

**DOCKET NO. SA-516**

**EXHIBIT NO. 20C**

**NATIONAL TRANSPORTATION SAFETY BOARD  
WASHINGTON, D.C.**

**FIRE AND EXPLOSION GROUPS FACTUAL REPORT**

**Appendix 111  
(Tests and Study)  
(81 pages)**

TWA FLIGHT 800 ACCIDENT INVESTIGATION

FIRE AND EXPLOSION

APPENDIX 111

(TESTS AND STUDY)

**APPENDIX III**  
**TESTS AND ANALYSIS RESULTS**

- | <b><u>Item #</u></b> | <b><u>Description of Analysis</u></b>   |
|----------------------|---|
| <b>1.</b>            | <b>Fuel Sample taken July 11, 1996 in Athens, Greece.<br/>Certificate of Quality Analysis</b>   |
| <b>2.</b>            | <b>Reference Samples Labeled MMB-1, MB-2, MB-3, MB-4, MB-5, and MB-6<br/>Kennedy Space Center, Florida (May 19, 1997)</b>   |
| <b>3.</b>            | <b>Gasper Tubing Sample # 1 from the Environmental Control System<br/>Kennedy Space Center, Florida (June 3, 1997)</b>  |
| <b>4.</b>            | <b>Gasper Tubing Samples # 2 from the Environmental Control System<br/>Kennedy Space Center, Florida (June 4, 1997)</b>   |
| <b>5.</b>            | <b>Seat Samples and Adhesive Reference Material Analysis<br/>Kennedy Space Center, Florida (June 24, 1997)</b>  |
| <b>6.</b>            | <b>Reports Pending for the following:</b> <ol style="list-style-type: none"><li><b>1. Description of Material embedded in CWT upper skin sealant.</b></li><li><b>2. Other Fuel Samples.</b></li><li><b>3. Various Soot Sample Analysis.</b></li></ol> |



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

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 CW 129) 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 nom 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

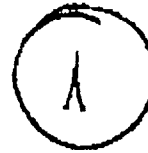
**MOBIL-SHELL-ERO**

ΠΕΤΡΟΛΑ ΕΛΛΑΣ Α.Ε.Β.Ε.  
 ΔΙΑΛΥΤΗΡΙΟ ΕΛΕΥΣΙΝΑΣ  
 PETROLA HELLAS S.A.  
 ELEFSIS REFINERY

**ΔΕΛΤΙΟ ΑΝΑΛΥΣΕΩΣ**  
 CERTIFICATE OF QUALITY  
 (BATCH N° 410)

ΗΜΕΡ  
 DATE 11-7-96  
 N° 1258

ΚΑΥΣΙΜΑ ΑΕΡΟΠΟΡΙΑΣ - AVIATION TURBINE FUEL  
 ΠΡΟΙΟΝ .....  
 PRODUCT .....  
 ΔΕΞΑΜΕΝΕΣ .....  
 SHORE TANKS .....  
 ΤΗ-204



page 1

LOADED ON THE TRUCKS N°:

**ΔΕΞΑΜΕΝΗ N° 3**

PROPERTIES	Method ASTM/IP	Results	PROPERTIES	Method ASTM/IP	Results
Density at 15 °C kg/m <sup>3</sup>	D-1298	799,7	<b>COMBUSTION</b>		
APPEARANCE Visual		Clear Bright	Specific Energy Net, MJ/Kg or Aniline Gravity Product	D-4809 D- 511 D-1298	43,2 26
<b>COMPOSITION</b>			Smoke Point, mm or Naphthalenes % vol and Smoke point	D-1322 D-1349 D-1322	
Total acidity mg KOH/gr	IP-354	0,003	<b>CORROSION</b>		
Aromatics % vol.	D-1319	17,0	Corrosion, copper classification	D- 130	10
Olefins % vol.	D-1319	9,5	Corrosion, Silver, classification	IP-227	ZERO
Sulphur total % mass or " " % mass	D-1266 D-4294	0,23	<b>STABILITY (NFTO) (control temperature 265° C)</b>		
Sulphur, Mercaptan, % mass	D-3227	0,0015	Thermal stability a-Filter pressure differential mm Hg.	D-3241	ZERO
<b>VOLATILITY</b>			b- Tube Deposit Rating (visual)		ZERO NO DEPOSIT OR ABNORMAL
Distillation °C	D- 85		<b>CONTAMINANTS</b>		
I.B.P.		150	Existent Gums mg/100ml	D- 351	15
10 % Vol.		173	Water reaction	D-1094	15/2
20 % Vol.		181	Water Separator index (without STABILISER)	D-3948	92
50 % Vol.		198	Electrical conductivity Perm at c	D-2824	100
90 % Vol.		234	<b>ADDITIVES</b>		
End point		250	Static Dissipator acid. STABILISER		98
Residue % Vol.		0,8			
Loss % Vol.		0,5			
Flash point (Abel) °C	IP- 170	45			
Flash point (Tag) °C	D- 55				
<b>FLUIDITY</b>					
Freezing point °C	D-2386	-49			
Viscosity - 20 °C, cet	D- 445	5,0			

1. This product is not Hydrocracked and Copper Sweetened.  
 2. This product meets joint fuelling system check list  
 issue ( ) and addendum No. ....  
 which embodies the following Specifications:  
 a- DEFQ 2494  
 b- IATA Guidance material, Keroline type fuel

SENT BY: AVIATION FUELS

8-16-86 : 8:57AM :

ECI-

314 588 3380: # 3/12

HLG-16-14 11125 11125

10.7755847

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Vol II  
10/12/86

11/12

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ΑΑ ΔΙΤΑΙΣΤΗΡΙΑ ΑΣΦΑΛΥΡΓΟΥ Α.Ε.  
LENIC ASPROPTOS REFINERY S.A.  
ΧΗΜΕΙΟΝ - LABORATORY

ΔΕΞΑΜΕΝΗ 4 ΣΕΛΙΔΩΝ ΑΝΑΛΥΣΕΩΣ JA-1 JET FUEL  
Νº 3 LABORATORY REPORT JA-1

ΠΡΩΤΗ ΔΕΛΤΙΔΙΟ: 104 ΗΜΕΡΟΜΗΝΙΑ 5/07/86 ΑΡΙΘ. ΔΕΞΑΜΕΝΗΣ P-2519  
REPORT NO: DATE: TANK NO.

ΠΥΚΝΟΤΗΤΑ ΣΕ 15°C, KG/L DENSITY AT 15°C, KG/L	0.8005	ΑΠΟΛΙΠΝΟ ΑΠΟΣΤΑΣΗΣ, % ΚΟ DISTILLATION LOSS, % VOL	4.0
ΕΜΦΑΝΙΣΗ APPEARANCE	h/c	ΣΗΜΕΙΟ ΑΝΑΦΛΕΞΗΣ, TAG, °C FLASH POINT, TAG, °C	47
ΟΞΙΤΗΤΑ, MG ΚΟΗ/Γ ACIDITY, MG ΚΟΗ/Γ	0.008	ΣΗΜΕΙΟ ΨΕΦΗΣ, °C FREEZING POINT, °C	-51
ΑΡΟΜΑΤΙΚΑ, % Κ.Ο AROMATICS, % V/V	18	ΙΣΚΟΡΣ ΣΕ -20°C, CST VISCOSITY AT -20°C, CST	4
ΟΛΕΦΙΝΕΣ, % ΚΟ OLEFINS, % V/V	0.6	ΚΑΤ. ΘΕΡΜΟΤ. ΔΥΝΑΜΗ, MJ/KG NET HEAT OF COMBUS., MJ/KG	43.231
Ο, % Κ.Ο SULFUR, % M/M	0.26	ΣΗΜΕΙΟ ΑΙΘΑΛΙΣΜΟΥ, MM SMOKE POINT, MM	25
ΒΕΙΟ ΜΕΡΚΑΠΤΑΝΟΝ, % Κ.Ο MERCAPTAN SULFUR, % M/M	0.0018	ΝΑΡΚΑΛΕΝΙΑ, % Κ.Ο NAPHTALENES, % V/V	
ΔΟΚΙΜΗ ΔΟΚΤΟΡ DOCTOR TEST		ΔΙΑΣΦΡΩΝ ΧΑΛΚΟΥ, ASTM N° COPPER STRIP CORROSION, N°	1A
ΑΡΧΟΤΑΣΗ ΑΡΧ. ΘΗΜ., °C INITIAL BOILING POINT, °C	150	ΔΙΑΣΦΡΩΝ ΑΡΓΥΡΟΥ, ASTM N° CORROSION SILVER, N°	0
10% Κ.Ο ΣΥΝΔΥΚΝΩΜΑ, °C 10% VOL RECOVERED, °C	154	ΨΕΦΟΤ: ΠΡΩΤΗ ΠΙΕΣΗ, MM HG ΨΕΦΟΤ: PRES. DROP, MM HG	0
20% Κ.Ο ΣΥΝΔΥΚΝΩΜΑ, °C 20% VOL RECOVERED, °C	190	ΨΕΦΟΤ: ΟΡΘΙΚΗ ΕΚΤΗΘ. ΣΤΑΘΜΑ ΨΕΦΟΤ: TUBE RATING VISUAL	0
50% Κ.Ο ΣΥΝΔΥΚΝΩΜΑ, °C 50% VOL RECOVERED, °C	210	ΨΕΦΟΤ: "P" Η "A" ΑΡΟΦΕΣΙΜΟ ΨΕΦΟΤ: "P" OR "A" DEPOSITS	NO
90% Κ.Ο ΣΥΝΔΥΚΝΩΜΑ, °C 90% VOL RECOVERED, °C	231	ΚΟΜ. ΟΥΖΙΕΣ, MG/100ML GUM EXISTENT, MG/100ML	2.8
ΑΡΧΟΤΑΣΗ ΤΕΛ. ΘΗΜ., °C FINAL BOILING POINT, °C	251	W.E-INTERFACE RATING WR-INTERFACE RATING	1
Α. ΑΠΟΣΤΑΣΗΣ, % 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



Ι.Δ. ΒΑΡΟΛ ΓΥΚ.  
10,8016

a/a Othm  
I. ΓΑΓΑΙΑΣ

7



ΣΕΙΜΕΝΗ Ν° 3

NEW 3

A ΟΙΥΑΙΕΤΗΡΙΑ ΑΕΡΟΠΩΤΩΝ Α.Ε.  
 C ΑΣΠΡΟΠΥΡΓΟΣ REFINERY S.A.  
 ΧΗΜΕΙΟΝ - LABORATORY

ΑΕΡΑΙΟΝ ΑΝΑΛΥΣΗ JA-1 JET FUEL  
 ΛΑΒΟΡΑΤΩΡΙΟ ΡΕΠΟΡΤ JA-1

ΑΡΙΘΜΟΣ ΕΠΙΣΤΗΜΗΣ REPORT NO	ΗΜΕΡΟΜΗΝΙΑ DATE	ΑΡΙΘ. ΣΕΙΜΕΝΗΣ P-8711B TANK NO.
ΑΡΧΗΤΗΤΑ ΣΕ 15°C, KG/L DENSITY AT 15°C, KG/L	0.7999	ΑΡΧΗΤΗΤΑ ΑΠΟΤΑΞΗΣ, % KO DISTILLATION LOSS, % VOL
ΒΑΝΙΣΗ PEARANCE	5/2	ΣΗΜΕΙΟ ΑΝΑΦΛΕΞΗΣ, TAG, °C FLASH POINT, TAG, °C
ΙΤΚΙΑ, % KOH, G IBITZ, % KOH, G	0.012	ΣΗΜΕΙΟ ΨΥΞΗΣ, °C FREEZING POINT, °C
ΡΗΑΤΙΚΑ, % K.O RHATICS, % V.V	16	ΙΣΟΘΕΣ ΣΕ -20°C, CST VISCOSITY AT -20°C, CST
ΥΠΕΡ-ΤΡΕΣ, % KO UR, % V.V	0.6	ΚΑΤ. ΘΕΡΜΟΤ. ΔΥΝΑΜΗ, MJ/KG NET HEAT OF COMBUS., MJ/KG
ΣΙΟ, % K.B SULFUR, % K.B	0.26	ΣΗΜΕΙΟ ΑΙΘΑΛΙΣΜΟΥ, MM SMOKE POINT, MM
ΕΙΟ ΜΕΡΚΑΠΤΑΝΟΝ, % K.B ERCAPTAN SULFUR, % MM	0.0015	ΝΑΦΘΑΛΕΝΑ, % K.O NAPHTALENES, % V.V
ΟΚΙΜΗ ΔΟΚΤΟΡ DOCTOR TEST		ΔΙΑΣΠΟΡΗ ΧΑΛΚΟΥ, ASTM N° COPPER STRIP CORROSION, N°
ΑΡΧΗΤΗΤΑ ΑΡΧ. ΟΜΗ, °C INITIAL BOILING POINT, °C	154	ΔΙΑΣΠΟΡΗ ΑΡΓΥΡΟΥ, ASTM N° CORROSION SILVER, N°
10% K.O ΣΥΝΤΕΚΝΗΜΑ, °C 10% VOL RECOVERED, °C	161	ΣΤΕΤΟ: ΠΡΟΣΩΝ ΠΙΣΤΗΣ, MM KO JETOT: PRES. DROP, MM KO
20% K.O ΣΥΝΤΕΚΝΗΜΑ, °C 20% VOL RECOVERED, °C	167	ΣΤΕΤΟ: ΟΡΤΙΚΑ ΣΕΤΙΜ, ΟΡΑΝΑ JETOT: THER RATING VISUAL
30% K.O ΣΥΝΤΕΚΝΗΜΑ, °C 30% VOL RECOVERED, °C	171	ΣΤΕΤΟ: "P" ΚΑΙ "A" ΑΠΟΘΕΣΕΙΣ JETOT: "P" DATA DEPOSITS
40% K.O ΣΥΝΤΕΚΝΗΜΑ, °C 40% VOL RECOVERED, °C	176	ΚΟΜ. ΟΥΣΙΕΣ, NO/COCK GUM EXISTENT, NO/COCK
ΑΡΧΗΤΗΤΑ ΤΕΛ. ΟΜΗ, °C L BOILING POINT, °C	180	W.R-INTERFACE RATING WR-INTERFACE RATING
ΥΠΟΛ. ΑΠΟΤΑΞΗΣ, % K.O DISTILLATION RESIDUE, % VOL	181	WSEK W O SBA, CEN WSEK W O SBA, CEN



C.A. BAPOE Γ.Υ.Κ.

Κ.Ο. Α.Β. Α.Ε.  
 ΕΛΛΗΝΙΚΗ ΑΕΡΟΠΩΤΟΝΟΜΙΑ

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(A)

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**ΕΛΛΗΝΙΚΑ ΚΑΥΣΙΜΑ - ΟΡΥΚΤΕΛΑΙΑ**  
**ΑΝΩΝΥΜΗ ΒΙΟΜΗΧΑΝΙΚΗ & ΕΜΠΟΡΙΚΗ ΕΤΑΙΡΙΑ**  
**ΧΗΜΕΙΟ ΣΚΑΡΑΜΑΓΚΑ**  
 ΠΑΛΑΔΑ 1 - ΣΚΑΡΑΜΑΓΚΑΣ 124 82  
 ΤΗΛ. 6872880

**ΑΝΑΛΥΣΗ ΑΕΡΟΣΟΠΙΟΥ ΚΑΥΣΙΜΟΥ**

ΑΝΑ ΔΕΙΓΜΑΤΟΣ: 336

ΠΡΟΕΛΕΥΣΗ ΔΕΙΓΜΑΤΟΣ: ΣΚΑΡΑΜΑΓΚΑΣ

ΕΙΔΟΣ: JET A1

ΗΜΕΡΟΜΗΝΙΑ ΠΑΡΑΛΑΒΗΣ: 9/7/96

ΔΕΞΑΜΕΝΗ N° 3

BN: 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	↓
WSIM	ASTM D - 3848	77
Existent Gum (mg/100ml)	ASTM D - 381	1,6
Copper Corrosion (2h, 100°C)	ASTM D - 130	10
Conductivity (pS/m)	ASTM D - 2024	117 (29°C)

ΠΑΡΑΤΗΡΗΣΕΙΣ

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

ΣΚΑΡΑΜΑΓΚΑΣ

9/7/96

Ο ΧΗΜΙΚΟΣ

Γ. ΜΑΥΡΟΠΟΛΟΣ

ΓΙΑ ΤΟΝ ΠΕΛΑΤΗ

aa

10X



**ΕΛΛΗΝΙΚΑ ΚΑΥΣΙΜΑ - ΟΡΥΚΤΕΡΑΛΙΑ**  
**ΑΝΩΝΥΜΗ ΒΙΟΜΗΧΑΝΙΚΗ & ΕΜΠΟΡΙΚΗ ΕΤΑΙΡΙΑ**  
 ΧΗΜΕΙΟ ΣΚΑΡΑΜΑΓΚΑ  
 ΠΑΛΑΙΑ 1 - ΣΚΑΡΑΜΑΓΚΑΣ 124 02  
 ΤΗΛ. 3372550

**ΑΡΑΤΟ ΑΝΑΛΥΣΗ ΑΕΡΟΠΟΡΙΚΟΥ ΚΑΥΣΙΜΟΥ**

Α/Α ΔΕΙΓΜΑΤΟΣ: 342 ΠΡΟΕΛΕΥΣΗ ΔΕΙΓΜΑΤΟΣ: ΣΚΑΡ/ΣΚΑ  
 ΕΙΔΟΣ: JET A1 ΗΜΕΡΟΜΗΝΙΑ ΠΑΡΑΛΑΒΗΣ: 11/7/96  
ΔΕΞΑΜΕΝΗ U93 ΔΕΞ. U93 5N: 10/7/96

ΕΛΕΓΧΟΙ	ΜΕΘΟΔΟΙ ΑΝΑΛΥΣΗΣ	ΑΠΟΤΕΛΕΣΜΑΤΑ
Appearance	Visual	B/C
Density at 15°C (gr/ml)	ASTM D - 1298	0,8004
Distillation	ASTM D - 85	
IBP (°C)		
10% Recovered (°C)		
20% (°C)		
50% (°C)		
80% (°C)		
F.B.P. (°C)		
Residue/Loss (%Vol)		
Flash Point TAG (°C)	ASTM D - 58	46,0
Freezing Point (°C)	ASTM D - 2365	-51,5
Water Reaction	ASTM D - 1094	2
WSIM	ASTM D - 9545	79
Existent Gum (mg/100ml)	ASTM D - 381	1,6
Copper Corrosion (2h, 100°C)	ASTM D - 130	1A
Conductivity (pS/m)	ASTM D - 8824	85 (29°C)

ΠΑΡΑΤΗΡΗΣΕΙΣ:

ΤΟ ΠΡΟΪΟΝ..... ΕΙΝΑΙ ΣΥΜΦΩΝΟ ΜΕ ΤΗΝ DEF STAN 91-01/1

ΣΚΑΡΑΜΑΓΚΑΣ 11/7/96  
 ΓΙΑ ΤΟΝ ΠΙΛΟΤΗ

Ο ΚΑΝΚΟΣ Ε. ΜΟΡΤΙΔΟΣ

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Α ΕΤΑΙΡΕΙΑ ΑΕΡΟΔΥΤΤΟΥ Α.Ε.  
 Α ΑΡΡΟΠΥΡΟΣΣΙ REFINERY S.A.  
 ΧΗΜΕΙΟΝ - LABORATORY

Α Ε Τ Ι Ο Ν Α Ν Α Λ Ξ Ε Σ Ε  
 J A - 1 J E T F U E L  
 L A B O R A T O R Y R E P O R T J A - 1

ΝΟΣ. ΑΕΤΙΟΥ: 127	ΗΜΕΡΟΜΗΝΙΑ 5/08/86	ΑΡΙΘ. ΟΡΘΑΝΩΜΕ Π-8819
ΕΚΦΩΤ. ΝΟΣ:	ΗΜΕΡΑ:	ΤΑΝΚ ΝΟΣ.
ΚΥΟΤΗΤΑ ΕΕ 15°C, KG/L	0.8013	ΑΠΟΧΛΗΞ ΑΠΟΧΤΑΣΗΣ, % ΚΟ 1.0
ΠΥΚΝΟΤΗΤΑ ΑΤ 15°C, KG/L		ΑΠΟΧΛΗΞ ΑΠΟΧΤΑΣΗΣ, % ΚΟ 1.0
ΕΜΦΑΝΙΣΗ	W/C	ΕΝΘΕΙΟ ΑΝΑΦΛΕΞΗΣ, TAG, °C 47
ΕΜΦΑΝΙΣΗ		ΠΛΑΞΗ ΠΟΙΝΤ, TAG, °C
ΕΥΚΡΑΤ. ΝΟΣ ΚΟΝ/Γ	0.011	ΕΝΘΕΙΟ ΠΥΚΝ., °C -52
ΕΥΚΡΑΤ. ΝΟΣ ΚΟΝ/Γ		ΠΡΕΣΣΙΟΝ ΠΟΙΝΤ, °C
ΕΚΚΑΤΑΧΑ, % Κ.Ο	16	ΕΚΚΑΤΑΧΑ ΕΕ -20°C, CBT 4
ΕΚΚΑΤΑΧΑ, % V/V		ΕΚΚΑΤΑΧΑ ΑΤ -20°C, CBT
ΕΚΚΑΤΑΧΑ, % Κ.Ο	0.4	ΚΑΤ. ΕΡΕΜΟΤ. ΔΥΝΑΜΗ, ΜΣ/ΚΟ 48.200
ΕΚΚΑΤΑΧΑ, % V/V		ΕΚΚΑΤΑΧΑ ΚΟΜΒΟΥ, ΜΣ/ΚΟ
ΕΚΚΑΤΑΧΑ, % Κ.Ο	0.29	ΕΚΚΑΤΑΧΑ ΑΙΘΑΝΙΣΜΟΥ, ΜΜ 24
ΕΚΚΑΤΑΧΑ, % Μ/Μ		ΕΚΚΑΤΑΧΑ ΠΟΙΝΤ, ΜΜ
ΕΚΚΑΤΑΧΑ, % Κ.Ο	0.0018	ΝΑΡΚΑΤΑΧΑ, % Κ.Ο
ΕΚΚΑΤΑΧΑ, % Μ/Μ		ΝΑΡΚΑΤΑΧΑ, % V/V
ΕΚΚΑΤΑΧΑ, % Κ.Ο		ΕΚΚΑΤΑΧΑ ΚΑΡΚΟΥ, ASTM M° 1A
ΕΚΚΑΤΑΧΑ, % Μ/Μ		ΕΚΚΑΤΑΧΑ ΚΑΡΚΟΥ, ASTM M°
ΕΚΚΑΤΑΧΑ, % Κ.Ο	165	ΕΚΚΑΤΑΧΑ ΑΡΓΥΡΟΥ, ASTM M° 0
ΕΚΚΑΤΑΧΑ, % Μ/Μ		ΕΚΚΑΤΑΧΑ ΑΡΓΥΡΟΥ, ASTM M°
ΕΚΚΑΤΑΧΑ, % Κ.Ο	165	ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ 0
ΕΚΚΑΤΑΧΑ, % Μ/Μ		ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ
ΕΚΚΑΤΑΧΑ, % Κ.Ο	190	ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ 0
ΕΚΚΑΤΑΧΑ, % Μ/Μ		ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ
ΕΚΚΑΤΑΧΑ, % Κ.Ο	202	ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ 0
ΕΚΚΑΤΑΧΑ, % Μ/Μ		ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ
ΕΚΚΑΤΑΧΑ, % Κ.Ο	224	ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ 0
ΕΚΚΑΤΑΧΑ, % Μ/Μ		ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ
ΕΚΚΑΤΑΧΑ, % Κ.Ο	248	ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ 0
ΕΚΚΑΤΑΧΑ, % Μ/Μ		ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ
ΕΚΚΑΤΑΧΑ, % Κ.Ο	1.2	ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ 0
ΕΚΚΑΤΑΧΑ, % Μ/Μ		ΕΚΚΑΤΑΧΑ ΕΚΚΑΤΑΧΑ, ΜΜ ΝΟΣ



Ο ΕΠΟΙΤΑΝΚΟΧ ΤΟΥ ΧΗΜΕΙΟΥ THE CHIEF CHEMIST

a/a Otrmi

0,8015

I. TATAIAS

11

page 2/10

ΠΕΤΡΟΛΙΑ ΕΛΛΑΔΟΣ Α.Ε.Β.Ε.  
 ΔΙΑΔΙΣΤΗΡΙΟ ΕΛΕΥΣΙΝΑΣ  
 PETROLIA HELLAS S.A.  
 ELEFSIS REFINERY

Mobil

ΔΕΛΤΙΟ ΑΝΑΛΥΣΕΩΣ  
 CERTIFICATE OF QUALITY  
 (BATCH N° 57)

DATE 12-8-96  
 No 1474

BE-5

ΚΑΥΣΙΜΑ ΑΕΡΟΠΟΡΙΑΣ - AVIATION TURBINE FUEL  
 ΠΡΟΪΟΝ JET A-1  
 ΠΡΟΪΟΝ PRODUCT  
 ΔΕΞΑΜΕΝΕΣ 7K-204  
 SHORE TANKS

5

LOADED ON THE TRUCKS No:

PROPERTIES	Method ASTM/IP	Results	PROPERTIES	Method ASTM/IP	Results
Density at 15 °C kg/m3	D-1298	800,6	<u>COMBUSTION</u>		
<u>APPEARANCE</u> Visual		Clear Bright	Specific Energy		43,2
<u>COMPOSITION</u>			Net, MG/Kg or Aniline Gravity Product	D-4808 D- 611 D-1298	
Total acidity mg KOH/gr	IP-354	0,003	Smoke Point mm or Naphthalenes % vol and Smoke point	D-1322 D-1840 D-1322	26
Aromatic % vol.	D-1319	12,0	<u>CORROSION</u>		
Olefins % vol.	D-1319	0,5	Corrosion, copper classification	D- 130	19
Sulphur total % mass	D-1286	0,13	Corrosion, Silver, classification	IP- 227	ZERO
or " " % mass	D-4294		<u>STABILITY (JFTOT) (control temperature 200° C)</u>		
Sulphur, Mercaptan, % mass	D-3227	0,0009	Thermal stability		
<u>VOLATILITY</u>			a-Filter pressure differential mm Hg.	D-3241	ZERO
Distillation °C	D- 86		b- Trace Deposit Rating (visual)		ZERO, NO PLACOCK OR ABNORMAL COLOUR DEPOSITS
I.B.P.		154	<u>CONTAMINANTS</u>		
10 % Vol.		175	Existent Gum mg/10Gml	D- 381	1,5
20 % Vol.		183	Water reaction	D-1094	16/2
50 % Vol.		202	Water Separator index (without 450)	D-3948	92
90 % Vol.		234	Electrical conductivity Pam at c	D-2624	140
End point		252	<u>ADDITIVES</u>		
Residue % Vol.		0,8	Static Dissipator add.		0,8
Loss % Vol.		0,5	Static Dissipator add.		
Flash point (Abel) °C	IP- 170	45			
Flash point (Tag) °C	D- 56				
<u>FLUIDITY</u>					
Freezing point °C	D-2386	-49,0			
Viscosity - 20 °C, cSt	D- 445	5,8			

