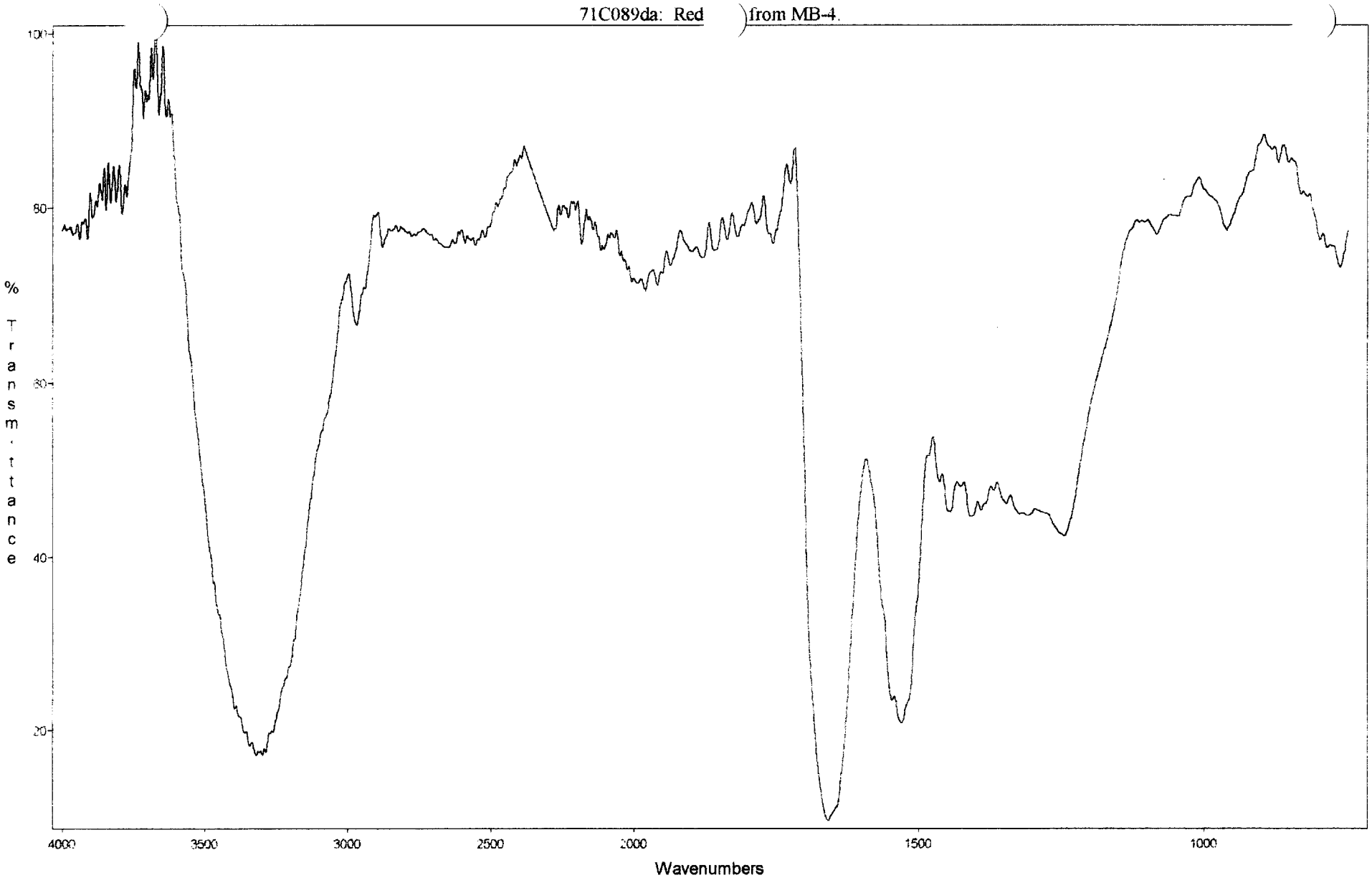

FIGURE 21. RED "AZLON" FIBER OF SEAT #21-5.

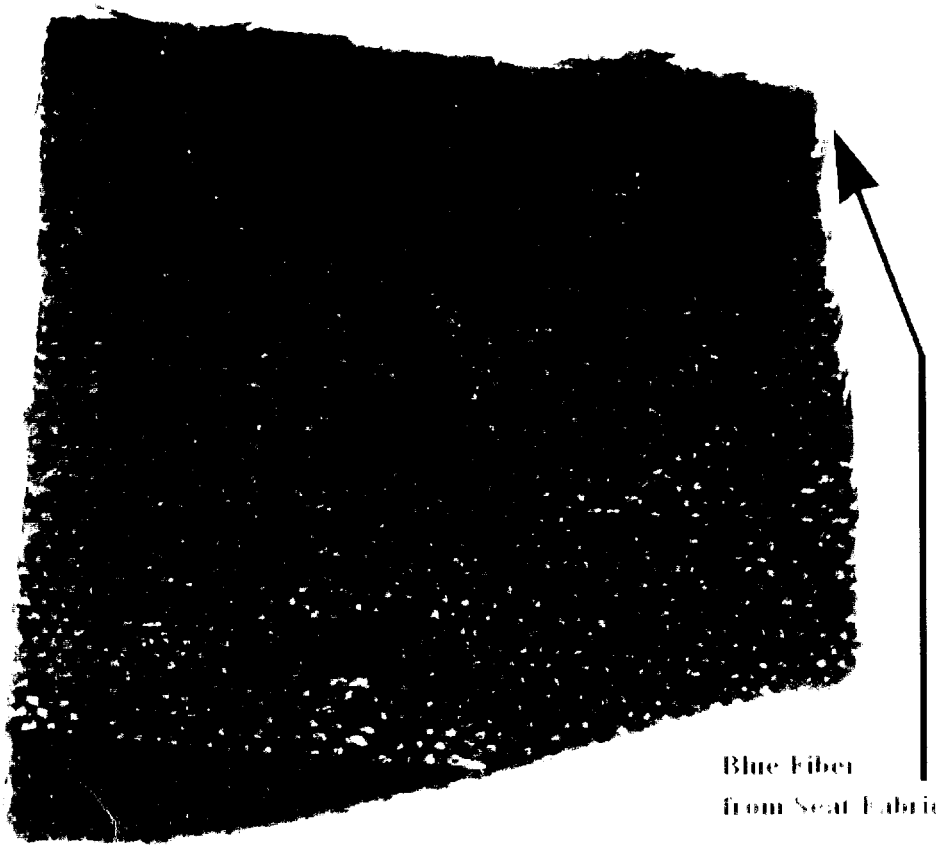

Figure 22: Fabric of Seat #20 4; MB 5

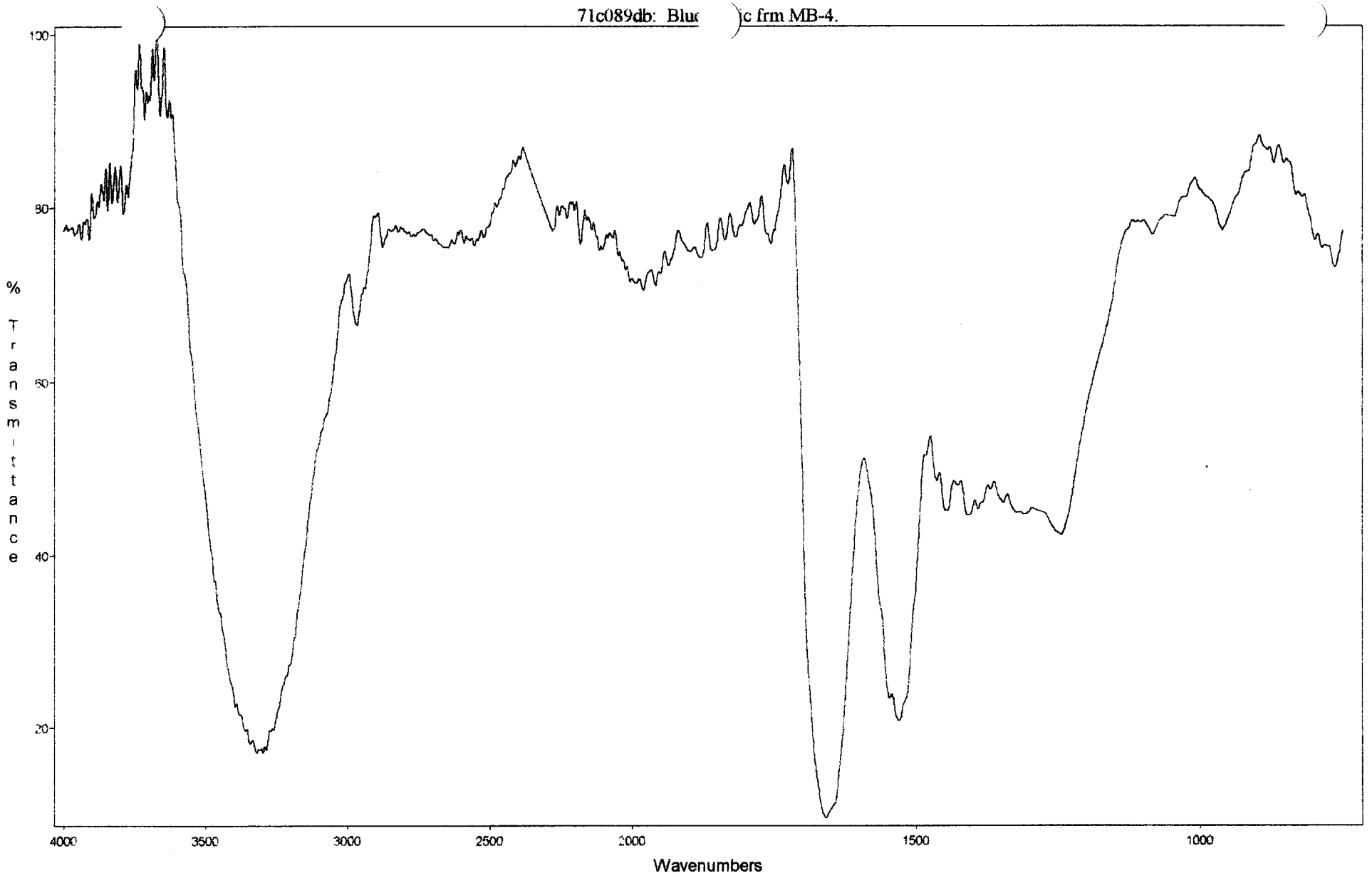

FIGURE 23. BLUE "AZLON" FABRIC OF SEAT #20-4.

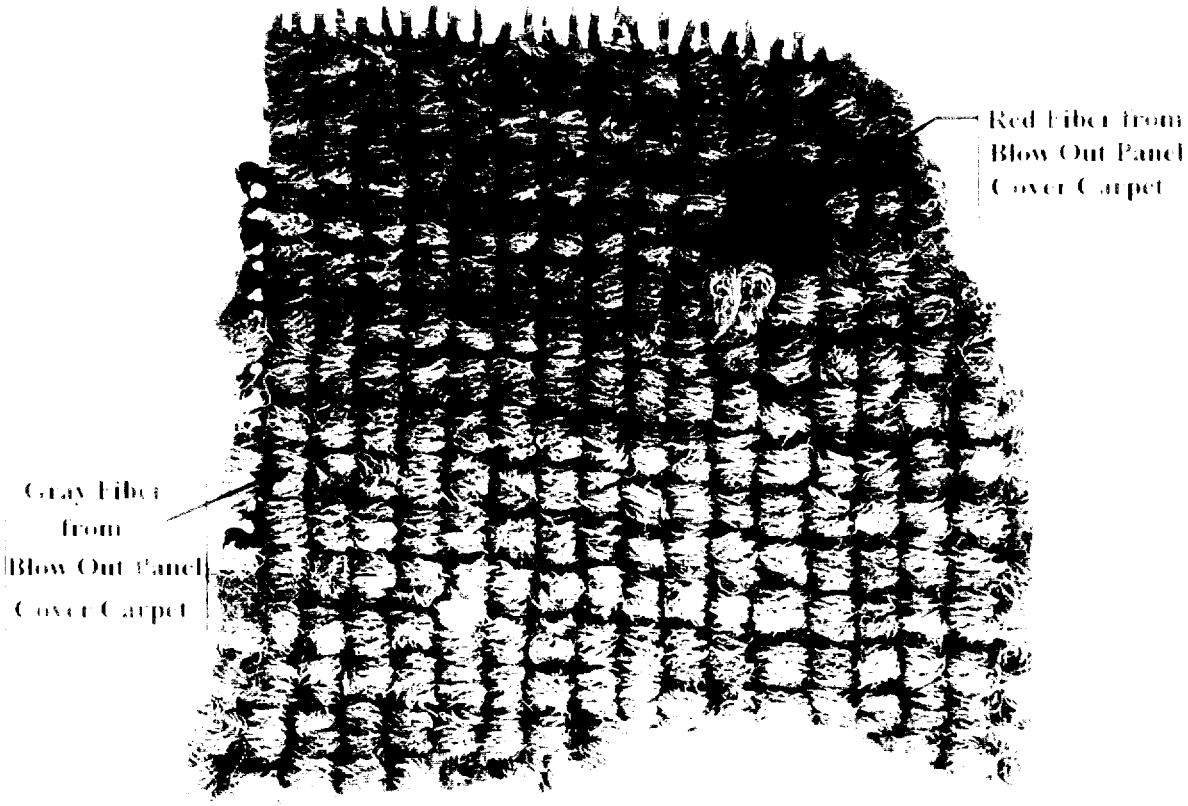

Figure 24: Carpet from Blow Out Panel Cover #62-75231354: MB-6

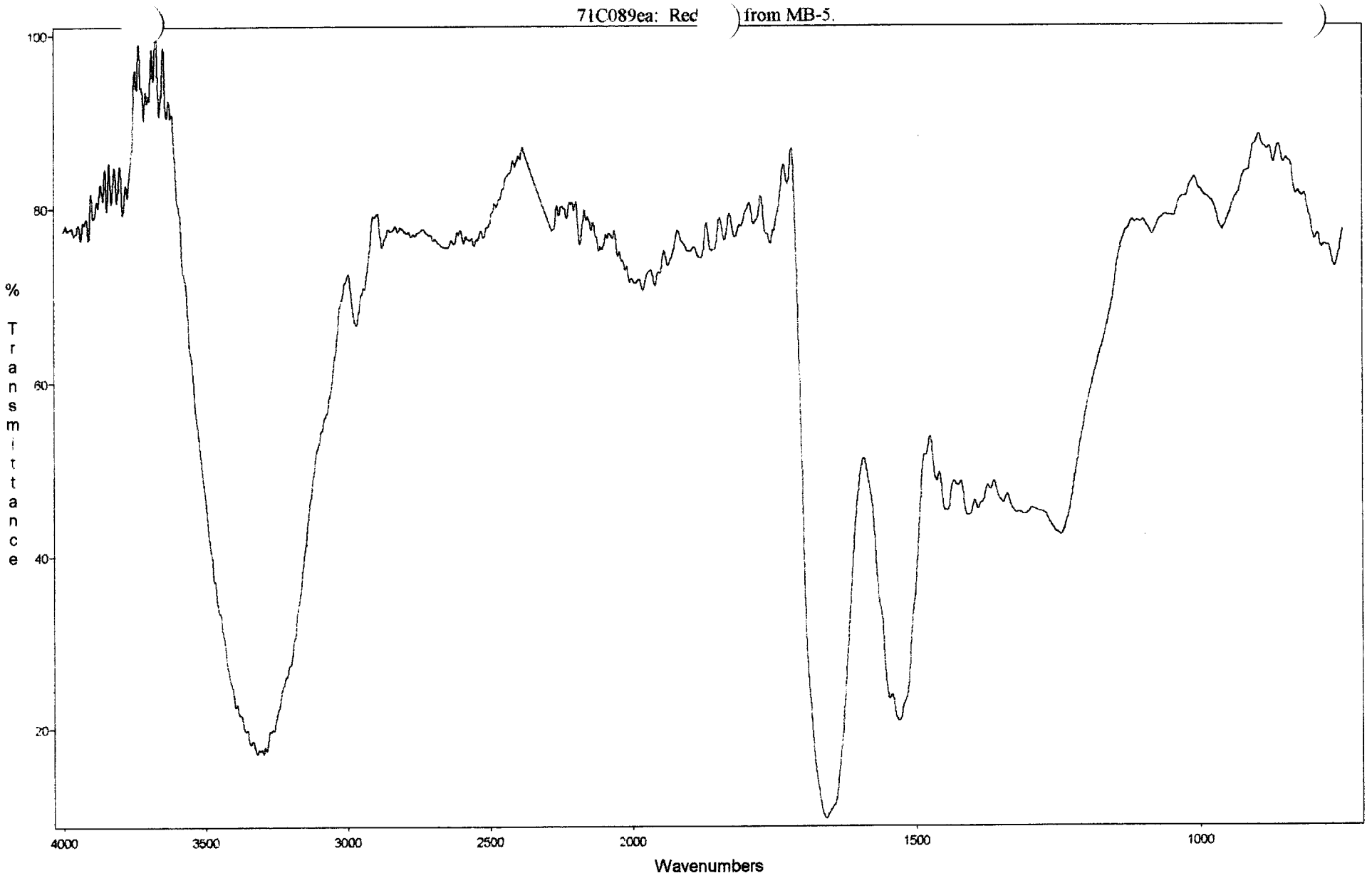

FIGURE 26. RED "AZLON" FABRIC FROM "BLOW-OUT" PANEL COVER #62-76231354.

