Determining the Amount of Plastic and Compostable Plastic in Compost "Overs"

Study conducted on behalf of the
Biodegradable Products Institute

October 2012

INTEGRATED WASTE MANAGEMENT CONSULTING, LLC
NEVADA CITY, CALIFORNIA

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Objective

The objective of this study was to analyze a random sampling of "overs"[1] at selected composting facilities to determine if compostable plastics account for more than 10 percent of the overs and to characterize the type and amount of remaining plastic residue. This work will help to quantify the composition of overs which are ordinary plastics and which are "compostable plastics".

Introduction

As more and more food scraps diversion programs come on line, compostable plastics are seen as helping to facilitate increased participation and increased capture rate of these programs. The city of Portland and similar jurisdictions implementing source-separated food scraps collection programs must make choices and policy decisions as to what types of materials are allowable and which are not. Most food scraps collection programs, due to the desire to maximize diversion from landfills, tend to be fairly inclusive in terms of materials accepted. For example, while we broadly categorize these programs as "food scraps" collection programs, most of these programs also allow food-soiled paper and food related paper products (e.g. pizza boxes) in addition to food scraps. In addition many of these emerging programs allow or encourage "compostable" food service ware (i.e., plates, cups, forks, etc.) or bags as part of the program. There is emerging information from Europe, Canada, and Washington state[2], that programs that allow compostable bags (primarily as in-home bin liners) can increase participation in food scraps collection programs. In addition many commercial food scraps programs allow and encourage "wet-strength" cardboard that is commonly used to package produce and similar materials as part of the "food scraps" stream.

Study Methodology

The scope of this project included identifying two large commercial compost facilities receiving food scraps collected from the city of Portland, Oregon. The facilities were interviewed to establish baseline composting conditions (i.e., composting technology, retention time, separation methods, etc.). Random samples of "overs" from the screening process were selected and sorted using manual sorting techniques. Samples were collected from stockpiles identified by the facility operators (See Figure 1). Individual samples were gathered in 5-gallon buckets. Each 5-gallon subsample was weighed, documented, and then hand-sorted (See Figure 2). Sorters selected any and all contaminants encountered in the overs and classified each item into one of three possible categories:

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[1] Most commercial compost facilities screen the finished compost product prior to sale in order to create a homogenous product. Some screens can create two products, some three. The oversize particles (those not passing through the screens) are commonly referred to as "overs".

[2] *"Italy as a Case Study Going the Extra Mile for High Residential Food Waste Capture",* Christian Garaffa, Novamont, August 2012.

Figure 1. Typical Pile of Overs to be Sampled for Sorting.

Figure 2. Sorting Table.

1) Film Plastic, which included any thin extruded plastic such as bags, cup liners, gloves, wrappers, etc. (Please see Figures 3 & 4)

2) Rigid Plastic. This category included essentially all non-film plastic including hard plastic, cutlery, plates, etc.

3) Other. The other category included any non-plastic contaminants encountered in the overs. This included wet-strength cardboard, glass, wire, rocks, and other non-plastic items.

Interestingly, though it was not documented for this study, the "other" category included a significant amount of wet-strength cardboard (the type of cardboard that is commonly used to package some produce for grocery stores). This material would appear to be a challenge to fully breakdown during an abbreviated composting process.

Little effort was made to distinguish between the types of plastic encountered during the sorting process, because visually distinguishing one type of plastic from another can be very difficult after the rigors of the composting process. At the end of each subsample, the recovered commodities were photographed, weighed, and bagged for shipment to a third-party laboratory (Advanced Materials Center – AMC) in Illinois for further laboratory analysis and identification (Please see Figures 5 & 6).

Five-gallon buckets were chosen as the sorting volume because they are a convenient and manageable size for this type of project. Also there are roughly 40, five-gallon buckets in a cubic yard, thus using five-gallon buckets allows for easy bulk density conversion. However, the relatively low bulk density of say, film plastic does not really lend itself to weight-to-weight comparisons. Thus the weight of the plastic itself is not the best way to represent the importance of the presence of this material in the overs.

Results

Both of the selected compost sites use covered aerated static pile composting systems. Both sites screen their finished compost after the composting process, though one site's screen used a one-pass type screen (which creates "overs" and "fines") and the other used a screen which made three products – overs, "middles", and fines. Plastics and other contaminants were encountered in all overs products and also in the "middles" product. The results of the field sorting are summarized in Table 1, below. The field sorting showed that the weight of plastics relative to the weight of the overs was not significant. Also the weight of "other" contaminants was greater than the weight of all plastics removed. Because of the two fractions at the first facility, two distinct sorts were done – one of the overs, one of the middle fraction. However, it is not valid to say that more or less contaminants were encountered at this facility, but rather that more material was sorted, thus a larger weight of contaminants was removed.

Figure 3. Consolidated Film Plastic.

Figure 4. Close-Up of Sorted Film Plastic.

Figure 5. Film Plastic as Received by AMC.

Figure 6. Film Plastic, Including Trail Blazer's "Banger" Noise Maker, Gloves, and Candy Wrappers.

Table 1
Total Weight of Plastics Encountered
(Field Data)

Site	Total Weight of Overs Sampled (Pounds)	Film Plastics		Hard Plastics		Total Plastics		Other Contaminants	
		Lbs	%	Lbs	%	Lbs	%	Lbs	%
PRC Gross Overs	292.6	4.6	1.57	4.0	1.37	8.6	2.94	13.0	4.44
PRC Middles	448.8	4.2	0.94	1.2	0.27	5.4	1.21	2.8	0.62
Total PRC	741.4	8.8	2.51	5.2	1.64	14	4.15	15.8	5.06
Nature's Needs	352.6	3.2	0.91	1.2	0.34	4.4	2.16	6.2	1.76
TOTAL	1094.0	12.0	1.1	6.4	0.6	18.4	1.68	22.0	2.01

PRC – Pacific Region Compost

The collected material from both sites was shipped to AMC in Illinois for laboratory identification. AMC's final report is included in Appendix A. There are obvious discrepancies between the weights on the field data and the weights reported by AMC. This is largely explained by moisture loss during transport and analysis. This weight difference was expected and is not considered significant. However, it does make it hard to compare the data in Table 1 and Table 2. Table 2 provides a summary of the relative percentages of the plastics in the overs as determined by AMC. Table 3 provides a summary of the type and frequency of plastics encountered in the sorted material.

Table 2
Weights and Relative Percentages of
Compostable and Non-Compostable Plastic in Overs
(AMC Data)

Site	Category	Weight (Lbs)*	Potentially Compostable	Non-Compostable	Most Frequent
PRC Gross	Film Plastic (PRC1)	1.59	<3%	>97%	PP/PE
	Film Plastic (PRC2)	2.00	13%	87%	PE
	Film Plastic (PRC3)	0.91	4%	96%	PP
PRC Gross	Hard Plastics (PRC1)	1.03	<1%	>99%	PP/PE
	Hard Plastics (PRC2)	1.48	<1%	>99%	PP/PE
	Hard Plastics (PRC3)	1.00	<1%	>99%	PP/PE
PRC Middles	Film Plastics (PRC4)	2.38	1%	99%	PE
	Film Plastics (PRC5)	1.48	3%	97%	PE
PRC Middles	Hard Plastics (PRC4)	1.04	1%	99%	PP/PE
Nature's Needs	Film Plastic (NN1)	1.45	5%	95%	PE
	Film Plastic (NN2)	1.33	2%	98%	PE
	Other Plastics (NN2)	0.02	0%	100%	PE
	Hard Plastic (NN1)	1.52	1%	99%	PP/PE
	Hard Plastic (NN2)	0.18	60%	40%	PLA

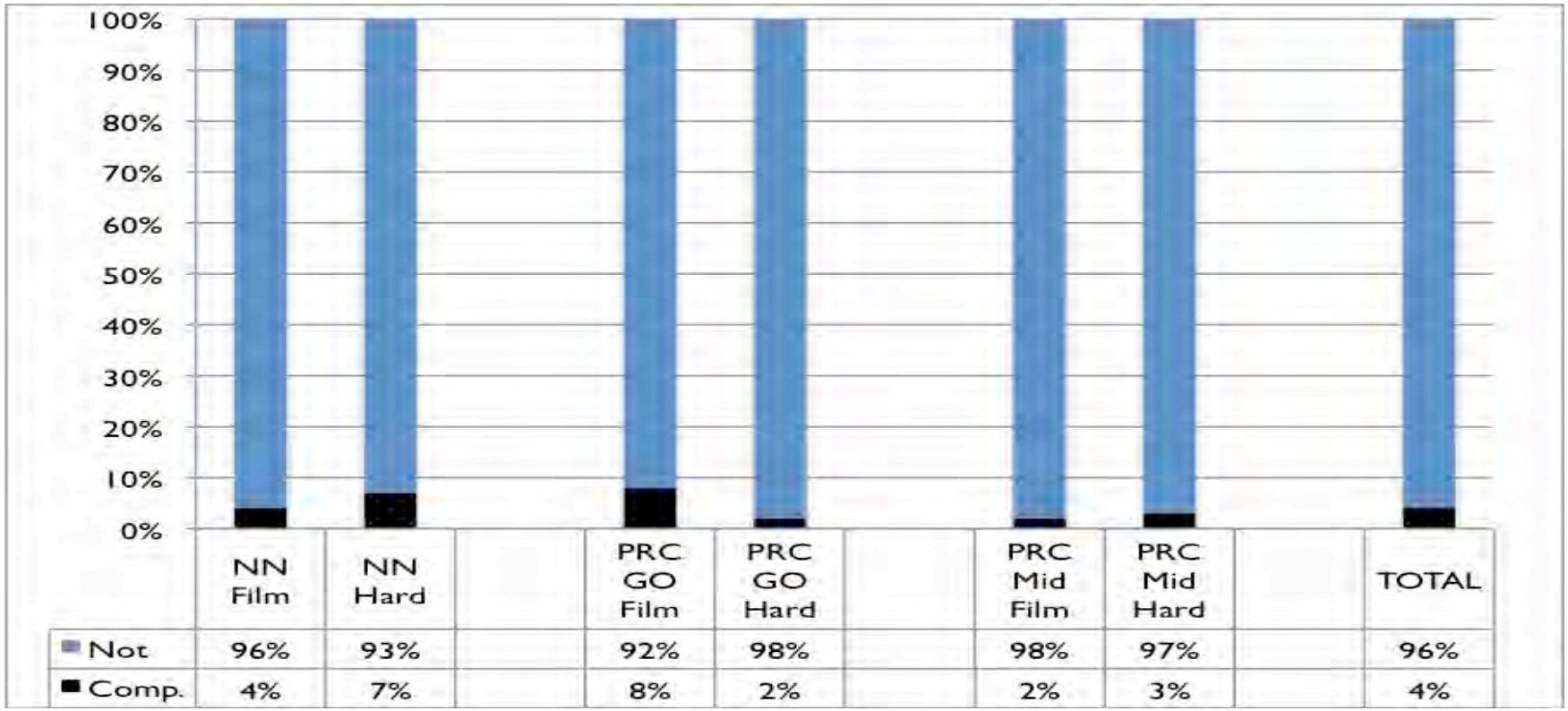
*AMC's data was reported in grams, but was converted to pounds for ease of review.

PRC1, PRC2, NN1, etc. are individual identifiers used for a consolidated bag of material. Film plastic pulled out at Nature's Needs for example, was placed in sample bag NN1. Higher numbers indicated additional bags, from the same sample. "Other Plastics (NN2)" was a bag of cutlery suspected of potentially being compostable.

Table 3
Types of Plastic Encountered by Sample (AMC Data)

Content Description	Cellulose	Regenerated Cellulose	Starch/ PP	Polyester and PLA	PP	PE	PS	PET	Nylon	Latex	PVC	Inert	Rubber	Cellulose Acetate
Typical Examples	Paper/ Cardboard	Metalized Materials			Straws	Bags			Eater String	Gloves				Rags
	Compostable													
Film Plastic	N	N	Y	N	Y	Y	N	N	Y	N	Y	N	N	N
Film Plastic	Y	Y	N	N	Y	Y	N	N	N	Y	N	N	N	N
Hard Plastic	N	N	N	N	Y	Y	Y	N	Y	Y	Y	Y	N	N
Other Plastics - Possible Compostable Cutlery	N	N	Y	Y	Y	N	N	N	N	N	N	N	N	N
Other Plastics - Possible Compostable Film	N	N	N	N	N	Y	N	N	N	N	N	N	N	N
Film Plastic – Mid. and Gross Overs	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	N	N
Film Plastic - Gross Overs	Y	Y	N	N	Y	Y	Y	N	N	Y	N	N	N	Y
Film Plastic - Gross Overs	Y	N	N	N	Y	Y	N	N	N	Y	N	N	N	N
Hard Plastic - Gross Overs	Y	N	N	N	Y	Y	N	N	Y	N	Y	Y	Y	N
Hard Plastic - Gross Overs	N	N	N	N	Y	Y	N	N	N	Y	N	N	N	N
Hard Plastic - Gross Overs	Y	N	N	N	Y	Y	N	Y	N	Y	N	Y	N	N
Possible Compostable - Gross Overs	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N
Hard Plastic Middles	Y	N	N	N	Y	Y	Y	N	Y	N	N	N	Y	N
Film Plastic Middles	Y	N	N	N	Y	Y	N	N	N	Y	N	Y	N	N
Film Plastic Middles	Y	N	N	N	Y	Y	Y	N	Y	Y	N	N	N	N
Possible Compostable - Middles	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N
TOTALS by Content Presence:	10	3	3	2	14	15	4	1	6	9	3	4	2	1

Chart #1
Relationship of "Potentially Compostable"
Plastic to Non-Compostable Plastic



	NN Film	NN Hard	PRC GO Film	PRC GO Hard	PRC Mid Film	PRC Mid Hard	TOTAL
Not	96%	93%	92%	98%	98%	97%	96%
Comp.	4%	7%	8%	2%	2%	3%	4%

NN – Nature's Needs
PRC – Pacific Region Compost

Conclusions

Based on IWMC's experience the amount of all plastics removed from the overs at both facilities was comparable and fairly typical of composting facilities handling food scraps from relatively new collection programs. The amounts of compostable plastics recovered ranged from 2% to 8%. However it is clear, based on AMC's analysis, that the composition of the plastic was overwhelmingly "conventional" plastics (polyethylene, polypropylene, etc.). While a small amount of compostable plastic was recovered in the overs, it appears to be less than 4% of the total material analyzed by AMC. While this could indicate that truly compostable plastics are breaking down significantly during the composting process at these two sites, the study did not have any information on the "upstream" volume of compostable plastics. So it is impossible to make this conclusion.