1. This product is not Hydrotreated and Copper Sweetened.  
 2. This product meets joint fuelling system check list  
 latest issue ( 78 ) and addendum No. 1 (ISSUED JUNE '95)  
 which embodies the following Specifications.  
 a- OERD 2484  
 b- IATA Guidance material, Kerosene type fuel  
 c- ASTM D-1545, Kerosene type Jet A-1

*[Signature]*

6-15

6

DIL (HELLAS)  
THEODORI GREECE

No 471  
DATE 8/8/96  
LABORATORY QUALITY CERTIFICATE  
JET A-1

JET - A1		RESULTS	METHODS
NATION : SHELL PERAMA			
TANK : NEMEA		787	
DENSITY AT 15 DEG C. KG/M3		793.8	ASTM D-1298
DENSITY AT 15 POINT DEG C		40	IP-170
DENSITY AT -20 DEG C. CGT		3.8	ASTM D-445
FREEZING POINT DEG C		-47.0	ASTM D-2386
TOTAL SULFUR % WT		0.17	ASTM D-4294
AROMATIC SULFUR % WT		0.0016	ASTM D-3227
SULFUR CONTENT XMT		14.0	ASTM D-3701
WATER % VOL		16.1	ASTM D-1314
SOLIDS % VOL		0.3	ASTM D-1314
DISTILLATION IBP DEG C		145	ASTM D-86
OVERHEAD 10 % VOL DEG C		160	
OVERHEAD 20 % VOL DEG C		175	
OVERHEAD 30 % VOL DEG C		190	
OVERHEAD 40 % VOL DEG C		238	
OVERHEAD 50 % VOL DEG C		258	
TOLUENE LOSS		1.0/1.0	
HEATING VALUE NET MJ/KG		43.30	ASTM D-3330
FLASH POINT MP		25	ASTM D-3230
CORROSION COPPER STRIP. 2HRS AT 100 DEG C		1a	ASTM D-130
OVER CORROSION. 4HRS AT 50 DEG C		0	IP 227
ACIDITY NUMBER mg/100 ml		3	ASTM D-381
TOTAL ACID NUMBER mg KOH/gr		0.005	ASTM D-3242
UNPROCESSED FUEL IN BATCH % VOL		NIL	
SEPARATION INDEX MODIFIED		92	ASTM D-3948
INTER REACTION INTERFACE RATING		1b/2	ASTM D-1094
THERMAL STABILITY (JFTOT) TEMP 260°C			ASTM D-3241
FILTER PRESSURE. mmHg/TUBE DEPOSIT RATING		0/L1	
PEACOCK OR ABNORMAL COLOR DEPOSITES			
ELECTRICAL CONDUCTIVITY PS/M AT 34 DEG C		190	ASTM D-2624
TANIC DISSIPATOR MG/L		0.45	
APPEARANCE: CLEAR, BRIGHT AND FREE FROM SOLID MATTER AND UNDISSOLVED WATER AT AMBIENT TEMPERATURE			

conducted by

Approved by

13

ΥΠ' ΟΨΙΝ... Ηρ. Τουρνα...  
 1<sup>ος</sup> σφραγ.  
 (C)  
 page

ΔΕ-5



**ΕΛΛΗΝΙΚΑ ΚΑΥΣΙΜΑ - ΟΡΥΚΤΩΡΑ ΑΙΑ**  
**ΑΝΩΝΥΜΗ ΒΙΟΜΗΧΑΝΙΚΗ & ΕΜΠΟΡΙΚΗ ΕΤΑΙΡΙΑ**  
 ΧΗΜΕΙΟ ΣΚΑΡΑΜΑΓΚΑ  
 ΠΑΛΑΣΚΑ 1 - ΣΚΑΡΑΜΑΓΚΑΣ 124 02  
 ΤΗΛ. 6572 860

**ΔΕΛΤΙΟ ΑΝΑΛΥΣΗΣ ΑΠΡΟΠΟΡΤΟΥ ΚΑΥΣΙΜΟΥ**

Α/Α ΔΕΓΜΑΤΟΣ: 419 ΠΡΟΕΛΕΥΣΗ ΔΕΓΜΑΤΟΣ: ΑΣΤΡΟΥΠΥΡΟΣ  
 ΕΙΔΟΣ: Jet A1 ΗΜΕΡΟΜΗΝΙΑ ΠΑΡΑΛΑΒΗΣ: 6/8/96  
 ΔΕΣ: (N° 15.)

B.U. 51826

ΕΛΕΓΧΟΙ	ΜΕΘΟΔΟΙ ΑΝΑΛΥΣΗΣ	ΑΠΟΤΕΛΕΣΜΑΤΑ
Appearance	Visual	B/C
Density at 15°C (g/ml)	ASTM D - 1298	0.8010
Distillation	ASTM D - 86	
IBP (°C)		
10% Recovered (°C)		
20% " (°C)		
50% " (°C)		
80% " (°C)		
F.S.P. (°C)		
Residue/Loss (Y/G)		
Flash Point TAG (°C)	ASTM D - 56	46.5
Freezing Point (°C)	ASTM D - 2385	-52.0
Water Reaction	ASTM D - 1094	1
WSIM	ASTM D - 3948	19
Existent Gum (mg/100ml)	ASTM D - 381	4.6
Copper Corrosion (2h, 100°C)	ASTM D - 190	1a
Conductivity (pS/m)	ASTM D - 2624	77 (25°C)

ΠΑΡΑΤΗΡΗΣΕΙΣ:

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

ΣΚΑΡΑΜΑΓΚΑΣ 6/8/96

Ο ΥΠΕΥΘΟΣ C. ΜΠΕΛΛΥΡΟΣ

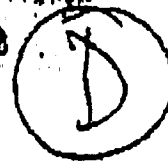
14

SENT BY: AVIATION FUELS

8-16-96 10:02AM

ΥΠ ΟΨΙΝ

Ηρ. Τσιπουράκης  
 119 ορόφο



page

ΔΕΣ 5



**ΕΛΛΗΝΙΚΑ ΚΑΥΣΙΜΑ - ΟΡΥΚΤΕΛΑΙΑ**  
**ΑΝΩΝΥΜΗ ΒΙΟΜΗΧΑΝΙΚΗ & ΕΜΠΟΡΙΚΗ ΕΤΑΙΡΙΑ**  
 ΧΗΜΕΙΟ ΣΚΑΡΑΜΑΓΚΑ  
 ΠΑΛΑΣΚΑ 1 - ΣΚΑΡΑΜΑΓΚΑΣ 124 02  
 ΤΗΛ. 85 72 990

**ΔΕΛΤΙΟ ΑΝΑΛΥΣΗΣ ΑΕΡΟΧΗΜΙΚΟΥ ΚΑΥΣΙΜΟΥ**

ΑΝ ΔΕΙΓΜΑΤΟΣ: 419 ΠΡΟΕΛΕΥΣΗ ΔΕΙΓΜΑΤΟΣ: ΑΣΤΡΟΝΑΥΤΟΣ  
 ΕΙΔΟΣ: Jet A ΗΜΕΡΟΜΗΝΙΑ ΠΑΡΑΛΑΒΗΣ: 6/2/96  
 ΔΕΣ: (N° 15)

B.U. 5/8/96

ΕΛΕΓΧΟΙ	ΜΕΘΟΔΟΙ ΑΝΑΛΥΣΗΣ	ΑΠΟΤΕΛΕΣΜΑΤΑ
Appearance	Visual	B/C
Density at 15°C (g/ml)	ASTM D - 1299	0.8210
Distillation	ASTM D - 88	
IBP (°C)		
10% Recovered (°C)		
20% " (°C)		
50% " (°C)		
80% " (°C)		
F.B.P. (°C)		
Residue/Loss (%Vol)		
Flash Point (°C)	ASTM D - 58	46.5
Freezing Point (°C)	ASTM D - 2386	-52.0
Water Reaction	ASTM D - 1294	1
WBM	ASTM D - 3943	1.9
Existent Gum (mg/100ml)	ASTM D - 381	1.6
Copper Corrosion (2h, 100°C)	ASTM D - 130	1a
Conductivity (pS/m)	ASTM D - 2624	FF (25°C)

ΠΑΡΑΤΗΡΗΣΕΙΣ:

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

ΣΚΑΡΑΜΑΓΚΑΣ 6/2/96

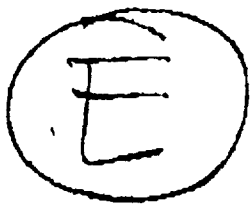
Ο ΧΗΜΙΚΟΣ C. ΜΠΕΛΥΡΟΣ

ΓΙΑ ΤΟΝ ΠΡΑΚΤΟΡΑ

15



16-5



W.M.I. WILAS A.B.  
 Oil and Chemicals company  
 PERARA LABORATORY

RECERTIFICATION TEST REPORT		SHELL JET-A1	
ANALYSIS BULLETIN No	1622	INSTALLATION:	
REPORT No	95/96	DEPOT-AIRPORT	PERARA
TANK No	19	BATCH No	PERR/15/183/96
Product drawn from tanks of P/T	INDIA	Date sample drawn	05/08/96
Quantity received (KG)	1900	Sample was drawn by	A. ECONOMOU
REFINERY/LOADING PORT	KOH	Date received at laboratory	05/08/96
QUALITY certificate of refinery	471/4-9-96		
Quantity before receipt (KG)	3250		
Last batch	PERR/15/182/96		

This report relates only to the samples tested and does not guarantee 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 BAYBOLT	+19	Report	ASTM D 156
Viscosity		Report	ASTM D 85
Initial Boiling Point	°C 145	Report	
Fuel Recovered 10% vol	°C 170	20% max	
" 20% vol	°C 178	Report	
" 30% vol	°C 188	Report	
" 50% vol	°C 240	Report	
Final Boiling point (P.T.)	°C 255	50% max	
Residue	% vol 2.0	1.5 max	
Loss	% vol 1.0	1.5 max	
Flash Point- ABZL	°C 0	38 min	IP 170
or Flash point -SETAFLASH	°C 0	38 min	ASTM D 3825
Density at 15 °C	Kg/ltr 0.7743	0.775/0.840	ASTM D 1298
Freezing Point	°C -47.5	-47 max	ASTM D 2500
Copper corrosion rating	1a	1 max	ASTM D 150
Silver corrosion rating	0	1 max	IP 227
Existent Gum (steam Jet) mg/100ml	2.9	7.0 max	ASTM D 381
Water Reaction	interface rating 1b	1 b max	ASTM D 1004
Additional Tests			
Conductivity	PS/m at °C 150	50/400	ASTM D 2624
	at °C 24		

REMARKS: Results comply with the requirements of APOQUOS Joint Fueling System Check List specification for JET-A1 ISSUE 15-JUN-05 for the properties tested above

DATE 05/08/96 SIGNED BY

*[Signature]*  
 A. ECONOMOU

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

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.

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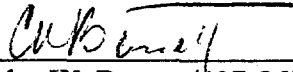
- 3.3 The orange floor material provided in the sample bag labeled MB-2 (Figure 14) was identified by FTIR as a phenoxy resin based substance such as a molding compound. The IR spectrum for the resin is provided in Figure 15.
- 3.4 The orange colored material from the honeycomb structure of the large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

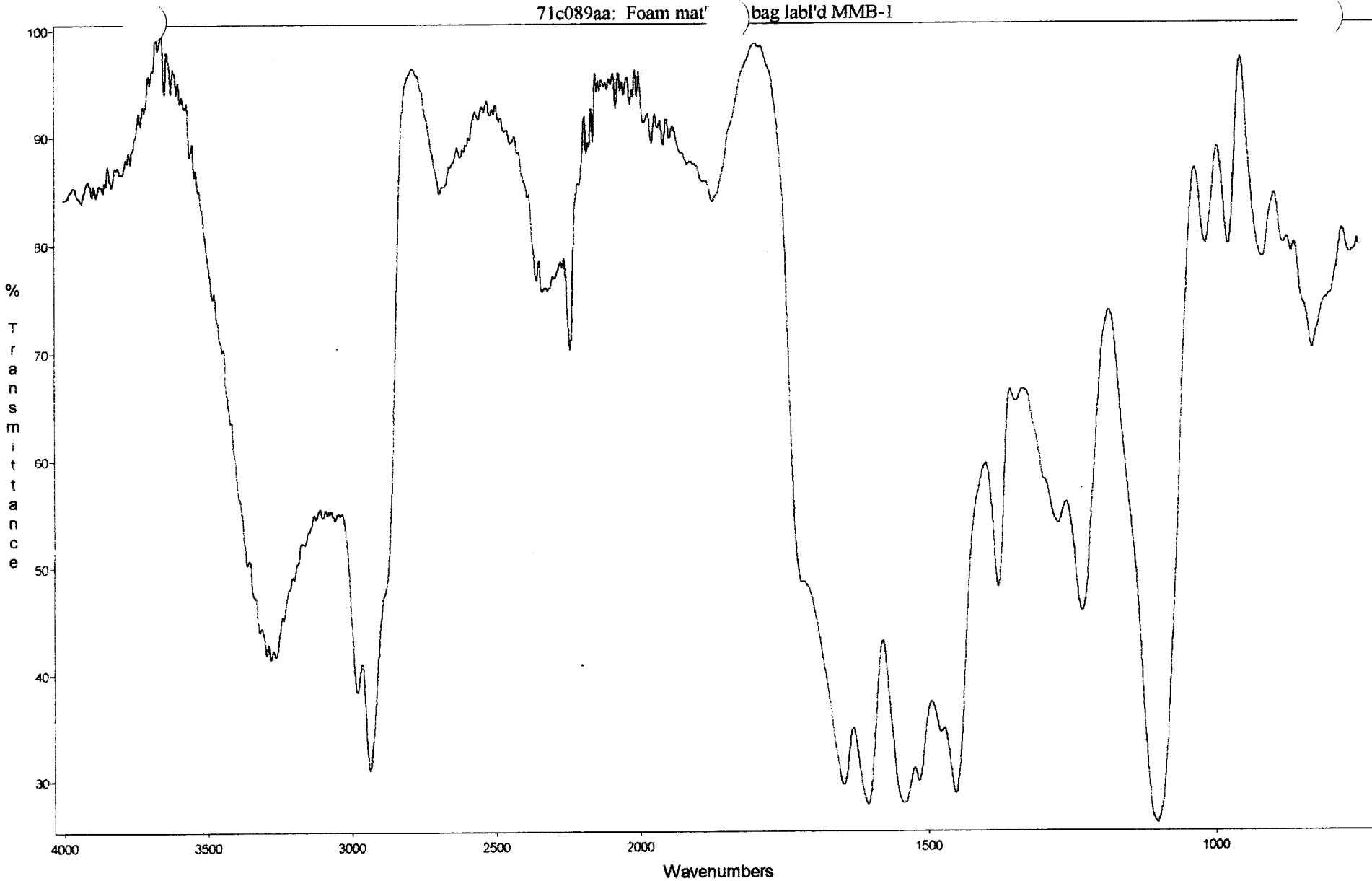


FIGURE 2. FOAM MATERIAL

22

Operator : Sandy Loucks  
Client : Charlie Bassett  
Job : 97-1C0089  
Foam Light Side (2/27/97 14:11)

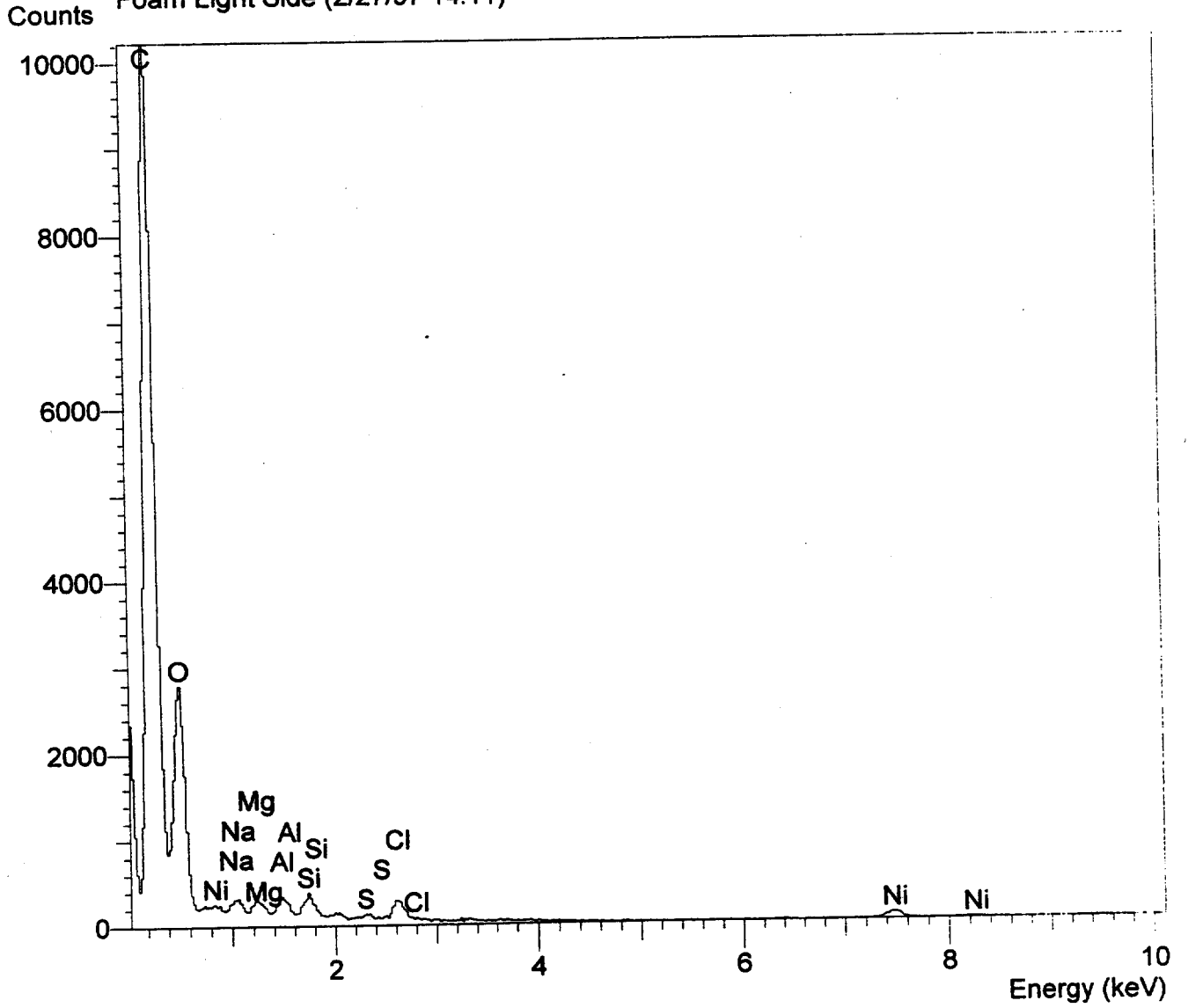


FIGURE 3. LIGHTER SIDE



Operator : Sandy Loucks  
Client : Charlie Bassett  
Job : 97-1C0089  
Foam Dark Side (2/27/97 14:17)

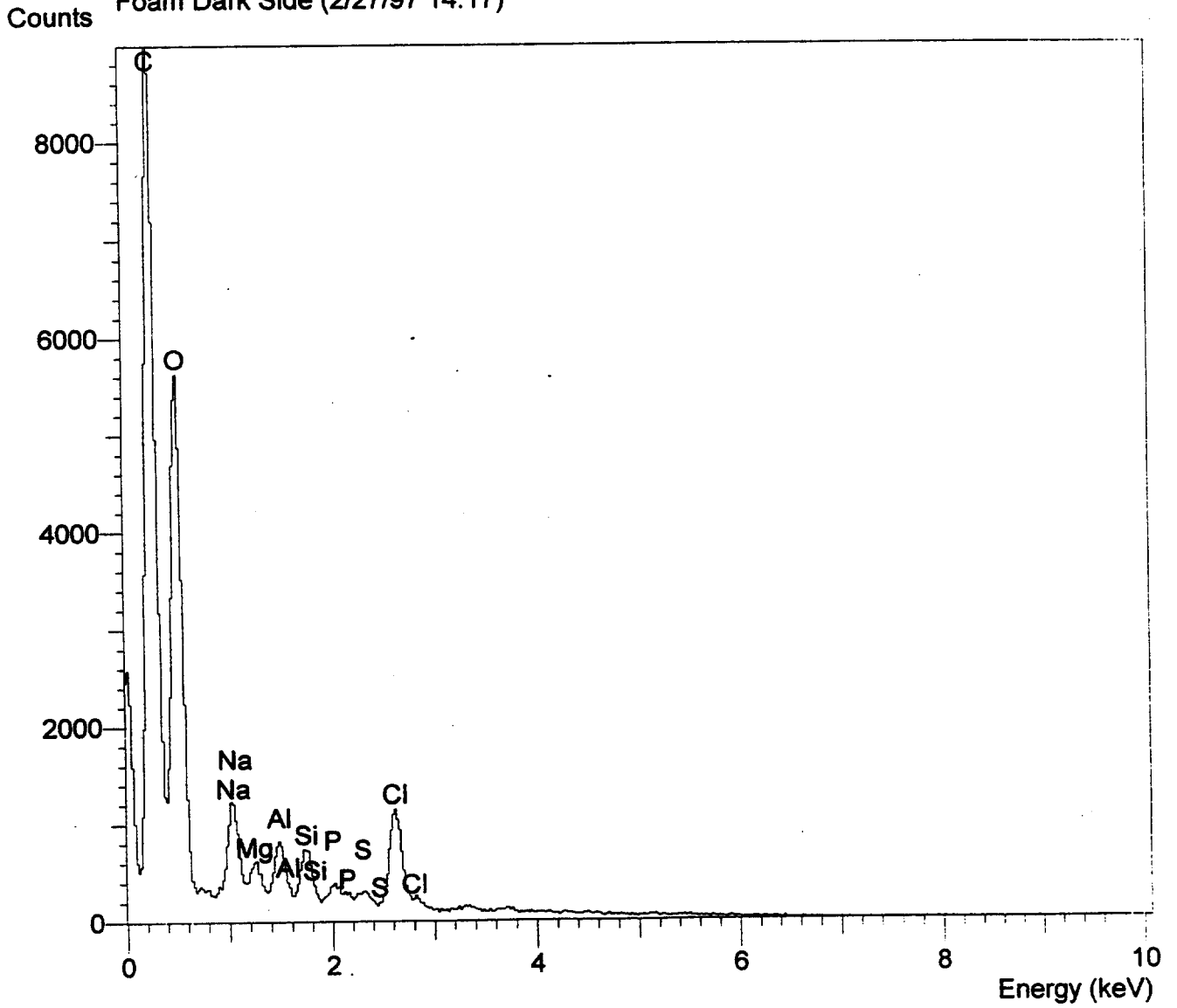
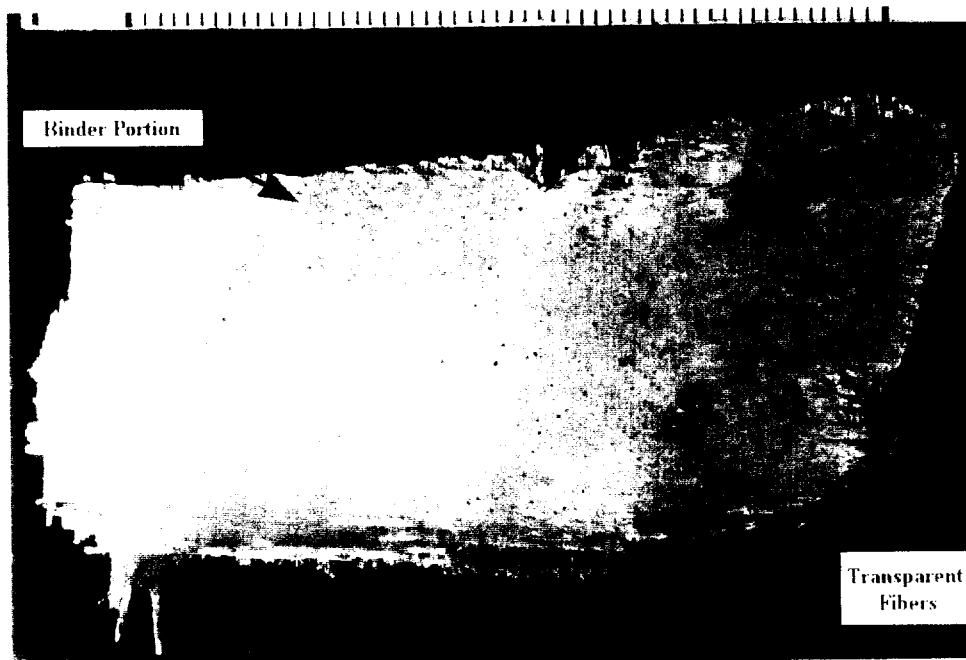


FIGURE 4. DARKER SIDE



**Figure 5: Duct Material from MMB-1**

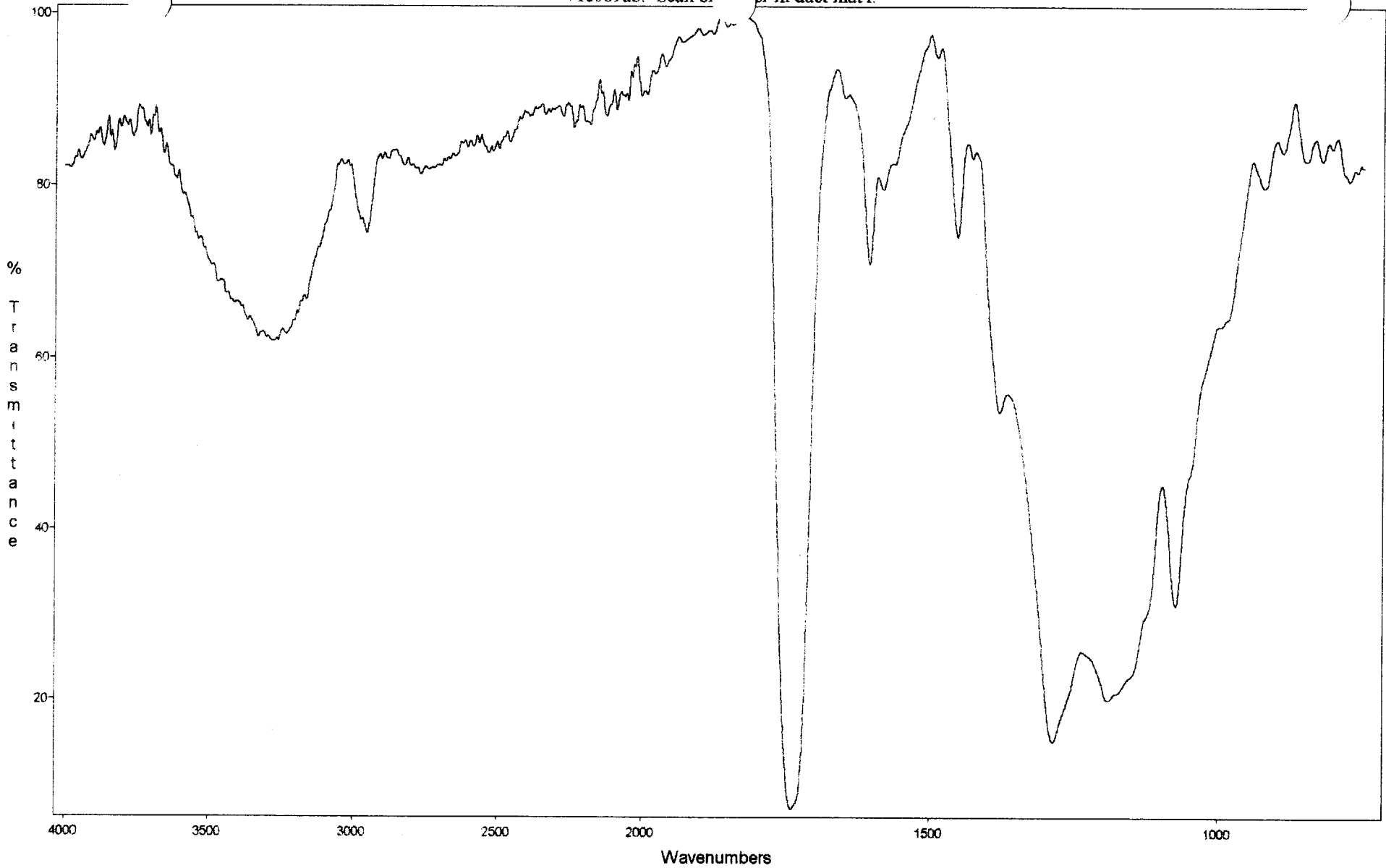


FIGURE 6. BINDER MATERIAL

96



FIGURE 7.