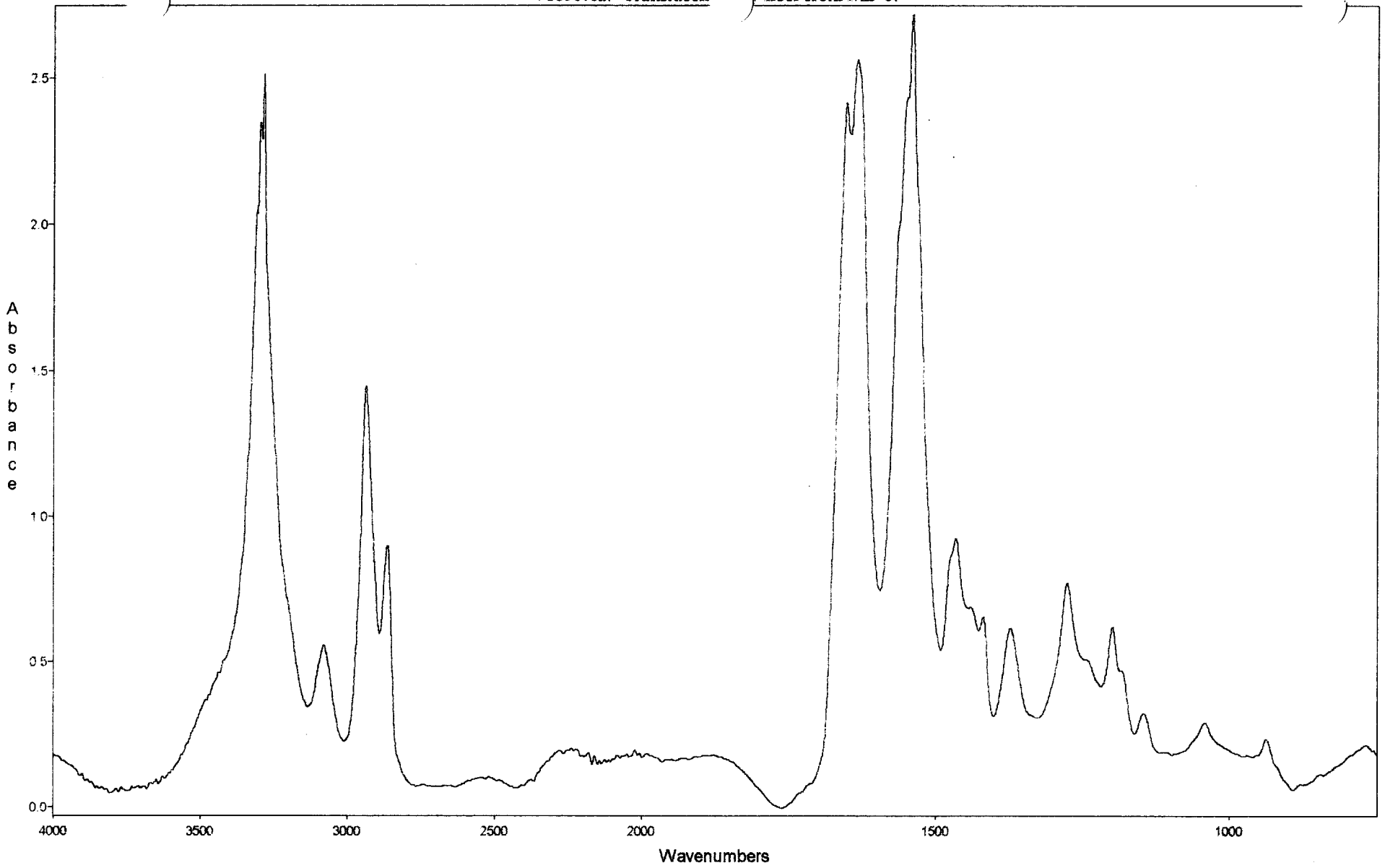

FIGURE 26. TRANSLUCENT BLUE-GRAY FABRIC FROM "BLOW-OUT" PANEL COVER #62-75231354.

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June 3, 1997

REPORT 97-1C0090

SUBJECT: National Transportation Safety Board (NTSB) Sample MB-7 TWA-800

REQUESTER: Dr. Merritt M. Birky/NTSB/(202) 314-6503

RELATED DOCUMENTATION: Report 97-1C0063
Report 97-1C0064
Report 97-1C0089

INVESTIGATOR: C. W. Bassett/LO-MSD-1C

CONTRIBUTORS: Wayne Marshall/LO-MSD-1C
Sandy Loucks/LO-MSD-1C
Stan Young/LO-MSD-1C

1.0 FOREWORD

The sample was submitted by the NTSB as part of the ongoing investigation of TWA's flight #800 accident. The objective of the analysis is to characterize the organic and inorganic chemical nature of the sample.

2.0 SAMPLE DESCRIPTION

The sample was collected on February 17, 1997. The piece of tubing was labeled "BEMCO" 1 Q 71 BE 418-6 and was part of the environmental control system (ECS) of the aircraft.

3.0 CHEMICAL ANALYSIS

3.1 The analyses was accomplished using Fourier-Transform Infrared (FTIR) microscope spectroscopy and Scanning Electron Microscope with Energy Dispersive Spectrometry (SEM/EDS). Ion analysis was accomplished using Ion Chromatography (IC).

3.2 The sample was distinguishable by certain characteristics. One side of the sample was labeled and uniformly dark in color, much like a reddish-brown. The other side of the sample was characterized by an overall lighter tint of this reddish-brown color. This side was further characterized by a dark area and a light area. For this report the darker side

will be referred to as the outer side and the lighter side with its characteristic darker and lighter areas, will be referred to as the inner side.

3.3 The sample was optically examined under a microscope and organic appearing material was prepared for FTIR analysis. The sample was very rigid and appeared to have a fibrous texture. Closer examination revealed that it was composed of translucent looking fibers held together with a tinted organic looking binder.

3.4 A sampling of the binder material was separated, then prepared and an IR spectrum generated. Concurrently, SEM/EDS and IC analyses were performed.

3.5 The sample was digested in deionized (DI) water, the liquor diluted and then analyzed for the nitrate ion using IC. Other ions were detected but not quantified during this analysis.

4.0 RESULTS AND CONCLUSIONS

4.1 The red, tinted binder material seen in Figure 1, was identified by FTIR as a [monomeric ester] substance commonly used as ceramic additives, strengtheners, plasticizers and binders. The IR spectrum of the material is shown in Figure 2.

4.2 EDS analysis of an isolated fiber, indicates high concentrations of silicon, moderate amounts of calcium, aluminum and oxygen, with trace amounts of carbon, magnesium and titanium also present. The EDS chart is provided as Figure 3.

4.3 An EDS analysis of the surface of the outer side (Refer to Figure 1) shows high concentrations of chlorine, moderate amounts of oxygen, silicon and carbon with minor amounts of sulfur, sodium, magnesium, aluminum, potassium, calcium, barium, iron and zinc. The EDS chart of these results is provided in Figure 4.

4.4 An EDS analysis of the dark tinted surface area on the inner side of the sample (Refer to Figure 5) shows high concentrations of chlorine, moderate amounts of oxygen, silicon, carbon and sodium with minor to trace amounts of sulfur, magnesium, aluminum, potassium, calcium, barium, iron and zinc. The EDS chart of these findings is provided in Figure 6.

4.5 An EDS analysis of the light tinted surface area on the inner side of the sample (Refer to Figure 5) shows high concentrations of chlorine, moderate amounts of oxygen, silicon, carbon and sodium with minor to trace amounts of sulfur, magnesium, aluminum, potassium, calcium, barium, iron and zinc. The EDS chart reflecting these measurements is provided in Figure 7.

4.6 EDS analysis indicates that there are only minor differences between the outer side and the inner side of the gasper tube sample, and no significant differences between the light and dark areas on the inner side.

4.7 Analysis by IC indicates a total of 4 μg of nitrate ion per surface square inch of sample. Nitrate levels were at the low end of the instrument detection limits. Pursuing further quantification of the nitrate levels was considered not appropriate because of the potential exposure of the ECS unit to sea water and other external sources over many years of use in the aircraft.

INVESTIGATOR: _____

Charles W. Bassett/407-867-9618

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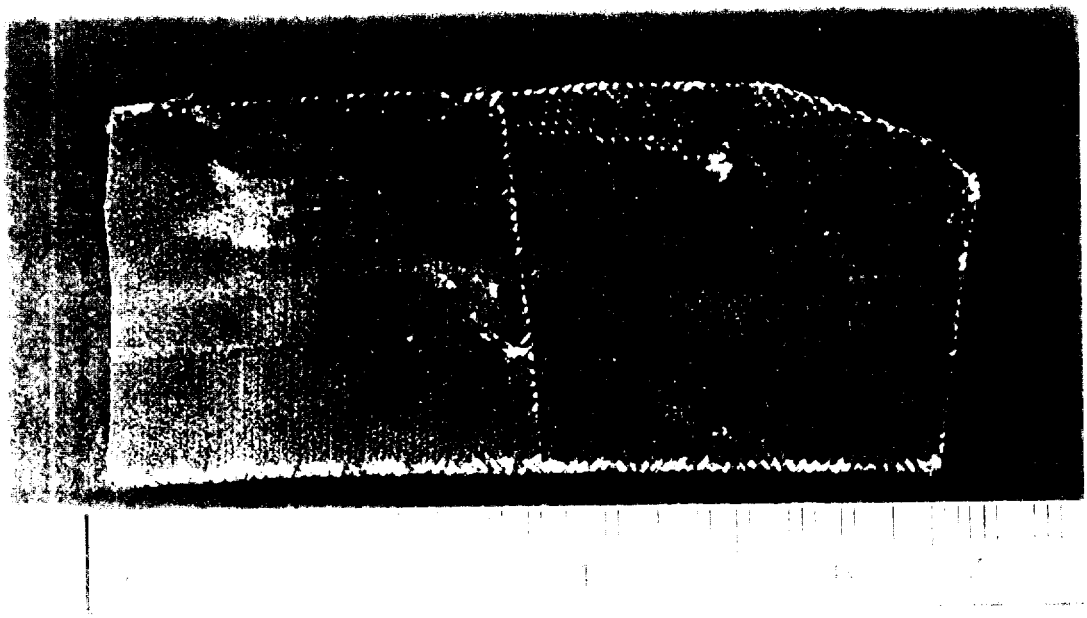

Figure 1: Gasper Tubing from ECS unit, "Outer Side"

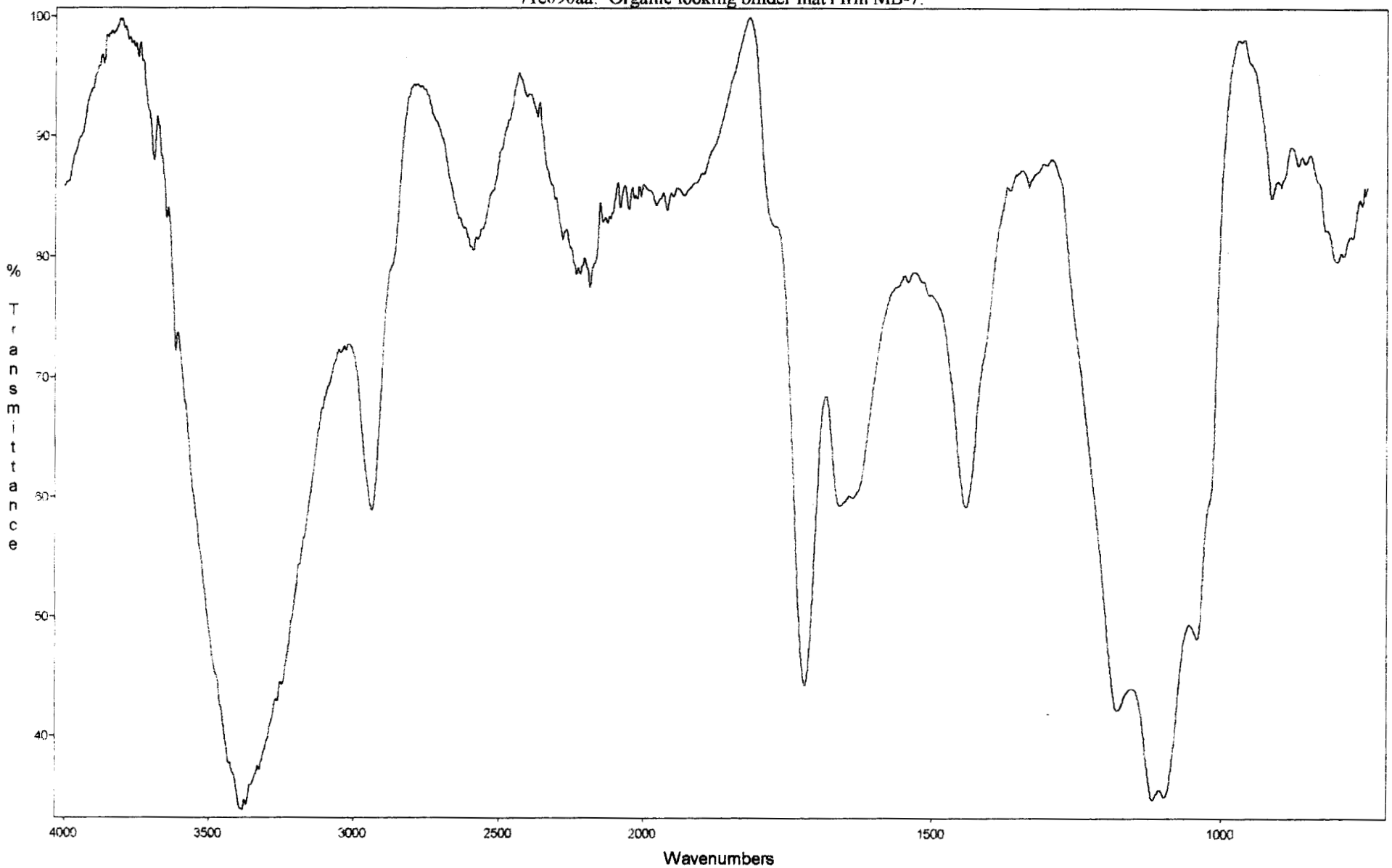

FIGURE 2. IR SPECTRUM OF BINDER MATERIAL.

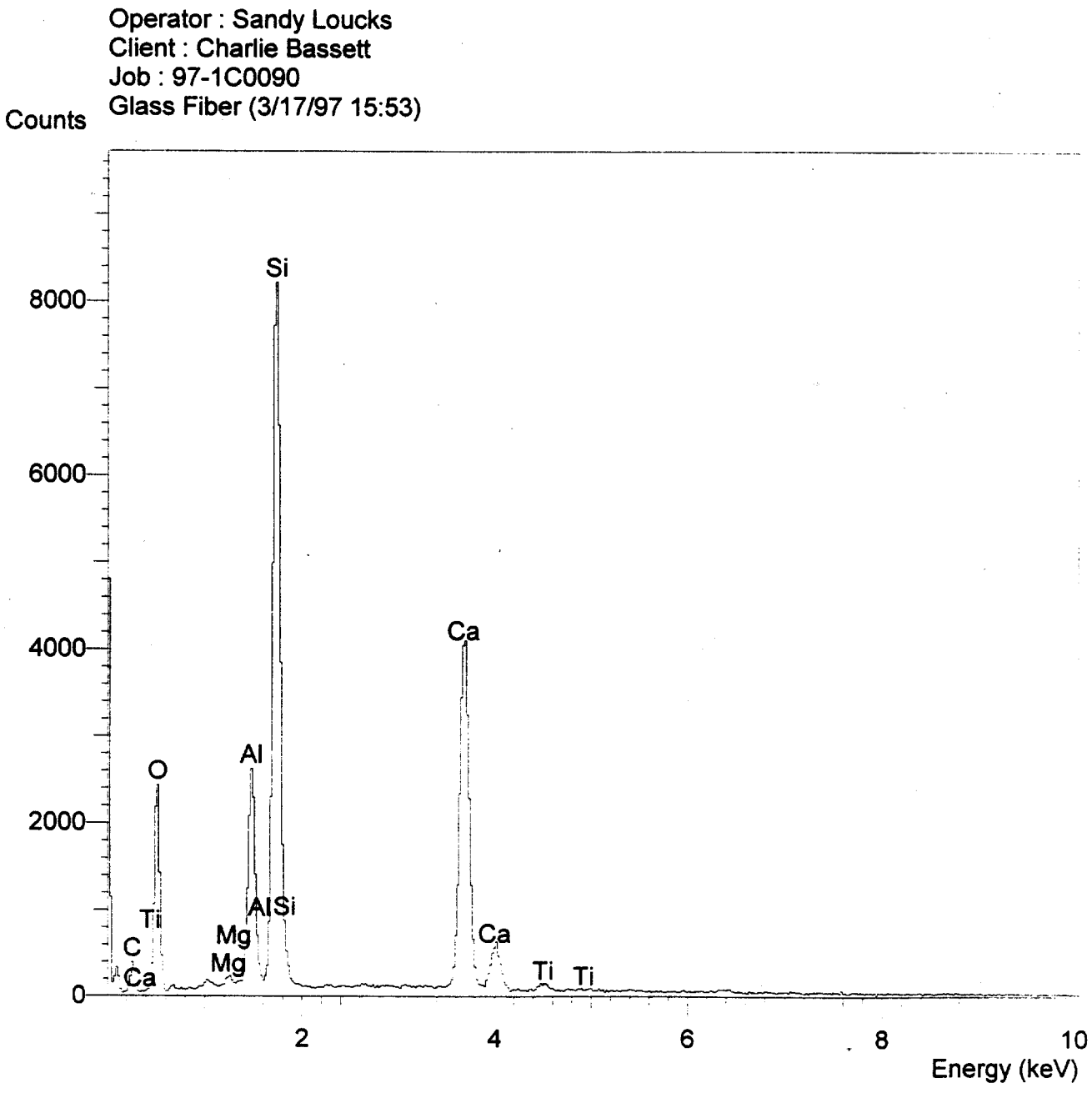

FIGURE 3. EDS OF FIBER.