The most prevalent plastics in the overs were film plastic, consisting of two-thirds of the total sampled in the field. Subsequent lab analysis showed these to be overwhelmingly made from non-biodegradable plastic (Polyethylene and Polypropylene). Less than one percent of the total samples of hard plastic were cutlery. Approximately half of this consisted of starch and polypropylene and would not be expected to biodegrade or disintegrate. The other half was identified as potentially compostable. The study did not have enough data to determine why the cutlery might not be breaking down, though the fact that large amounts of wet-strength cardboard was also recovered suggests the compost retention time might not be sufficient to degrade these types of materials.

Recommendations

The study found that the overwhelming majority of the plastics in the overs were non-degradable plastics. As such, limiting the distribution and promotion of truly compostable items will do little to reduce the total plastic in the overs stream. Portland and its surrounding cities with food scraps collection programs need to address the prevalence of non-degradable plastic in the food scraps stream. This can best be done through a targeted outreach program. Outreach should be targeted at all sectors of the collection stream, including generators, vendors, and collectors.

Appendices

Appendices A and B follow this page.

Appendix A
AMC REPORT

CONFIDENTIAL! Not to be released Without appropriate Authorization!

LABORATORY REPORT

125 Swanson Street Ottawa, IL 61350 Phone (815) 433 – 1495 Fax (815) 433 – 1795

To: BPI
Steve Mojo

Date: October 1, 2012
Project: 12P1135
PO# S. Mojo

Purpose:

Review the contents of supplied bags containing films, hard plastics and possible compostable materials to determine material composition using FTIR infrared analysis, visual examination and burn tests. Evaluate and quantify non-compostable items and compostable items gathered from the Nature's Needs and Portland Recycling Center.

Sample Identification:

A-P**.** Bags of Samples, 16 total per Table

Source:

PRC & Nature's Needs, Oregon

***Refer to Table I for Individual Bag Sample Identification**

Conclusions:

In our opinion, based on the combination of FTIR, burn analysis and visual examination, the Sixteen (16) Bags of samples contain primarily non-compostable materials such as PP, PE, PS and PVC. A small amount of the observed specimens were composed of potentially compostable materials such as cellulose, starch and polyester based resins.

Results:

***Refer to Tables I-II for Individual Bag Content**

Bag #1: NN1 Film Plastics: Approximately 95% of the contents observed in this bag were composed of non-compostable material. This included PE, PP, PVC, Nylon and Vinyl. The remaining contents (~5%) were composed of potentially compostable materials. This includes cellulose and starch. FTIR spectra are attached.

Bag # 2: Film Plastic, NN2: Approximately 98% of the samples observed in this bag were non-biodegradable. The 98% was comprised of PE/PP Bags and latex gloves. The remaining ~2% was composed of cellulose and regenerated cellulose which have potential of composting.

Bag # 3: Hard Plastic, NN1: Bag # 3 contained 100% non-compostable materials. PE, PP, PVC, Inert Material (glass, rocks), Nylon, PS and Latex made up the non-compostable materials.

Bag #4: NN1 – Other Plastics: Approximately 98% of the contents observed in this bag were composed of non-compostable material. This included PP, PE and Latex. The remaining contents (~2%) were composed of potentially compostable materials. This includes starch and a polyester based resin. FTIR spectra are attached.

Bag #5: NN2 – Other Plastics: Bag # 5 contained 100% non-compostable material. This included PE. FTIR spectra are attached.

Bag # 6: Film Plastic – Middles and Gross Overs, PRC 1: Approximately 97% of the contents observed in this bag were composed of non-compostable material. This included PP, PE, Latex and Nylon. The remaining contents (~3%) were composed of potentially compostable materials. This includes cellulose and regenerated cellulose.

Bag# 7: Film Plastic – Gross Overs, PRC 2: Approximately 87% of the contents observed in this bag were composed of non-compostable material. This included PE, PP, Latex and PS. The remaining contents (~13%) were composed of potentially compostable materials. This includes cellulose, cellulose acetate and regenerated cellulose.

Bag# 8: Film Plastic – Gross Overs, PRC 3: Approximately 96% of the contents observed in this bag were composed of non-compostable material. This included PP, PE and Latex. The remaining contents (~4%) were composed of potentially compostable materials. This included cellulose.

Bag# 9: Hard plastic – Gross Overs, PRC 1: Approximately 99% of the contents observed in this bag were composed of non-compostable material. This included PP, PE, Rubber (EPDM), Nylon, PVC and Copper. The remaining contents (~1%) were composed of potentially compostable materials. This included cellulose acetate.

Bag# 10: Hard plastic – Gross Overs, PRC 2: Bag # 10 contained 100% non-compostable material. This included PE, PP and Latex.

Bag# 11: Hard plastic – Gross Overs, PRC 3: Approximately 99% of the contents observed in this bag were composed of non-compostable material. This included PP, PE, PET, Latex, Glass and Metal. The remaining contents (~1%) were composed of potentially compostable materials. This included cellulose.

Bag# 12: Possible Compostable Gross Overs, PRC: Approximately 70% of the contents observed in this bag were composed of non-compostable material. This included PP. The remaining contents (~30%) were composed of potentially compostable materials. This included cellulose which was the majority and polyester. FTIR spectra are attached.

Bag# 13: Hard Plastic – Middles, PRC 4: Approximately 99% of the contents observed in this bag were composed of non-compostable material. This included PP, PE, PS, Nylon and Rubber. The remaining contents (~1%) were composed of potentially compostable materials. This included cellulose.

Bag# 14: Film Plastic – Middles, PRC 4: Approximately 99% of the contents observed in this bag were composed of non-compostable material. This included PE, PP, Latex, Metal and Glass. The remaining contents (~1%) were composed of potentially compostable materials. This included cellulose.

Bag# 15: Film Plastic – Middles, PRC 5: Approximately 97% of the contents observed in this bag were composed of non-compostable material. This included PP, PE, PS, Nylon and Latex. The remaining contents (~3%) were composed of potentially compostable materials. This included cellulose.

Bag# 16: Possible Compostable, Middles: Approximately 60% of the contents observed in this bag were composed of non-compostable material. This included PP and PE. The remaining contents (~40%) were composed of potentially compostable materials. This included starch, PLA and polyester based resin.

Discussion/ Experimental:

The materials were reviewed and categorized by a combination of visual examination, burn testing (for color and odor) and when appropriate, spectroscopy. Spectroscopy was performed using an ATR Module FTIR on an Infrared Spectrometer Perkin Elmer Model 100.

James Cameron
James Cameron
Lab Manager

Greg Geil
Greg Geil
Environmental Scientist

Attachments: Tables I-II, FTIR Spectra, Digital Photographs

BPI

Project#: 12P1135

Table I - Approximate Values of Potentially Compostable and Non Compostable Contents by Volume

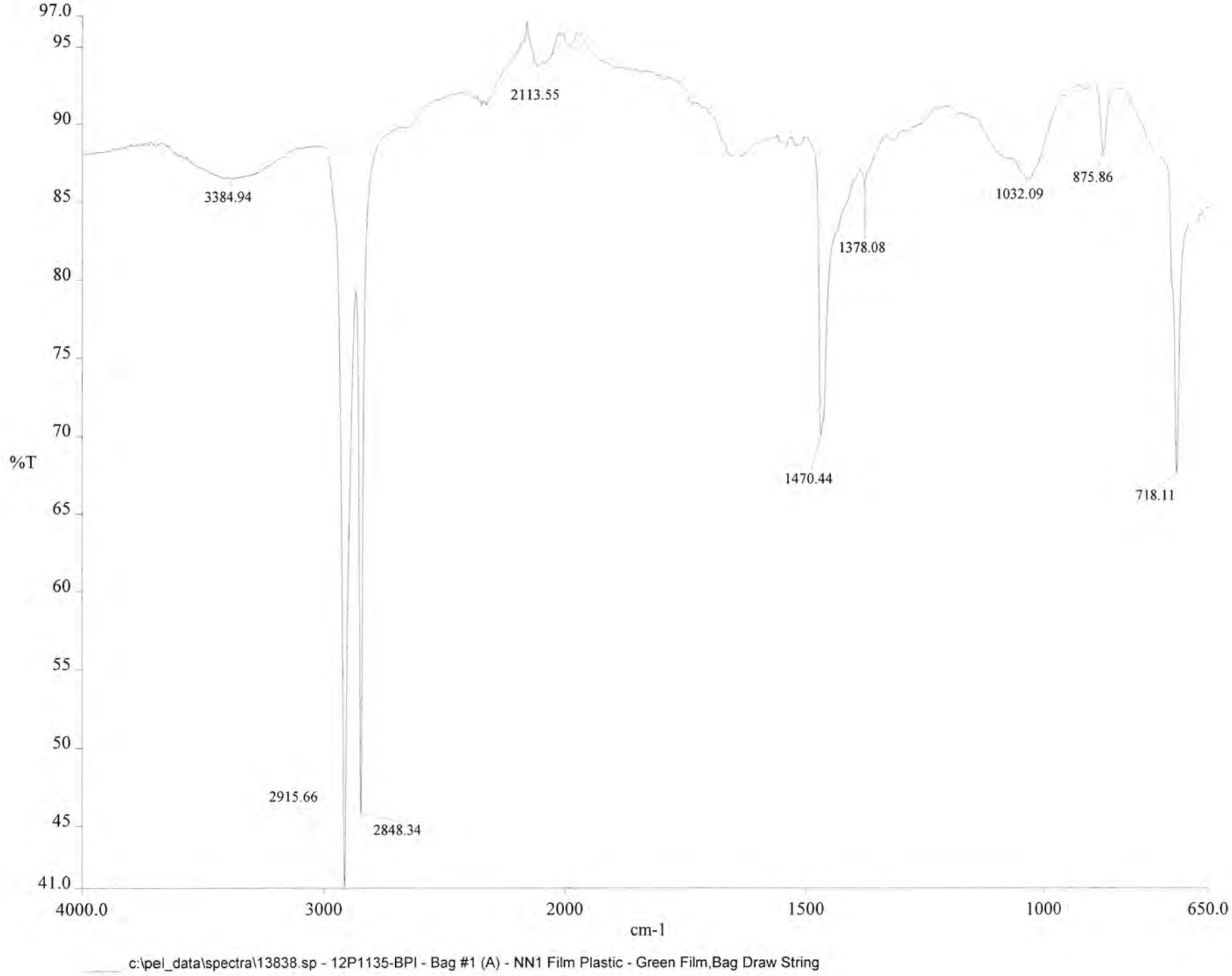
Bag #	AMC Sample ID	Location	Content Description	Potentially Compostable	Non Compostable	Most Frequently Found Materials	As Received Total Bag Weight (Kg)
1	A	NN1	Film Plastic	<5.00%	>95.00%	PE	0.6560
2	B	NN2	Film Plastic	<2.00%	>98.00%	PE	0.6035
3	C	NN1	Hard Plastic	<1.00%	>99.00%	PP/PE	0.6900
4	D	NN1	Other Plastics - Possible Compostable Cutlery	60.00%	40.00%	PLA Based	0.0840
5	E	NN2	Other Plastics - Possible Compostable Film	0.00%	100.00%	PE	0.0100
6	F	PRC1	Film Plastic - Middles and Gross Overs	<3.00%	>97.00%	PP/PE	0.7240
7	G	PRC2	Film Plastic - Gross Overs	13.00%	87.00%	PE	0.9075
8	H	PRC3	Film Plastic - Gross Overs	4.00%	96.00%	PP	0.4155
9	I	PRC1	Hard Plastic - Gross Overs	<1.00%	>99.00%	PP/PE	0.4685
10	J	PRC2	Hard Plastic - Gross Overs	<1.00%	>99.00%	PE	0.6720
11	K	PRC3	Hard Plastic - Gross Overs	<1.00%	>99.00%	PP	0.4535
12	L	PRC	Possible Compostable - Gross Overs	<10.00%	>90.00%	PP	0.1330
13	M	PRC4	Hard Plastic Middles	<1.00%	>99.00%	PP/PE	0.4715
14	N	PRC4	Film Plastic Middles	<1.00%	>99.00%	PE	1.0820
15	O	PRC5	Film Plastic Middles	3.00%	97.00%	PE	0.6740
16	P	PRC	Possible Compostable - Middles	40.00%	60.00%	PP/PE	0.0270

NN = Natures Needs
PRC = Portland Recycling Center
*Compostable refers to materials with the potential to biodegrade when placed in a composting environment