90X

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



FIGURE 8.

360X

Operator : Sandy Loucks  
Client : Charlie Bassett  
Job : 97-1C0089  
clear fiber (2/25/97 13:34)

Counts

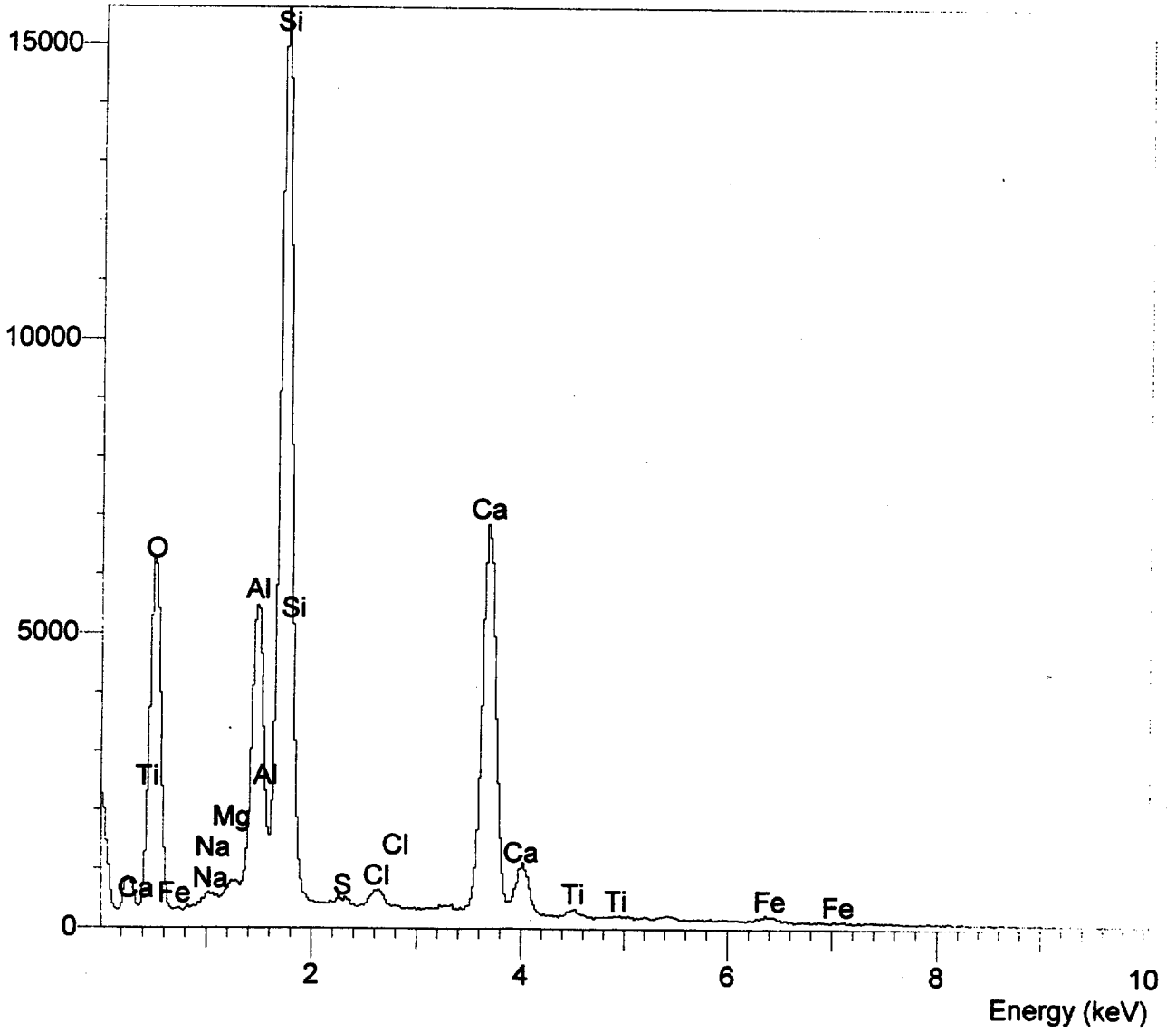


FIGURE 9. CLEAR FIBER

28

Operator: Sandi Louch  
Client: Charlie Bassett  
Job: 97-1C0089  
Label: MapGroup 1 (25 Feb 97 14:05:26)



FIGURE 10 COMPOSITE ELEMENTAL VIEW OF BINDER AND GLASS MATERIAL

Operator : Sandy Loucks  
Client : Charlie Bassett  
Job : 97-1C0089  
Coating on Glass Fibers (Organic (2/25/97 13:55))

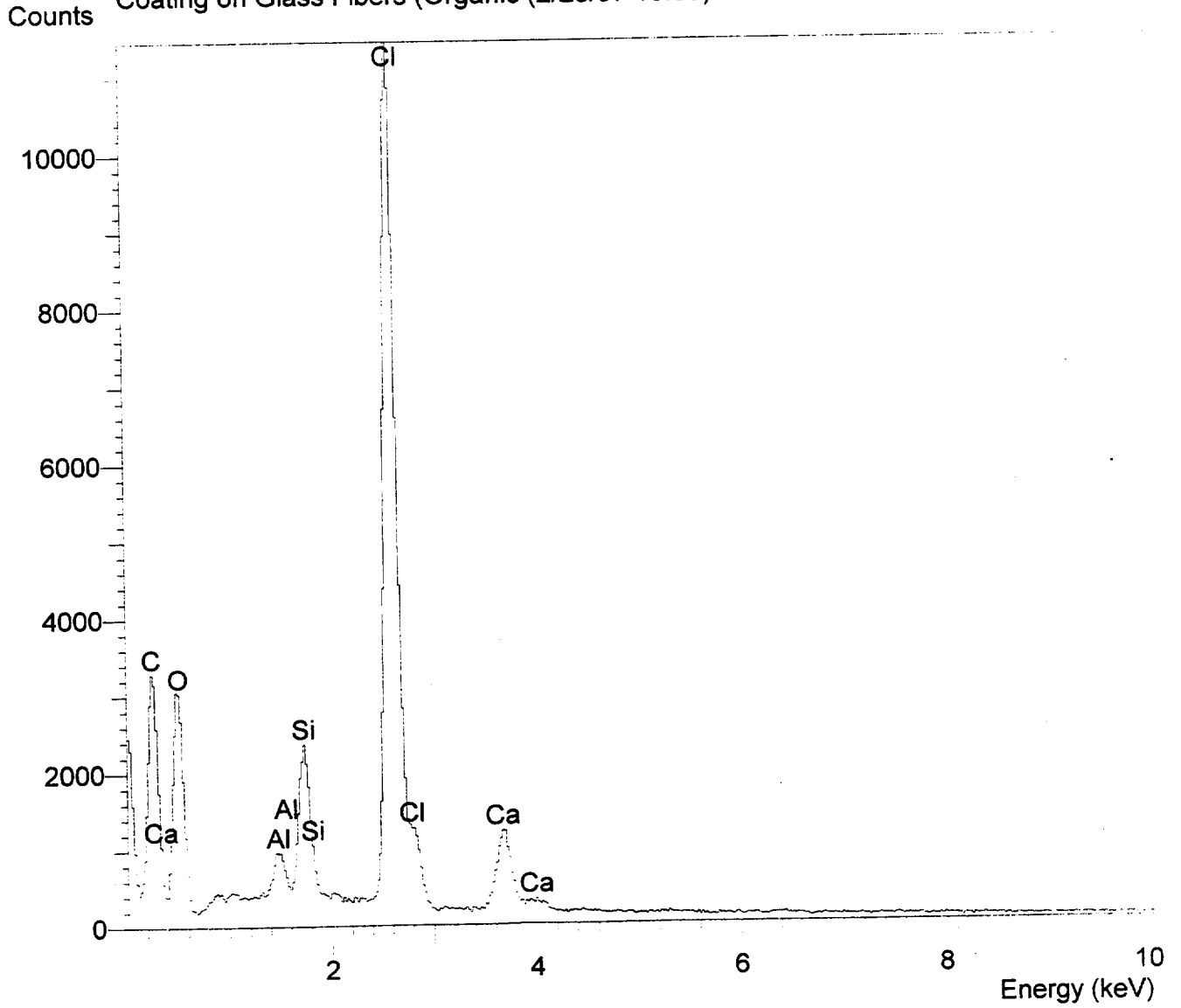


FIGURE 11. COATING ON FIBERS

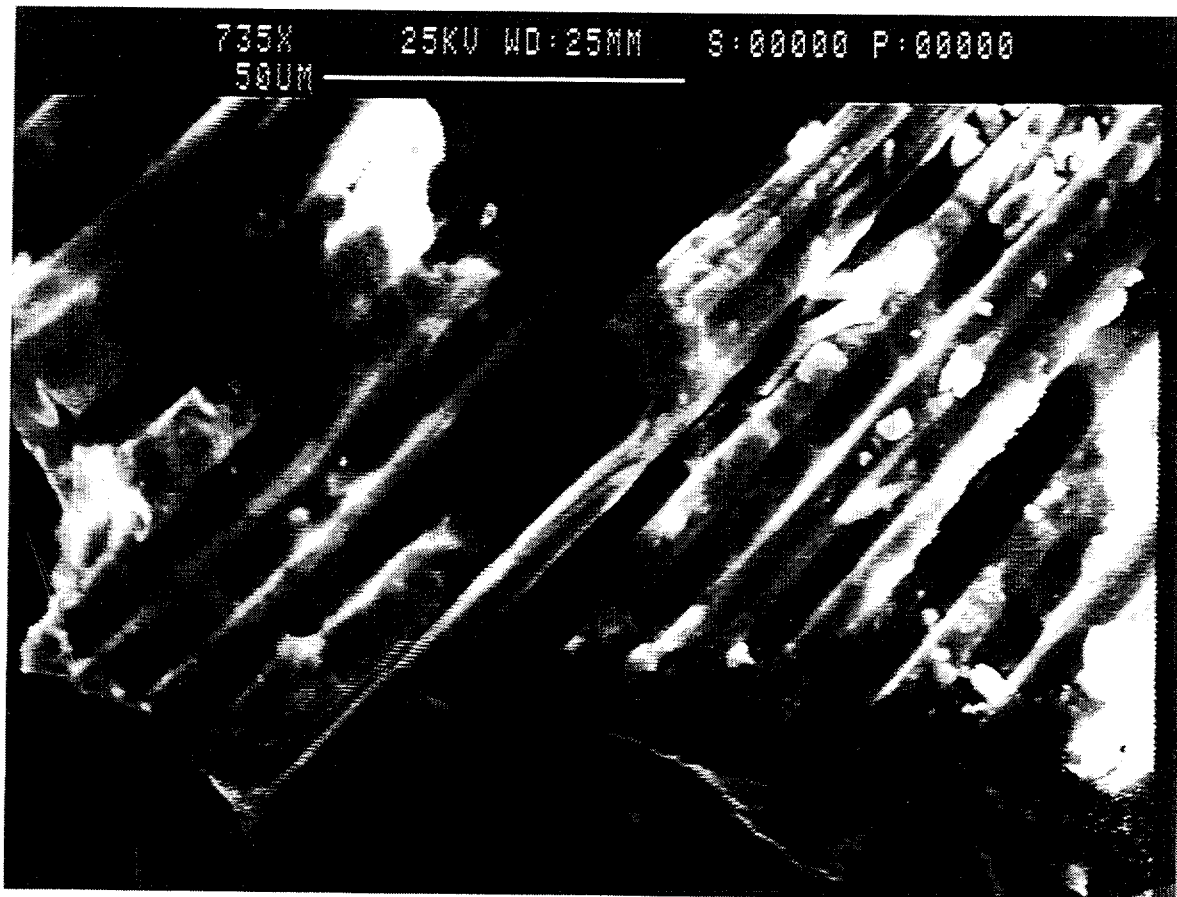


FIGURE 12. SEM SECONDARY ELECTRON VIEW OF FIBER AND BINDER TAKEN FROM DUCT MATERIAL.



Operator: SA 92, 1/14/97  
Client: Charlie Bassett  
Job: 97-100085  
Label: (untitled) (25 Feb 97 14:05:21)

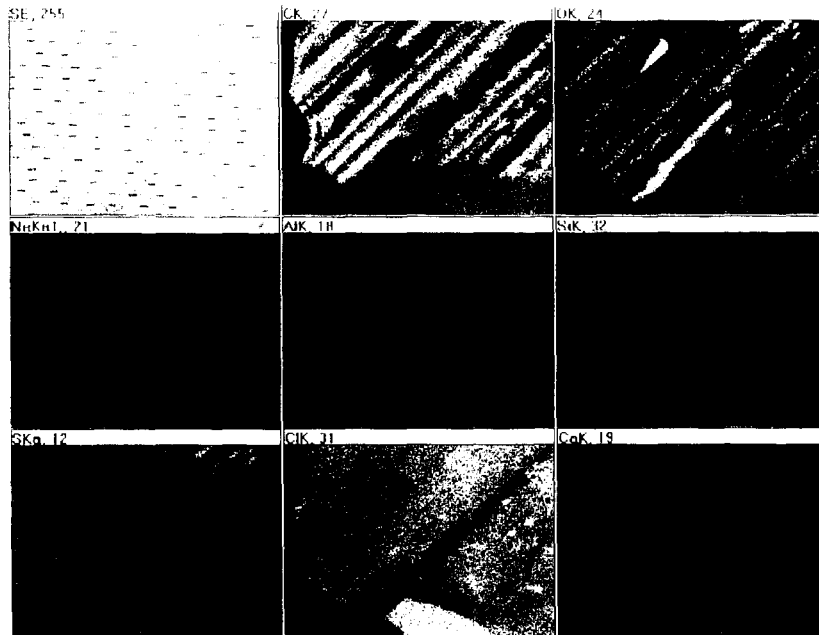
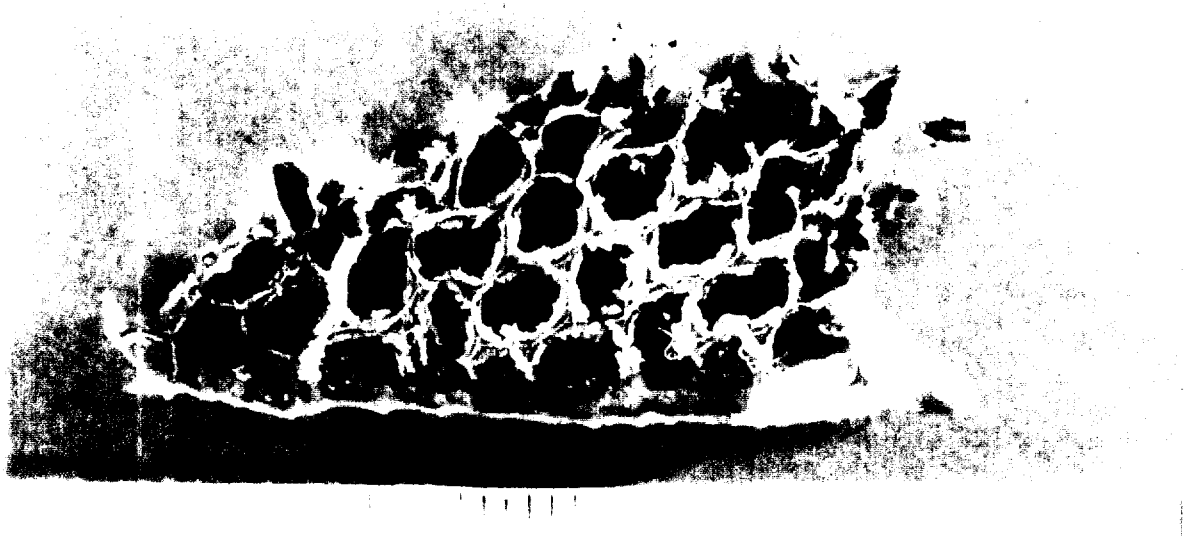


FIGURE 13 - ELEMENTAL DOT MAP IMAGES OF FIBER AND BINDER TAKEN FROM DUCT MATERIAL.



**Figure 14: Orange Floor Material from MB-2**

71c089ba: Bag MB-2, Org floor

(a) station 1050: Resin layer.

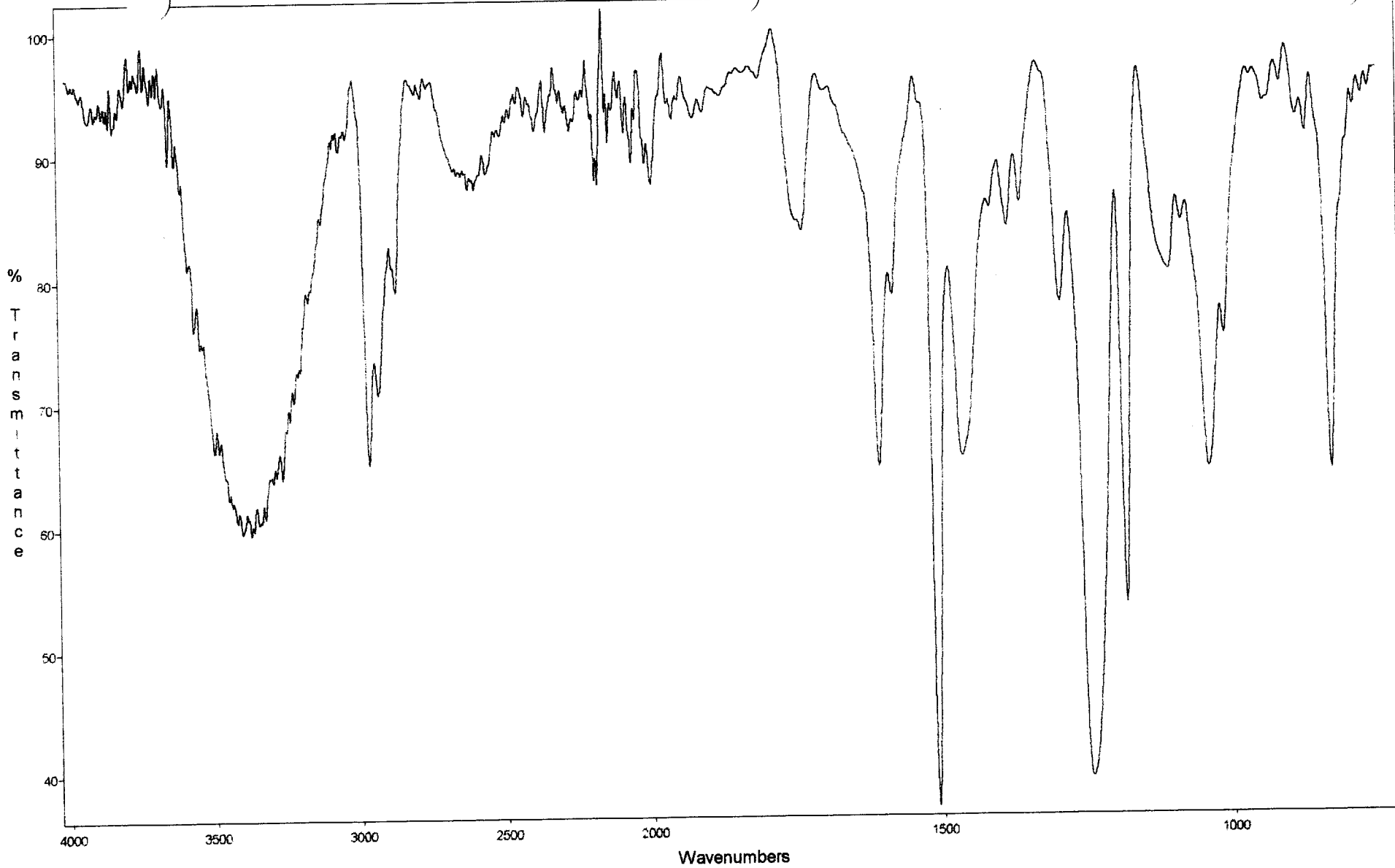
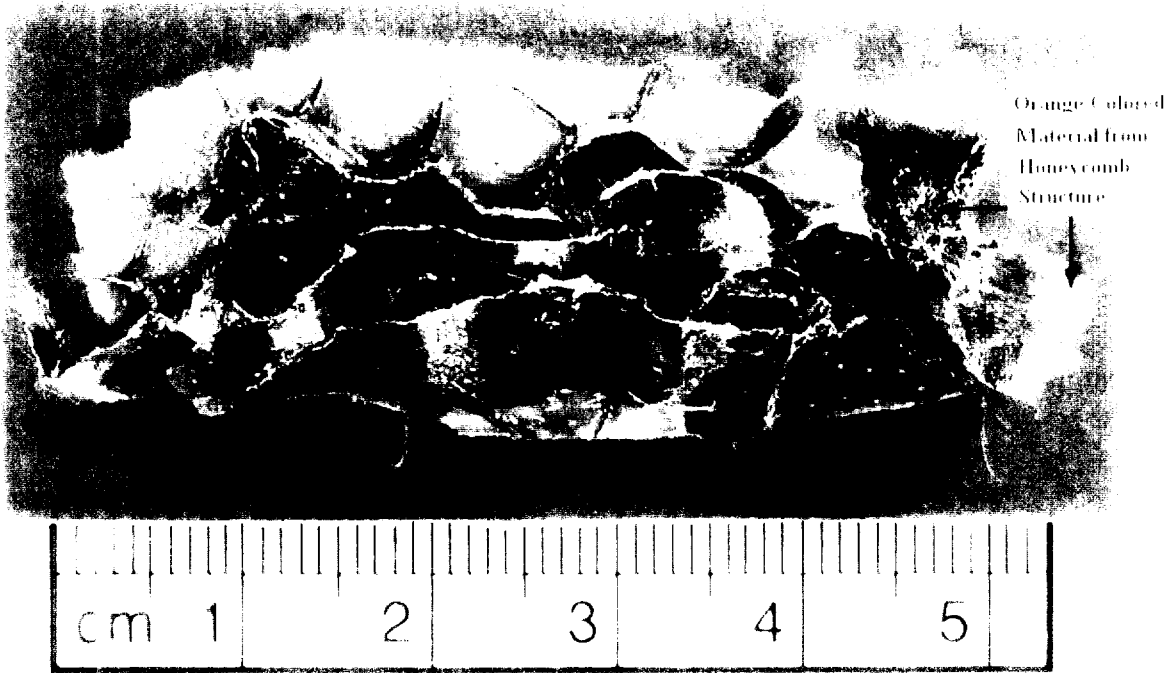


FIGURE 15. ORANGE FLOOR MATERIAL AT STATION 1050.