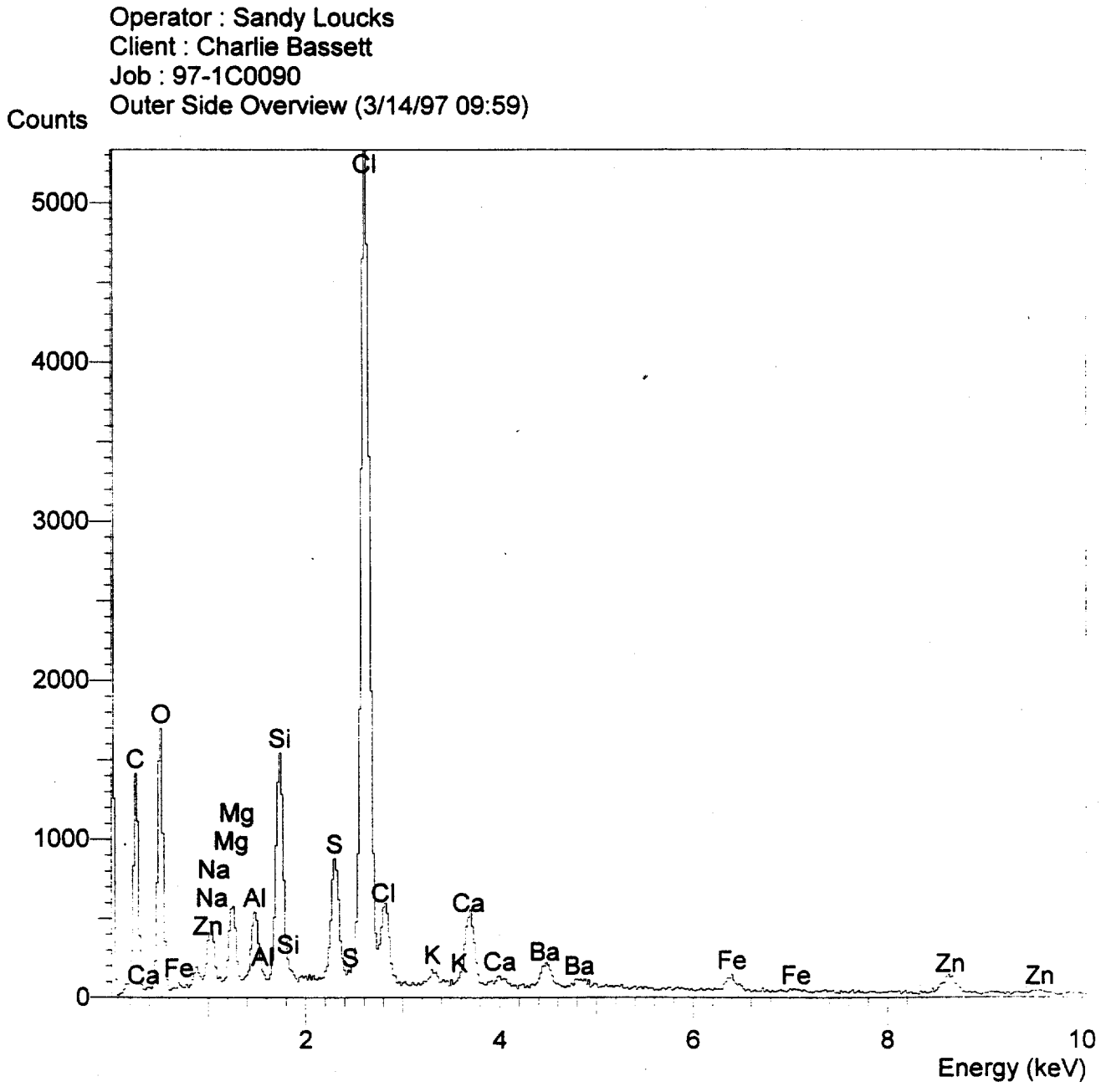

FIGURE 4. EDS OVERVIEW OF "OUTER" SIDE.

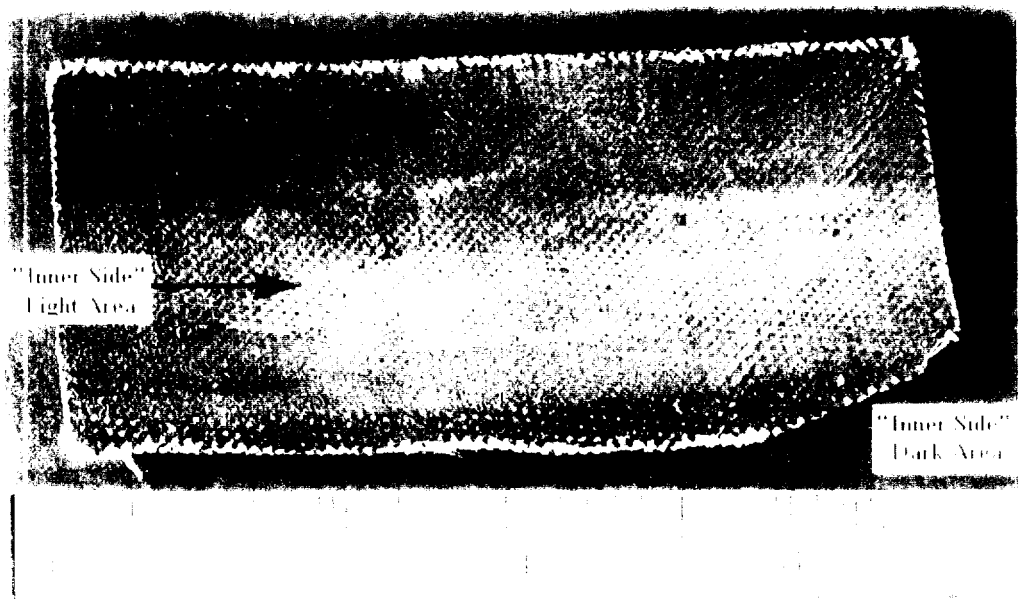

Figure 5: Overview of "Inner Side"

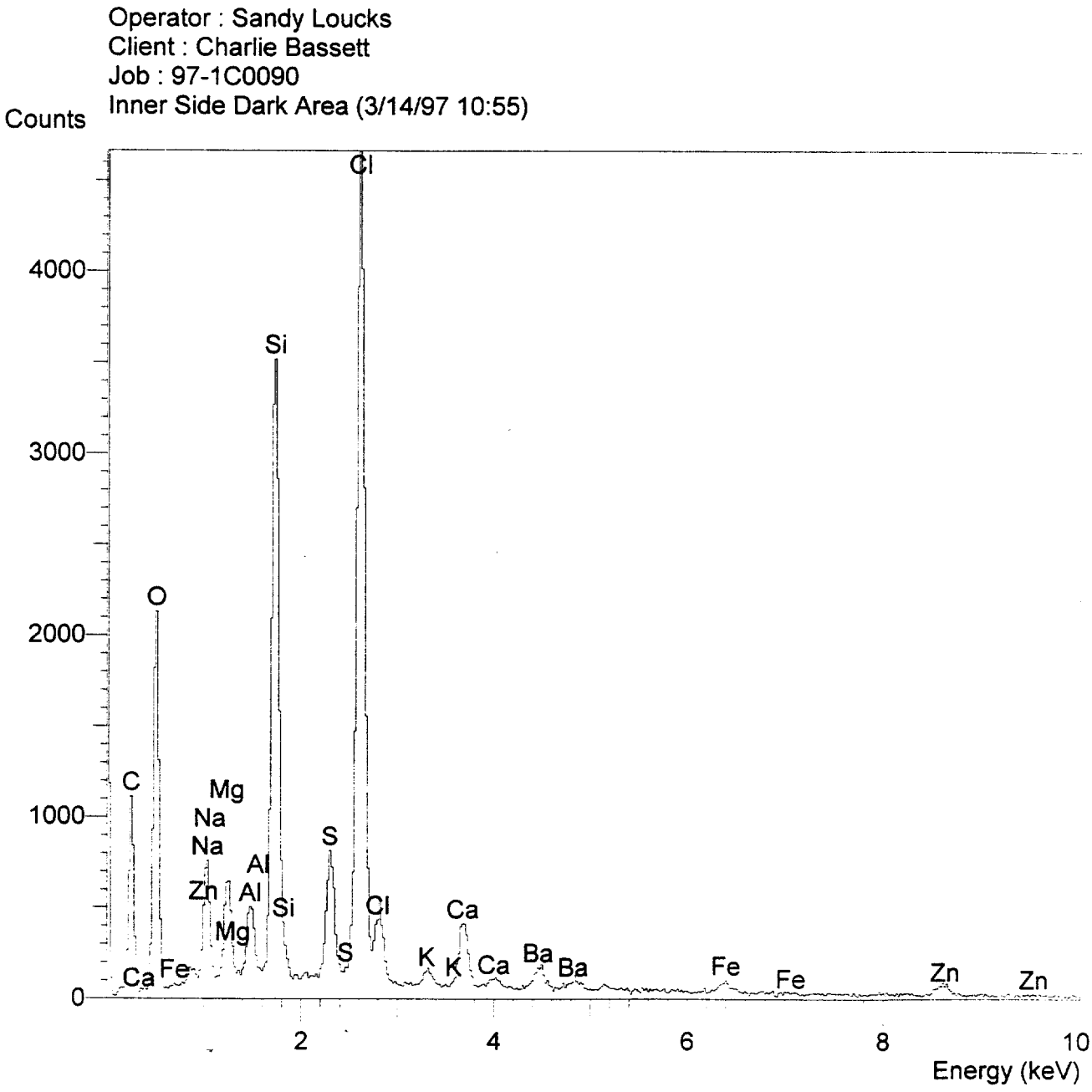

FIGURE 6. EDS OF DARK AREA OF "INNER" SIDE.

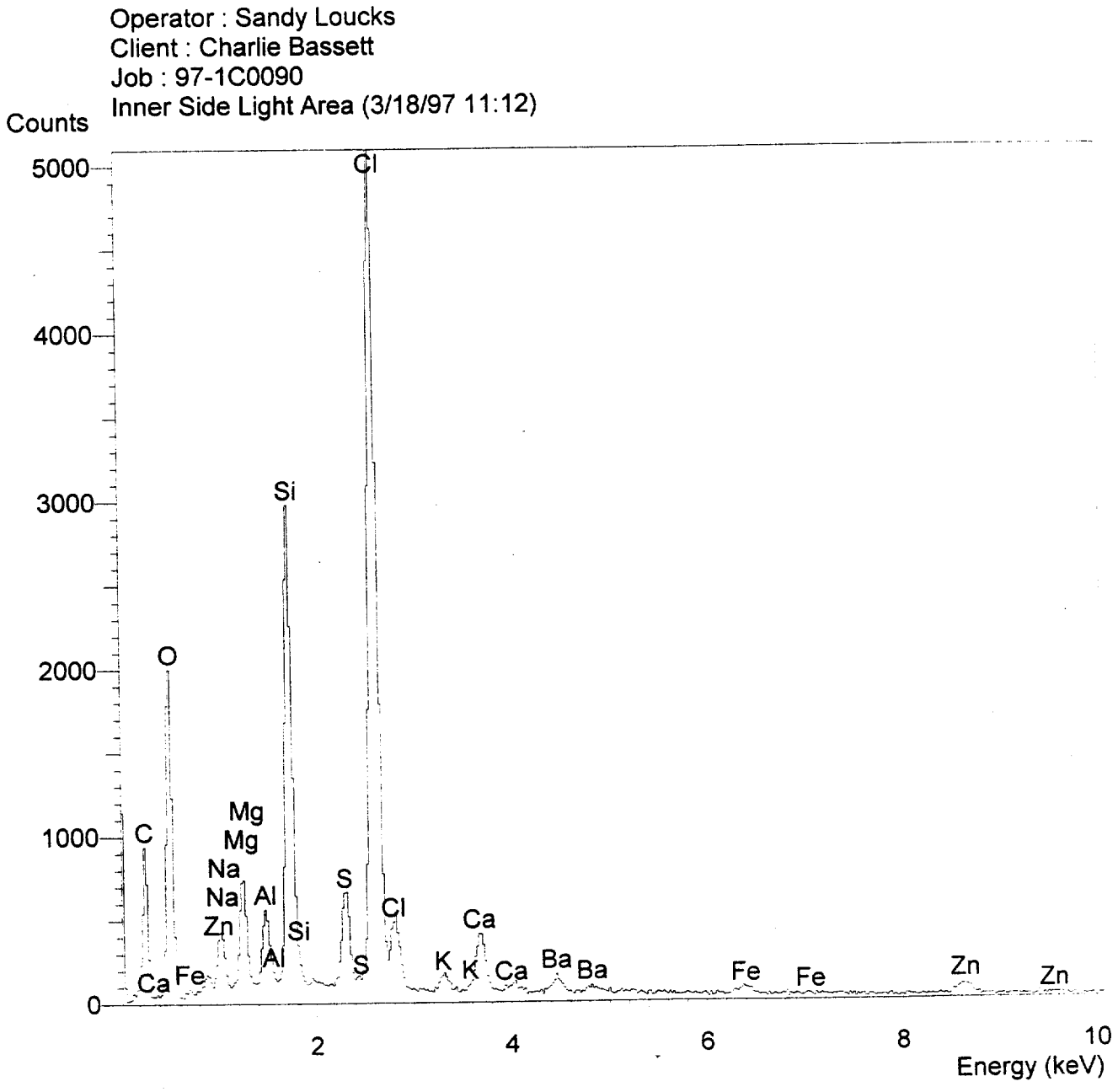

FIGURE 7. EDS OF LIGHT AREA OF "INNER" SIDE.

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June 4, 1997

REPORT 97-1C0153

SUBJECT: Gasper Tubing Samples from the Environmental Control System of TWA Flight 800.

REQUESTER: Dr. Merritt Birky/NTSB/(202) 314-6503

RELATED DOCUMENTATION: Report 97-1C0063
Report 97-1C0064
Report 97-1C0089
Report 97-1C0090

INVESTIGATOR: C. Bassett/LO-MSD-1C

CONTRIBUTOR: Wayne Marshall/LO-MSD-1C

1.0 FOREWORD

Samples were submitted by the NTSB to help define the nitrate finding discussed in reports 97-1C0063, 97-1C0064 and 97-1C0090. Three gasper tubing samples from the aircraft's environmental control system (ECS), were submitted for analysis. It was requested that the samples be analyzed for the presence of ions with particular emphasis placed on nitrates and to furthermore determine if there was a significant difference in the nitrate concentration on the inside surface area versus the outside surface area of the samples.

2.0 SAMPLE DESCRIPTION

The samples were submitted in ziplock bags labeled 83A, 84A and 85A. Sample 83A was the tube from which sample MB-5 (addressed in Report 97-1C0090) was taken, whereas samples 84A and 85A were selected at random from the aircraft wreckage lying on the hangar floor.

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3.0 CHEMICAL ANALYSIS

3.1 The analysis was accomplished using Ion Chromotography (IC).

3.2 From each sample bag a 2" by 6" rectangular section was selected, further cut into small pieces, placed in high purity (18.3 mg ohm) deionized (DI) water and digested overnight. The resultant liquor was then filtered and diluted to 100 ml with water.

3.3 In each of the analyses of samples 84A and 85A, the respective rinses were conducted quickly. The material was quite porous and soaking the samples or digesting them as before would have given a total ion measurement and not a surface analysis.