Table II - Content Classification

			Content Description	Cellulose	Regenerated Cellulose	Polyester AND PLA	Starch/PP	Cellulose Acetate	PP	PE	PS	PET	Nylon	Latex	PVC	Inert	Rubber
			Typical Examples	Paper/Cardboard	Metalized Materials	Film & Cutlery	Cutlery	Rags	Straws	Bags	Foam/ Cutlery	Bottles	Weed Eater String	Gloves	Gloves	Copper/ Glass	Gloves
Bag #	AMC Sample ID	Location	Compostability status	Compostable	Compostable	Compostable	Partially compostable	Potentially compostable	Non-Compostable								
1	A	NN1	Film Plastic	N	N	N	Y	N	Y	Y	N	N	Y	N	Y	N	N
2	B	NN2	Film Plastic	Y	Y	N	N	N	Y	Y	N	N	N	Y	N	N	N
3	C	NN1	Hard Plastic	N	N	N	N	N	Y	Y	Y	N	Y	Y	Y	Y	N
4	D	NN1	Other Plastics - Possible Compostable Cutlery	N	N	Y	Y	N	Y	N	N	N	N	N	N	N	N
5	E	NN2	Other Plastics - Possible Compostable Film	N	N	N	N	N	N	Y	N	N	N	N	N	N	N
6	F	PRC1	Film Plastic - Middles and Gross Overs	Y	Y	N	N	N	Y	Y	N	N	Y	Y	N	N	N
7	G	PRC2	Film Plastic - Gross Overs	Y	Y	N	N	Y	Y	Y	Y	N	N	Y	N	N	N
8	H	PRC3	Film Plastic - Gross Overs	Y	N	N	N	N	Y	Y	N	N	N	Y	N	N	N
9	I	PRC1	Hard Plastic - Gross Overs	Y	N	N	N	N	Y	Y	N	N	Y	N	Y	Y	Y
10	J	PRC2	Hard Plastic - Gross Overs	N	N	N	N	N	Y	Y	N	N	N	Y	N	N	N
11	K	PRC3	Hard Plastic - Gross Overs	Y	N	N	N	N	Y	Y	N	Y	N	Y	N	Y	N
12	L	PRC	Possible Compostable - Gross Overs	Y	N	N	N	N	N	Y	N	N	N	N	N	N	N
13	M	PRC4	Hard Plastic Middles	Y	N	N	N	N	Y	Y	Y	N	Y	N	N	N	Y
14	N	PRC4	Film Plastic Middles	Y	N	N	N	N	Y	Y	N	N	N	Y	N	Y	N
15	O	PRC5	Film Plastic Middles	Y	N	N	N	N	Y	Y	Y	N	Y	Y	N	N	N
16	P	PRC	Possible Compostable - Middles	N	N	Y	Y	N	Y	Y	N	N	N	N	N	N	N
			TOTALS by Content Presence:	10	3	2	3	1	14	15	4	1	6	9	3	4	2

NN = Natures Needs
PRC = Portland Recycling Center
N = Not Present
Y = Present
* FTIR, Flame Tests and visual Recycling Classification numbers were used to identify each material in Bags 1-16
** Each individual bag was separated into groups based on known material compositions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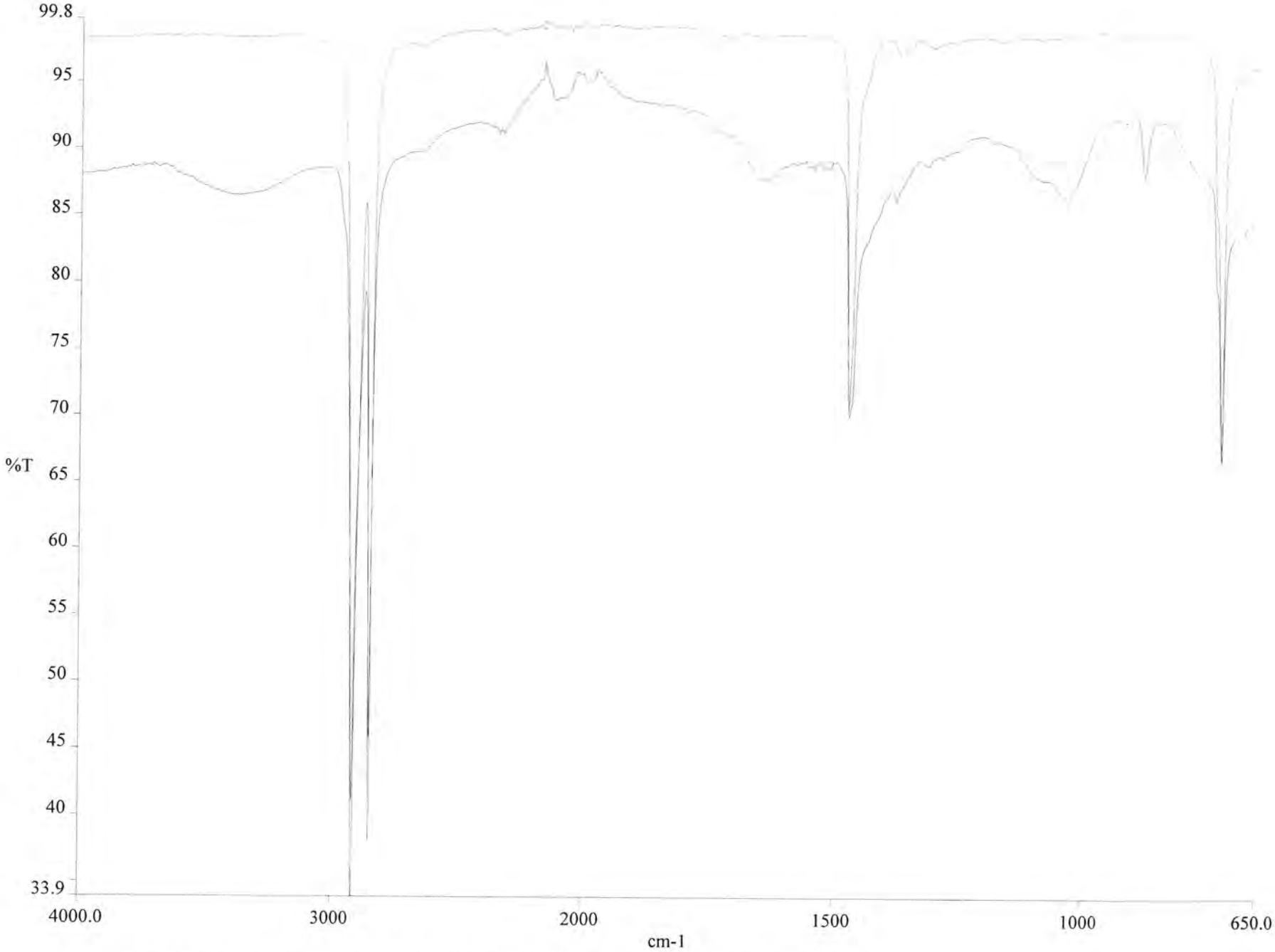
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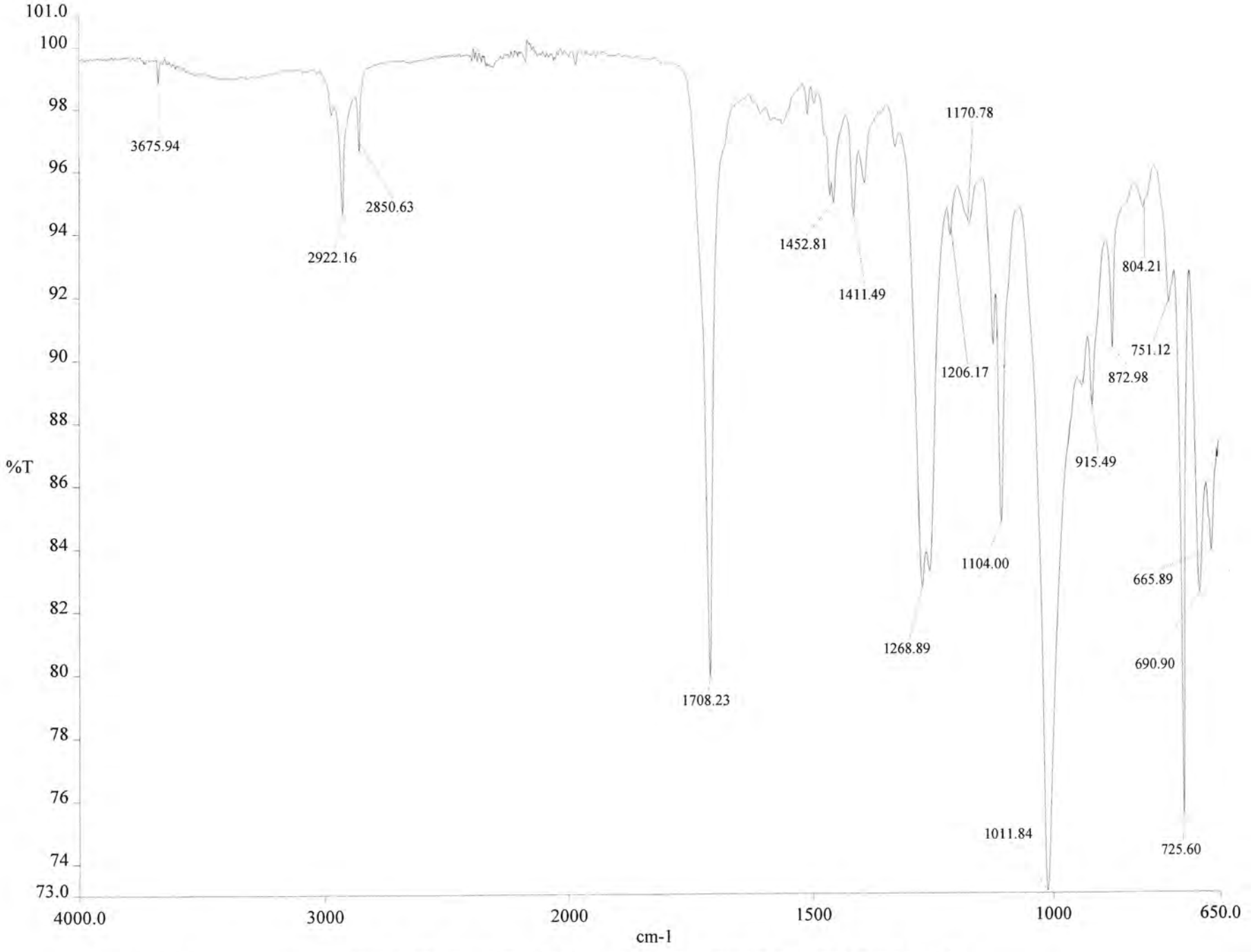