34



**Figure 16: Material from Large Exterior Duct. MB 3**

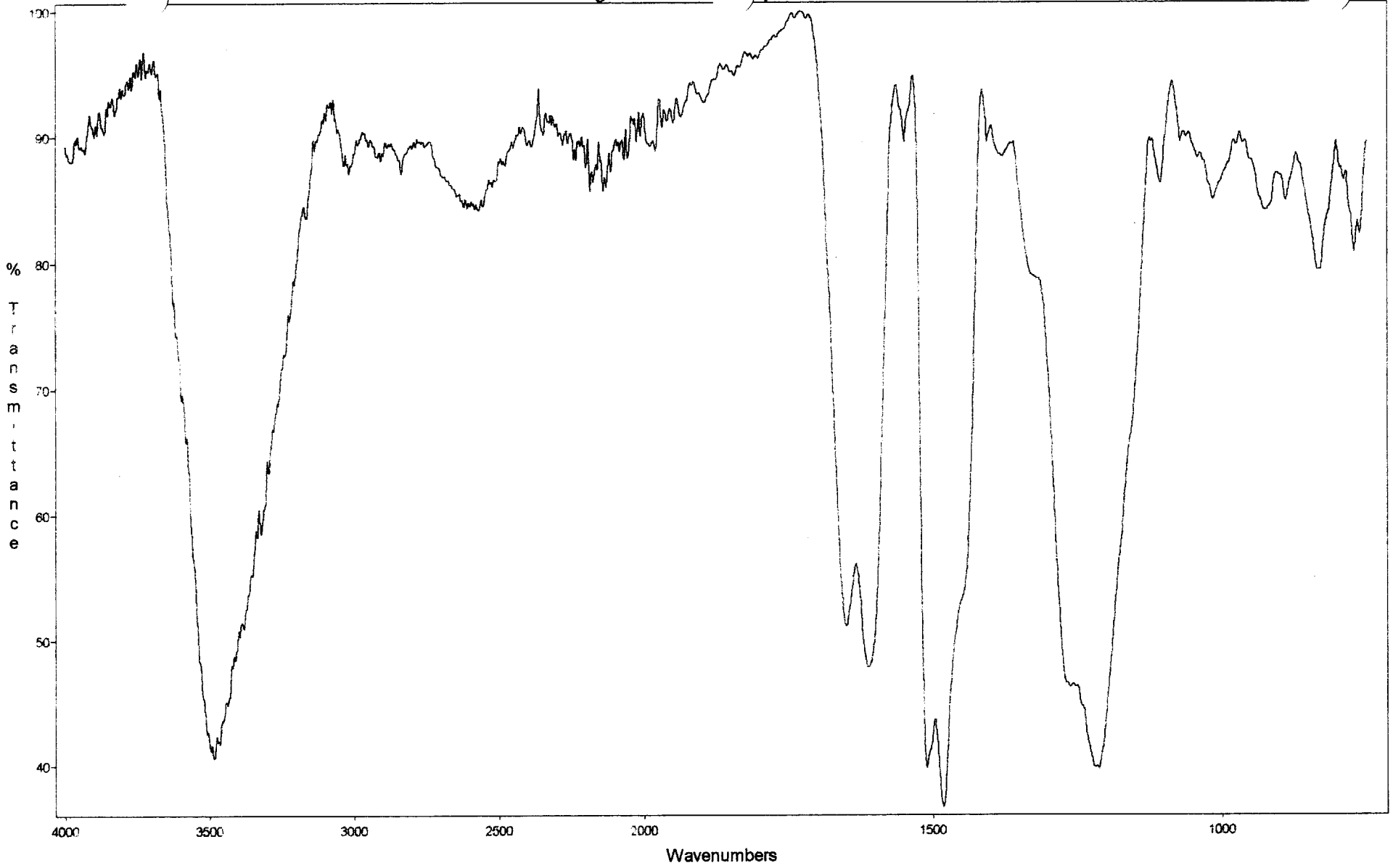
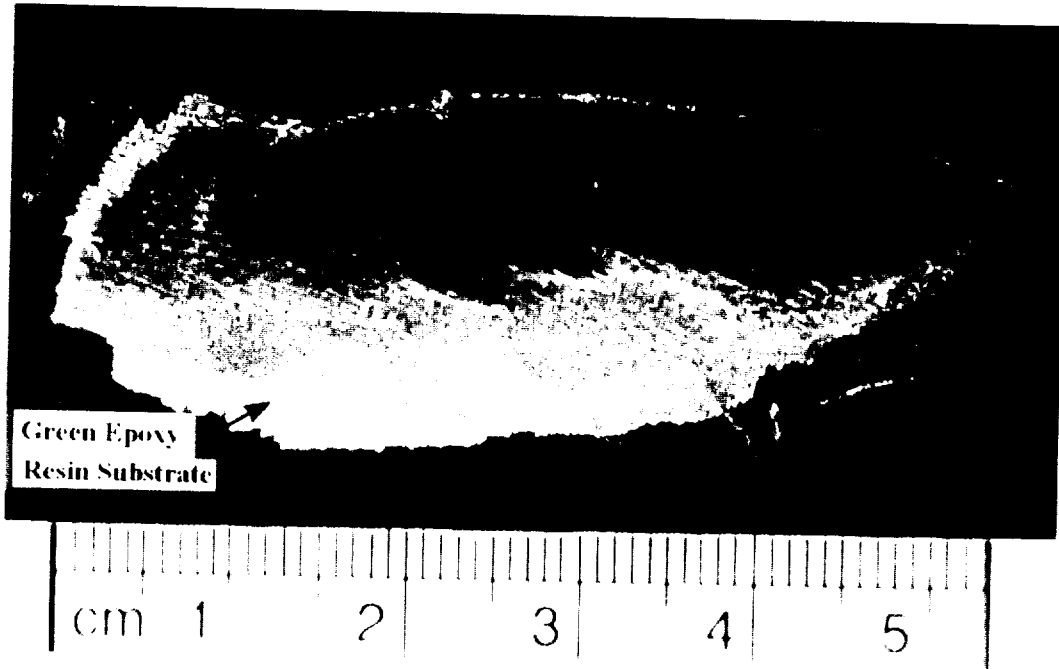


FIGURE 17. ORANGE COLORED MATERIAL FROM "HONEYCOMB" STRUCTURE.

36



**Figure 18: Green Surface Layer of MB-3**

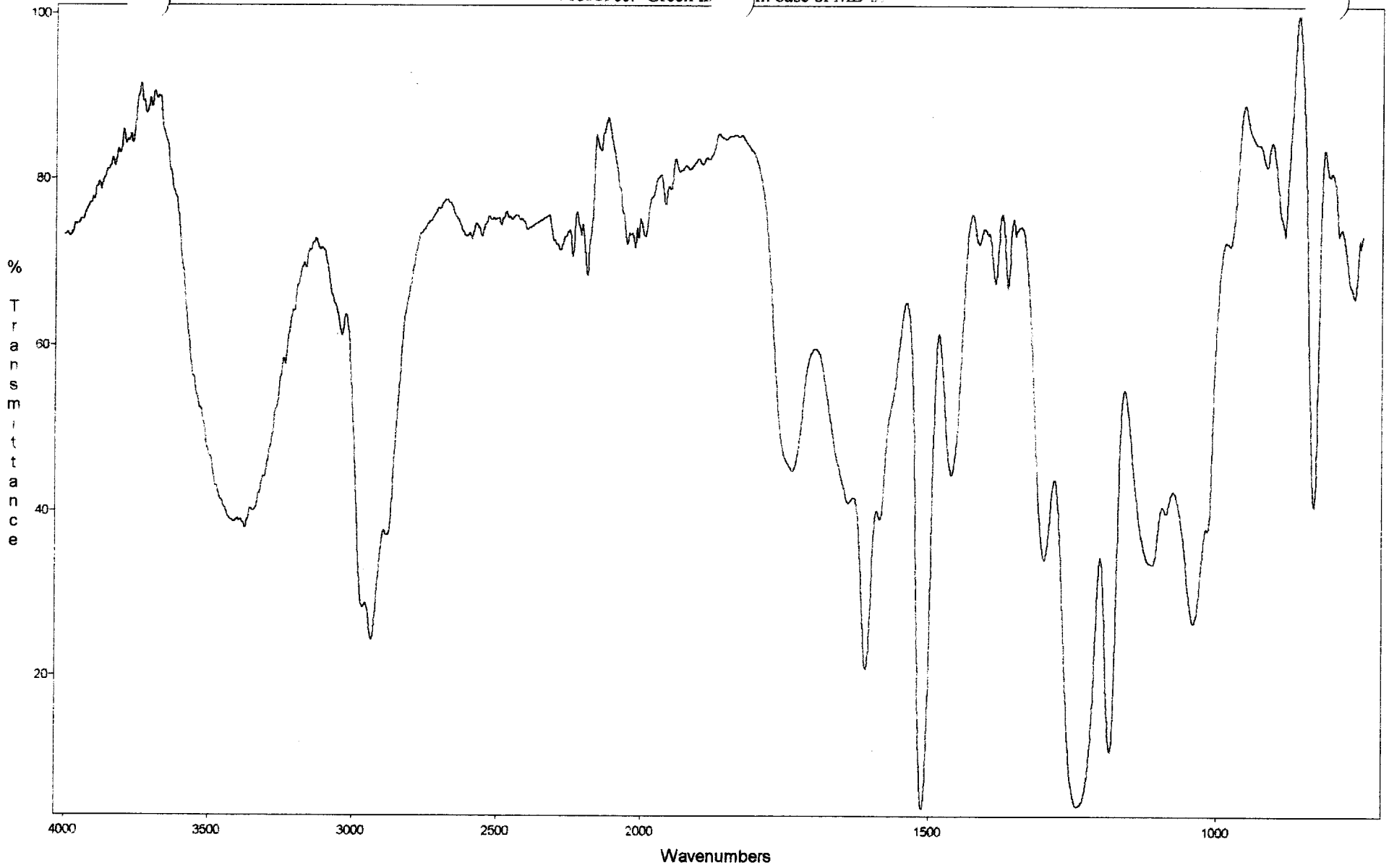
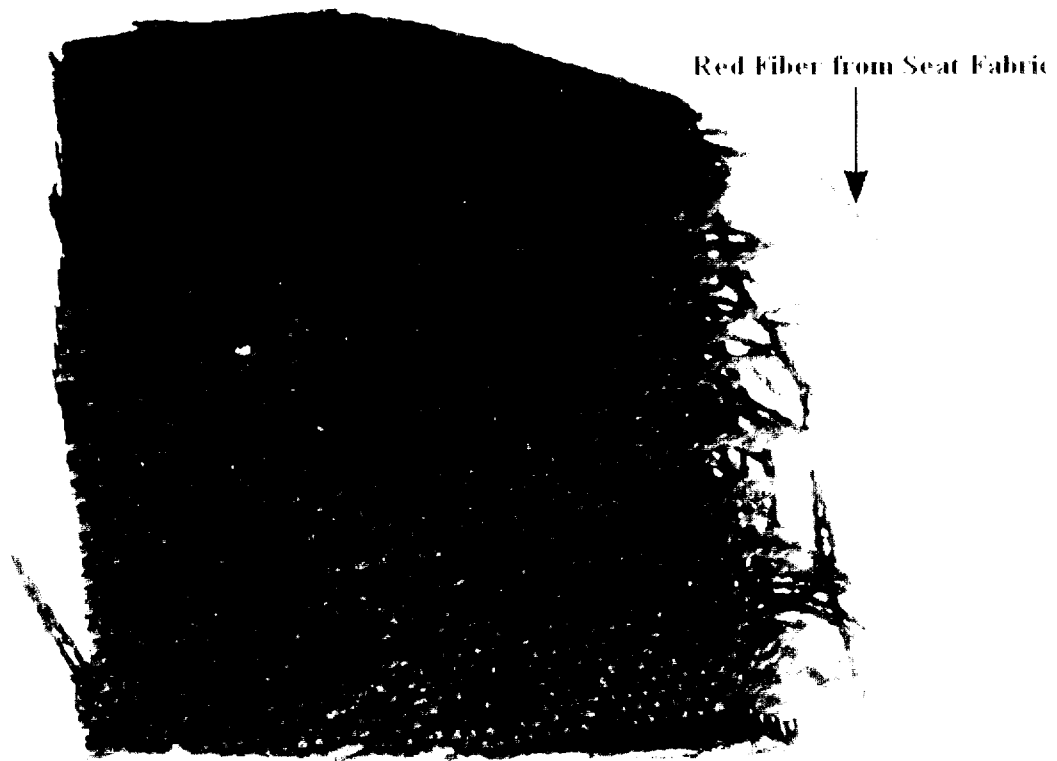


FIGURE 19. GREEN EPOXY RESIN.

88



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



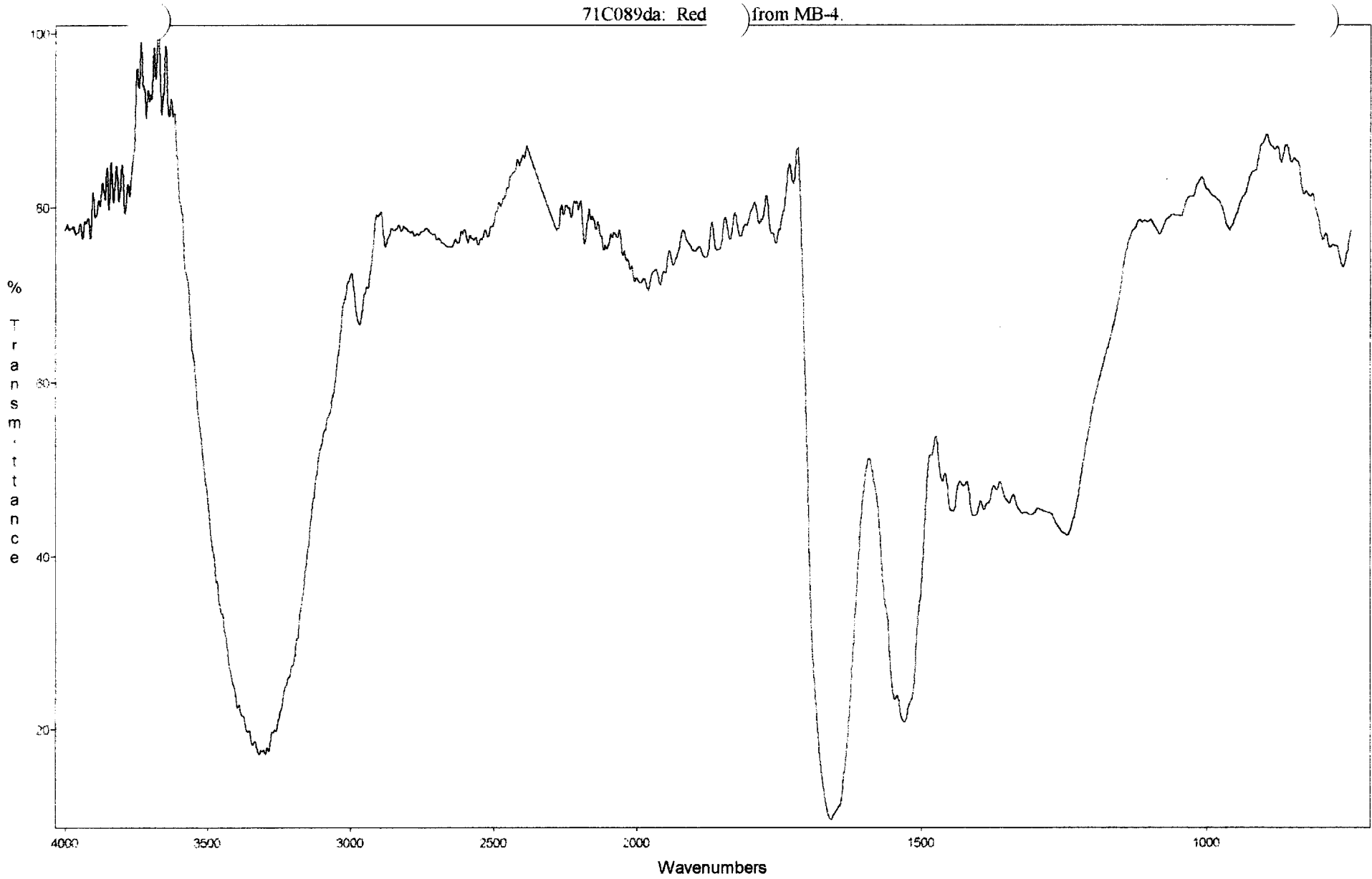


FIGURE 21. RED 'AZLON' FIBER OF SEAT #21-5.

40

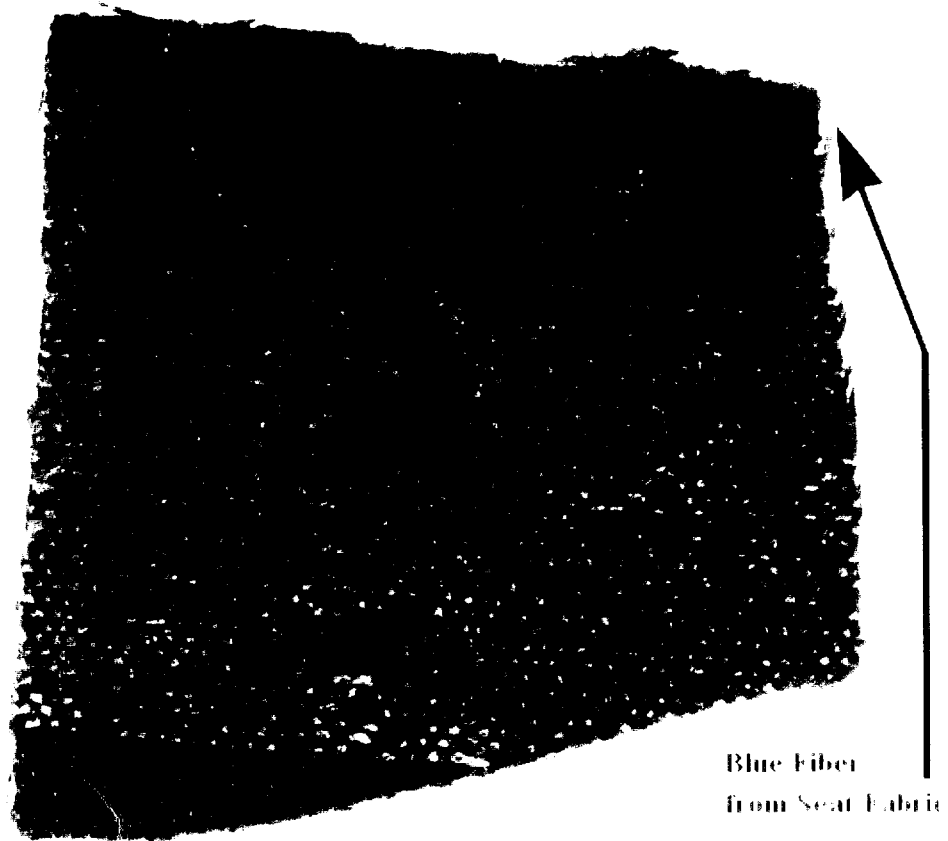


Figure 22: Fabric of Seat #20 4; MB 5

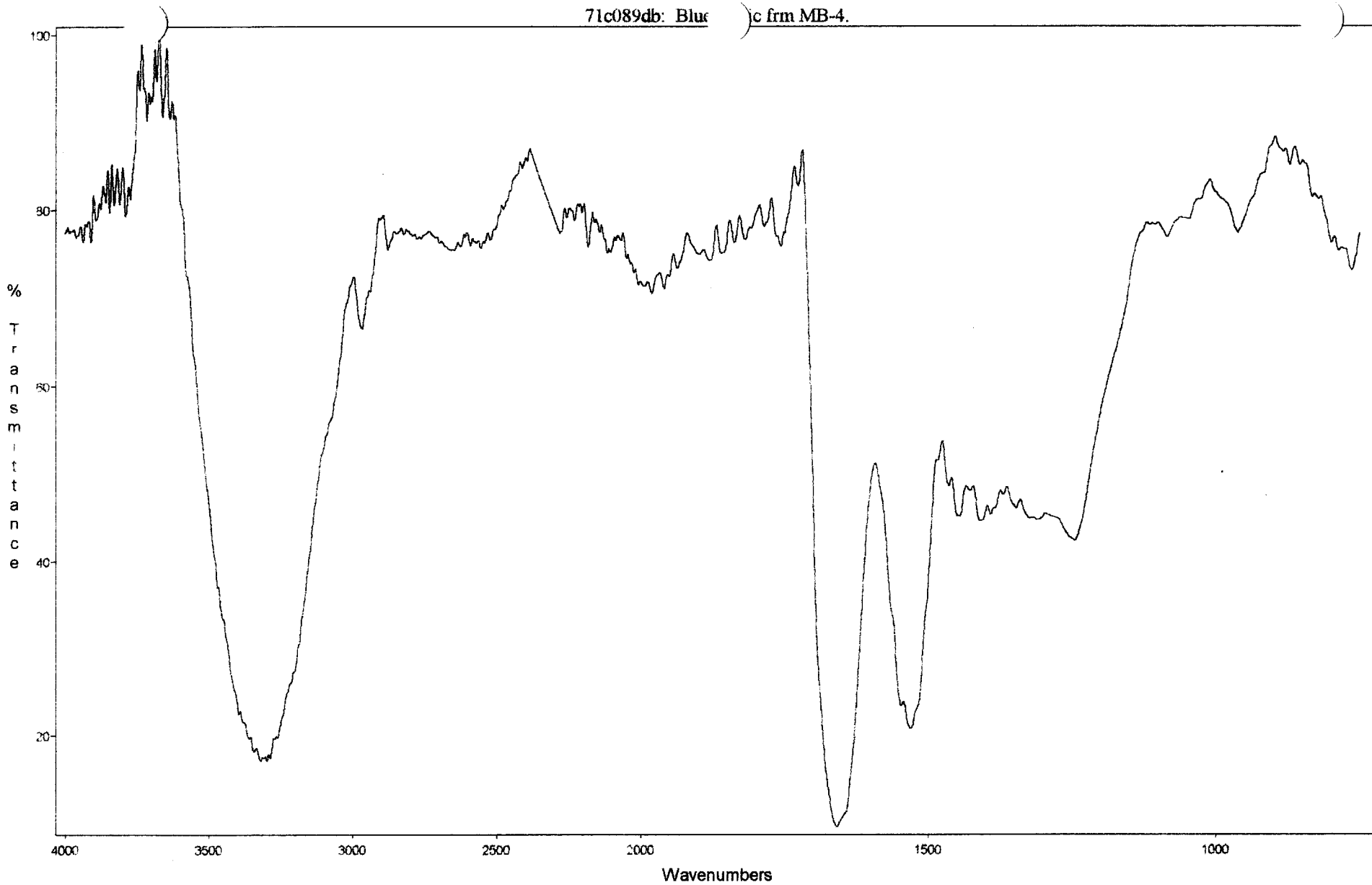
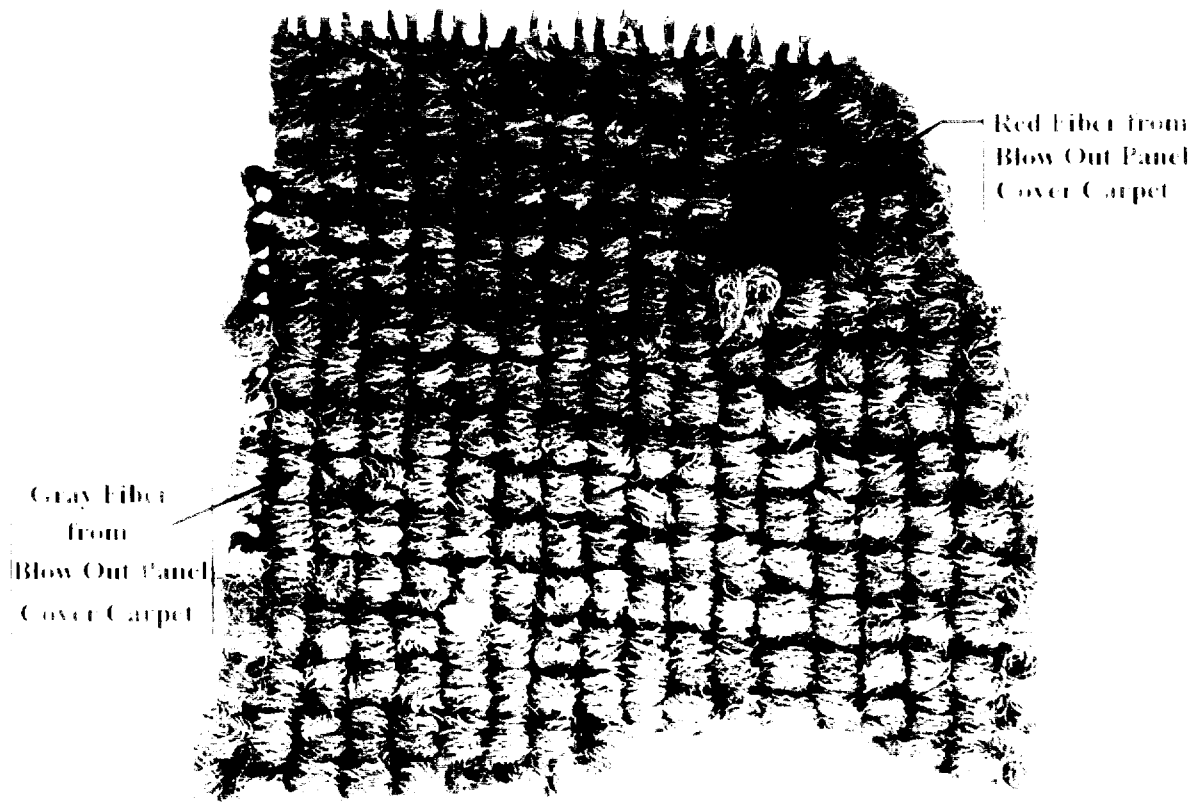
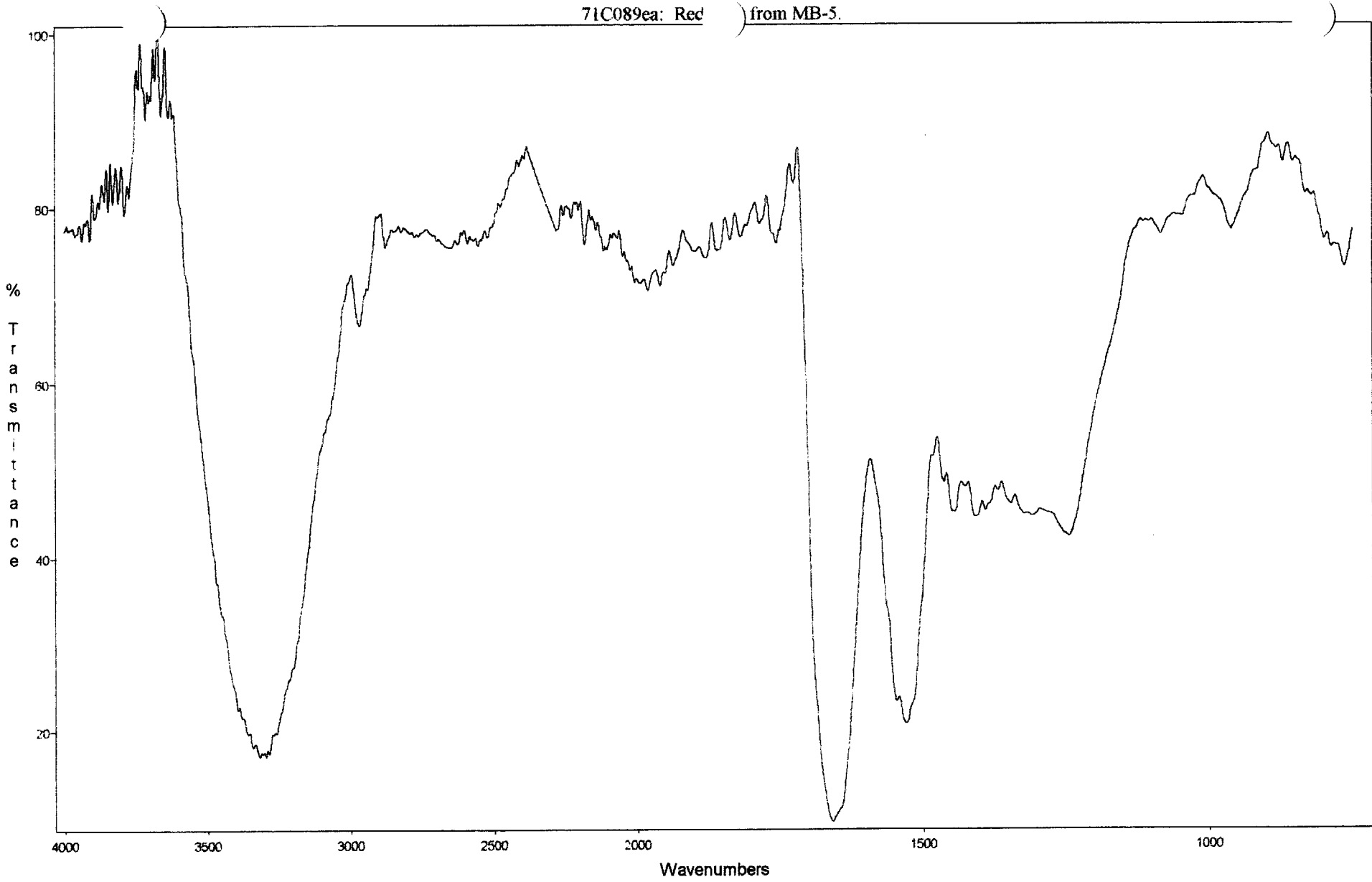


FIGURE 23. BLUE 'AZLON' FABRIC OF SEAT #20-4.