3.4 From sample 84A, a 2 inch section of the 2 inch diameter tubing was selected and the outside rinsed with high purity DI water. Because of the porosity of the material over night digestion of the sample was avoided in order to get a surface wash. Once the rinse of the outside surface area of the sample was accomplished, the liquor was diluted to 100 ml with high purity DI water and injected into the instrument column.

3.5 A six inch length of the 1.5 inch diameter rigid curved tubing from sample 84A was selected and the inside rinsed with high purity DI water in order to get a representative measure of the inside of the ECS tubing. Applying the same rationale as previously stated, overnight digestion did not take place. The liquor was diluted to 100 ml with high purity DI water and then injected into the column of the instrument.

3.6 From sample 85A, a 2 inch section of the 2 inch diameter tubing was selected and the outside rinsed with high purity DI water. Again, overnight digestion did not take place. The liquor was diluted to 100 ml with high purity DI water and injected into the column of the instrument.

3.7 In order to get a representative measure of the inside of the ECS tubing of 85A, the inside of the same piece was rinsed with high purity DI water. As before, overnight digestion did not take place. The liquor was diluted with 100 ml of high purity DI water and injected into the column of the instrument.

3.8 The mutilated condition of sample 83A was such that a determination of the ion presence on the inside area versus the presence on the outside area was not measurable. A measure of the total ion presence however, was feasible and is provided in the table under section 4.0.

3.9 The analysis also identified other ions that were present but these were not quantified. They are provided as follows:

Anions of; Chloride, bromide, fluoride, sulfate and phosphate.
Cations of; Sodium, potassium, magnesium and calcium.

RESULTS AND CONCLUSIONS

4.1 Results from the IC analyses are provided in the table that follows.

Sample Source	Surface I.D.	Sample I.D.	Nitrate $\mu g/in^2$
83A	total	153-08	54
84A	total	153-03	46
85A	total	153-04	33
84A	inside	153-11	11
84A	outside	153-12	04
85A	inside	153-09	02
85A	outside	153-10	02

4.2 In samples 84A and 85A there was no significant deviation in the amounts of nitrate ions detected for the inside and outside surface areas. Although the condition of the sample did not lend itself to the same inside versus outside analysis technique, it is plausible to conclude that similar results could be expected from an analysis of 83A.

4.3 When compared to information provided in the table found on page F-169 of the Chemical Rubber Company's (CRC) handbook of Chemistry and Physics, the ions detected in these samples are consistent with those found in sea water. The ECS unit and its component parts were in service in the aircraft for a number of years and were then exposed to sea water as a result of the accident.

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June 24, 1997

REPORT 97-1C0154

SUBJECT: Seat Samples and An Adhesive Reference Material Submitted by the National Transportation Safety Board (NTSB) During the Investigation of TWA #800.

REQUESTER: Dr. Merritt M. Birky/NTSB/(202) 314-6503

RELATED DOCUMENTATION: Report 97-1C0063
Report 97-1C0064
Report 97-1C0089
Report 97-1C0090
Report 97-1C0153

INVESTIGATOR: C. W. Bassett/LO-MSD-1C

CONTRIBUTORS: Stephen Huff/LO-MSD-2E
Kurt Leucht/LO-MSD-2E

1.0 FOREWORD

Samples of seat backing materials were submitted by the NTSB for the on-going investigation of TWA's flight #800 accident. The objective of the analysis was to characterize the reddish/brown material present on each of the samples. During the course of the investigation, the results were verbally communicated to the requester as they developed.

2.0 SAMPLE DESCRIPTION

The samples were contained in four sealed plastic bags labeled: #67, Row 19, Seat 2; #70, Row 17, seat 8; #73, Row 27, seat 2 and #74, Row 24, seat 7. The samples were collected from the seating area near the center of the aircraft. The 3M product Scotch-Grip™ 1357 High Performance (HP) Contact Adhesive was submitted by the NTSB as a reference material. The material safety data sheet (MSDS) identified the adhesive as a polychloroprene based product containing various hydrocarbon solvents.

3.0 CHEMICAL ANALYSIS

3.1 The analysis was accomplished using Fourier-Transform Infrared (FTIR) microscope spectroscopy.

3.2 Sample #67, Row 19, Seat 2 appeared to be a foam material. A red material was present on both sides with one side more heavily coated than the other (Figure 1). FTIR spectra for the foam material and the red material were independently generated and analyzed. The spectrum for each is provided at Figures 2, 3 and 4 respectively. The spectrum for the 3M reference adhesive (Figure 4) was compared to the spectra of the red material. The spectra for the comparison of the red material to the reference product is provided as Figure 6.

3.3 Sample #70, Row 17, Seat 8 (Figure 7) appeared to be a plastic or vinyl material with some of the unknown red material on one side. For the purposes of this discussion, the side which contained none of the suspected adhesive material will be referred to as the clean or non-contaminated side and the side which did contain some of the suspected adhesive material will be referred to as the contaminated side. FTIR spectra was generated for the clean side and for the contaminated side, the spectra of which are provided as Figure 8 and Figure 9 respectively. The spectrum of the reference adhesive was compared to the spectrum of the unknown red material. The spectral comparison is provided in Figure 10 and a spectral overlay in Figure 11.

3.4 The plastic or vinyl material from sample #73, Row 27, Seat 2 (Figure 12) was contorted much like the deformation which occurs when exposed to heat, whereas the material of sample #70 was smooth and exhibited no such altered conformation. Additionally, the unknown material which was attached to one side of sample #73 was tan or reddish-brown, whereas the contaminated side of sample #70 was red. The spectrum for the clean side of sample #73 is provided in Figure 13 and the spectrum for the contaminated side of the sample is provided in Figure 14. A spectral comparison of the reference adhesive and the red-brown material is provided in Figure 15 and a spectral overlay in Figure 16.

3.5 Sample #74, Row 24, Seat 7 (Figure 17) appeared to be a metal alloy (probably aluminum) and was characterized by charred material on both sides. Material from each side was removed and FTIR spectra generated. For the purposes of this discussion, the terms "darker side" and "lighter side" will be used to differentiate between the two sides. A gold colored glazed and a black organic appearing material were removed from the darker side and spectra generated. The FTIR spectra for each is provided in Figure 18 and Figure 19 respectively. From the lighter side, a "soot" looking material was extracted with an organic solvent and a spectrum generated. The spectrum is provided in Figure 20.

4.0 RESULTS AND CONCLUSIONS

4.1 Each IR spectrum of the seating materials (furnished as samples #67, 70 and 73) is consistent with the IR spectrum of the 3M polychloroprene reference contact adhesive. At no time during the analyses of these samples however, was there conclusive evidence to suggest that the Scotch-Grip™ 1357 High Performance (HP) contact adhesive was the polychloroprene based adhesive specifically used in any of these applications.

4.2 The IR data suggests that the flexible foam in sample #67, is consistent with a closed-cell, plasticized polyvinyl chloride (PVC) foam containing a nitrile rubber. Further evidence suggests that the red material found on both sides of the foam is the same. The unknown red material is characteristic of a resorcinol based, two-part room temperature curing adhesive containing a high concentration of a dye much like an orange cobalt complex azo dye. Use in dyes, pharmaceuticals and as a cross-linking agent for Neoprene™ are some of the applications of resorcinol products.

4.3 The spectrum for the "clean" or non-contaminated side of sample #70, was similar to a graft-copolymer of acrylonitrile and styrene on chlorinated polyethylene, probably coated with a flame retardant material. The red unknown material in sample #70 exhibited properties much more characteristic of a polychloroprene based contact adhesive. The IR data suggests that present here is a product more consistent with one like the Scotch-Grip™ adhesive cement reference.

4.4 The material of sample #73 was buckled and contorted as though it had been exposed to heat. The spectrum for the "clean" side of the sample, was consistent with a graft-copolymer of acrylonitrile and styrene on chlorinated polyethylene, probably coated with a flame retardant material. The contaminated side of the sample was not red but more tan or red-brown in color. The material appeared to be in an advanced state of oxidation and evidence further indicated that the sample had been hydrolyzed. The IR data indicates that the unknown material is a mixture, the major component of which is a product most consistent with a polymethacrylamide. It is not unreasonable to expect however, that a polychloroprene based substance could also be present.

4.5 The gold glazed looking material removed from the darker side of sample #74, was identified as an acrylic polymer. The black looking material from the darker side of the metal was identified as a phthalate resin product, probably a Dacron™ filler. The presence of an anti-static agent was also detected. The same organic presence was observed on the lighter side of the metal sample although it was much less abundant. Since it is plausible to expect similar results from these materials, they were not examined further. There was a "soot" like substance present on this side that was not found on the previous side. This soot material was extracted, concentrated to dryness and analyzed. The IR data indicates that the major component of the "sooty" material is a zinc oxide which could be the oxidized phase of a zinc based polyvinyl chloride stabilizer.

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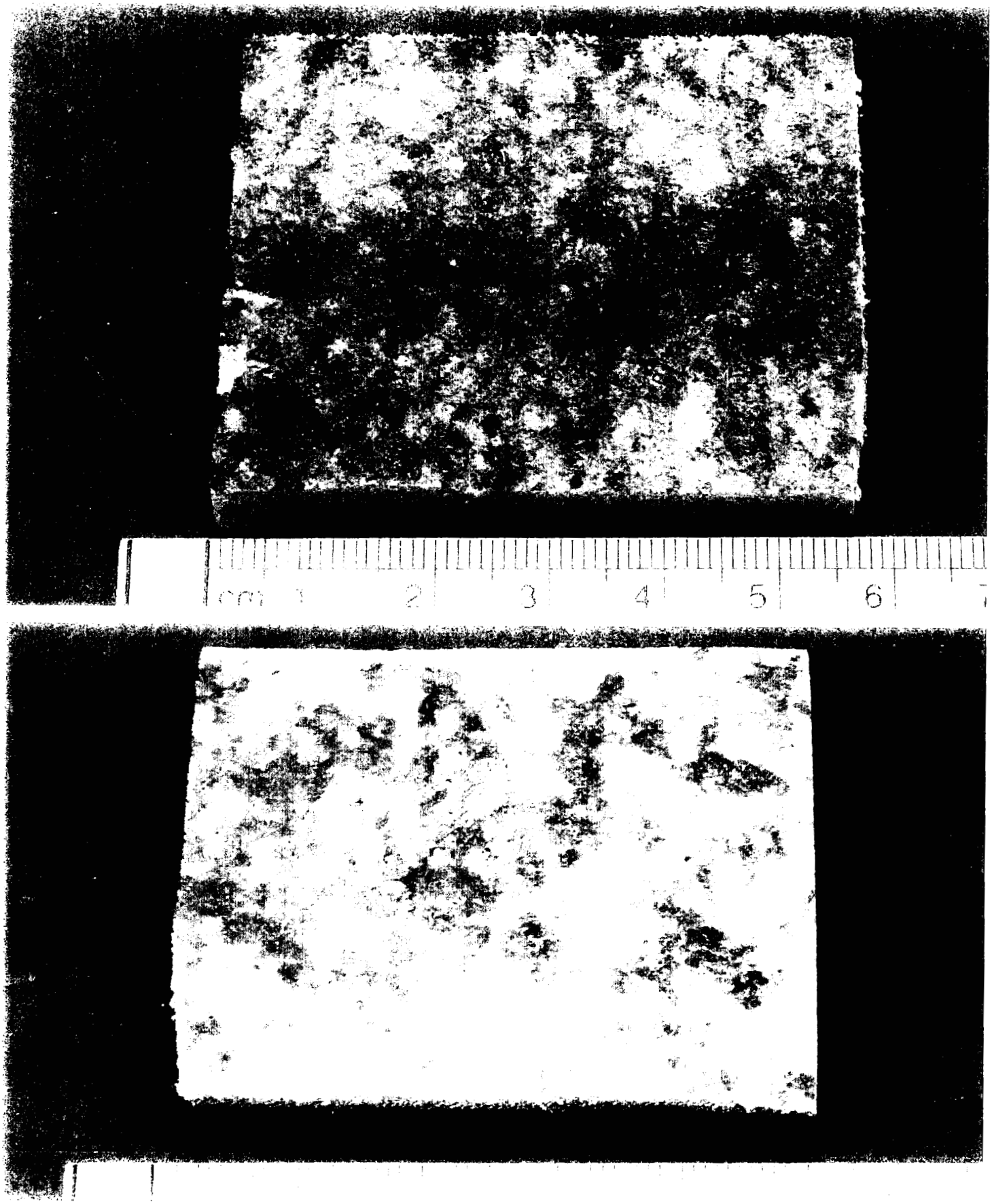


Figure 1. Sample #67, Row #19, Seat #2 Heavy and light coated sides.

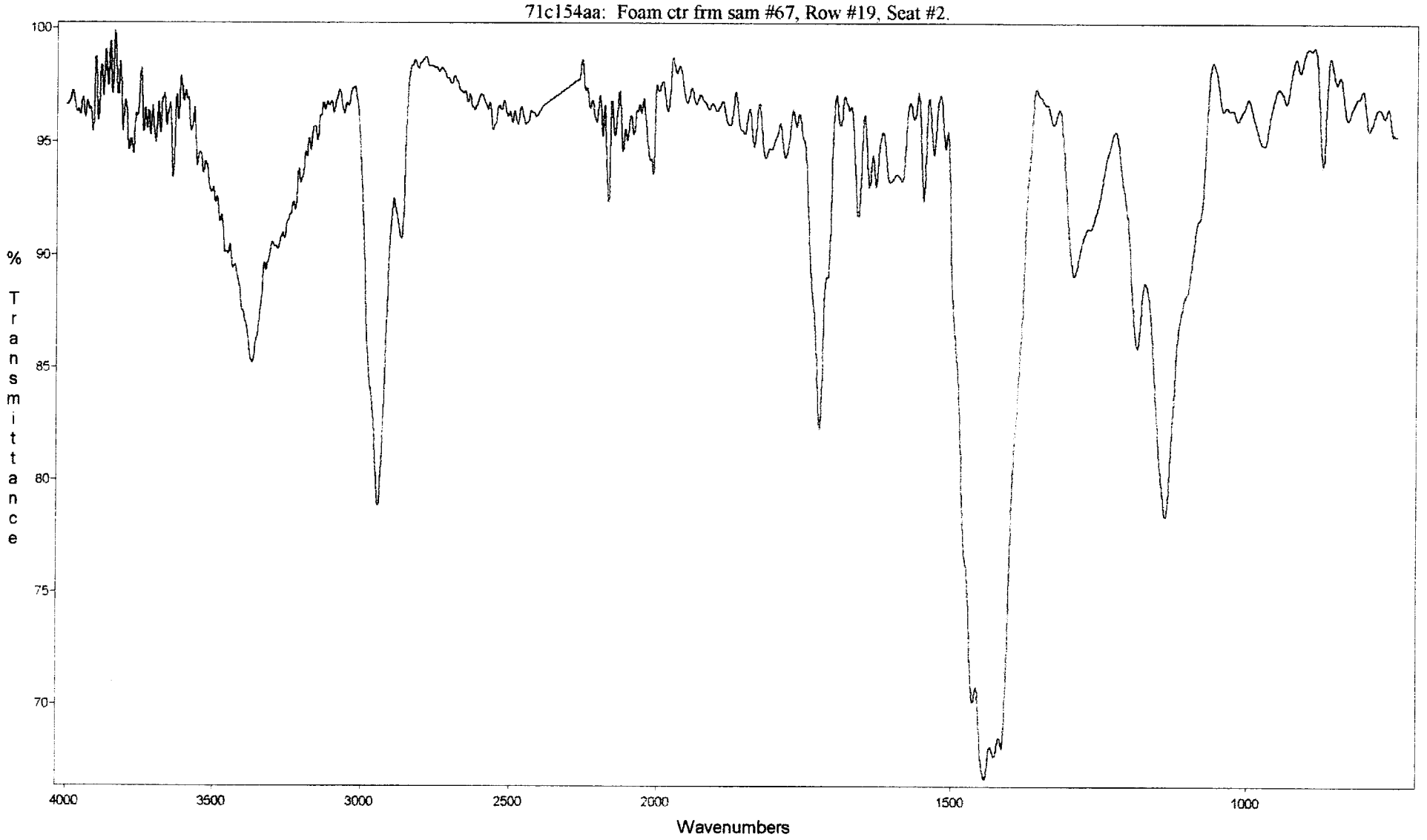


Figure 2. Center of flexible foam material.