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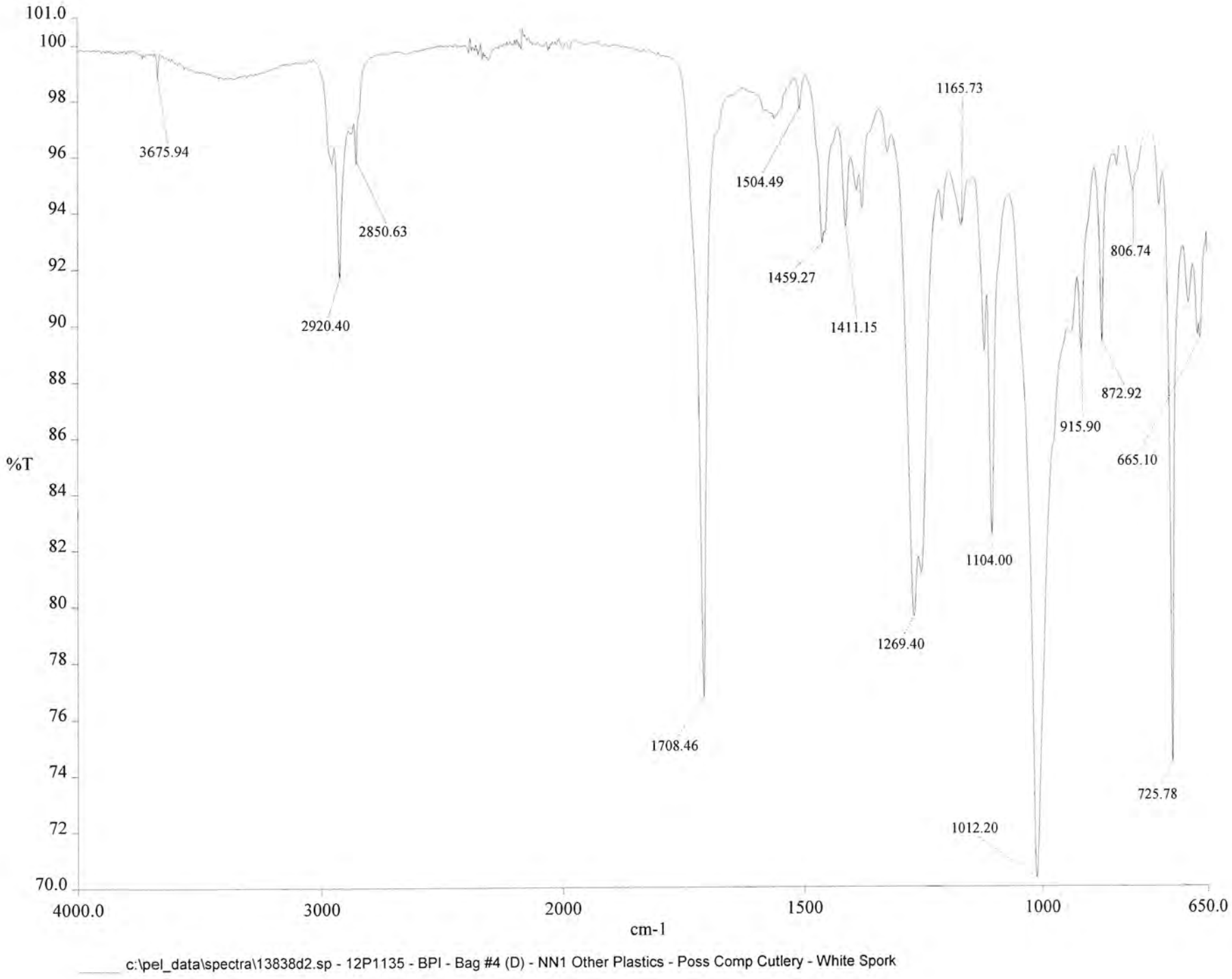
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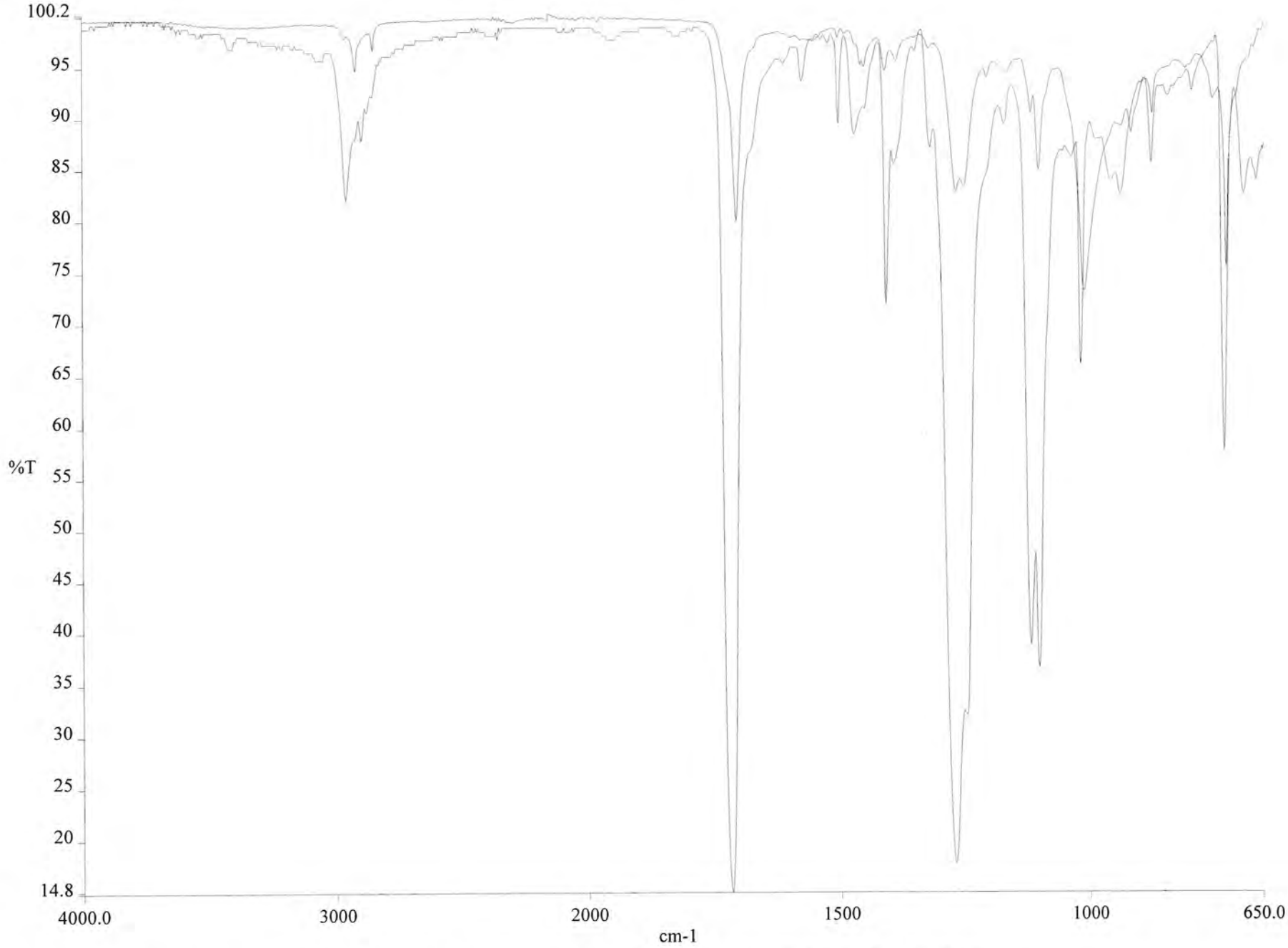
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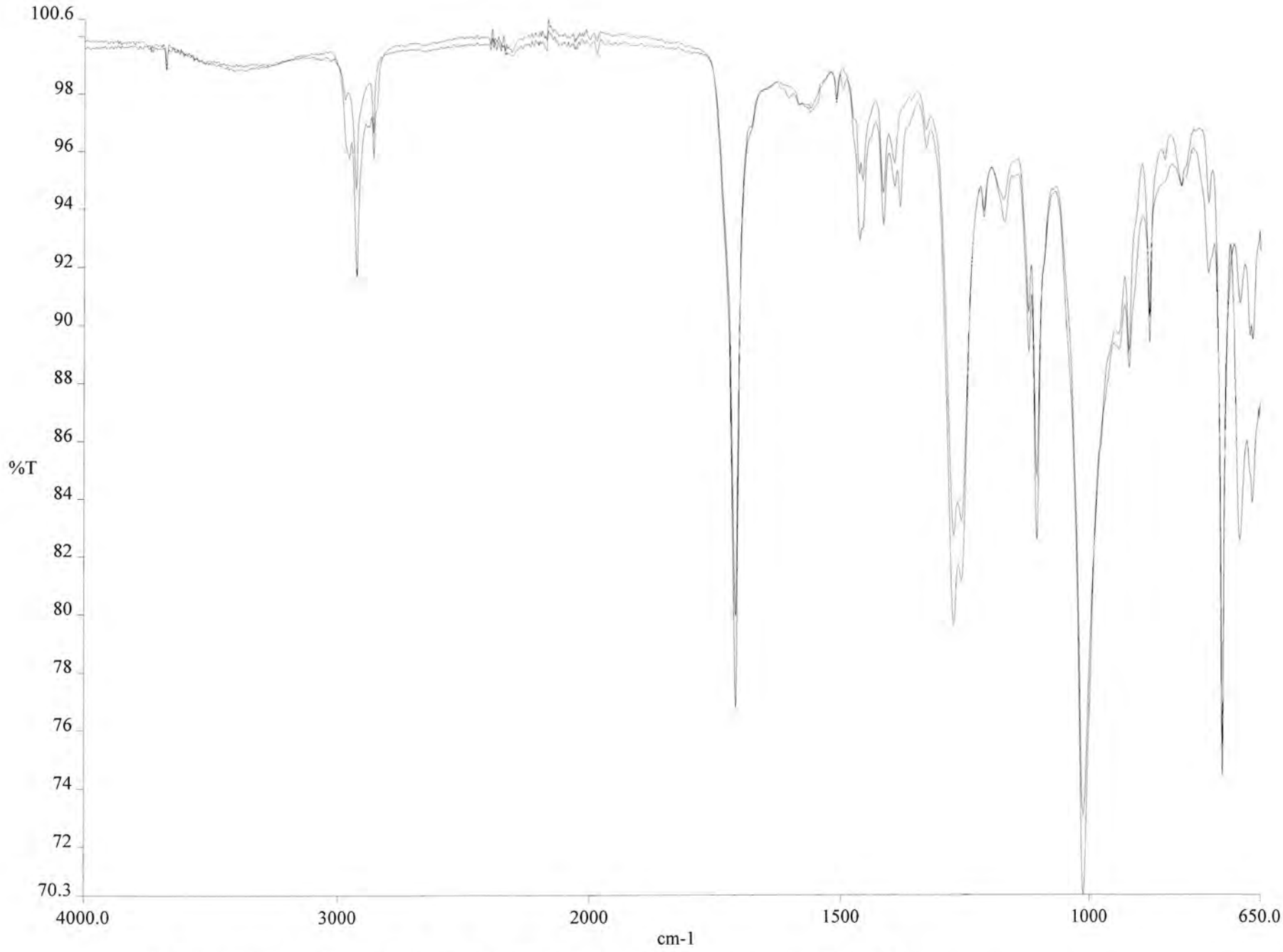
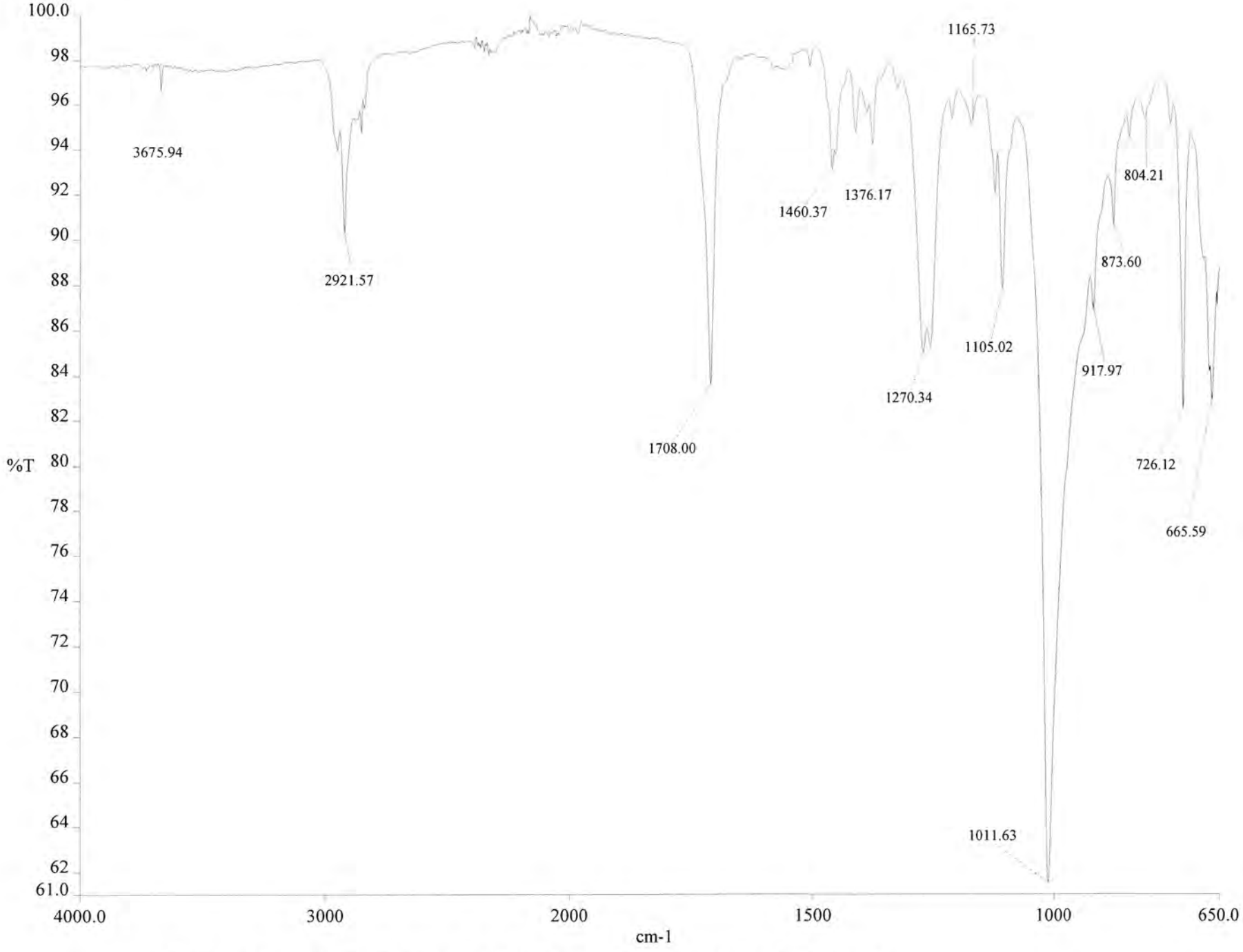
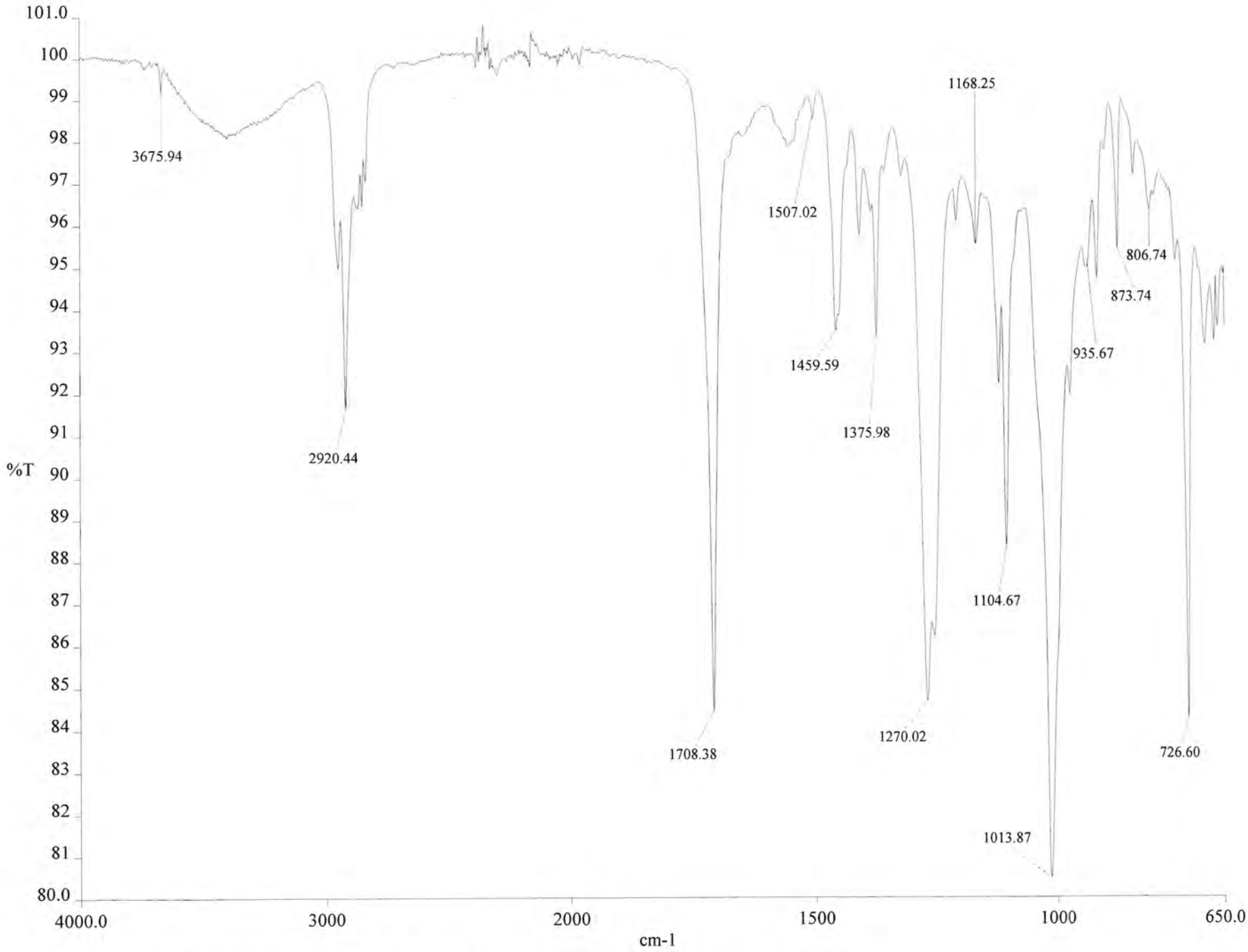
50
45
40
35
30
25
20
14.8
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838d.sp - 12P1135 - BPI - Bag #4 (D) - NN1 Other Plastics - Poss Comp Cutlery - White Cutlery Handle
ct0027.sp - CT0027 POLYESTER [PBT]