12

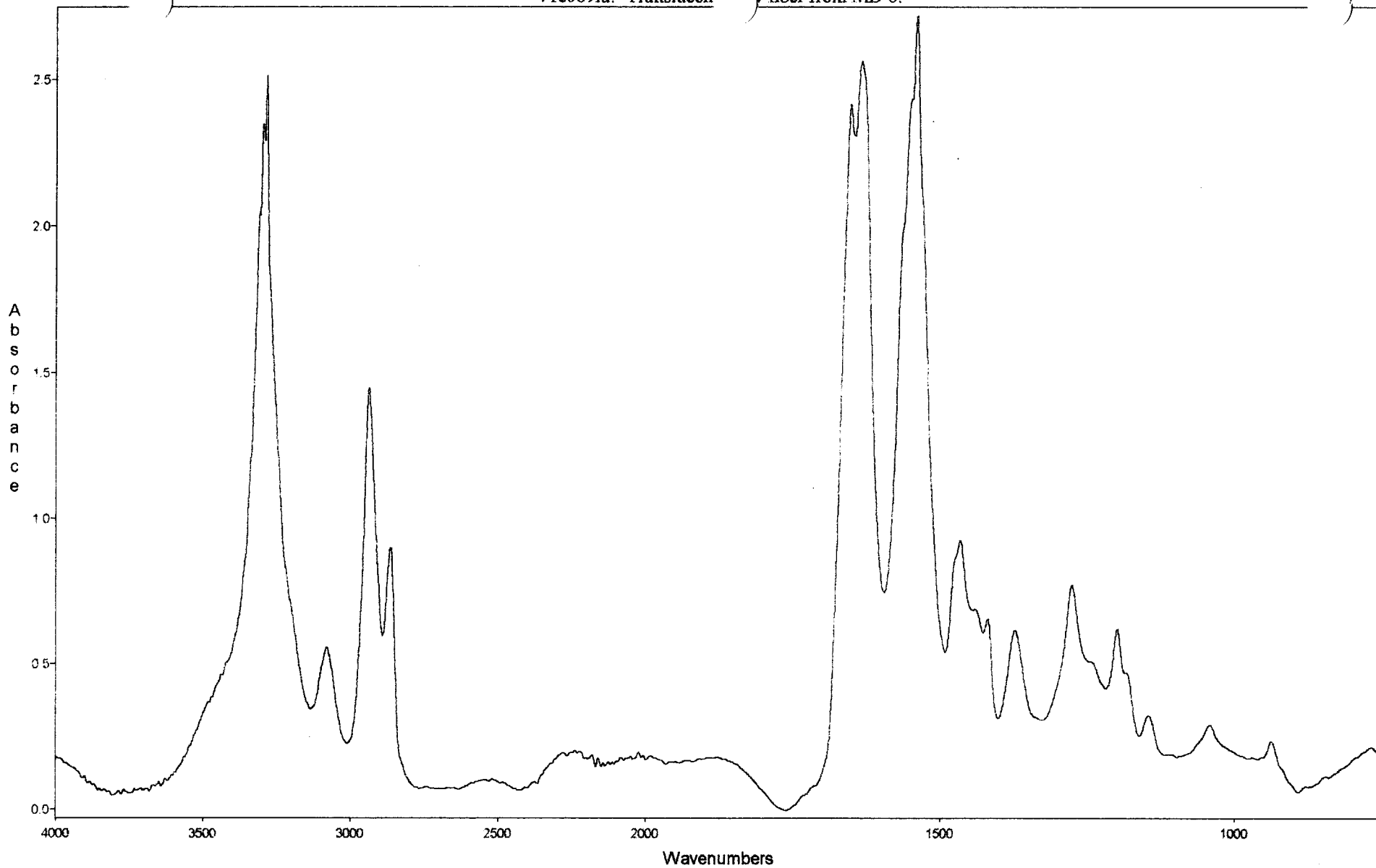


**Figure 24: Carpet from Blow Out Panel Cover #62-75231354; MB-6**



**FIGURE 26. RED "AZLON" FABRIC FROM  
"BLOW-OUT" PANEL COVER #62-75231354.**

(49)



**FIGURE 26. TRANSLUCENT BLUE-GRAY FABRIC FROM  
"BLOW-OUT" PANEL COVER #62-75291354.**

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MATERIALS AND CHEMICAL ANALYSIS BRANCH  
LO-MSD-1C  
KENNEDY SPACE CENTER, FLORIDA 32899

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.

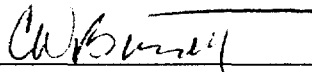
#### 4.0 RESULTS AND CONCLUSIONS

- 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.

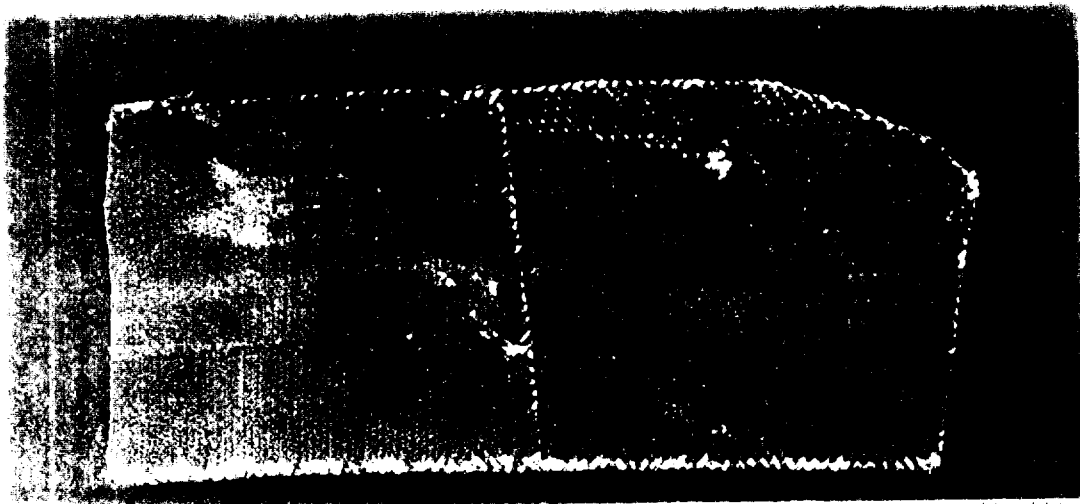


4.7 Analysis by IC indicates a total of 4 µg of nitrate ion per surface square inch of sample. Nitrate levels were at the low end of the instrument detection limits. Pursuing further quantification of the nitrate levels was considered not appropriate because of the potential exposure of the ECS unit 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"**

71c090aa: Organic looking binder mat'l frm MB-7.

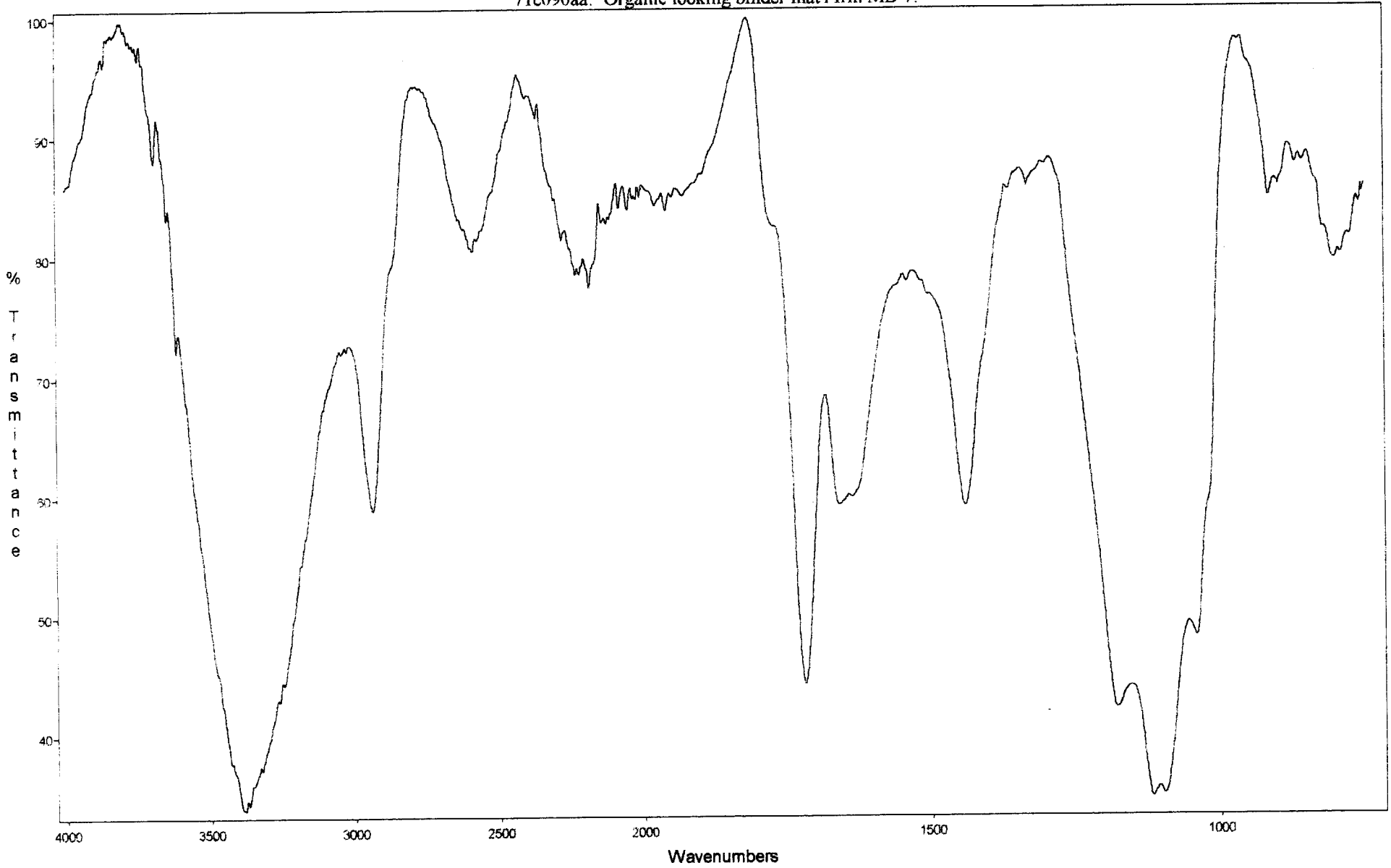


FIGURE 2. IR SPECTRUM OF BINDER MATERIAL.

ES

Operator : Sandy Loucks  
Client : Charlie Bassett  
Job : 97-1C0090  
Glass Fiber (3/17/97 15:53)

Counts

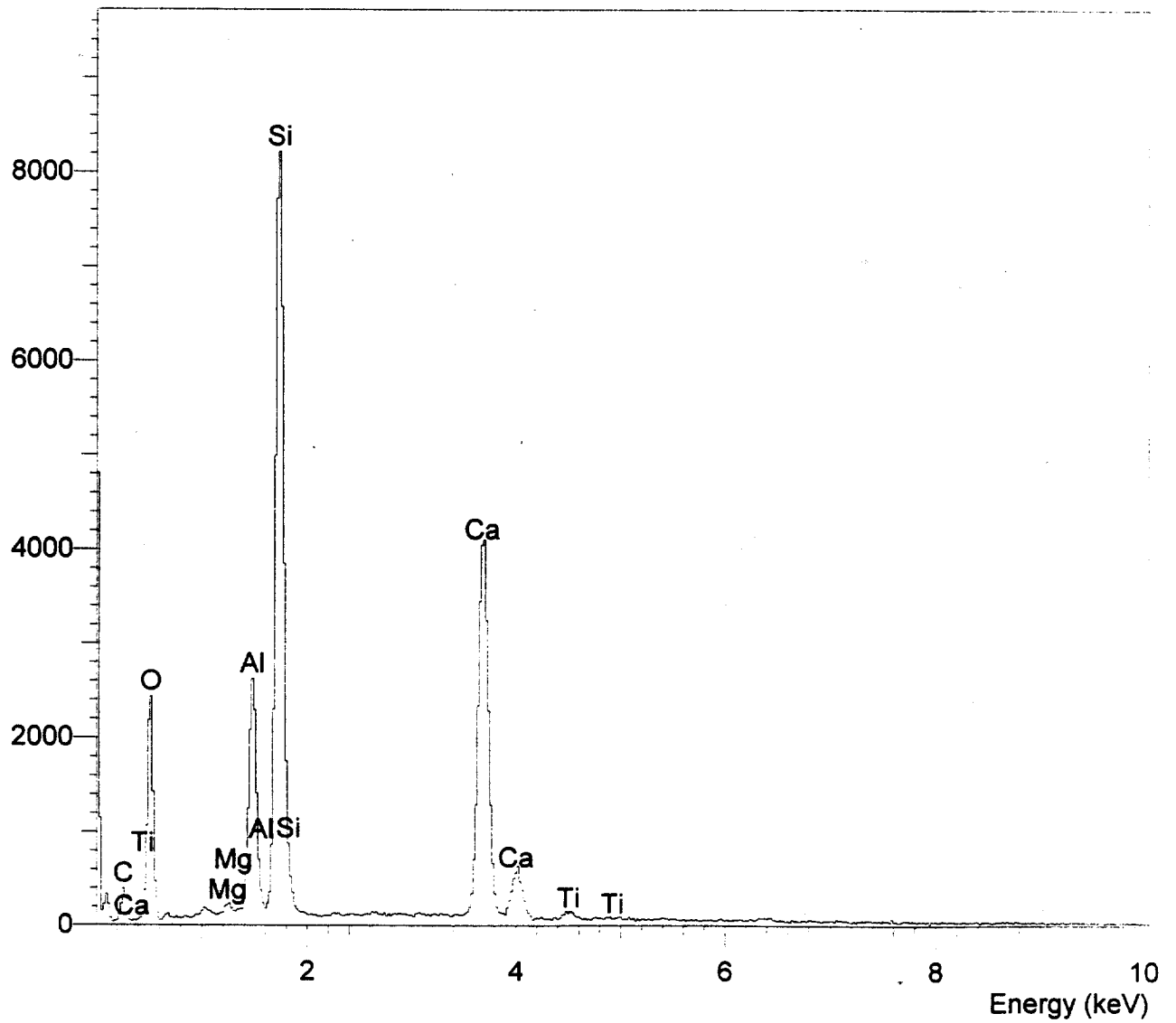


FIGURE 3. EDS OF FIBER.

(51)

Operator : Sandy Loucks  
Client : Charlie Bassett  
Job : 97-1C0090  
Outer Side Overview (3/14/97 09:59)

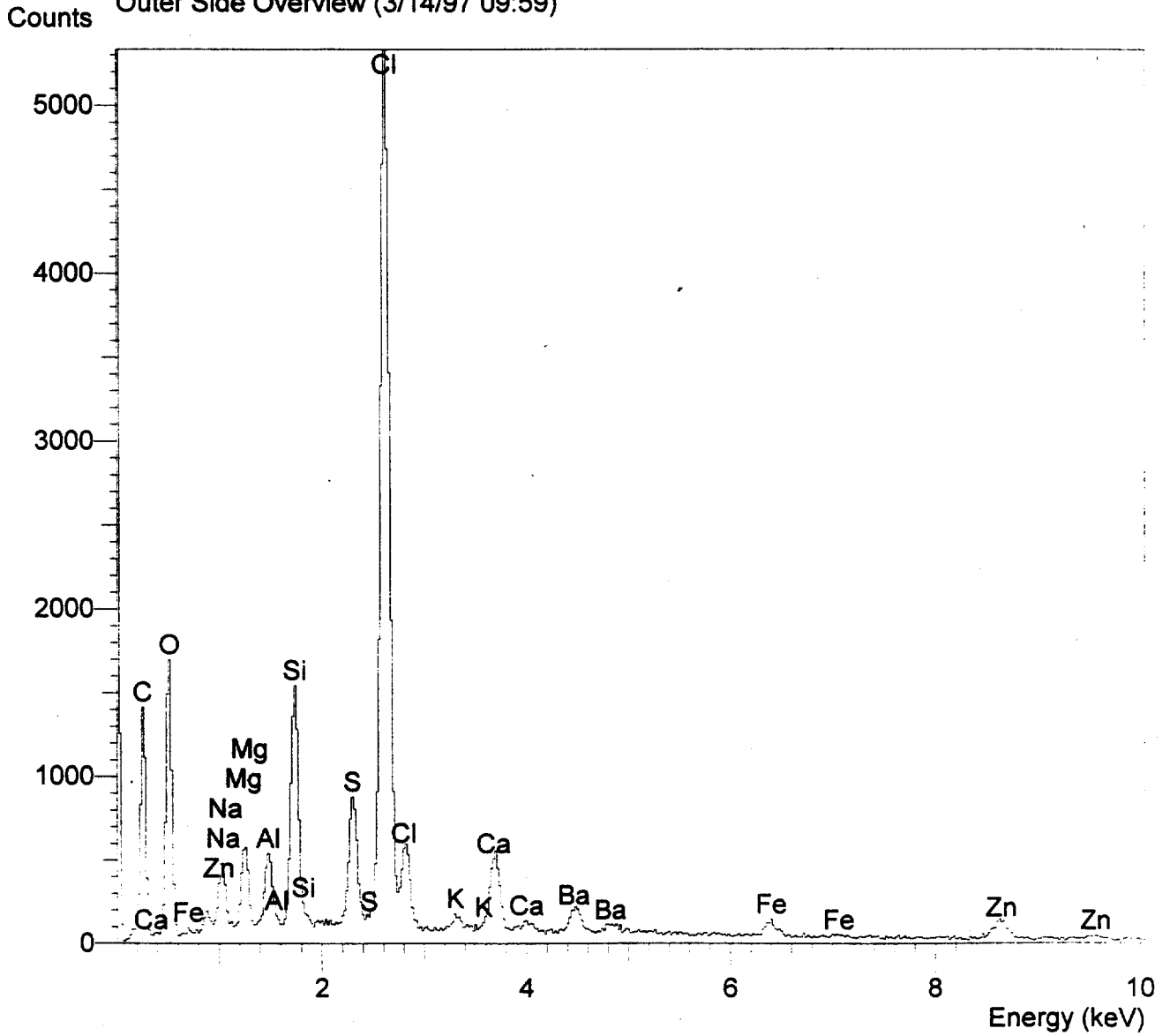
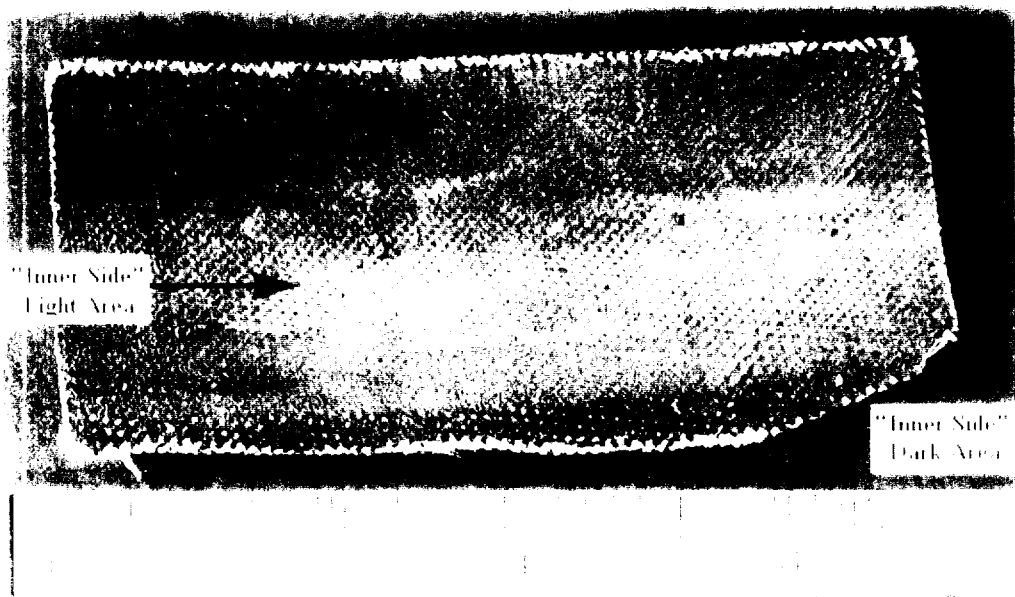


FIGURE 4. EDS OVERVIEW OF "OUTER" SIDE.

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**Figure 5: Overview of "Inner Side"**

Operator : Sandy Loucks  
Client : Charlie Bassett  
Job : 97-1C0090  
Inner Side Dark Area (3/14/97 10:55)

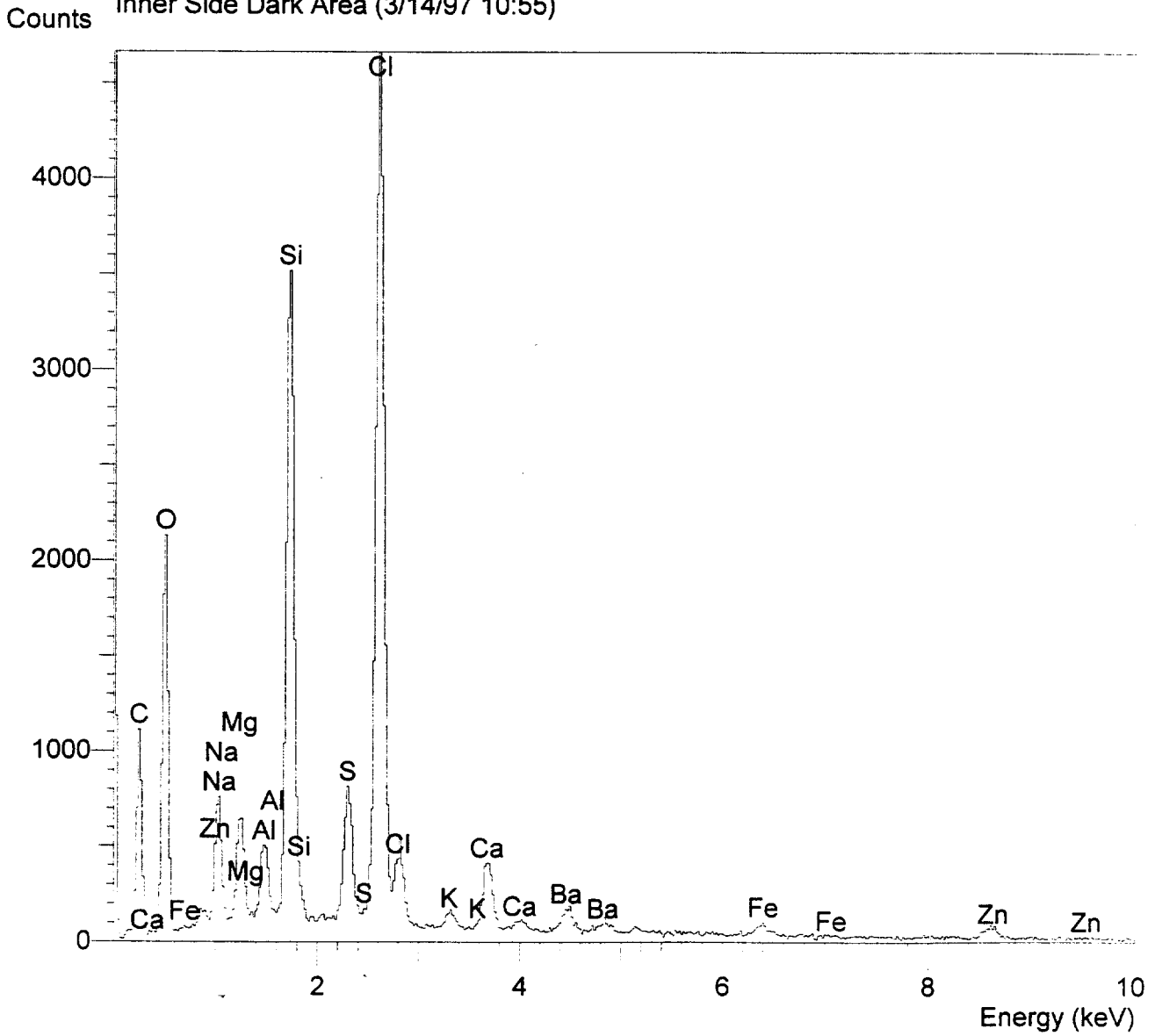


FIGURE 6. EDS OF DARK AREA OF "INNER" SIDE.