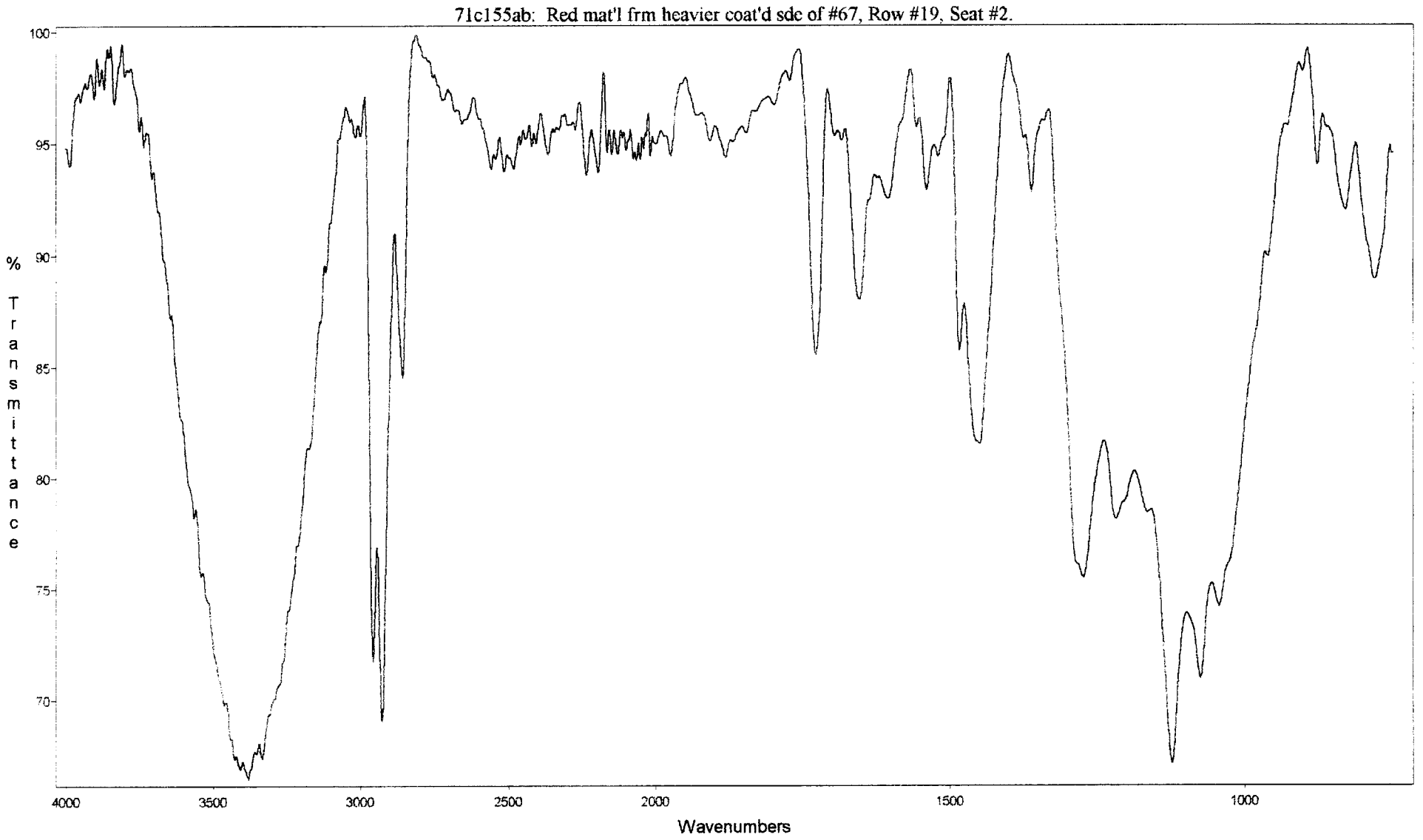


Figure 3. Heavier coated side of foam material.

GE

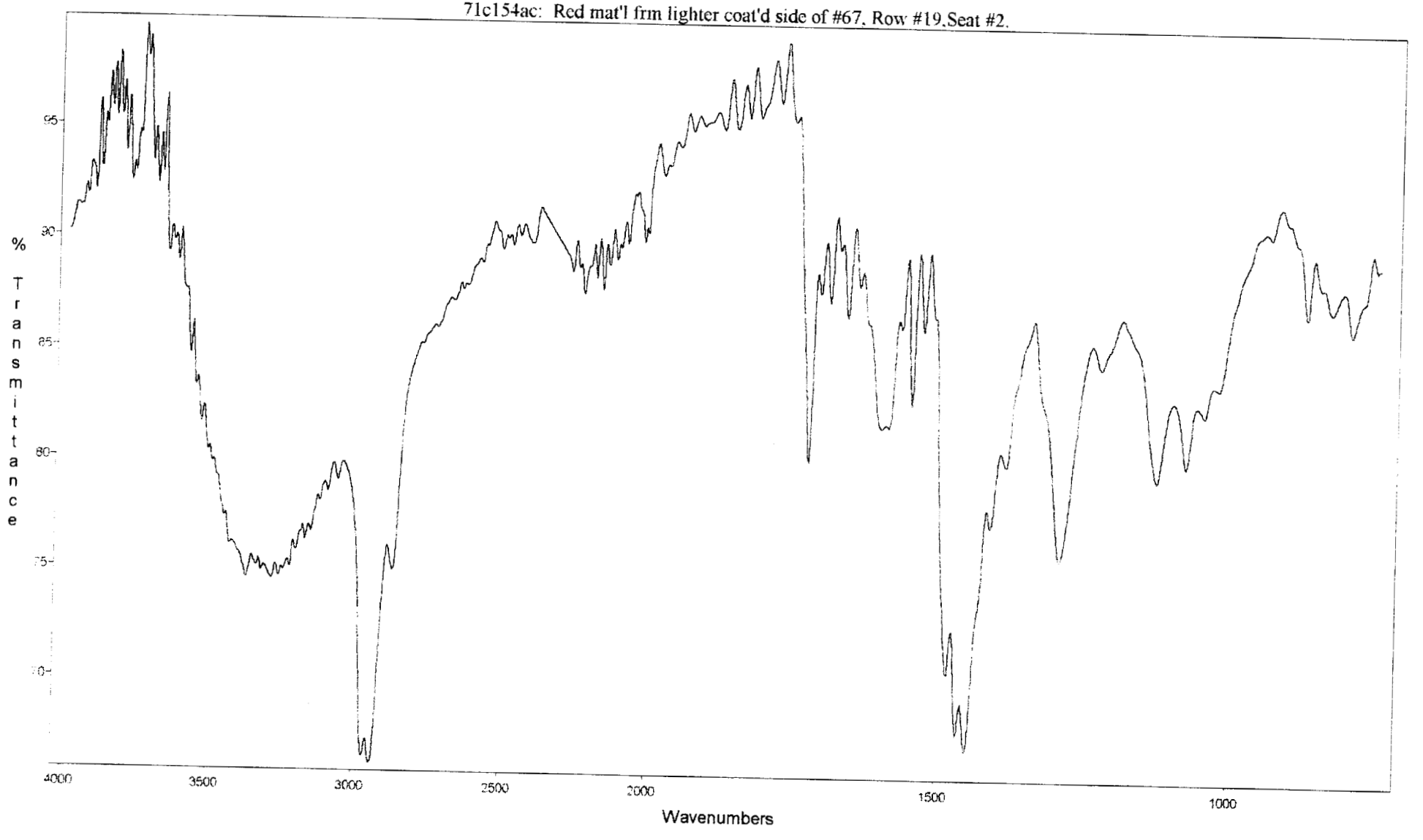


Figure 4. Lighter coated side of foam material.

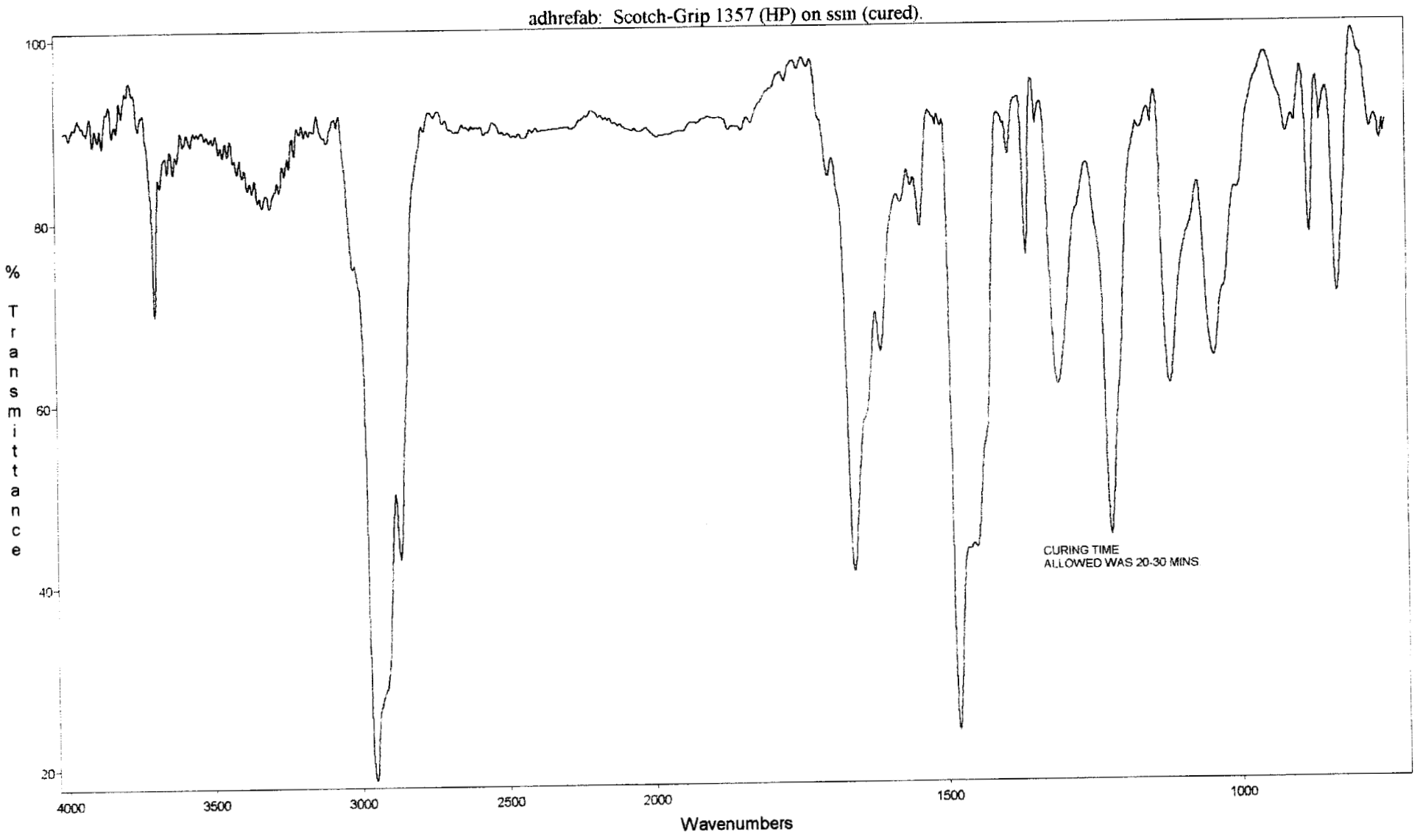


Figure 5. Adhesive reference.

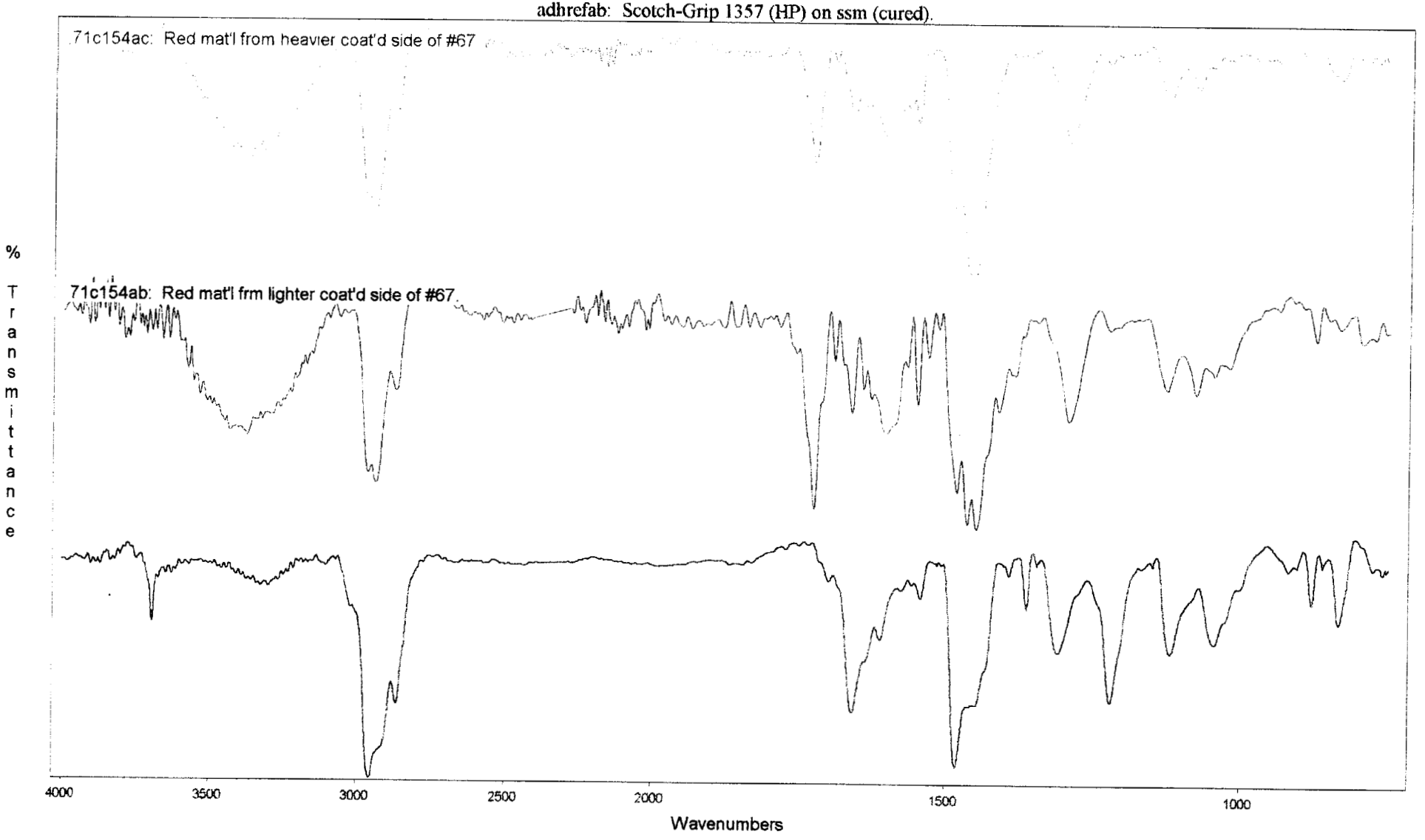


Figure 6. Spectral comparison with adhesive reference material.

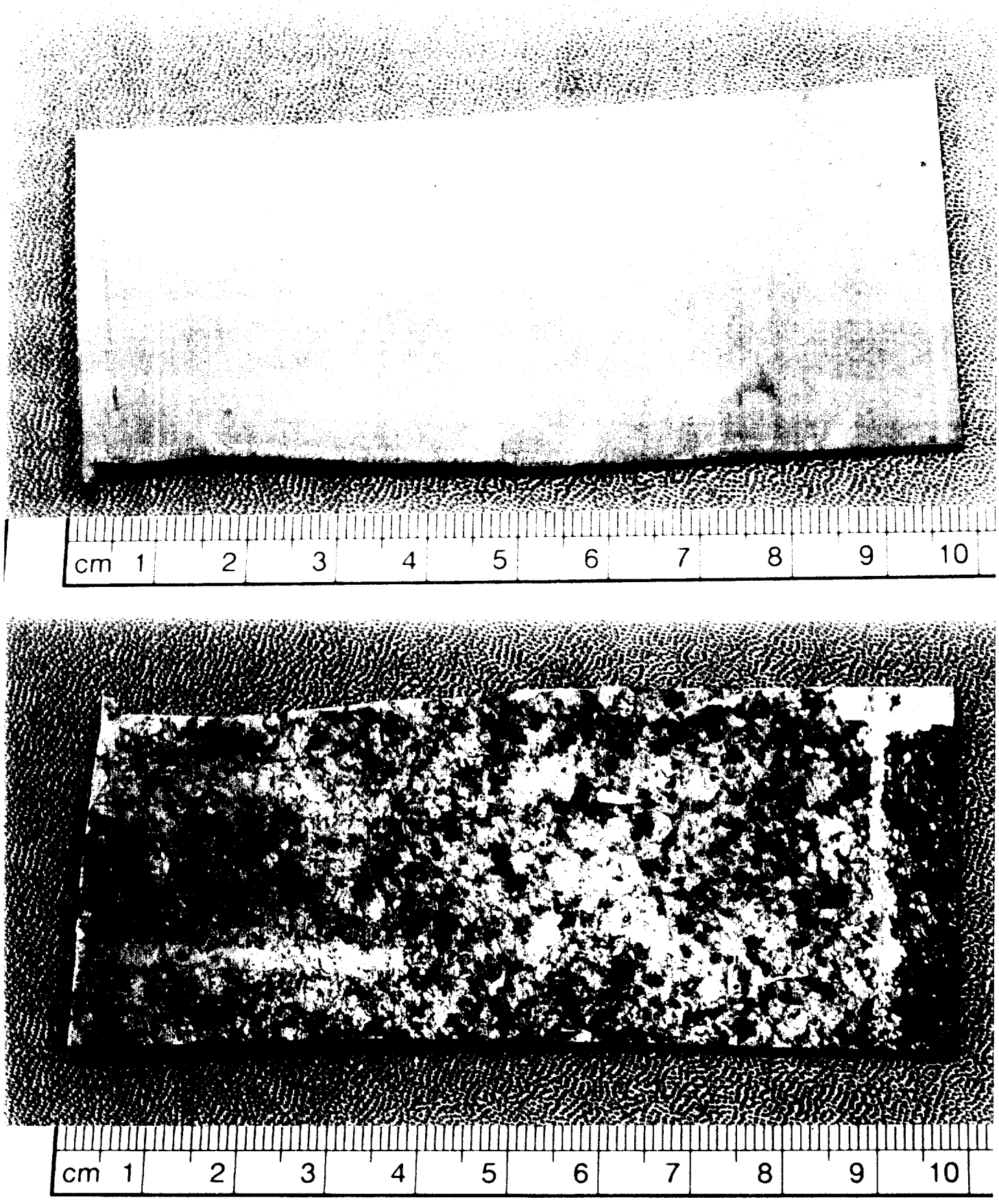


Figure 7. Sample #70, Row #17, Seat #8.