100.6
98
96
94
92
90
88
86
%T
84
82
80
78
76
74
72
70.3
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838d2.sp - 12P1135 - BPI - Bag #4 (D) - NN1 Other Plastics - Poss Comp Cutlery - White Spork
c:\pel_data\spectra\13838d.sp - 12P1135 - BPI - Bag #4 (D) - NN1 Other Plastics - Poss Comp Cutlery - White Cutlery Handle


100.0
98
96
94
92
90
88
86
84
82
%T 80
78
76
74
72
70
68
66
64
62
61.0
4000.0
3000
2000
1500
1000
650.0
cm-1
3675.94
2921.57
1708.00
1460.37
1376.17
1270.34
1165.73
1105.02
1011.63
917.97
873.60
804.21
726.12
665.59
c:\pel_data\spectra\13838d3.sp - 12P1135 - BPI - Bag #4 (D) - NN1 Other Plastics - Poss Comp Cutlery - Clamshell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100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
83
82
81
80.0
%T
4000.0
3000
2000
1500
1000
650.0
cm-1
3675.94
2920.44
1708.38
1507.02
1459.59
1375.98
1270.02
1168.25
1104.67
1013.87
935.67
873.74
806.74
726.60
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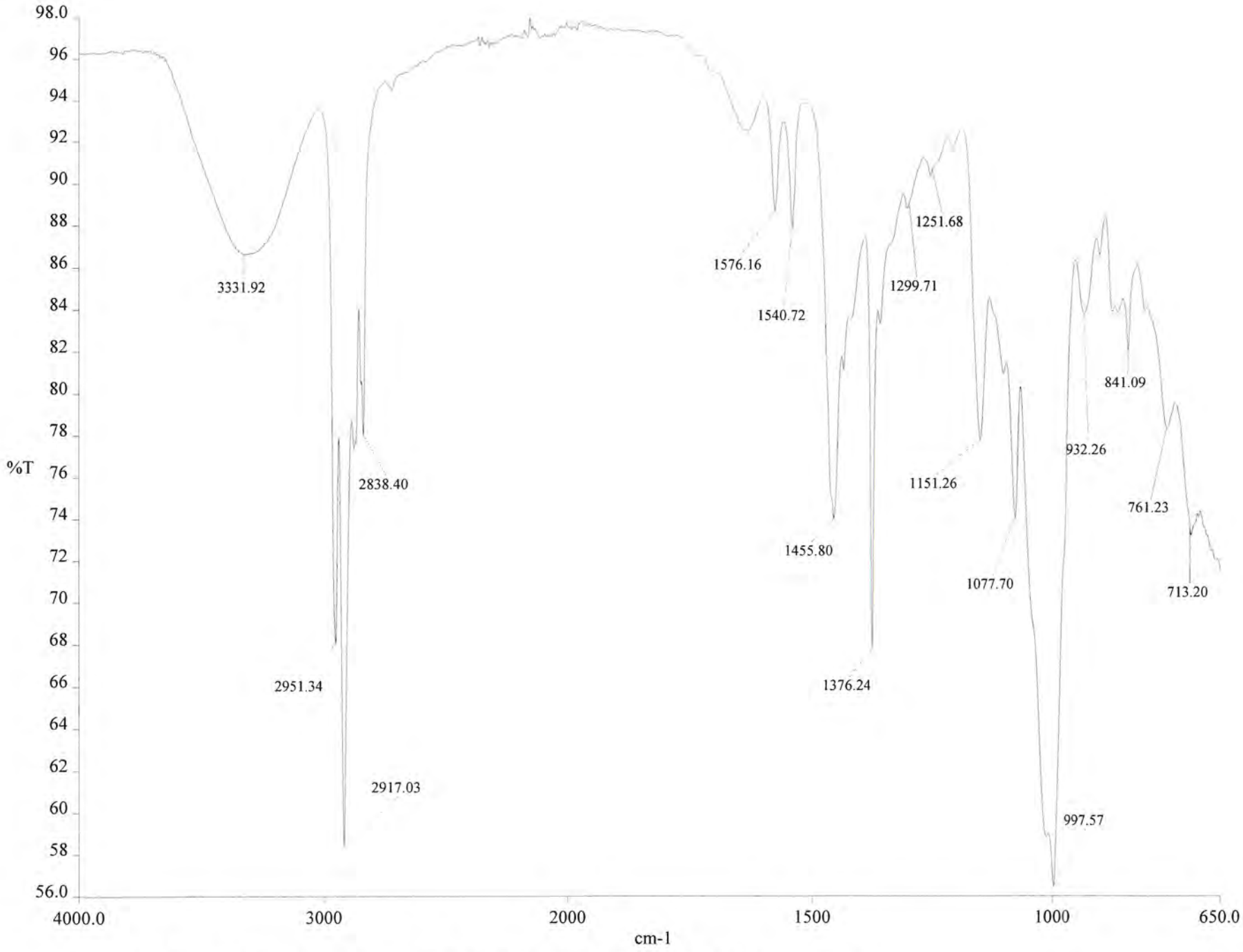
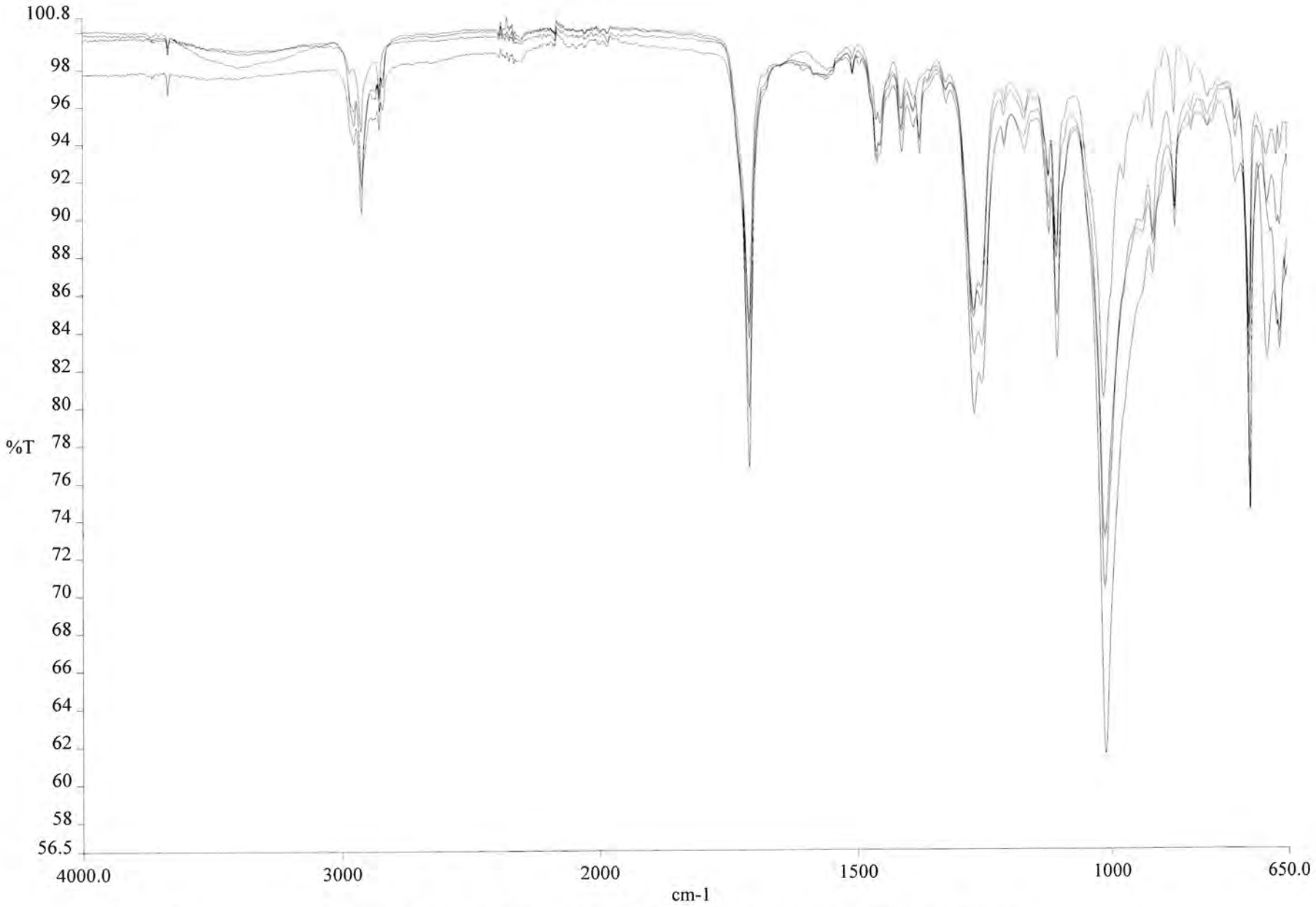

98.0
96
94
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
58
56.0
%T
4000.0
3000
2000
1500
1000
650.0
cm-1
3331.92
2951.34
2917.03
2838.40
1576.16
1540.72
1455.80
1376.24
1299.71
1251.68
1151.26
1077.70
997.57
932.26
841.09
761.23
713.20
c:\pel_data\spectra\13838d5.sp - 12P1135 - BPI - Bag #4 (D) - NN1 Other Plastics - Poss Comp Cutlery - Fork