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Operator : Sandy Loucks  
Client : Charlie Bassett  
Job : 97-1C0090  
Inner Side Light Area (3/18/97 11:12)

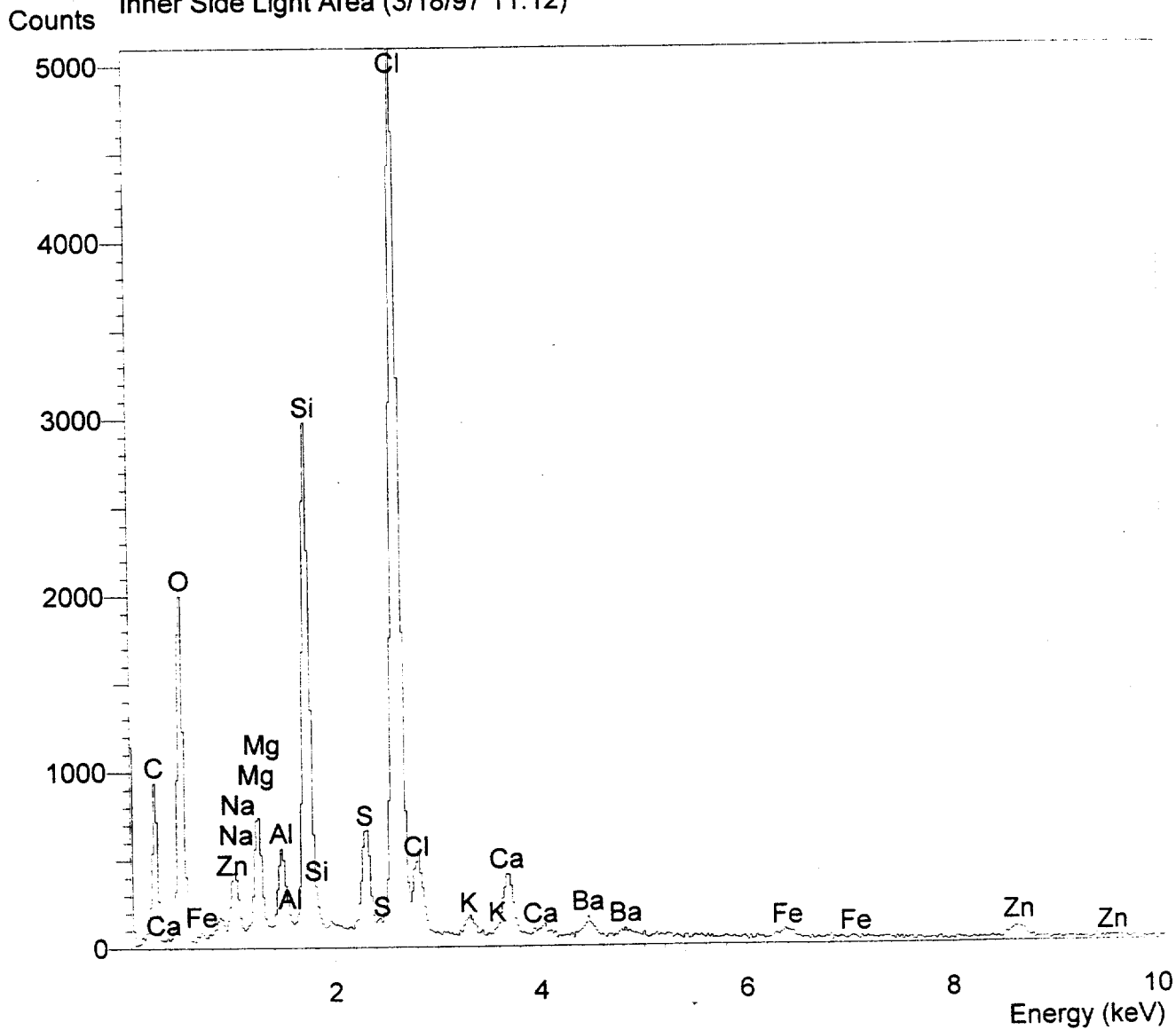


FIGURE 7. EDS OF LIGHT AREA OF 'INNER' SIDE.

SS



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MATERIALS SCIENCE DIVISION  
MATERIALS AND CHEMICAL ANALYSIS BRANCH  
LO-MSD-1C  
KENNEDY SPACE CENTER, FLORIDA 32899

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 $\mu\text{g}/\text{in}^2$
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.

INVESTIGATOR: \_\_\_\_\_

  
Charles W. Bassett/407-867-9618

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MATERIALS AND CHEMICAL ANALYSIS BRANCH  
LO-MSD-1C  
KENNEDY SPACE CENTER, FLORIDA 32899

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.

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- 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.

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- 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.

INVESTIGATOR: \_\_\_\_\_

  
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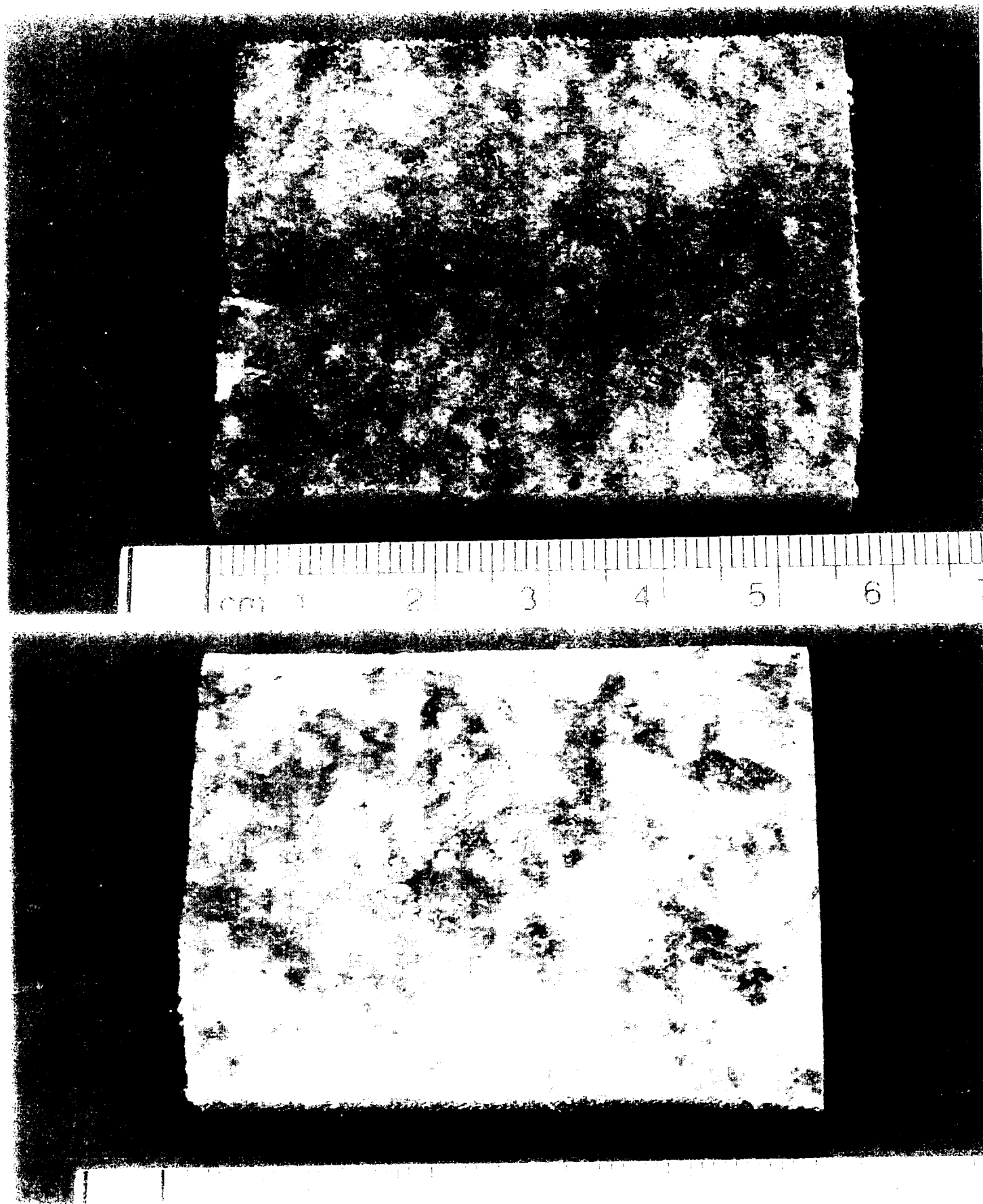


Figure 1. Sample #67, Row #19, Seat #2 Heavy and light coated sides.

67

71c154aa: Foam ctr frm sam #67, Row #19, Seat #2.

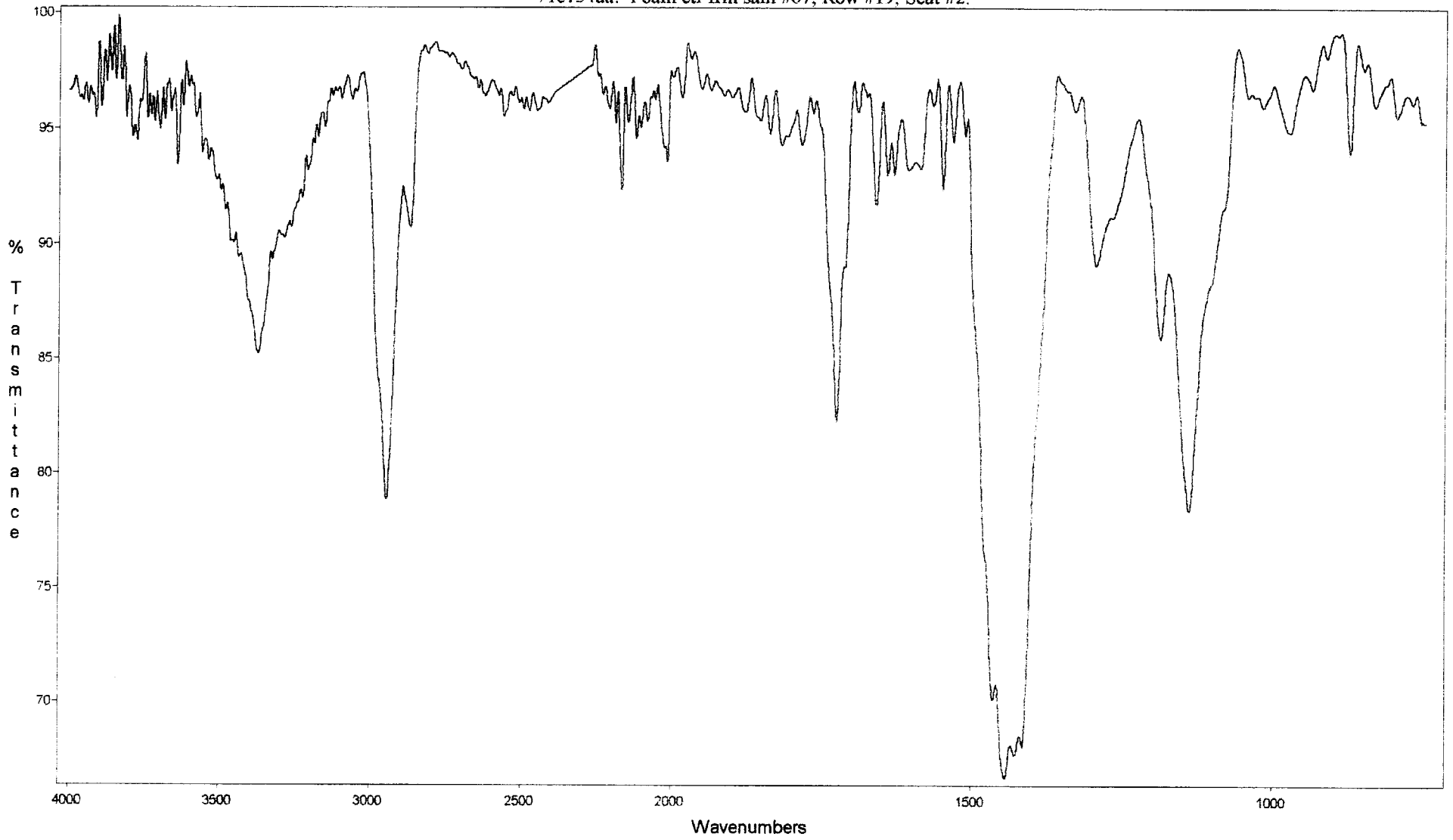


Figure 2. Center of flexible foam material.





71c155ab: Red mat'l frm heavier coat'd sdc of #67, Row #19, Seat #2.

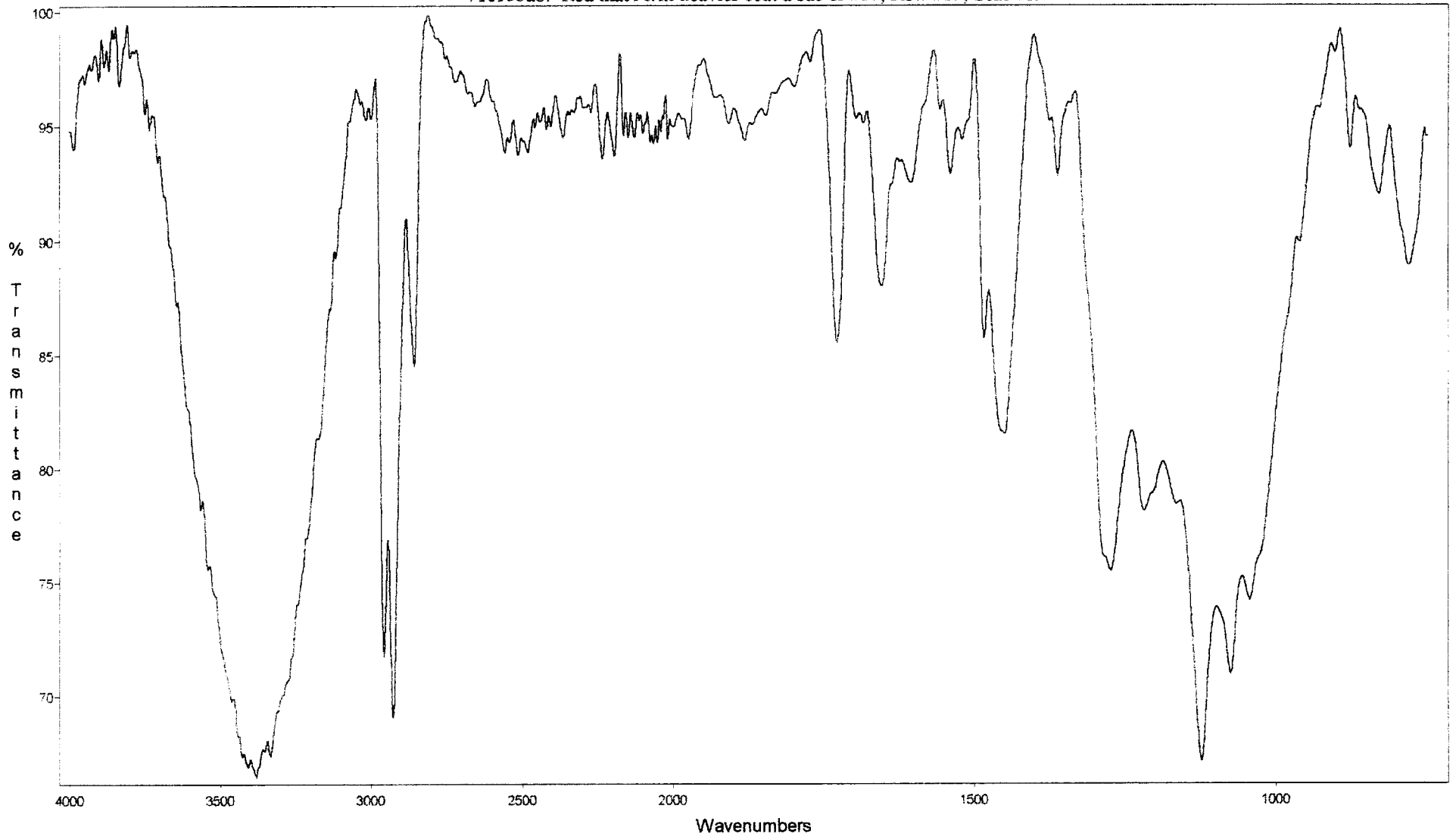


Figure 3. Heavier coated side of foam material.

67

71c154ac: Red mat'l frm lighter coat'd side of #67, Row #19, Seat #2.

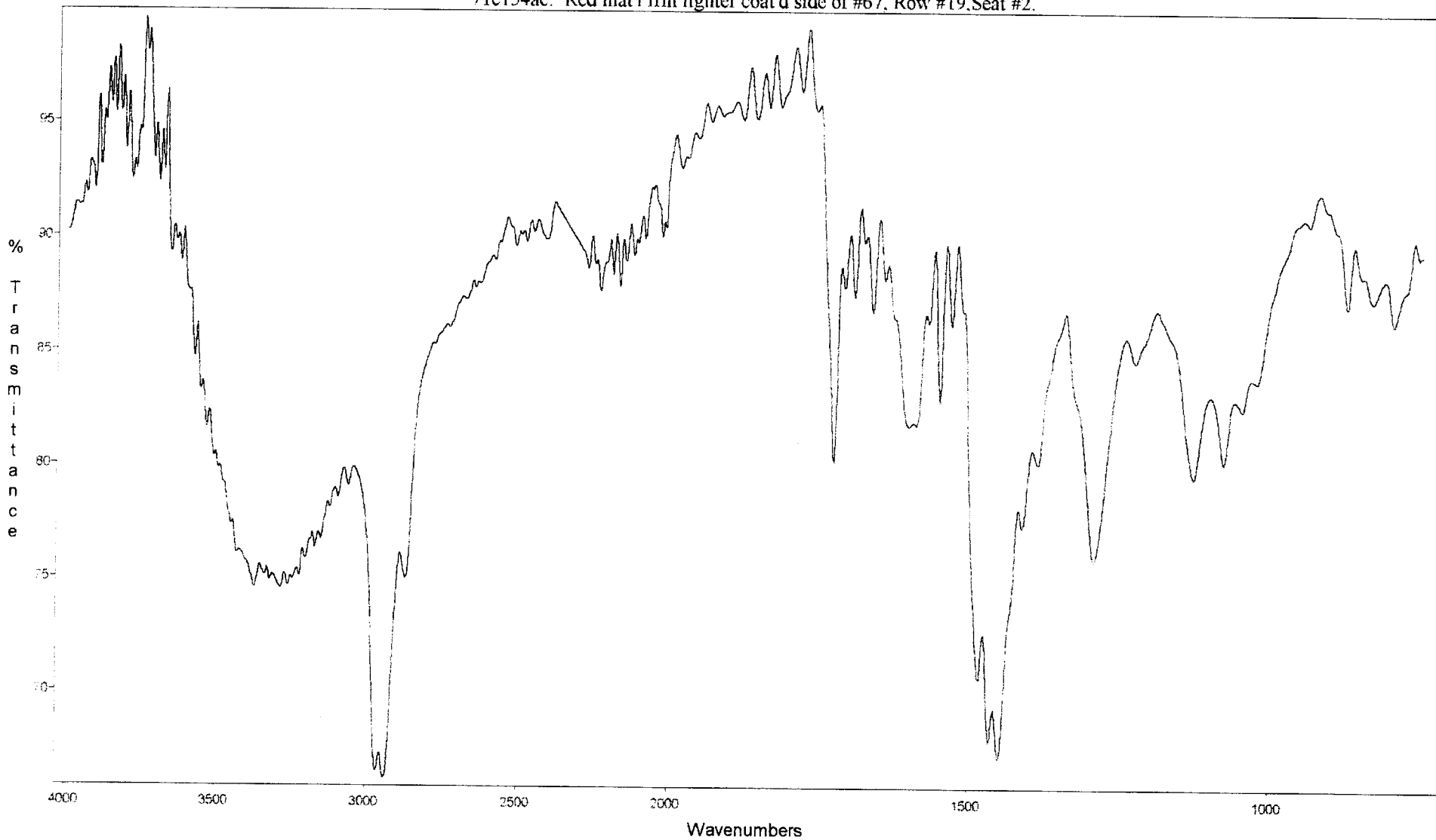


Figure 4. Lighter coated side of foam material.

65

adhrefab: Scotch-Grip 1357 (HP) on ssm (cured).

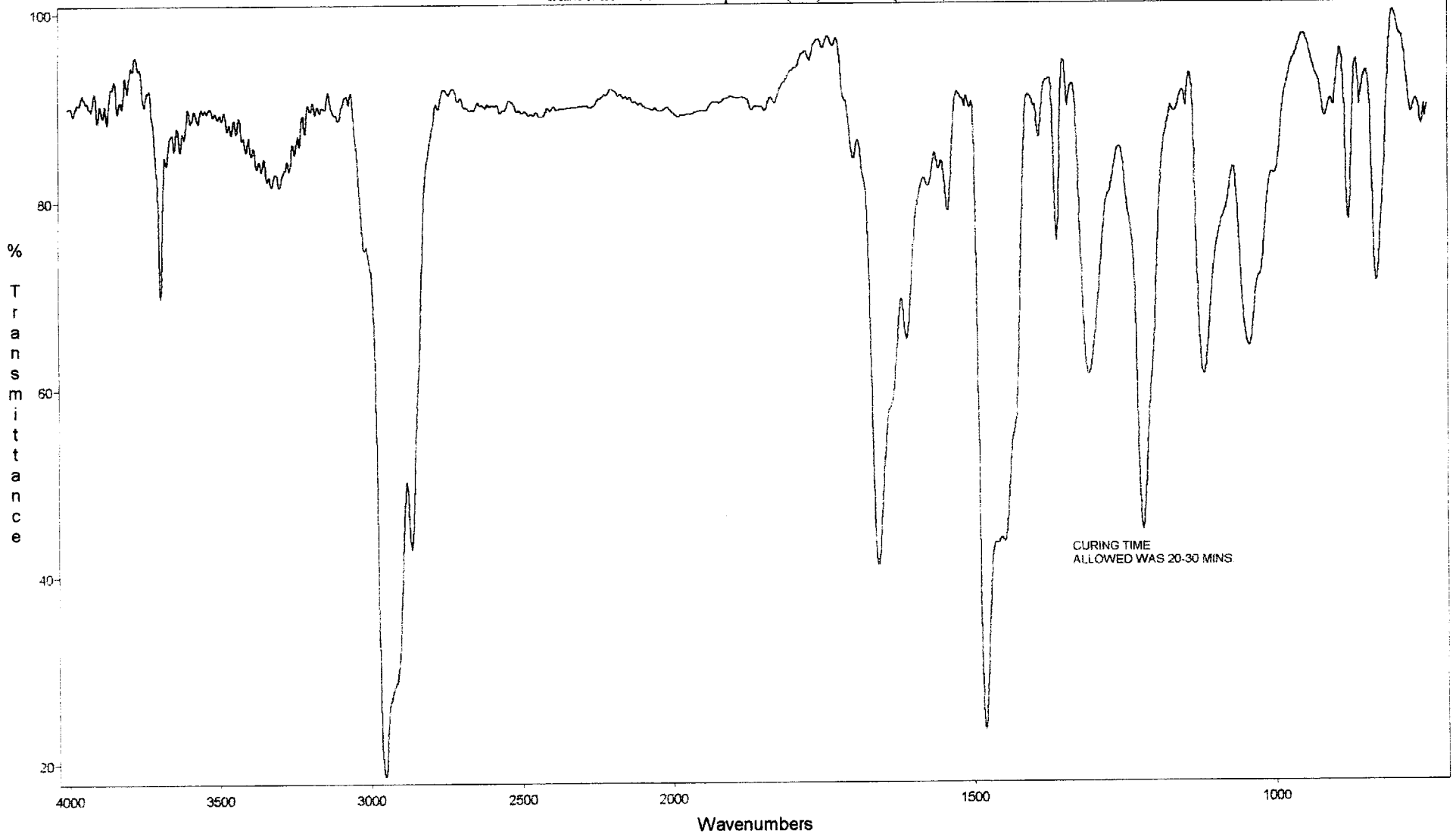


Figure 5. Adhesive reference.

606

adhrefab: Scotch-Grip 1357 (HP) on ssm (cured).

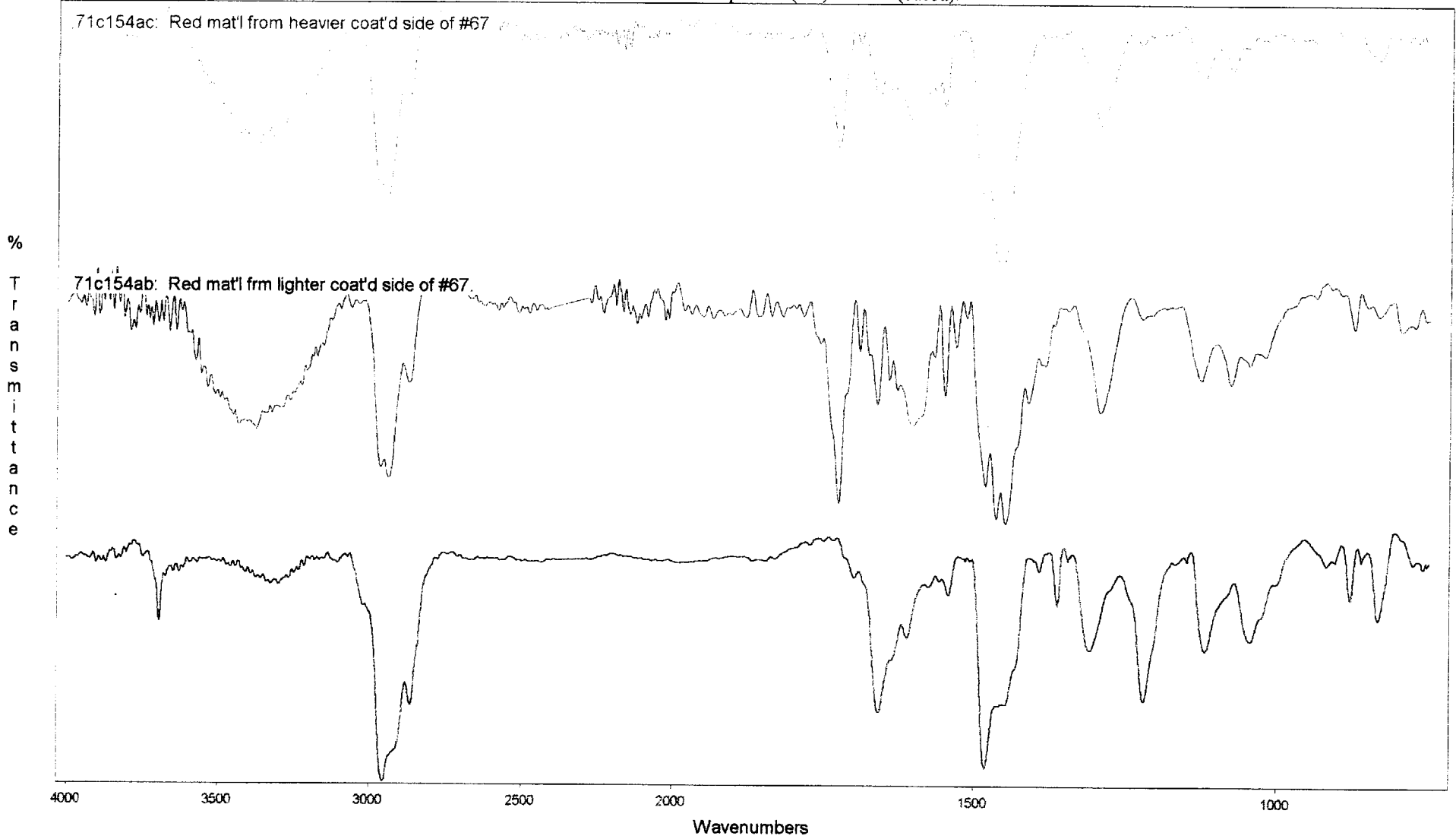


Figure 6. Spectral comparison with adhesive reference material.