69

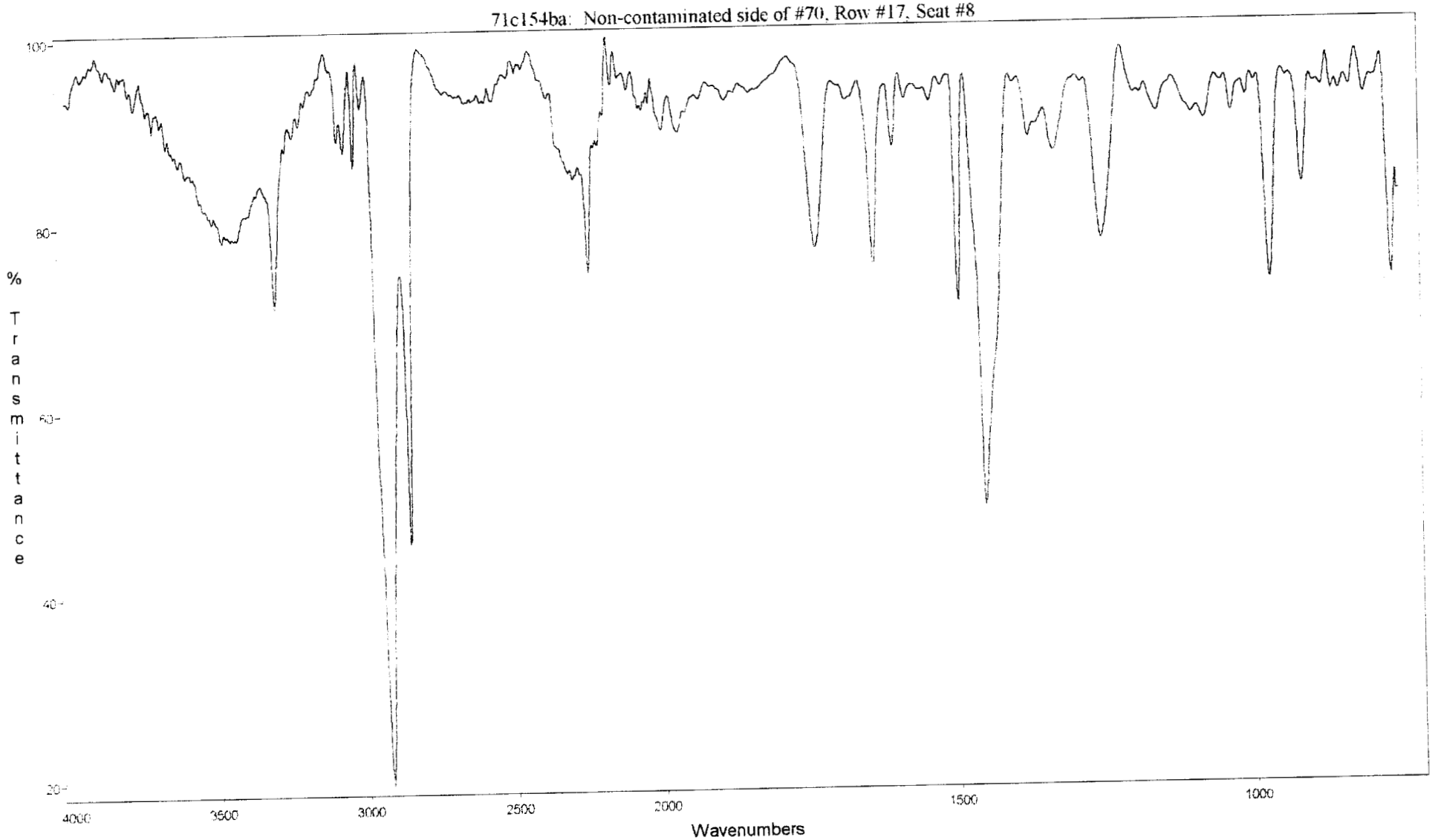


Figure 8. IR spectrum of "clean" side of sample #70.

69

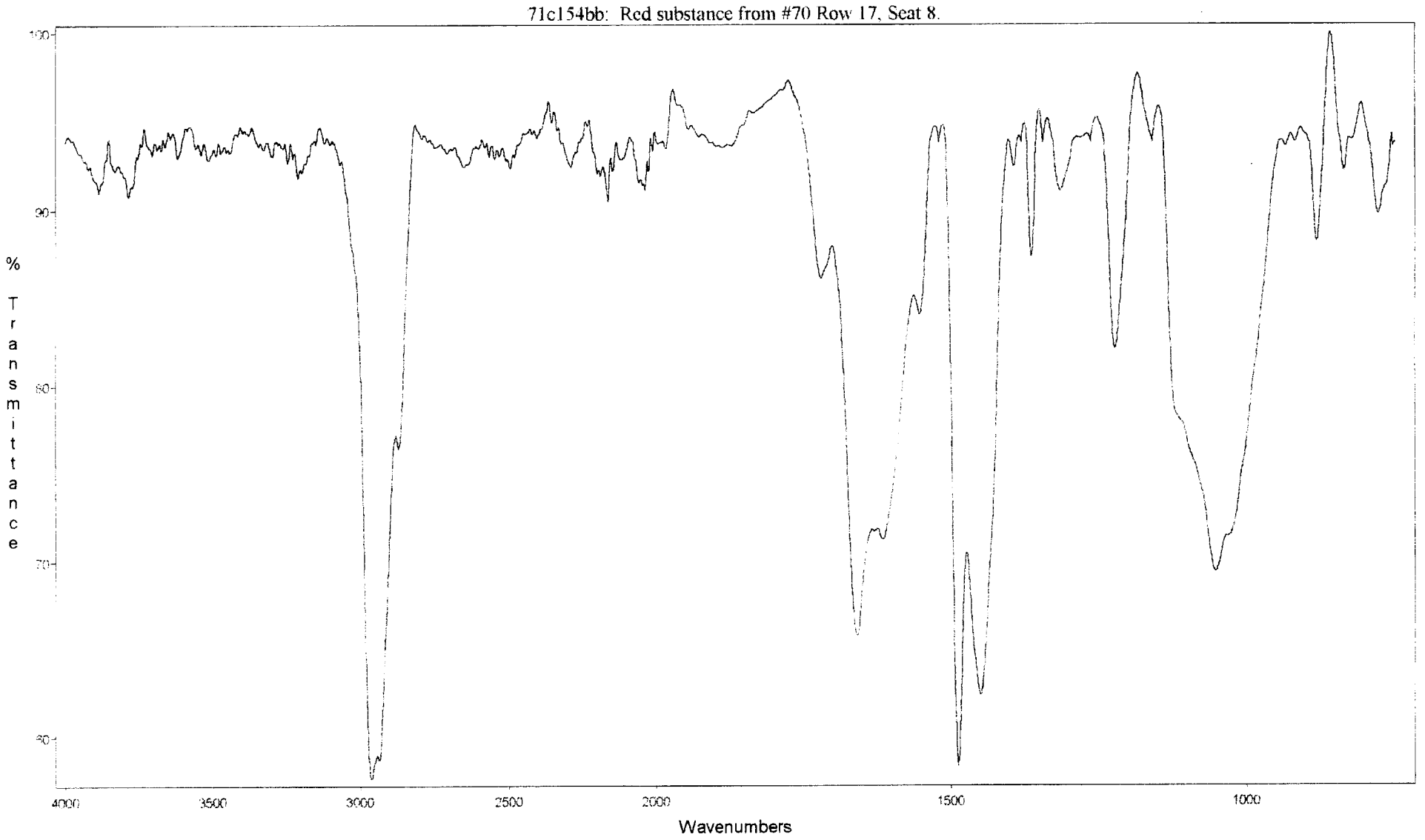


Figure 9. IR spectrum of red substance from sample #70.

70

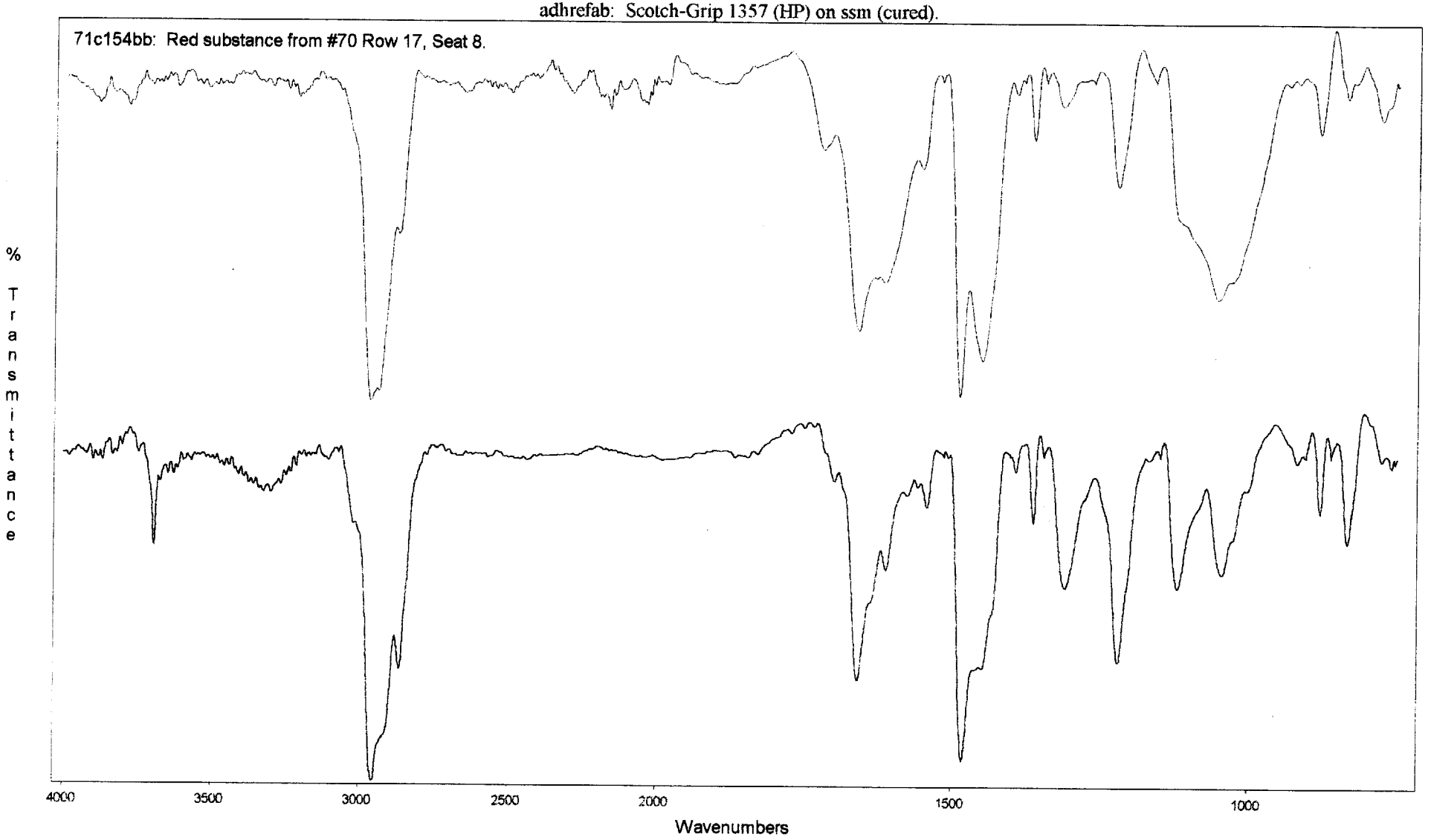


Figure 10. Spectral comparison of adhesive reference to red material.

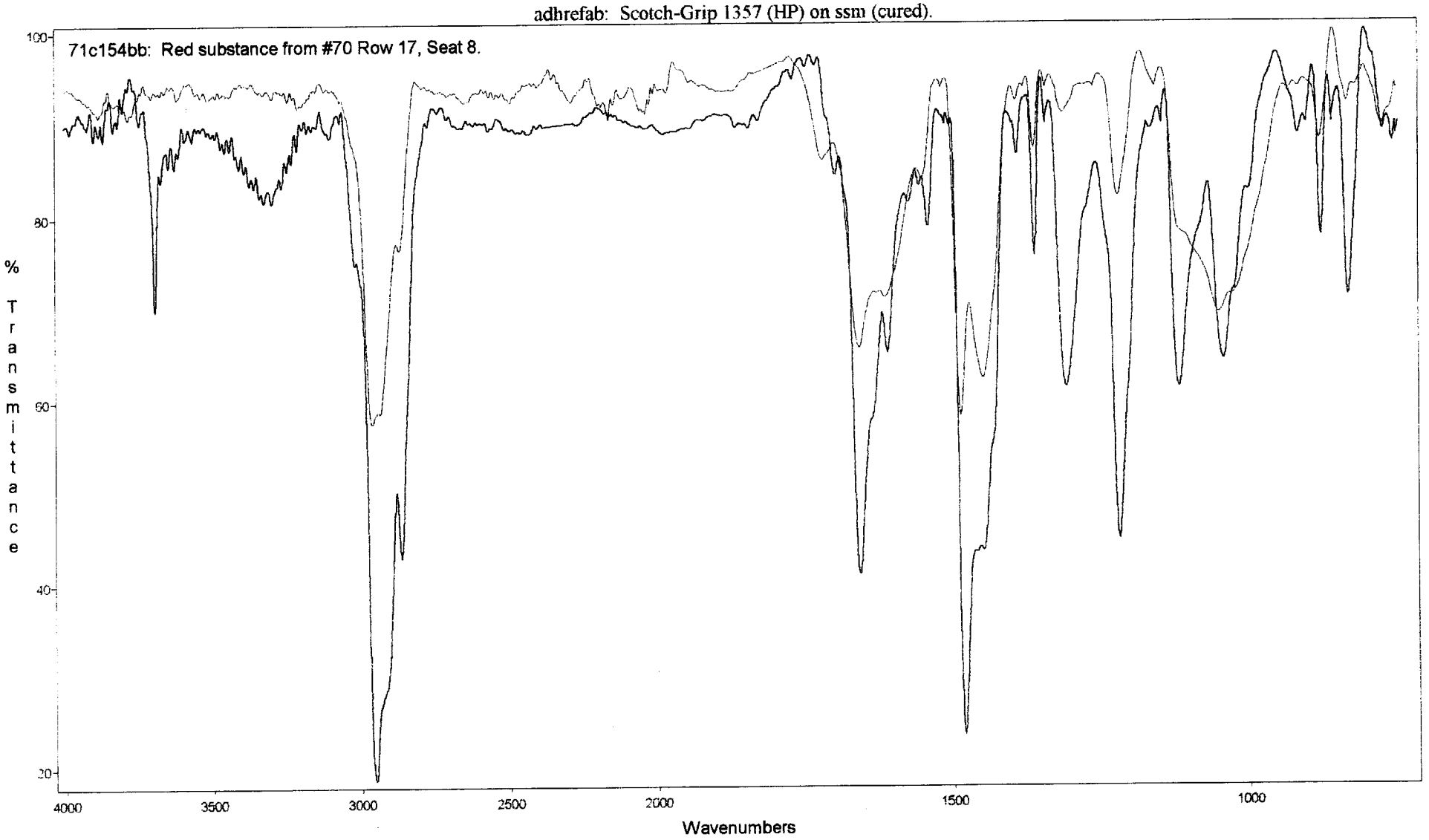
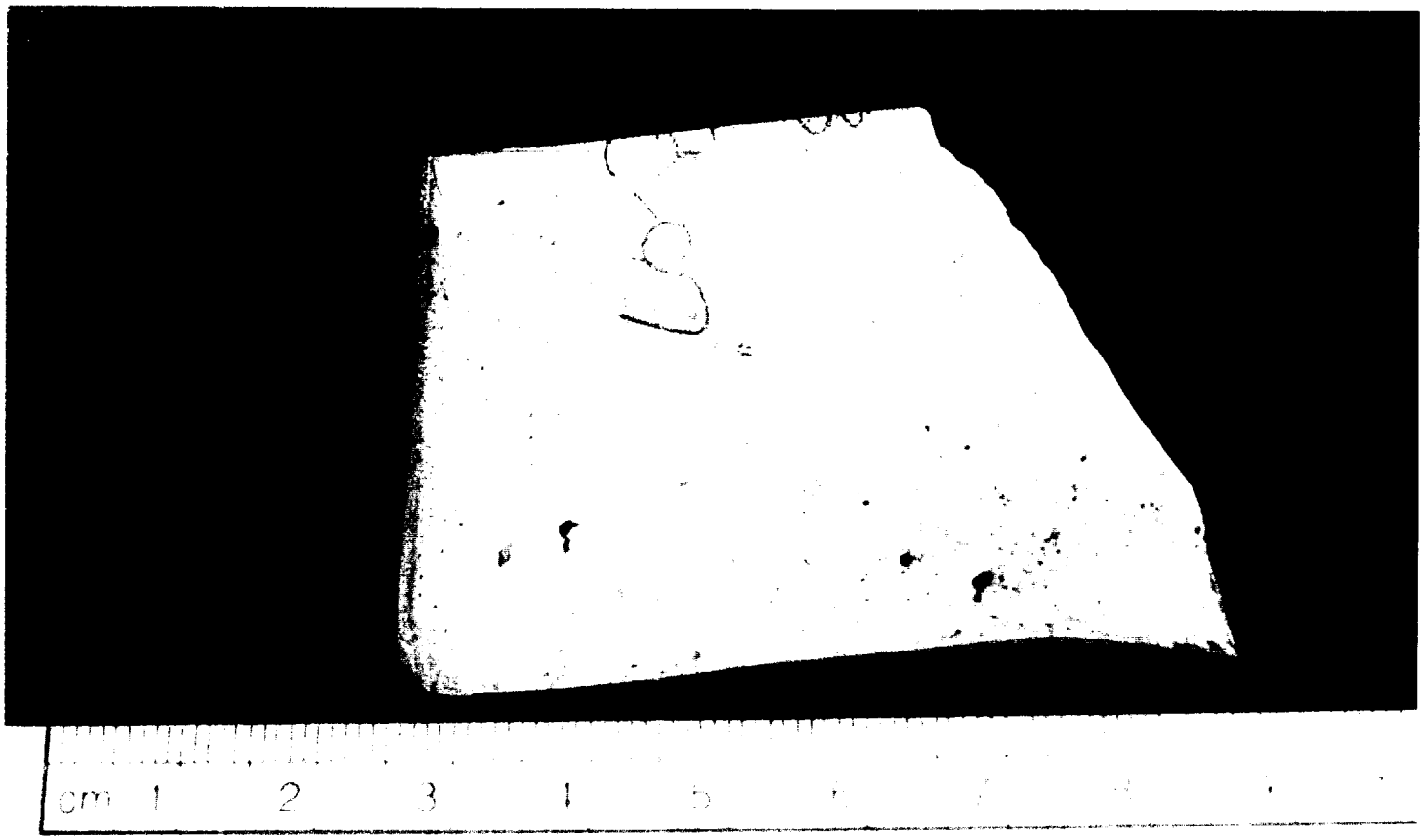