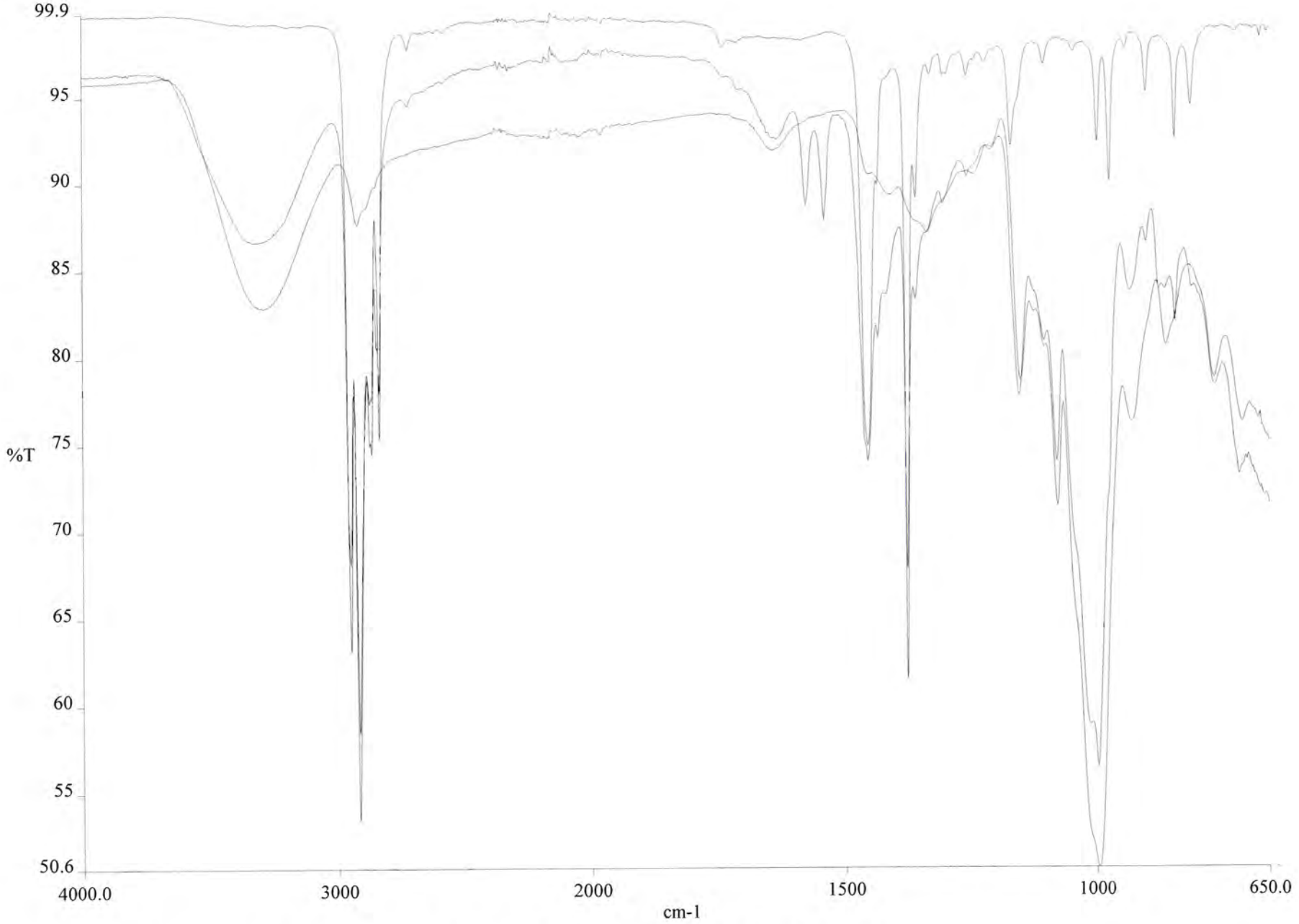


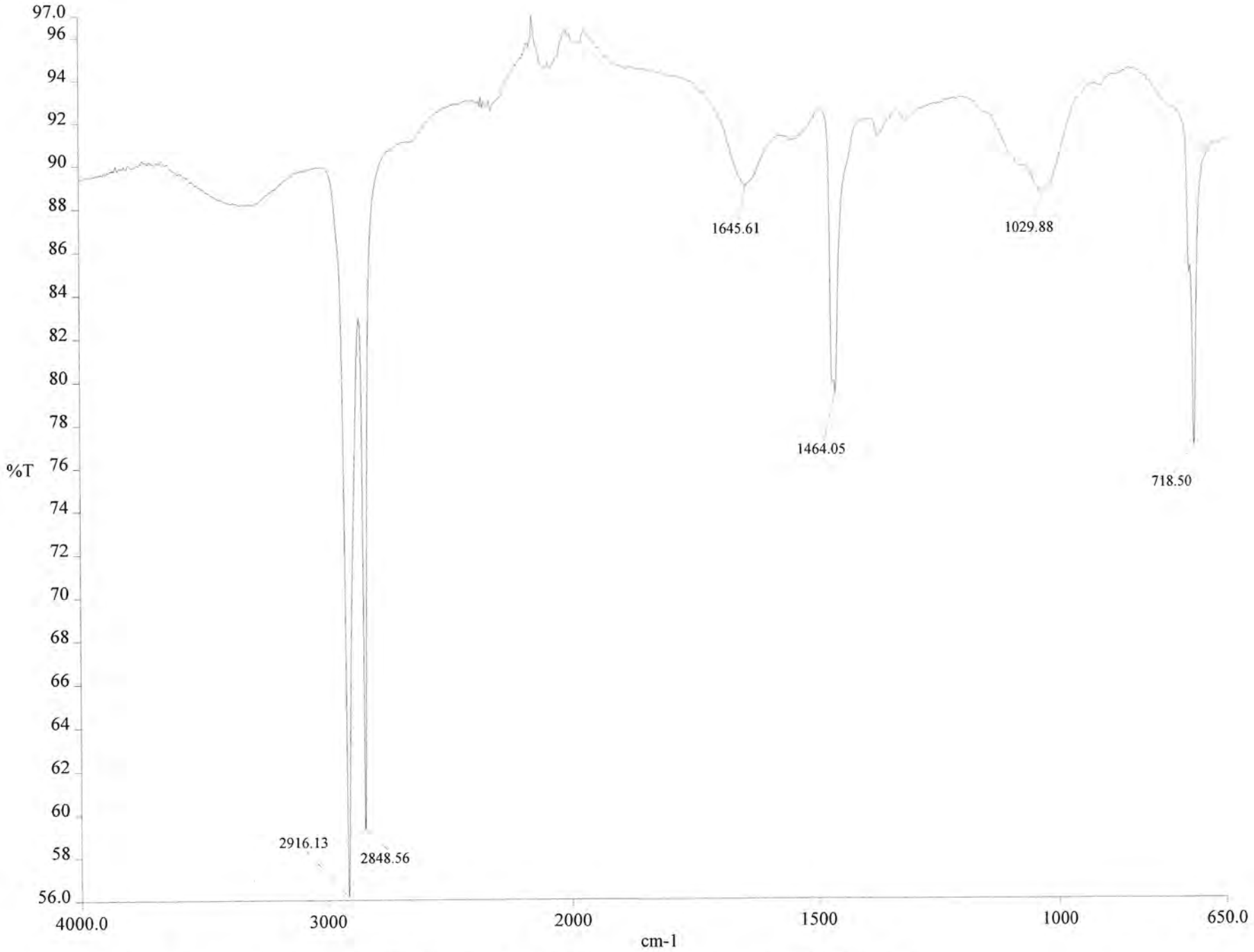
c:\pel_data\spectra\13838d.sp - 12P1135 - BPI - Bag #4 (D) - NN1 Other Plastics - Poss Comp Cutlery - White Cutlery Handle

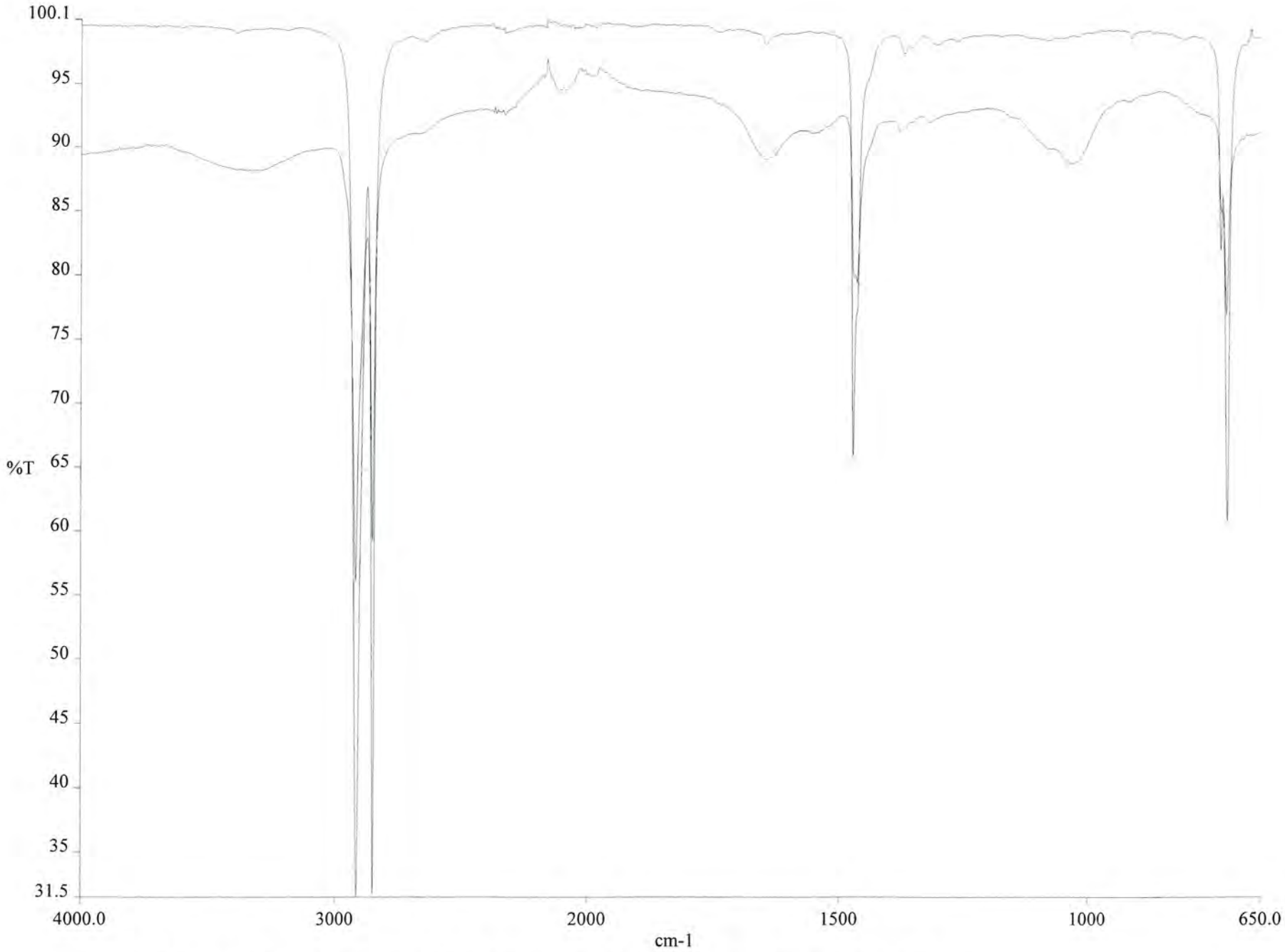
c:\pel_data\spectra\13838d2.sp - 12P1135 - BPI - Bag #4 (D) - NN1 Other Plastics - Poss Comp Cutlery - White Spork

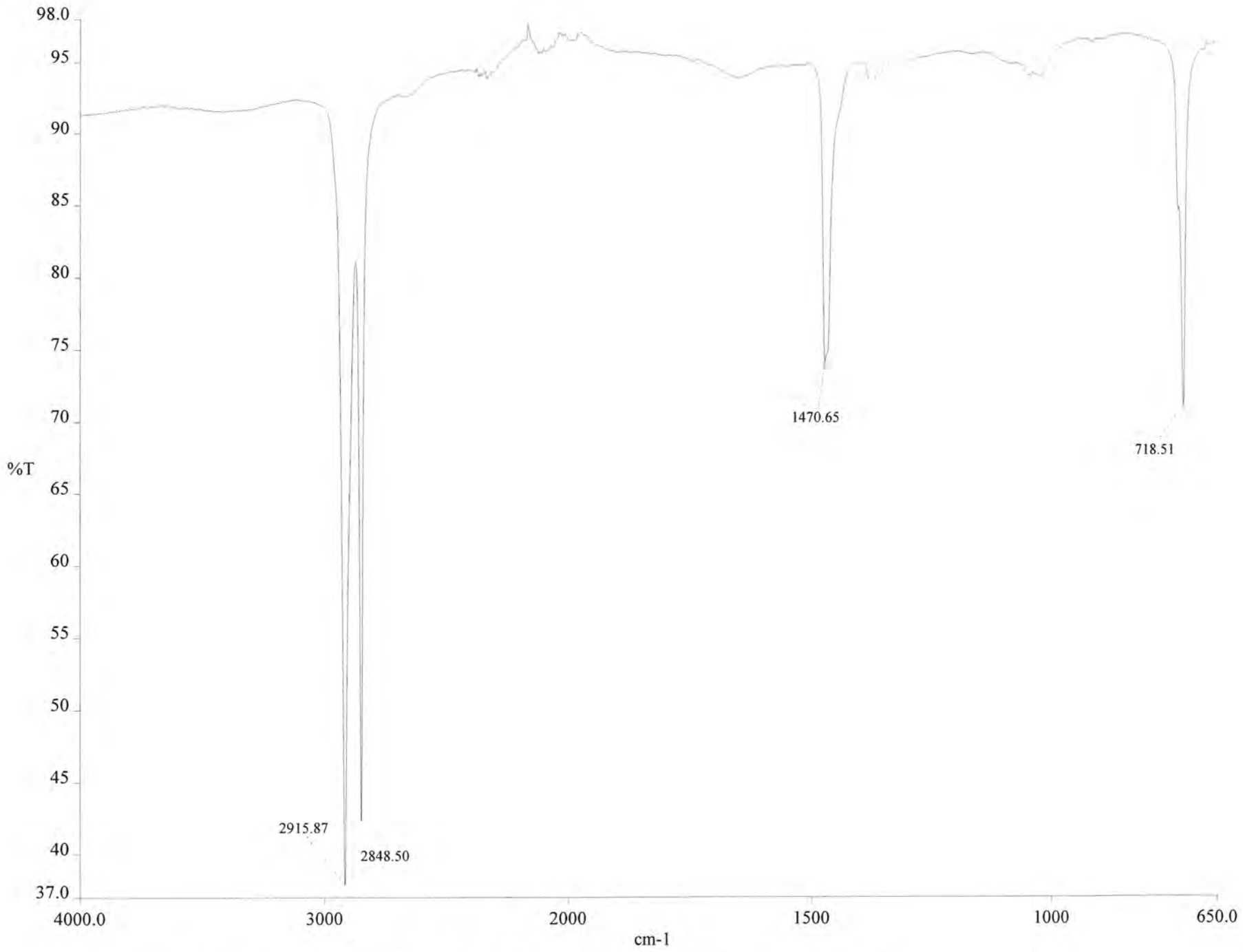
c:\pel_data\spectra\13838d3.sp - 12P1135 - BPI - Bag #4 (D) - NN1 Other Plastics - Poss Comp Cutlery - Clamshell

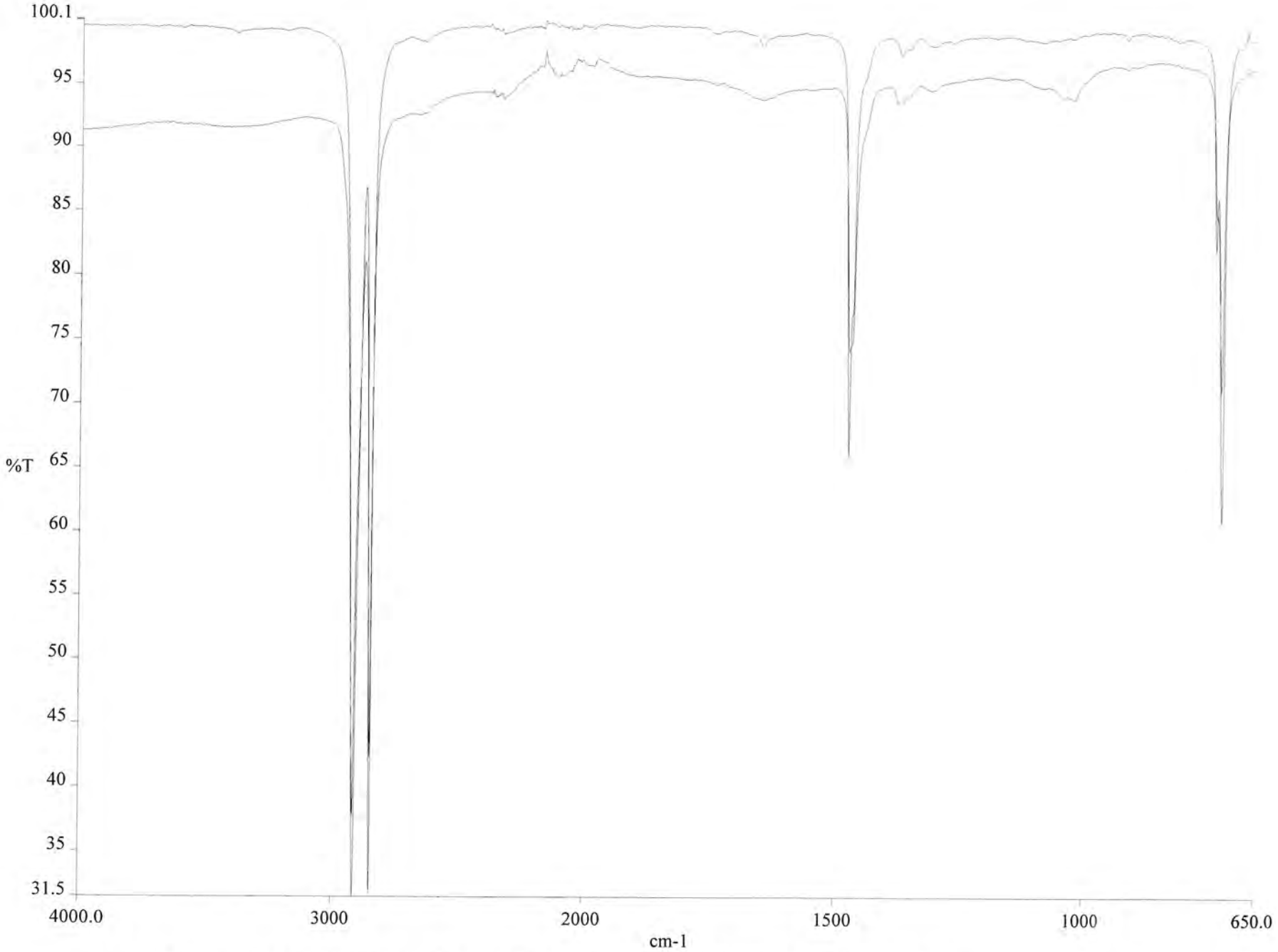
c:\pel_data\spectra\13838d4.sp - 12P1135 - BPI - Bag #4 (D) - NN1 Other Plastics - Poss Comp Cutlery - Spoon