67

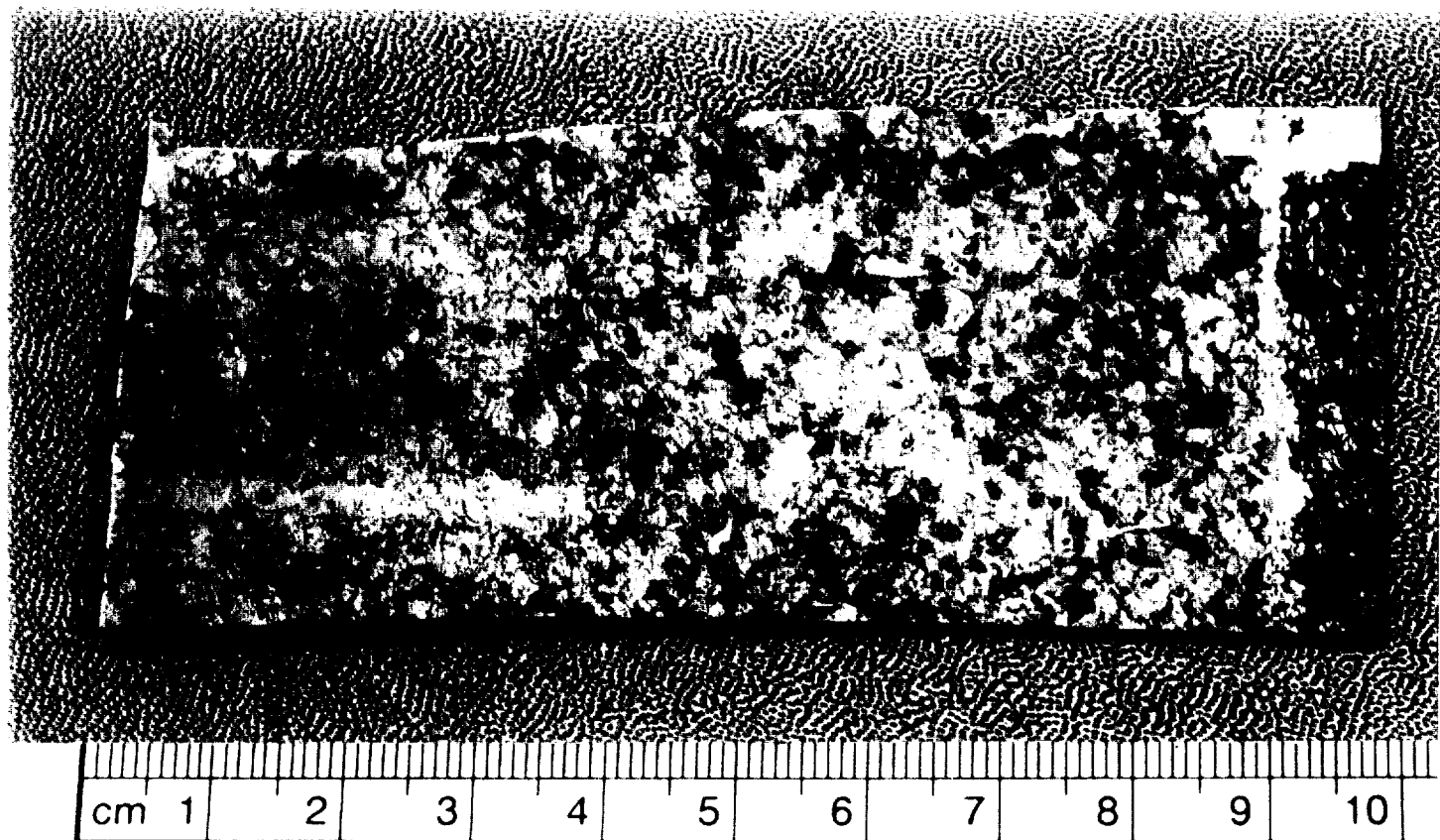
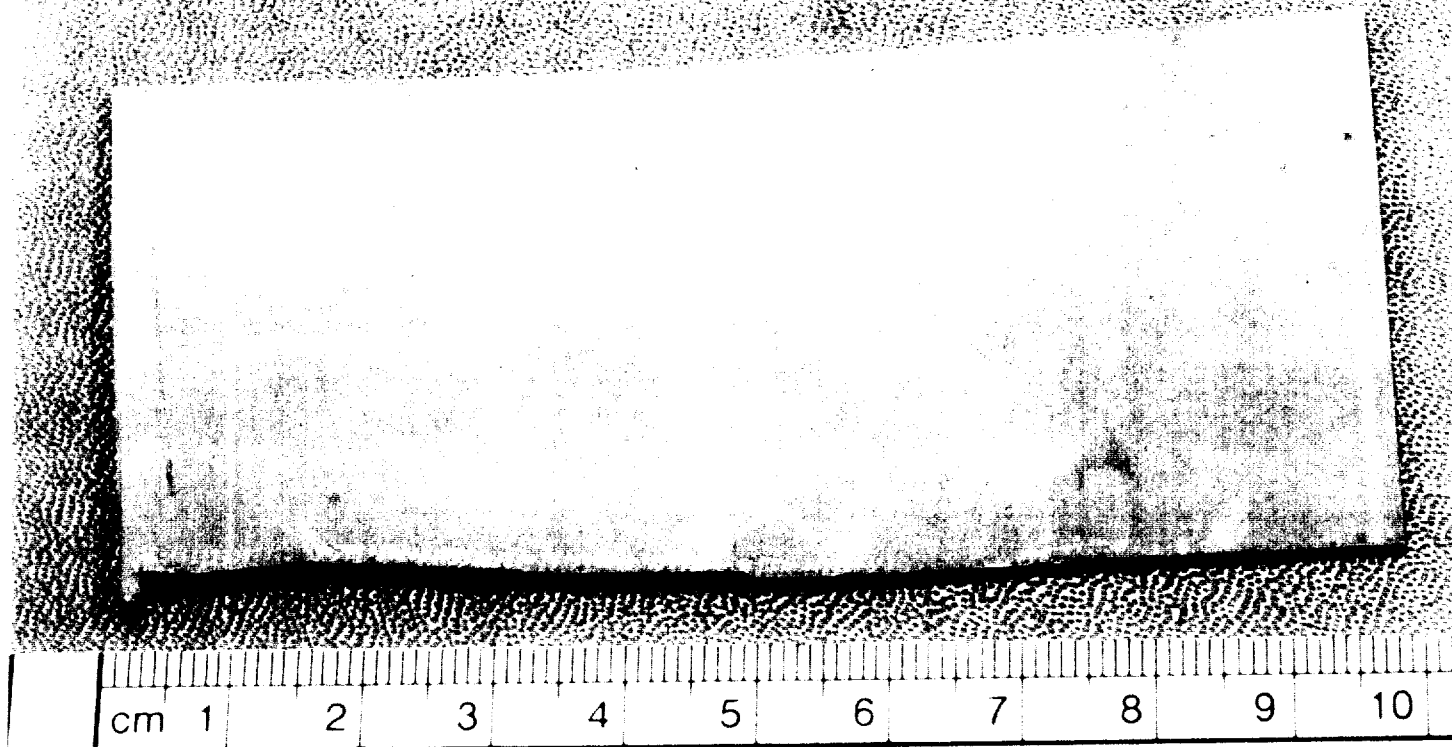


Figure 7. Sample #70, Row #17, Seat #8.

690

71c154ba: Non-contaminated side of #70, Row #17, Seat #8

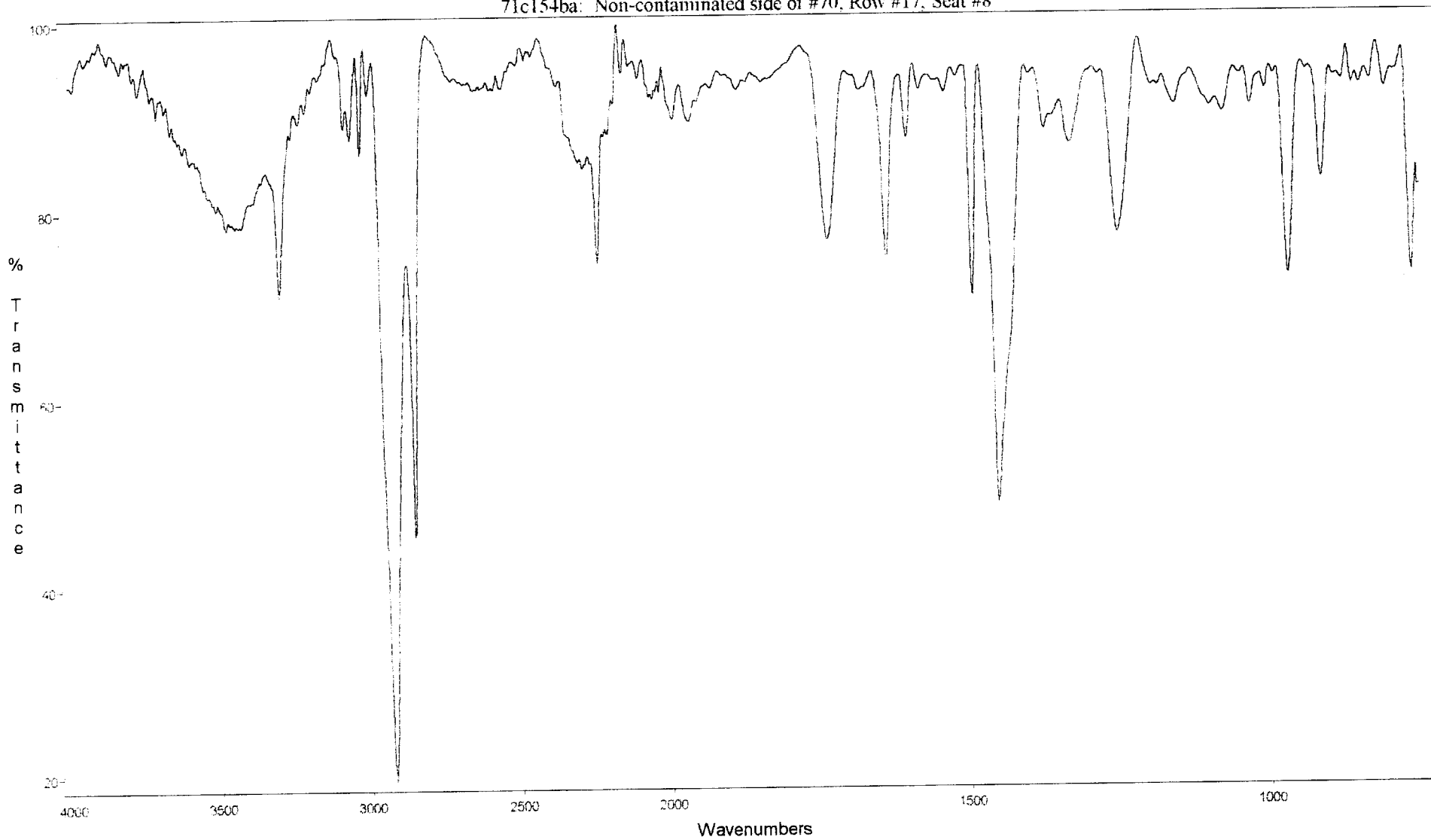


Figure 8. IR spectrum of "clean" side of sample #70.

69

71c154bb: Red substance from #70 Row 17, Seat 8.

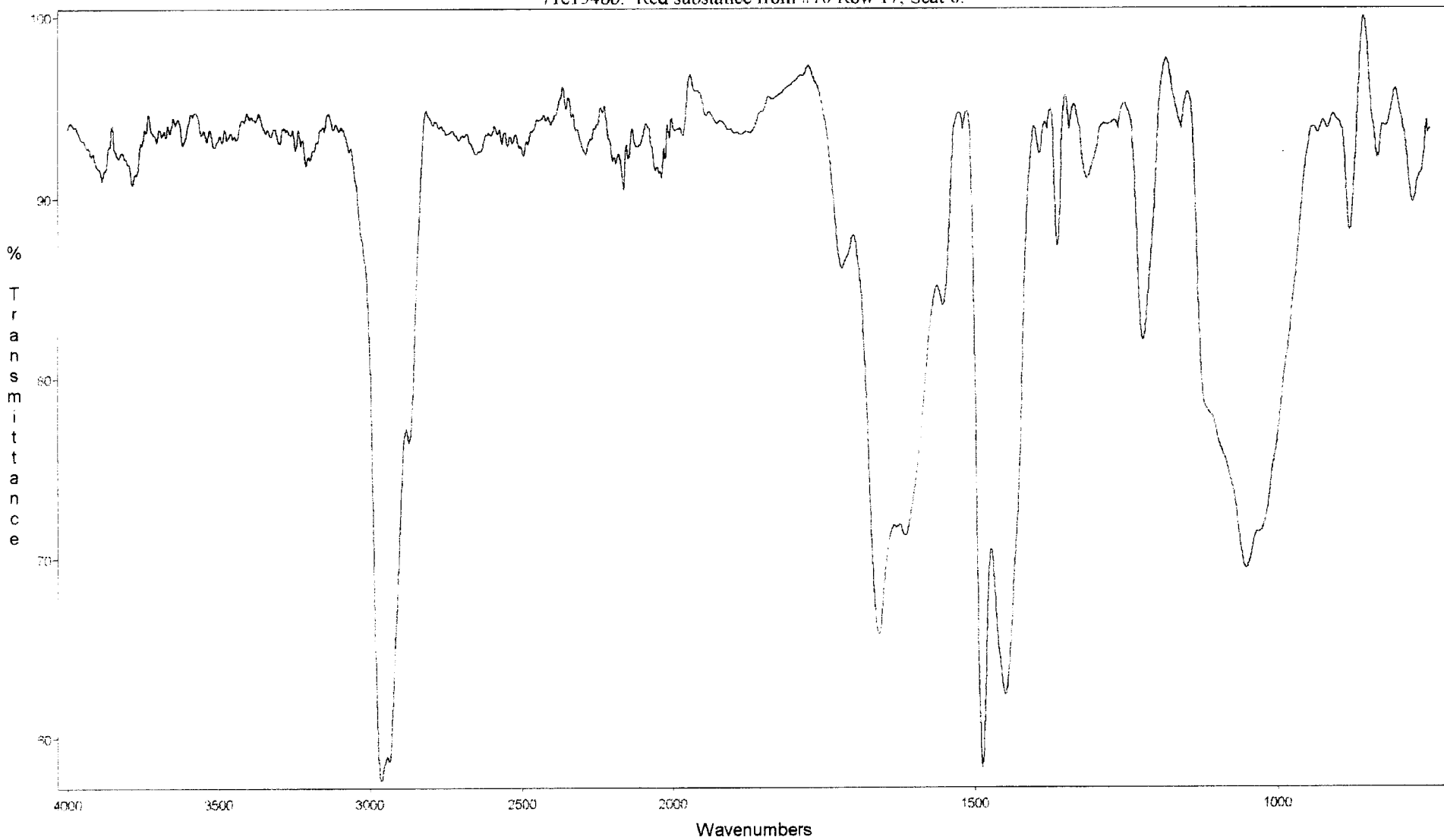


Figure 9. IR spectrum of red substance from sample #70.

70

adhrefab: Scotch-Grip 1357 (HP) on ssm (cured).

71c154bb: Red substance from #70 Row 17, Seat 8.

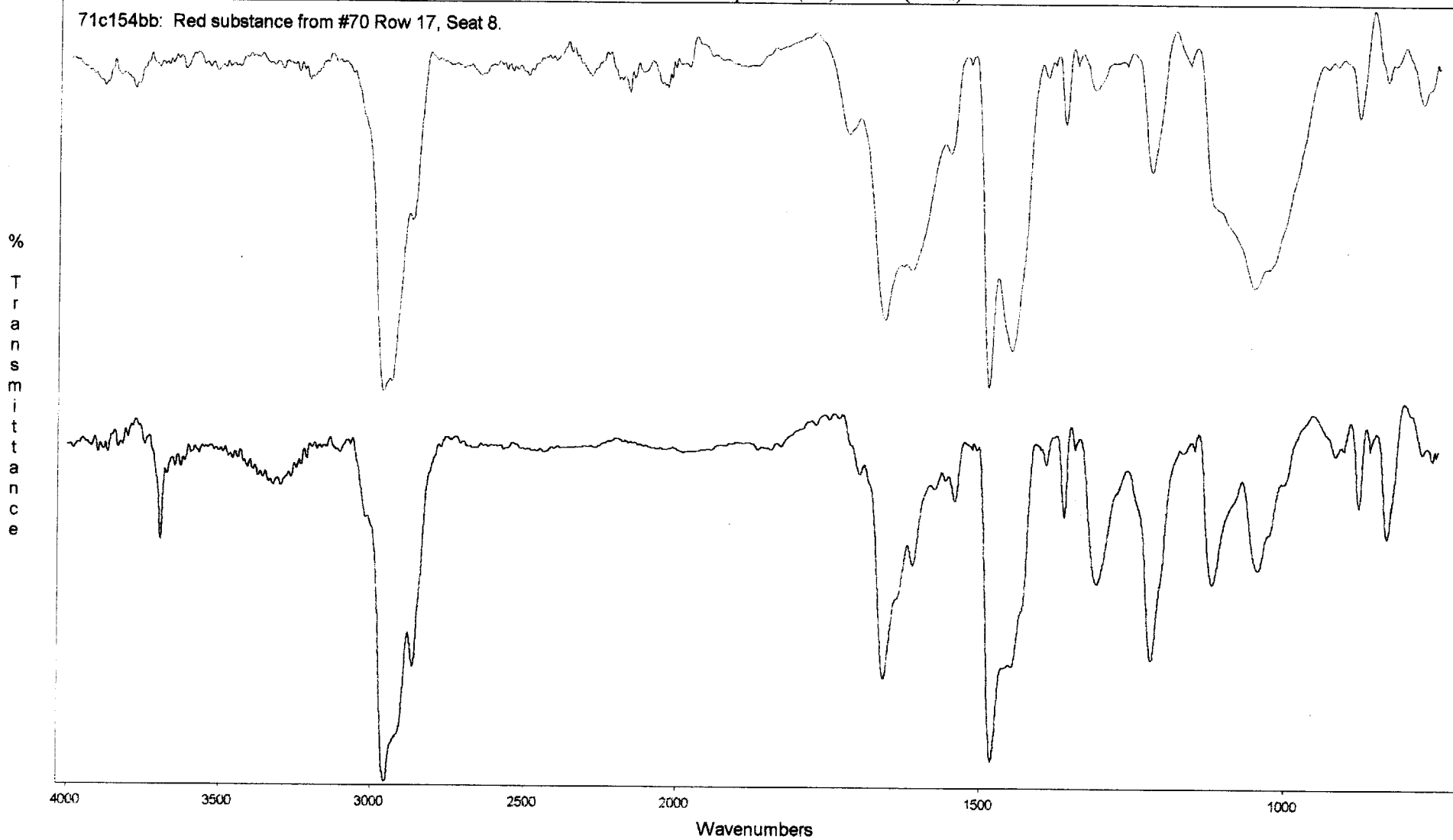


Figure 10. Spectral comparison of adhesive reference to red material.

71



adhrefab: Scotch-Grip 1357 (HP) on ssm (cured).

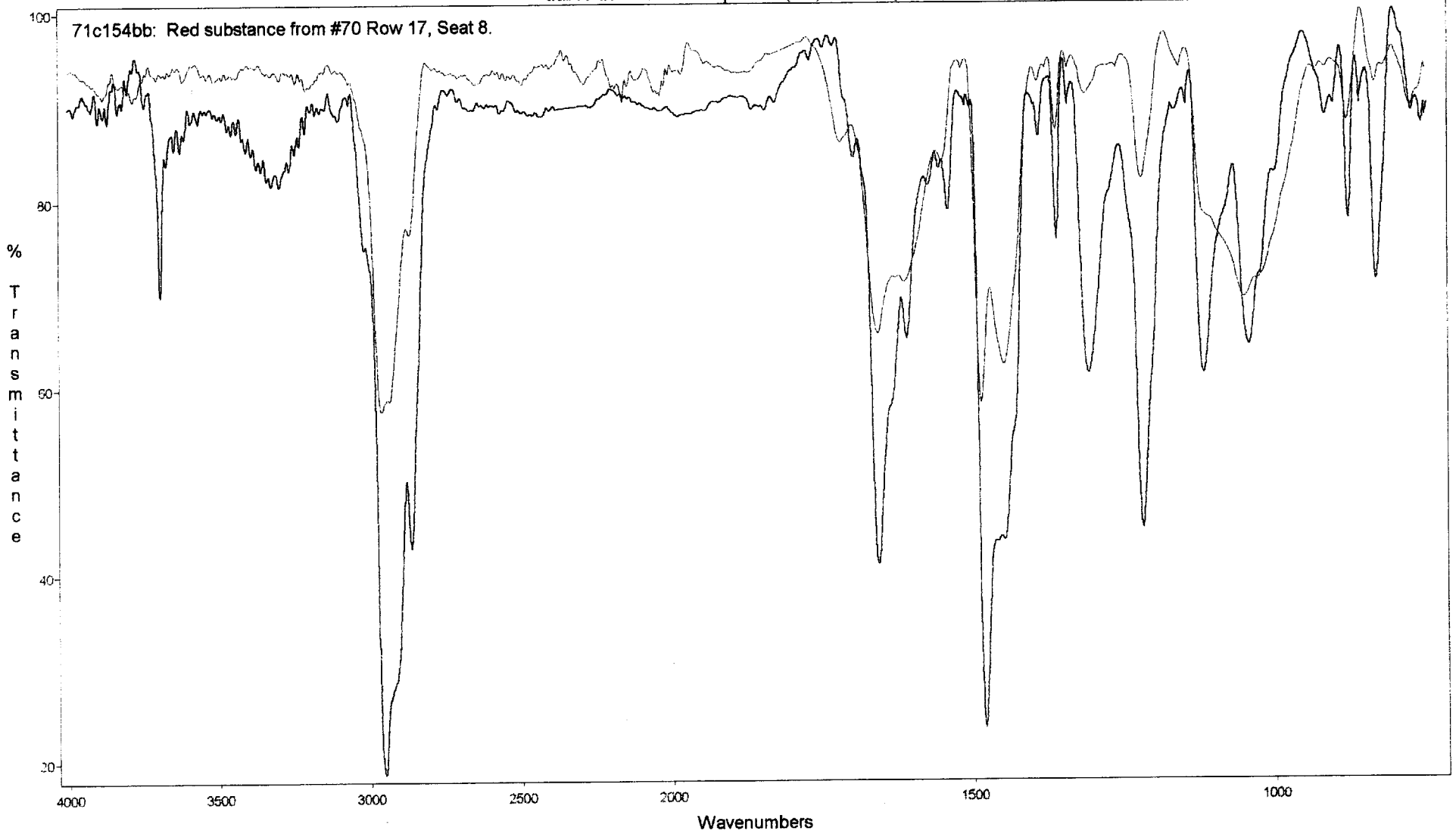


Figure 11. Spectral overlay of adhesive reference with red material.

72

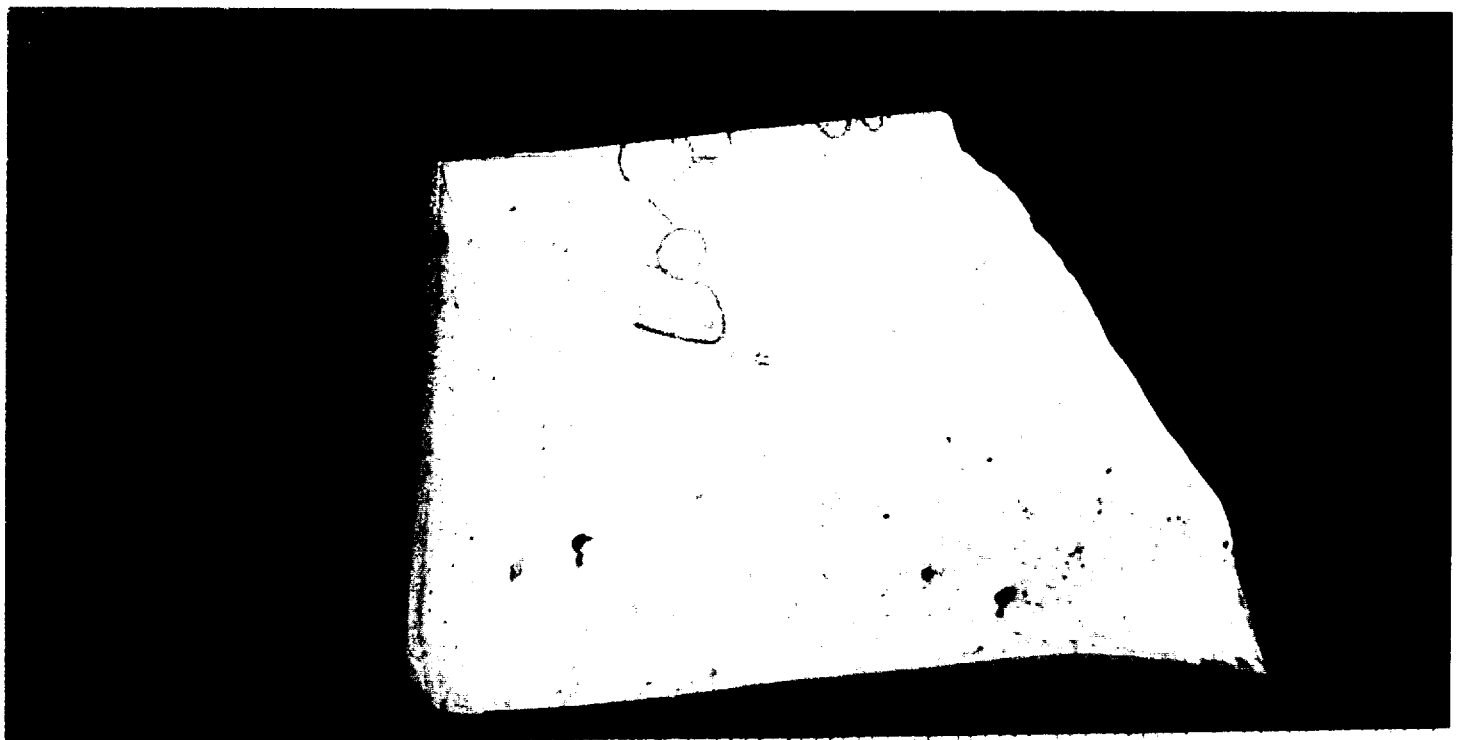


Figure 12. Sample #73, Row #27, Seat #2.

63

71c154ca: Non-contam'd sde of #73. Row #27. Seat #2.