Figure 11. Spectral overlay of adhesive reference with red material.



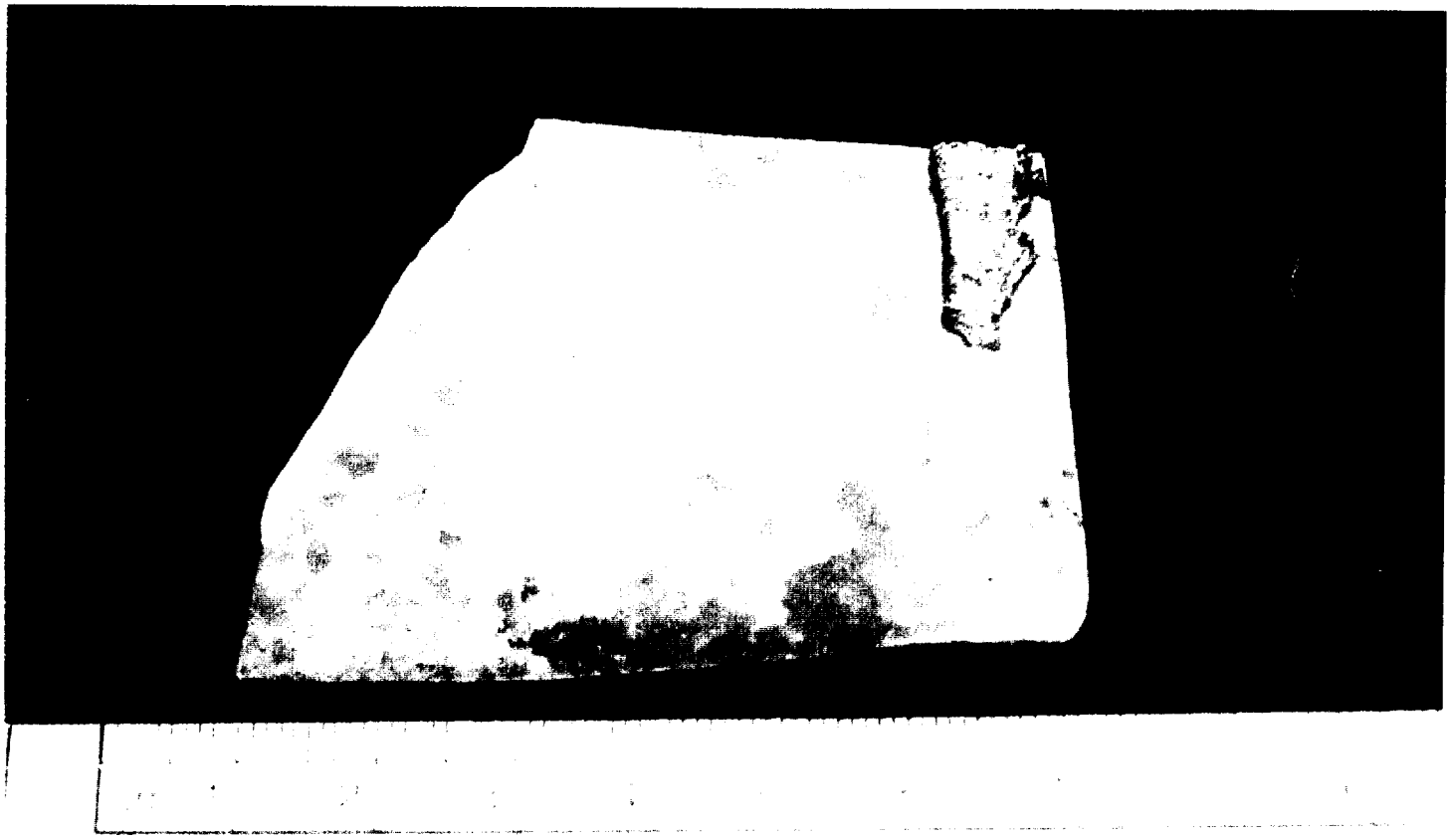


Figure 12. Sample #73, Row #27, Seat #2

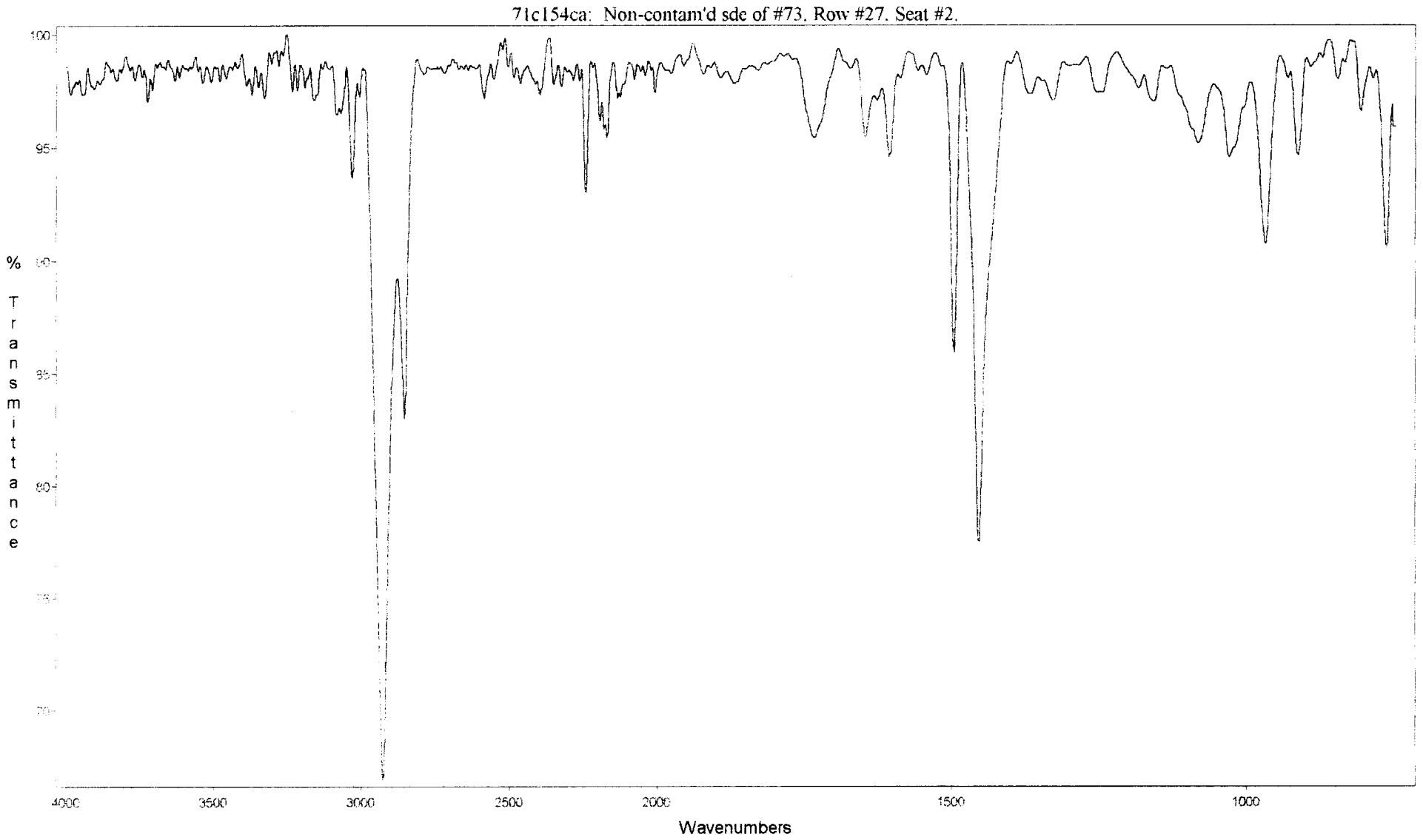


Figure 13. IR spectrum of "clean" side of sample #73, Row #27, Seat #2.

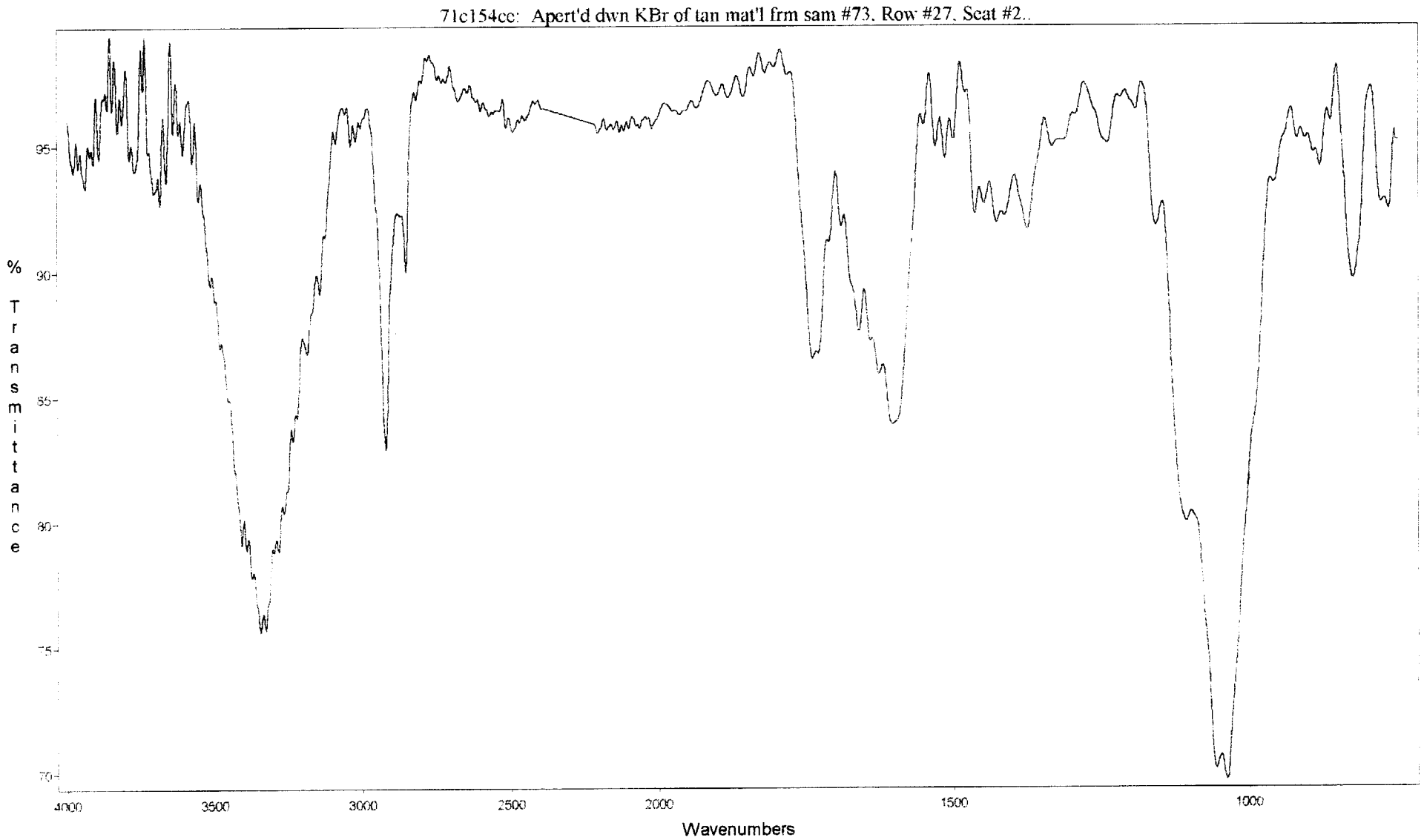


Figure 14. IR spectrum of contaminated side of sample #73, Row #27, Seat #2.

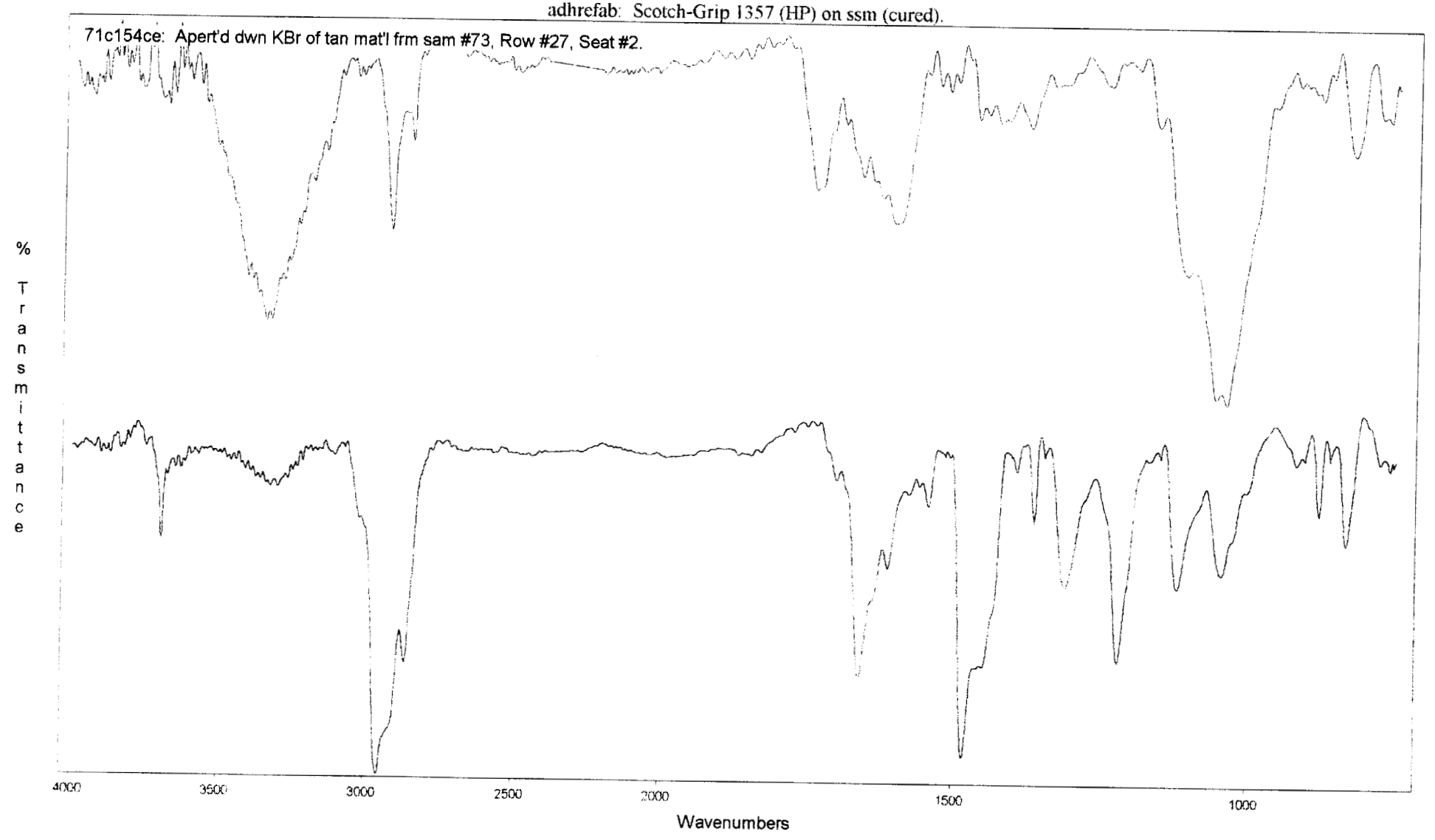


Figure 15. Spectral comparison of adhesive reference with contaminant of sample #73.