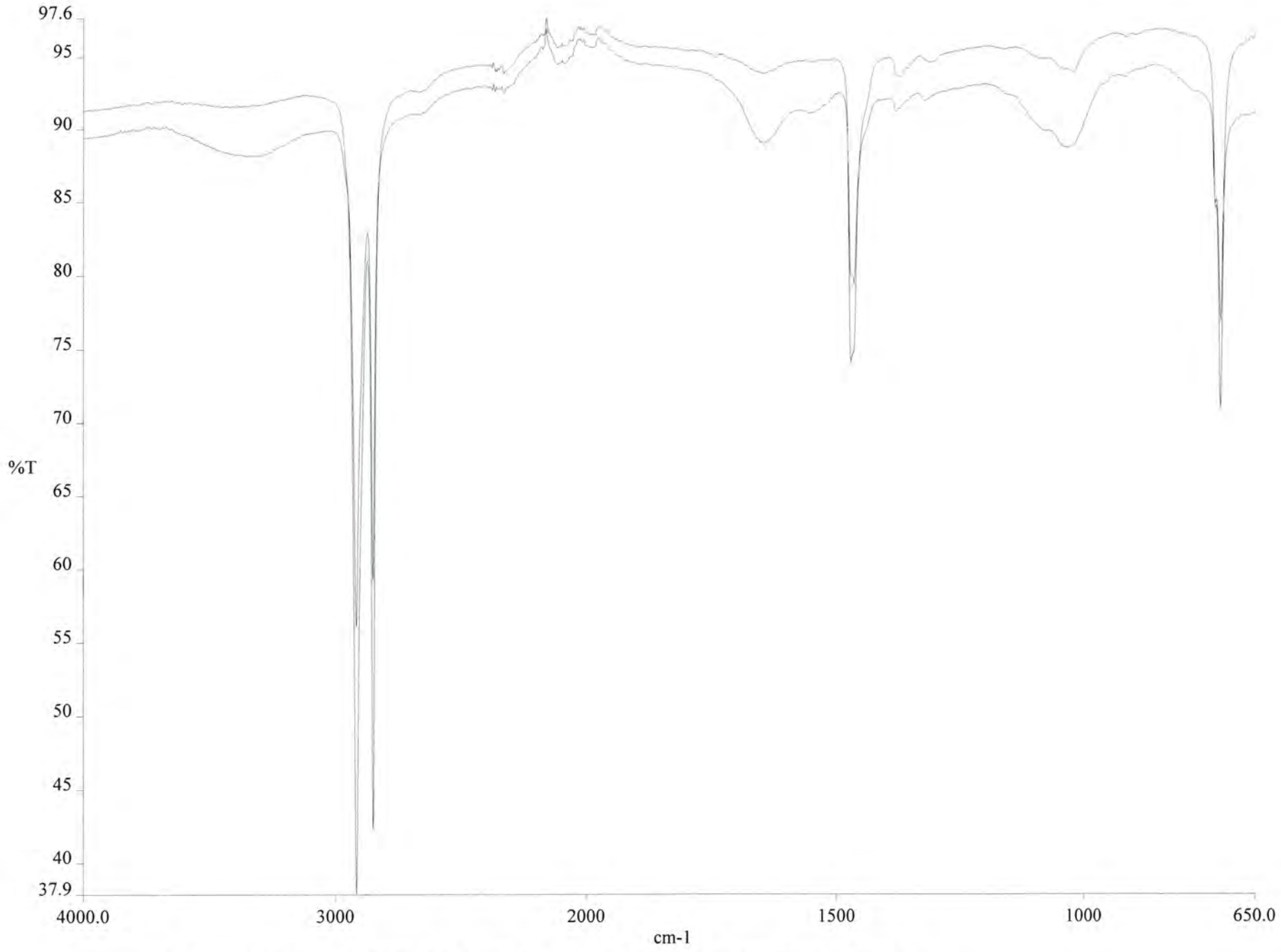

99.9
95
90
85
80
75
70
65
60
55
50.6
%T
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838d5.sp - 12P1135 - BPI - Bag #4 (D) - NN1 Other Plastics - Poss Comp Cutlery - Fork
c:\pel_data\spectra\pp.sp - Polypropylene
c:\pel_data\spectra\corn starch.sp

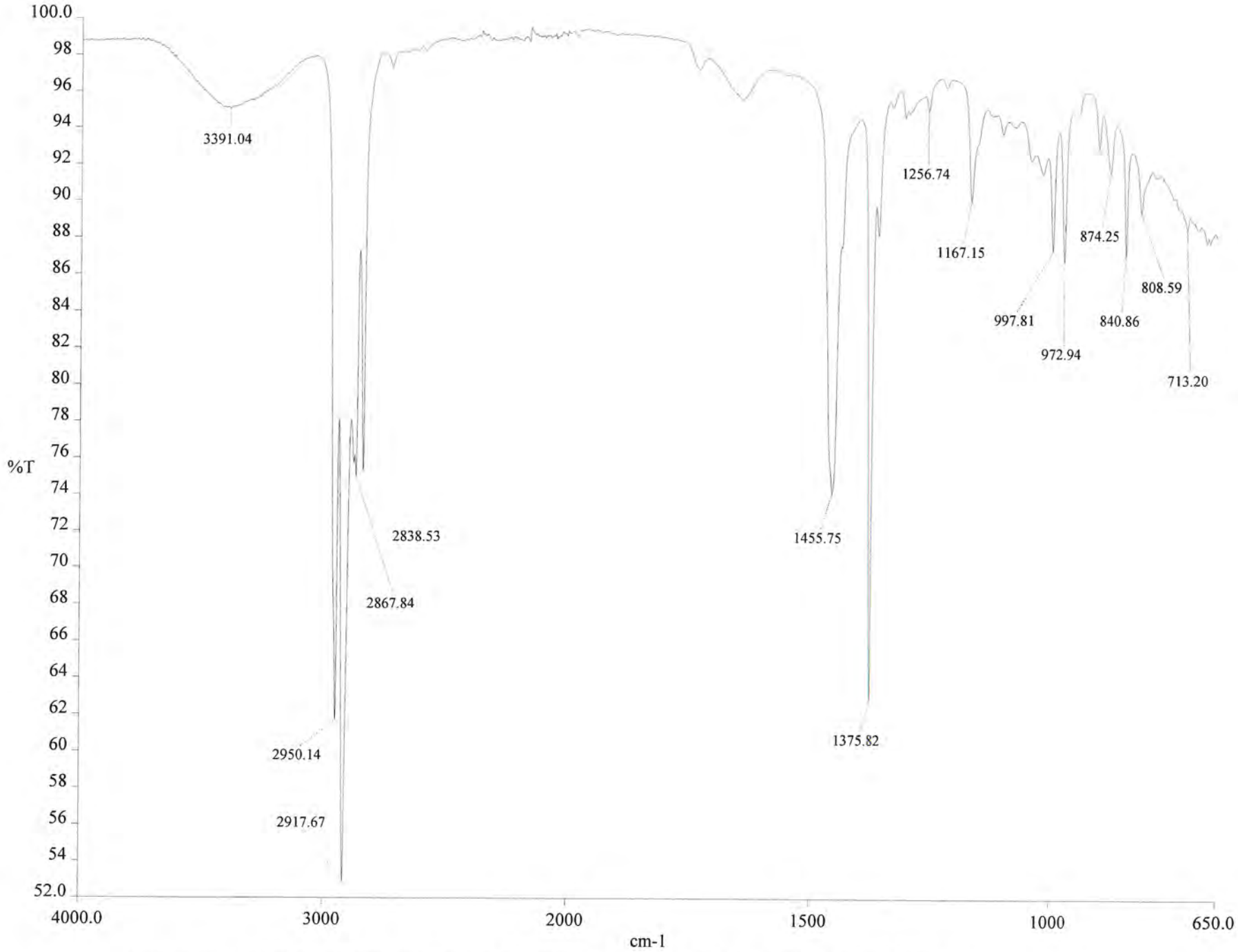

97.0
96
94
92
90
88
86
84
82
80
78
%T 76
74
72
70
68
66
64
62
60
58
56.0
1645.61
1464.05
1029.88
718.50
2916.13
2848.56
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838e.sp - 12P1135 - BPI - Bag #5 (E) - NN2 Other Plastics - Poss Comp Film - Dark Green Film


100.1
95
90
85
80
75
70
65
%T
60
55
50
45
40
35
31.5
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838e.sp - 12P1135 - BPI - Bag #5 (E) - NN2 Other Plastics - Poss Comp Film - Dark Green Film
c:\pel_data\spectra\pe_atr.sp - High Density Polyethylene

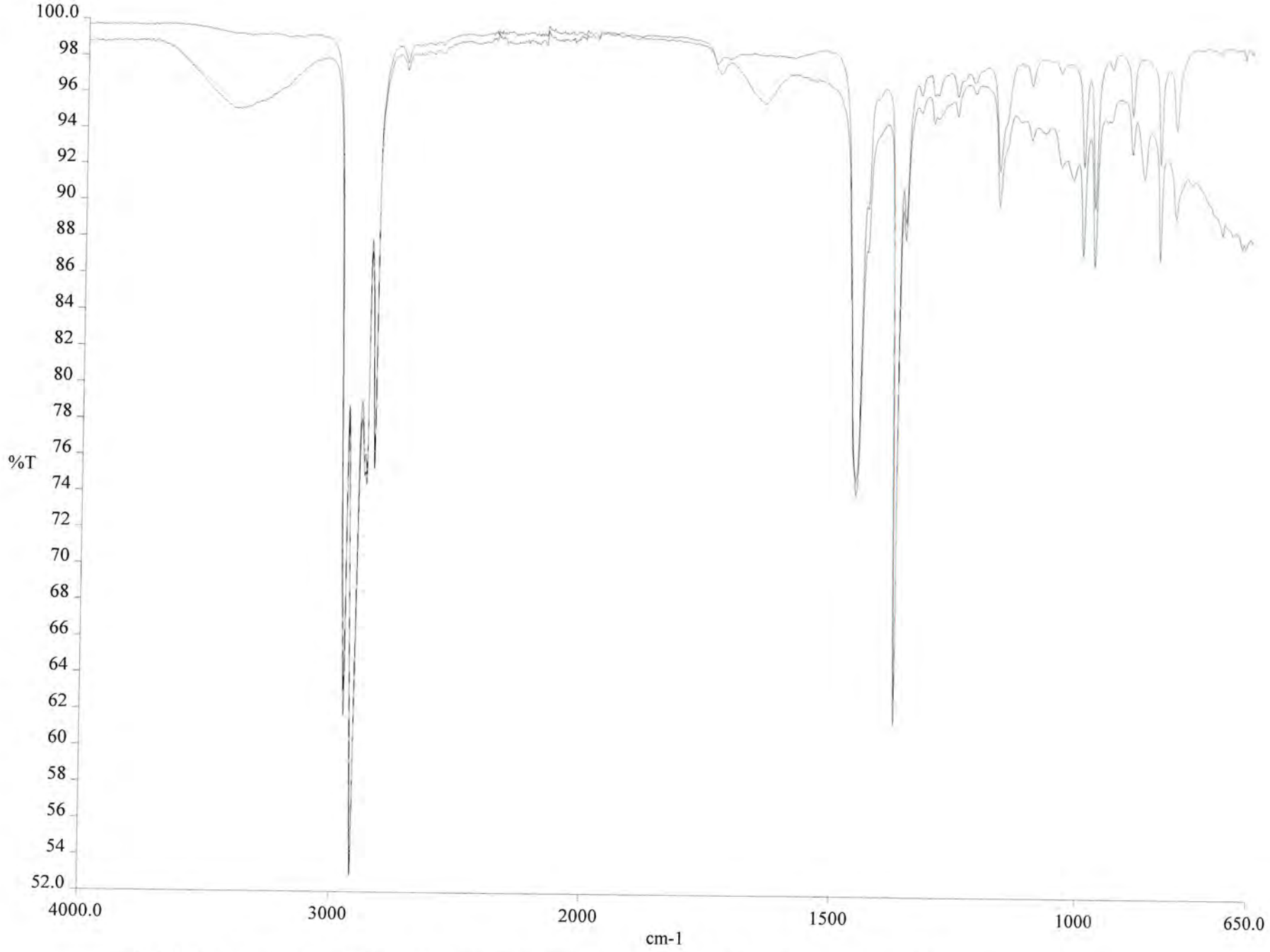

98.0
95
90
85
80
75
70
65
60
55
50
45
40
37.0
%T
2915.87
2848.50
1470.65
718.51
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838e2.sp - 12P1135 - BPI - Bag #5 (E) - NN2 Other Plastics - Poss Comp Film - Light Green Film