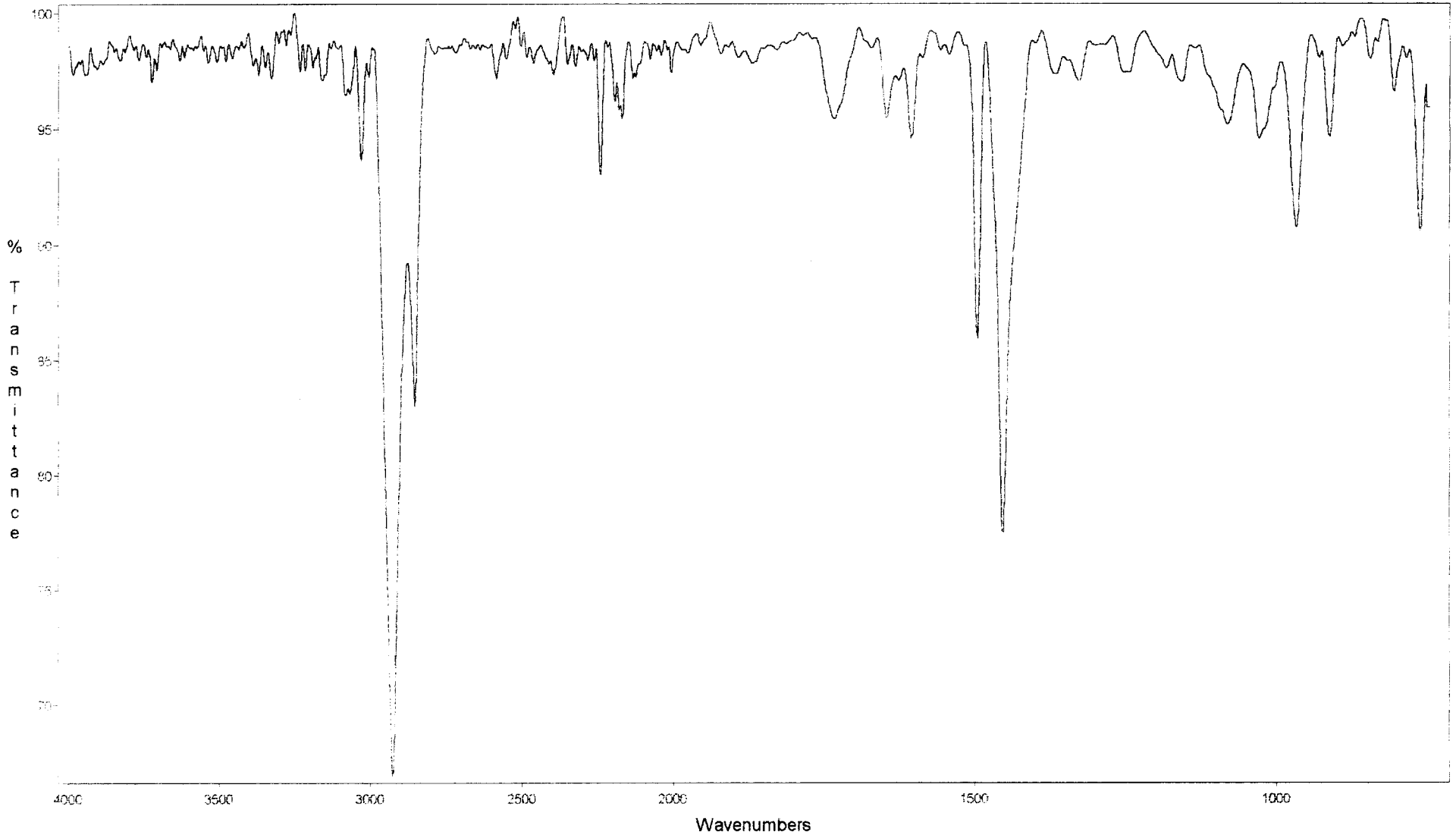


Figure 13. IR spectrum of "clean" side of sample #73, Row #27, Seat #2.

74

71e154cc: Apert'd dwn KBr of tan mat'l frm sam #73. Row #27. Seat #2..

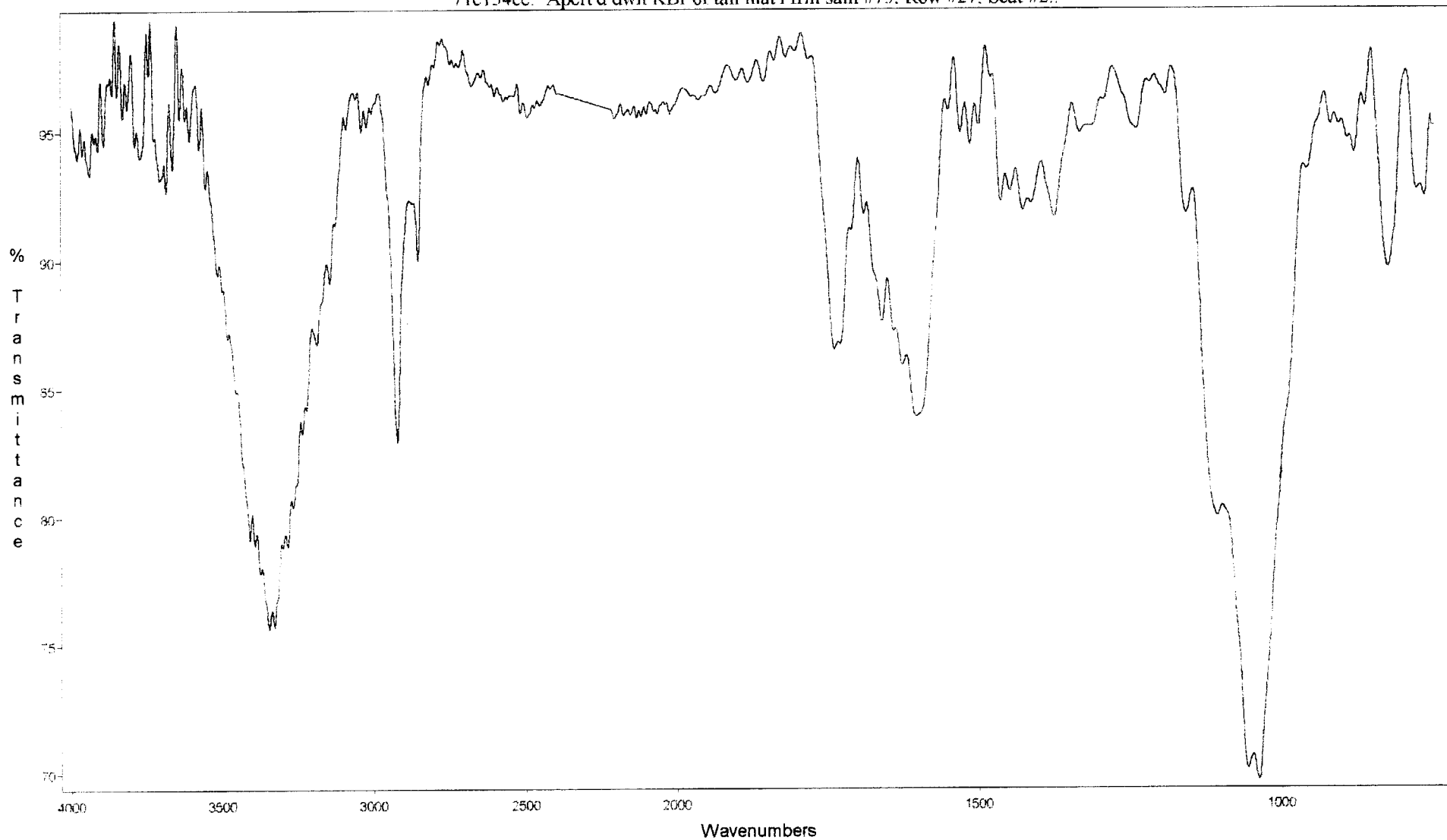


Figure 14. IR spectrum of contaminated side of sample #73, Row #27, Seat #2.

75

adhrefab: Scotch-Grip 1357 (HP) on ssm (cured).

71c154ce: Apert'd dwn KBr of tan mat'l frm sam #73, Row #27, Seat #2.

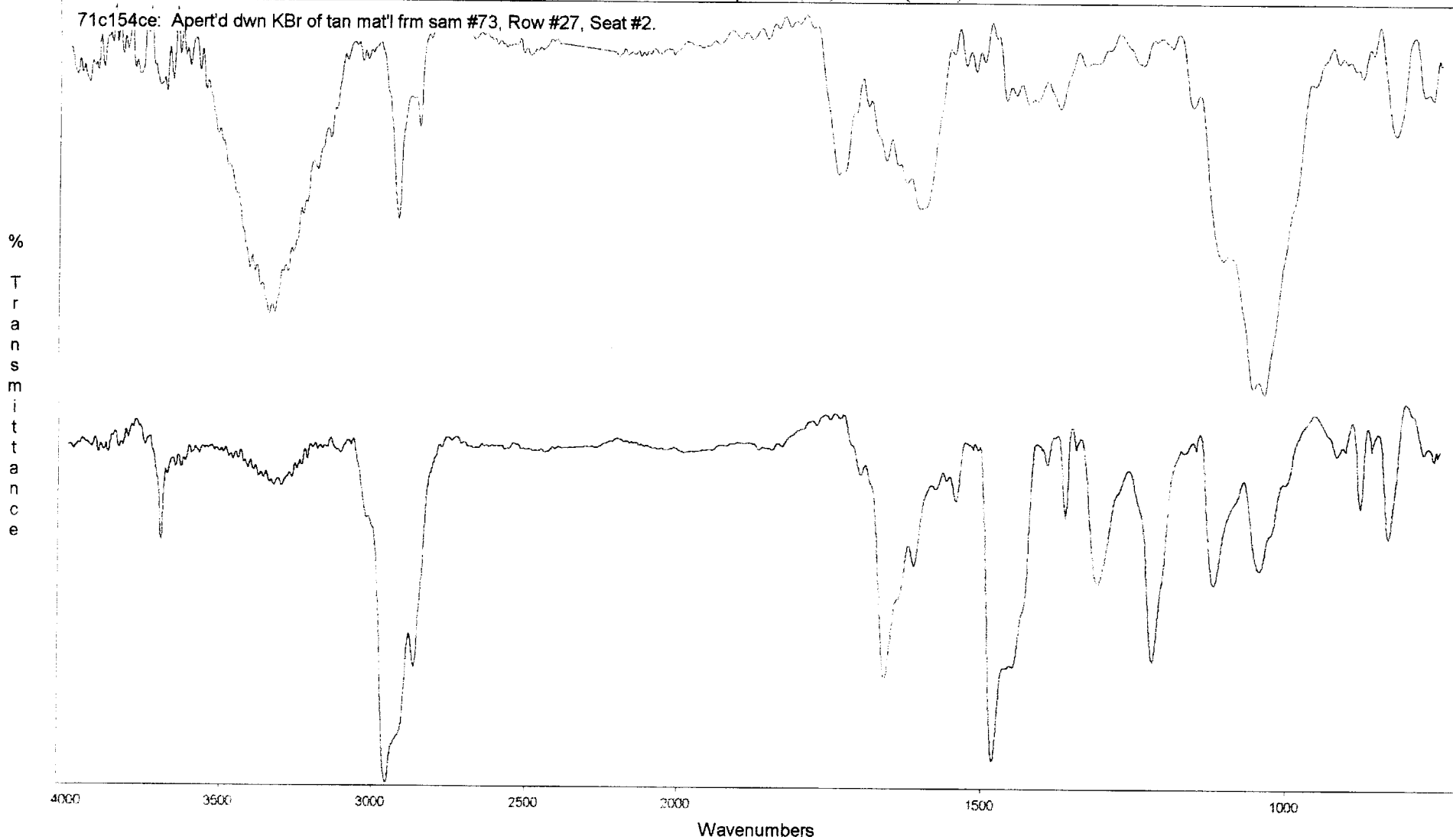


Figure 15. Spectral comparison of adhesive reference with contaminant of sample #73.



adhrefab: Scotch-Grip 1357 (HP) on ssm (cured).

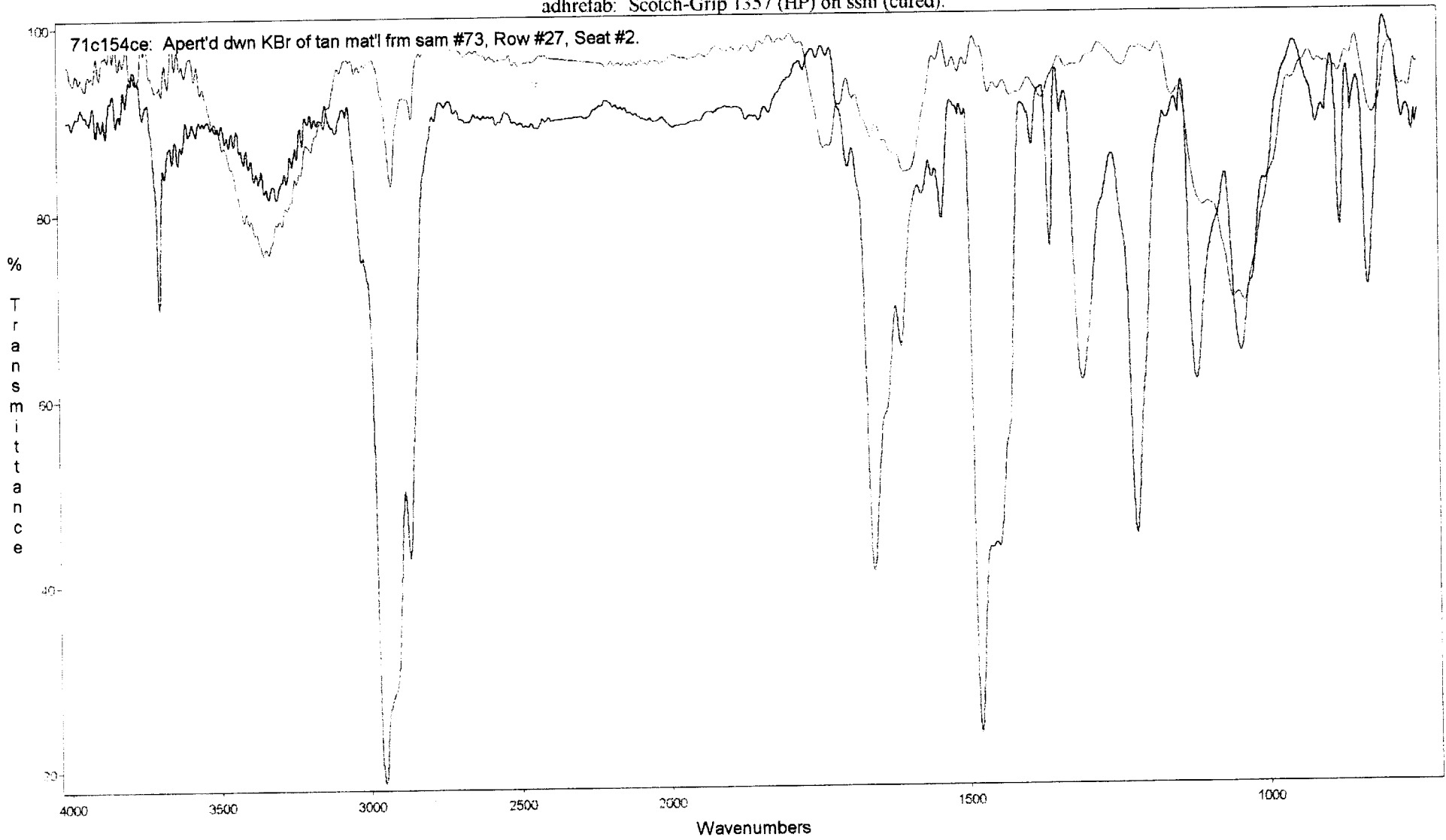


Figure 16. Spectral overlay of adhesive with contaminant.

DL



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

(78)

71c154da: Gold Glaz'd lkg mat'l frm Drk sde of Sam. #74; Row #24 Seat #7.

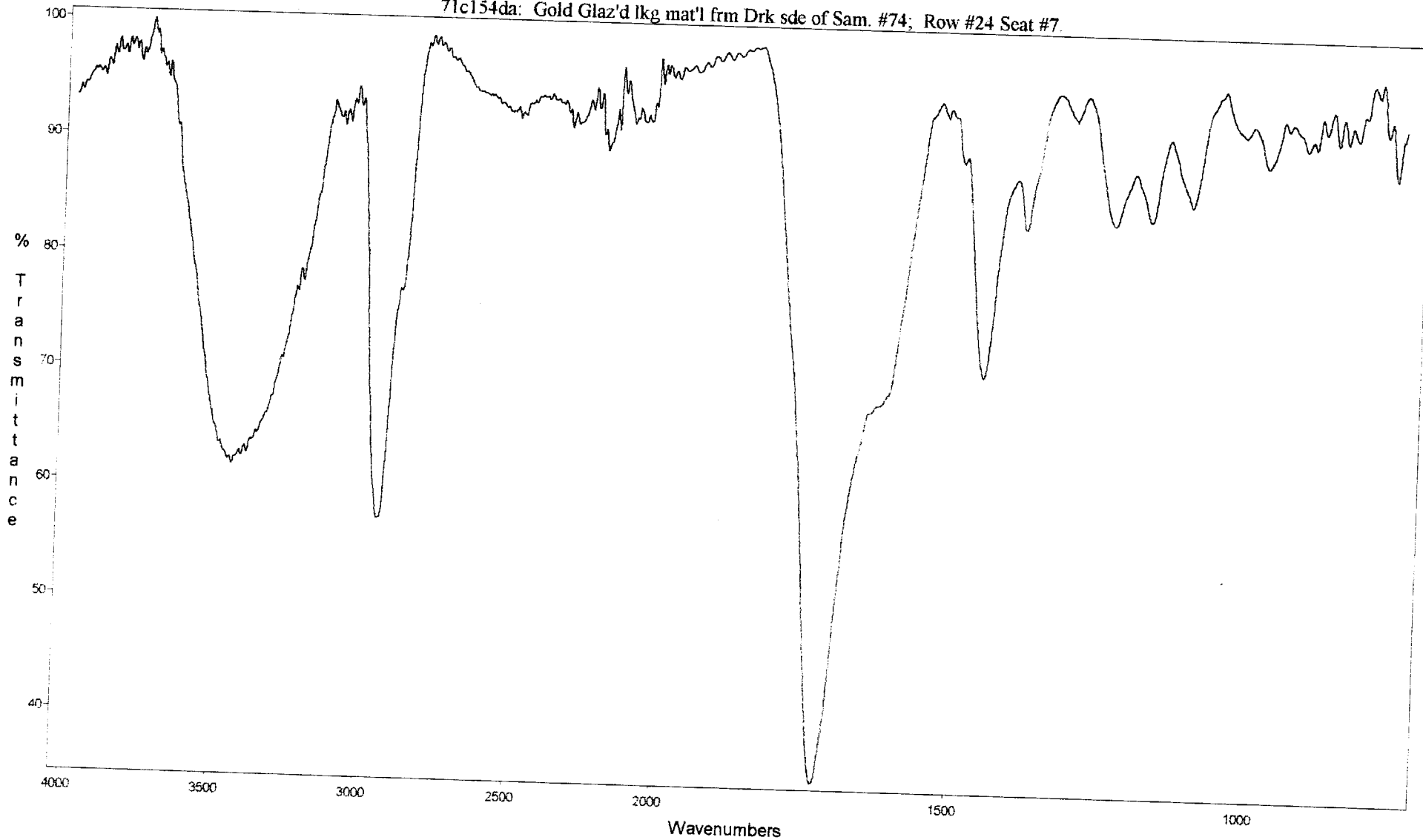
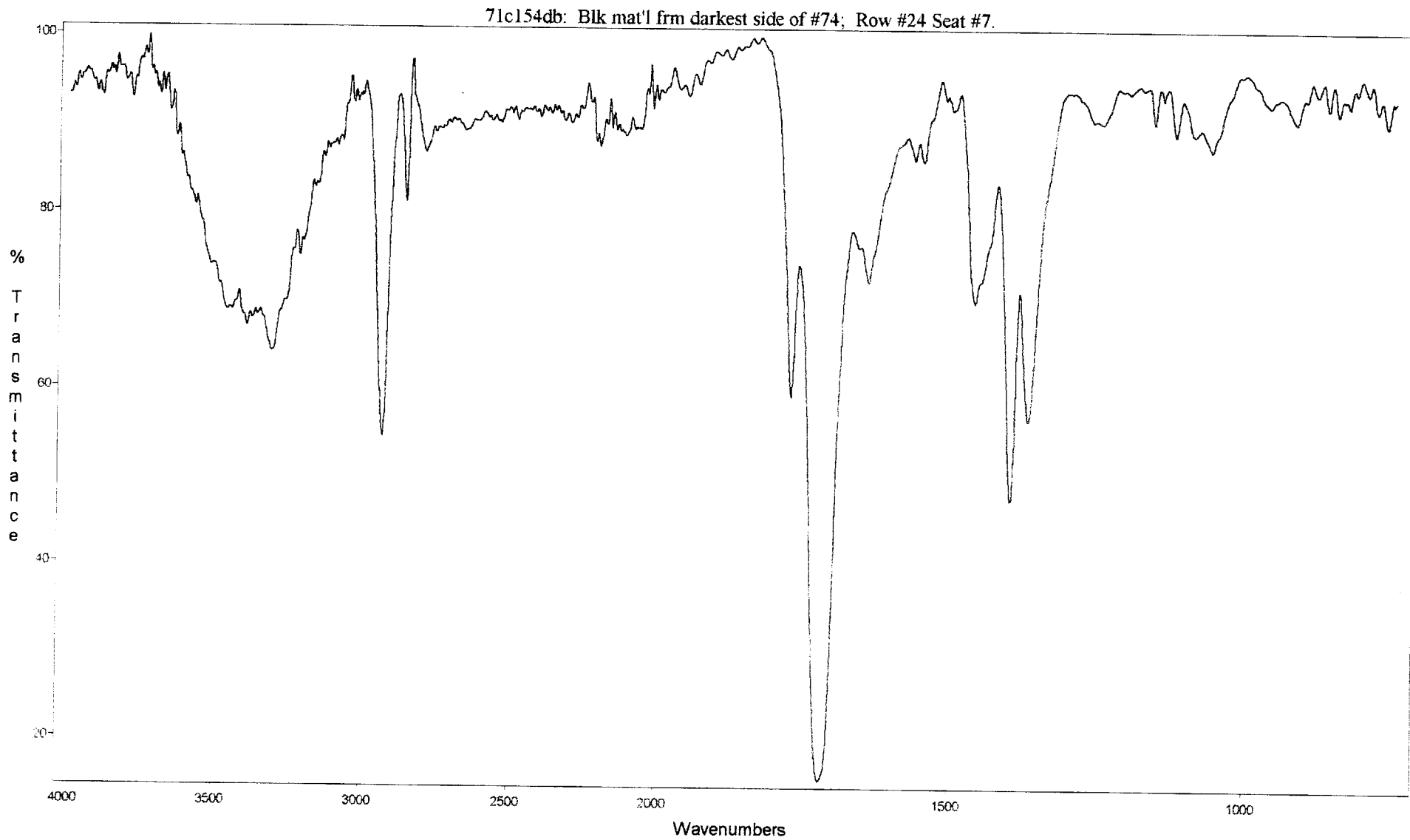


Figure 18. Glazed looking material from darkest side of sample #74.

79





PS.

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

71c154dd: MethChl extr of soot mat'l from ltr sde of #74. Row #24. Seat #7.

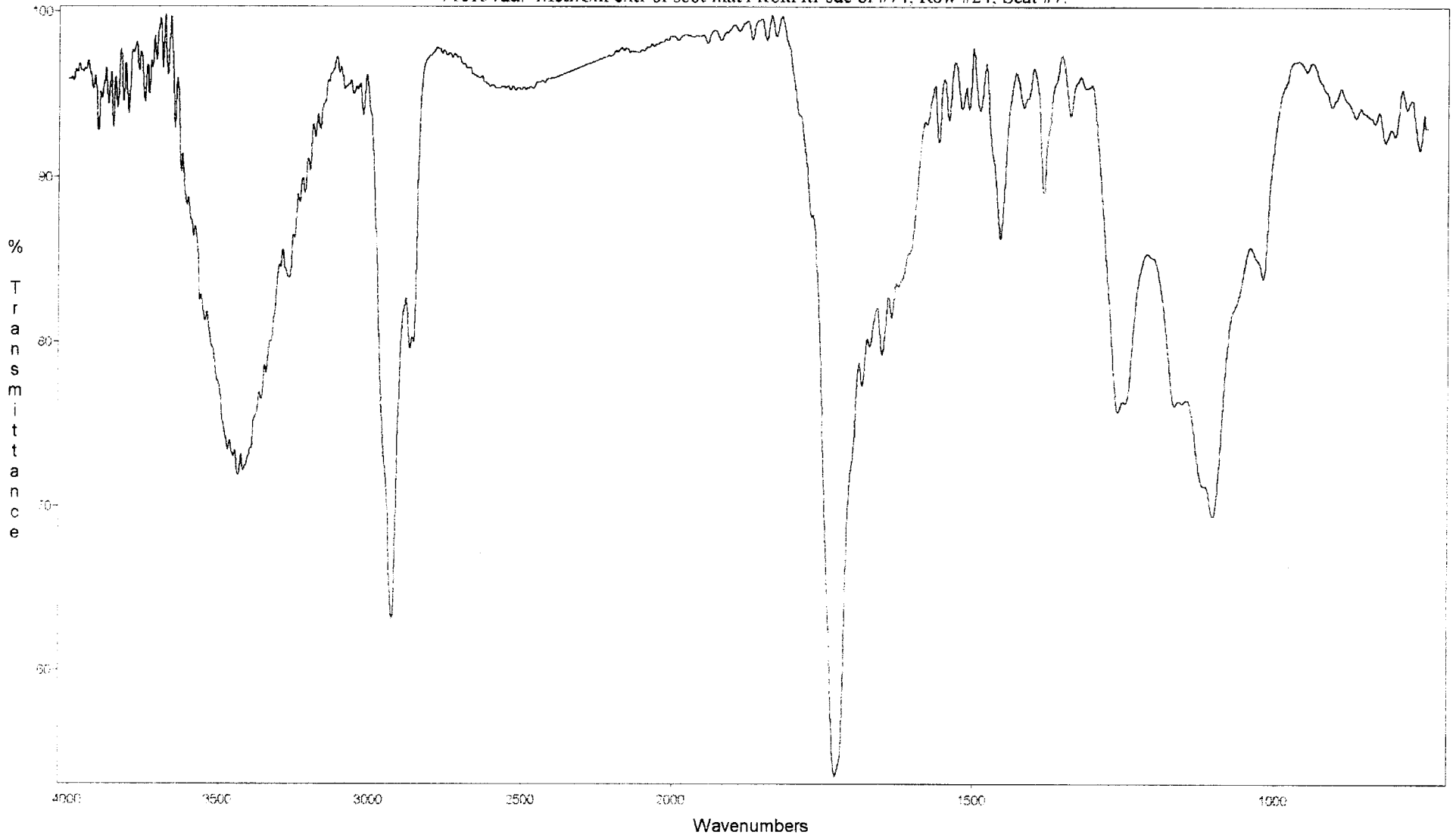


Figure 20. Extraction of "sooty" material from lighter side of sample #74.

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