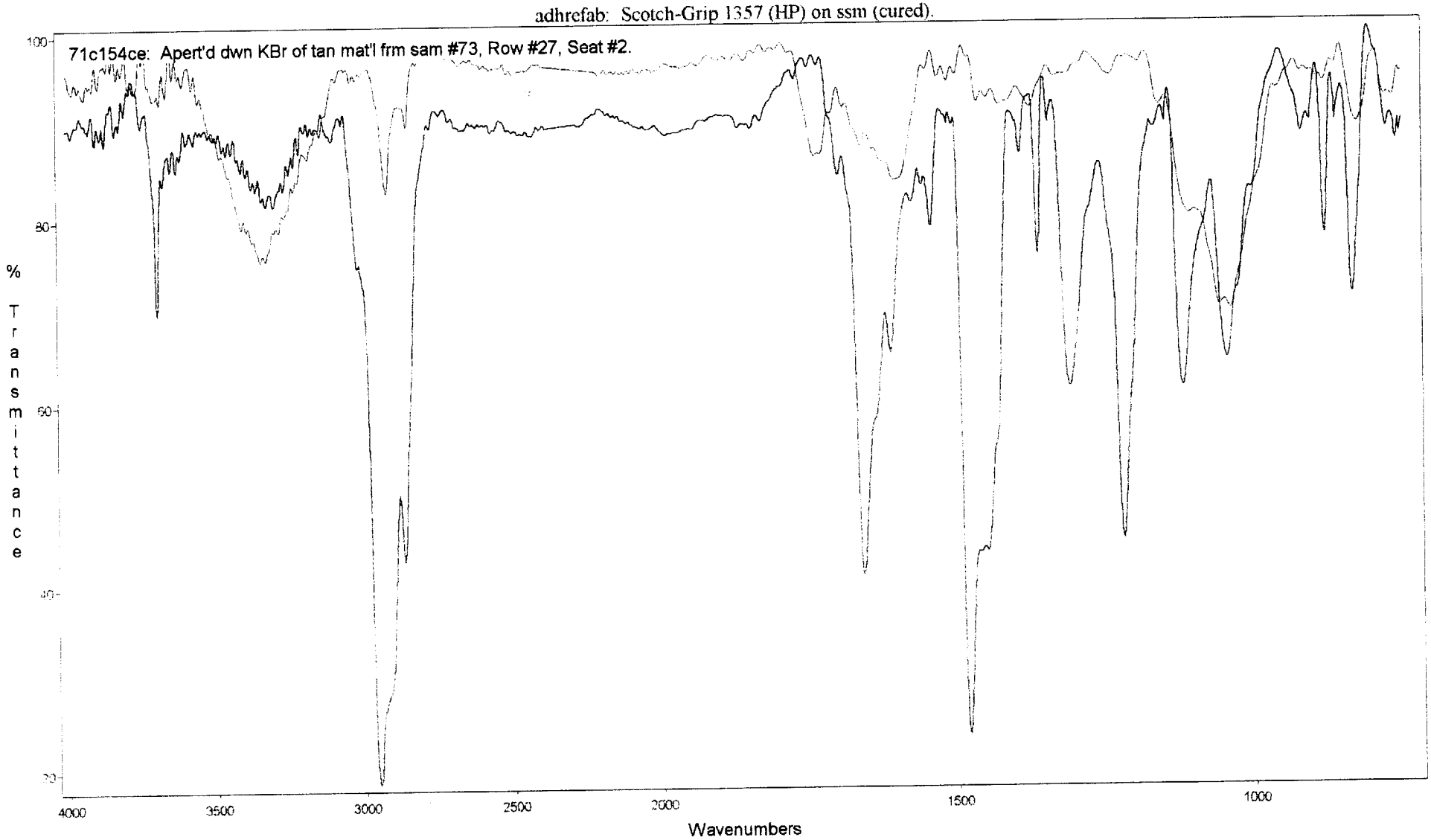


Figure 16. Spectral overlay of adhesive with contaminant.

Figure 17. Sample #74, Row #24, Seat #7.

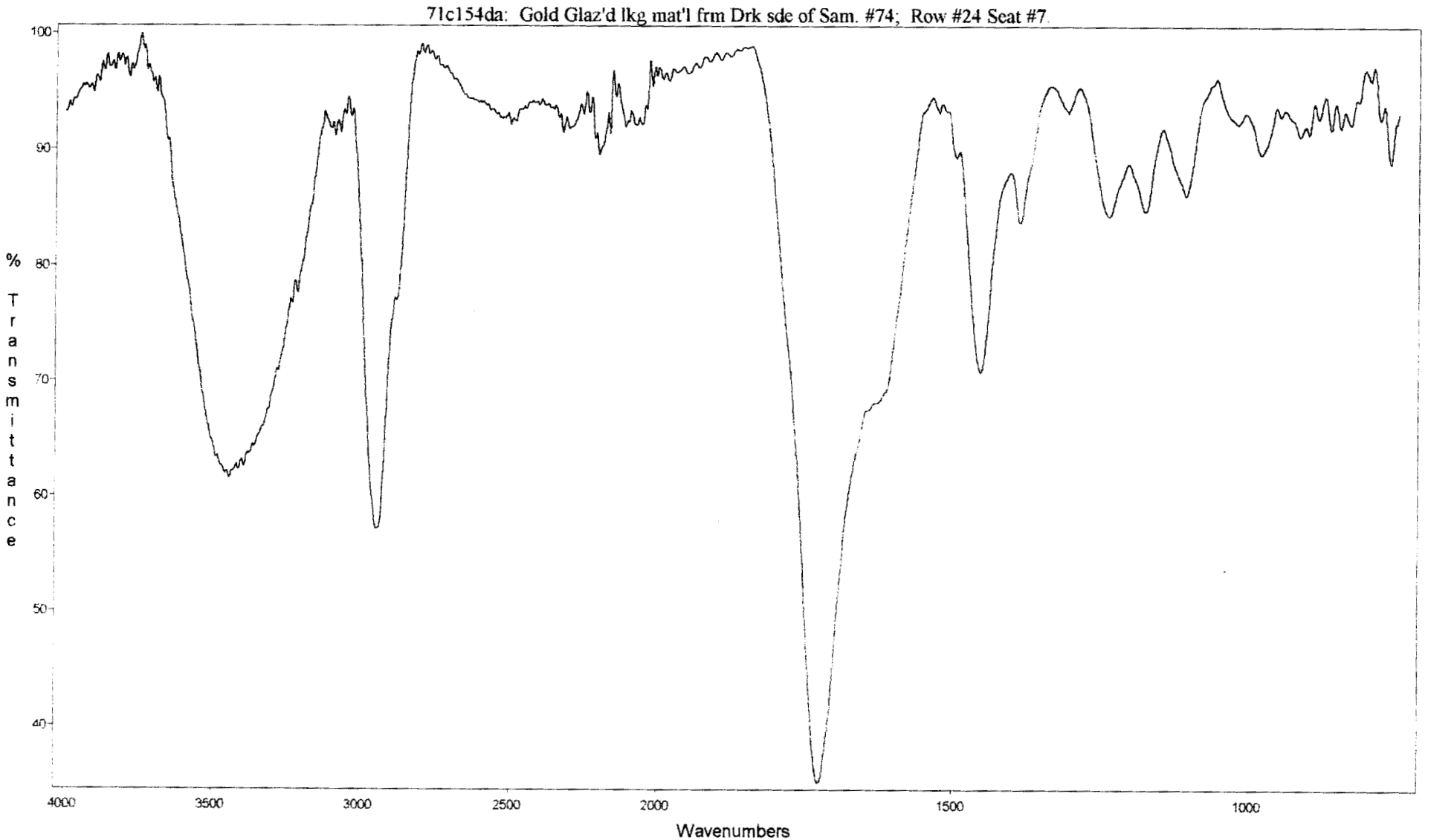


Figure 18. Glazed looking material from darkest side of sample #74.

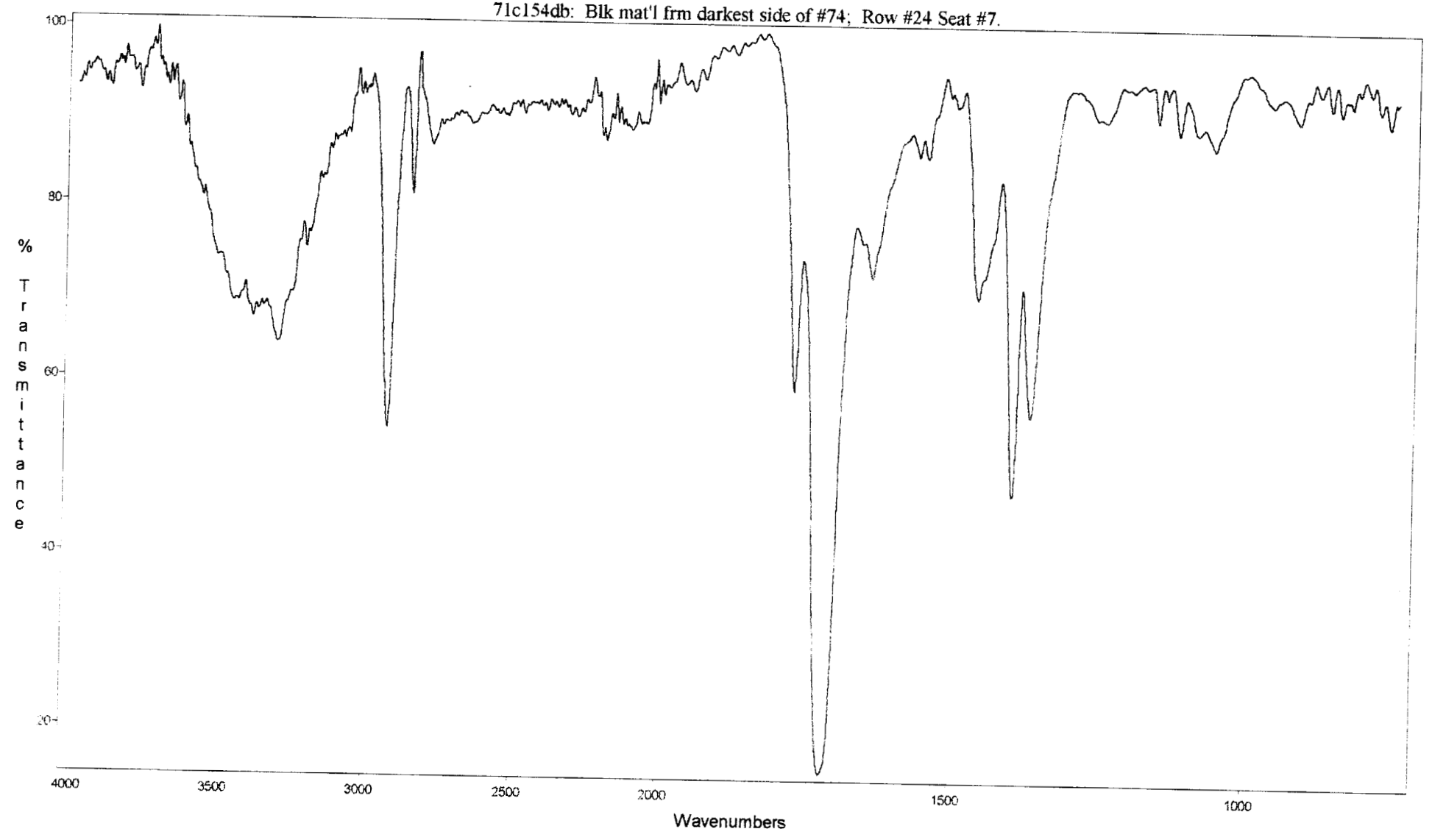


Figure 19. Black material from darkest side of sample #74.

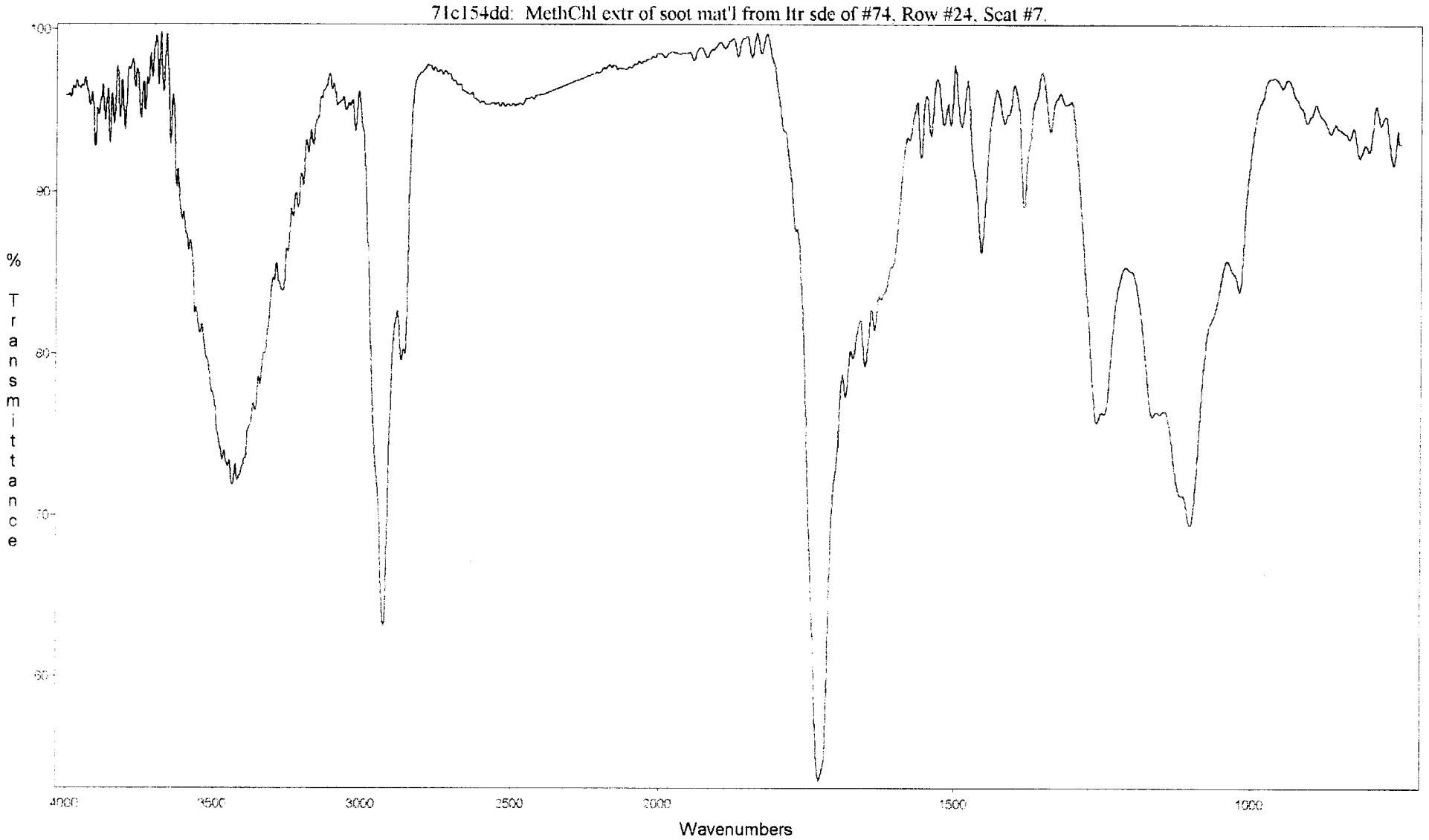


Figure 20. Extraction of "sooty" material from lighter side of sample #74.