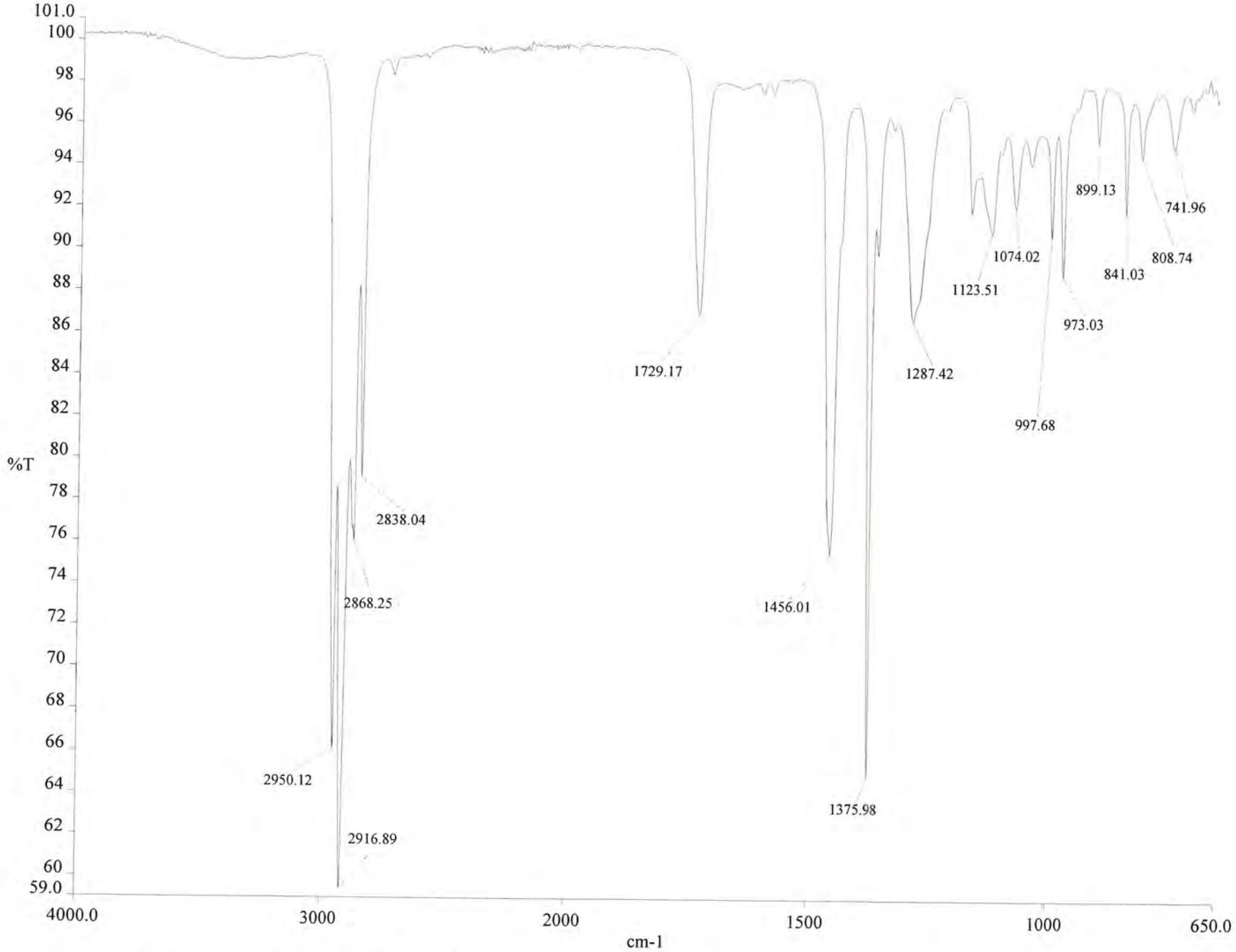

100.1
95
90
85
80
75
70
%T 65
60
55
50
45
40
35
31.5
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838e2.sp - 12P1135 - BPI - Bag #5 (E) - NN2 Other Plastics - Poss Comp Film - Light Green Film
c:\pel_data\spectra\pe_atr.sp - High Density Polyethylene

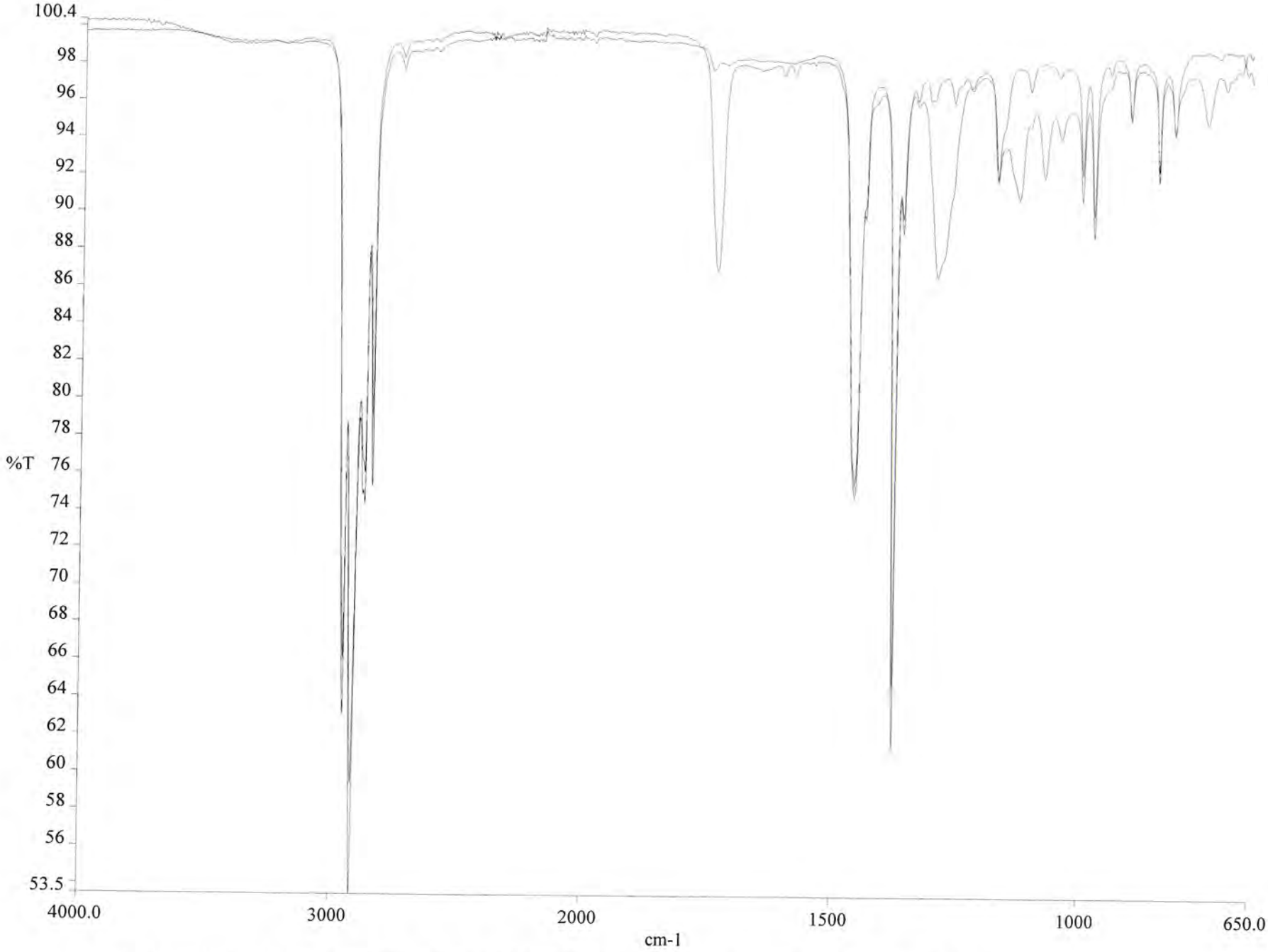

97.6
95
90
85
80
75
70
%T
65
60
55
50
45
40
37.9
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838e.sp - 12P1135 - BPI - Bag #5 (E) - NN2 Other Plastics - Poss Comp Film - Dark Green Film
c:\pel_data\spectra\13838e2.sp - 12P1135 - BPI - Bag #5 (E) - NN2 Other Plastics - Poss Comp Film - Light Green Film



c:\pel_data\spectra\13838l.sp - 12P1135 - BPI - Bag #12 (L) - PRC - Possible Compostable Gross Overs - Large Cup Bottom

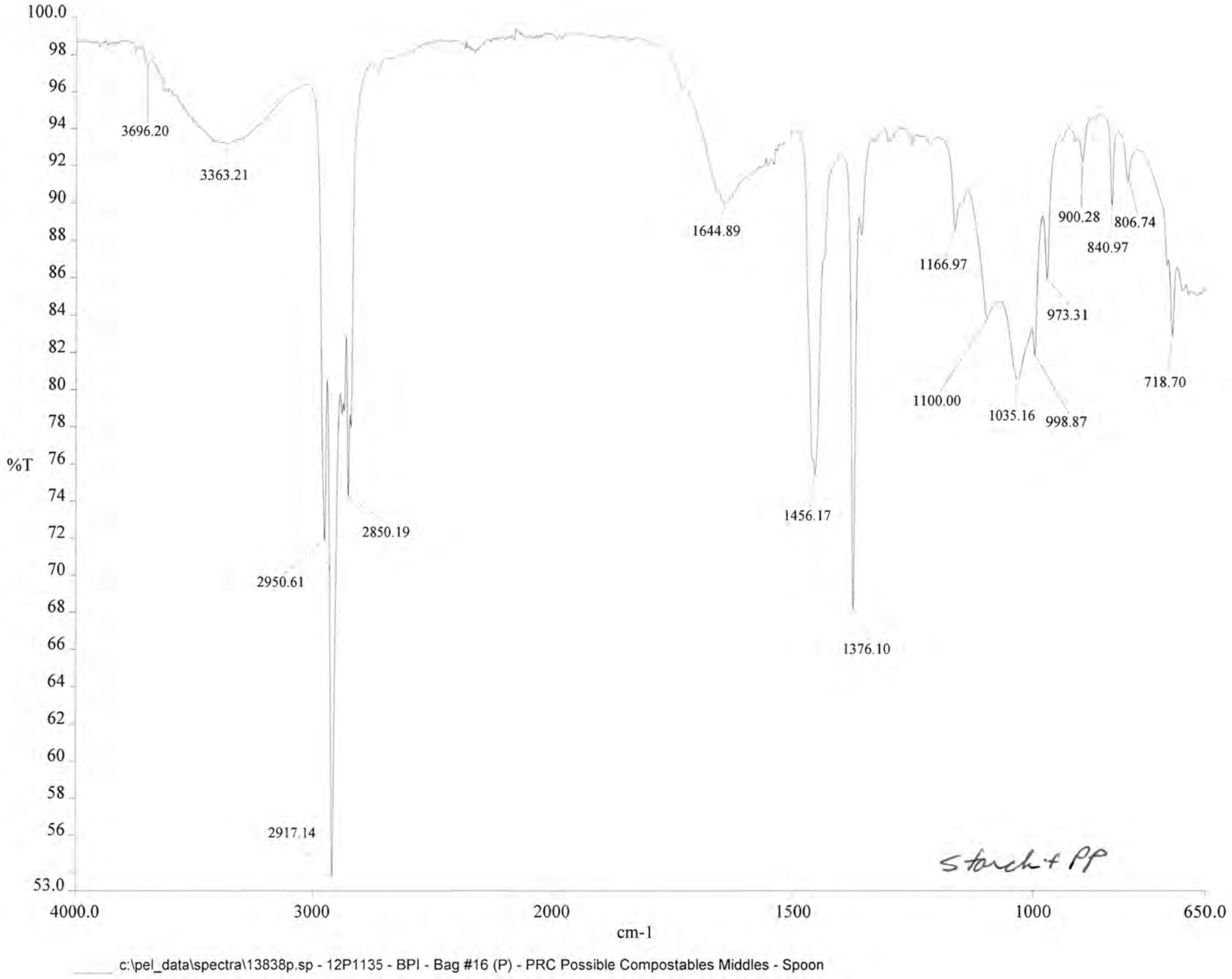

100.0
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52.0
%T
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838l.sp - 12P1135 - BPI - Bag #12 (L) - PRC - Possible Compostable Gross Overs - Large Cup Bottom
c:\pel_data\spectra\pp.sp - Polypropylene


101.0
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
59.0
%T
4000.0
3000
2000
1500
1000
650.0
cm-1
2950.12
2916.89
2868.25
2838.04
1729.17
1456.01
1375.98
1287.42
1123.51
1074.02
997.68
973.03
899.13
841.03
808.74
741.96
c:\pel_data\spectra\13838l2.sp - 12P1135 - BPI - Bag #12 (L) - PRC - Possible Compostable Gross Overs - Laminated Cup


100.4
98
96
94
92
90
88
86
84
82
80
78
%T 76
74
72
70
68
66
64
62
60
58
56
53.5
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838l2.sp - 12P1135 - BPI - Bag #12 (L) - PRC - Possible Compostable Gross Overs - Laminated Cup
c:\pel_data\spectra\pp.sp - Polypropylene

Compare - 13838L2.sp

File:	Correlation:	Factor:	Result:	Description:
1383812.sp	1.0000	1.0000	Pass (>0.000000)	12P1135 - BPI - Bag #12 (L) - PRC - Possible Composta
11904.sp	0.9756	0.1528	Pass (>0.000000)	07P1263-C, Olcott HDPE Resin Pellets #3
13697a3_Outer.sp	0.9738	0.9127	Pass (>0.000000)	11P1296-A3, Italian - #AYI1 film - Outer, As receivec
11995.sp	0.9735	0.1511	Pass (>0.000000)	08P1014-D, Sears Mfg S26086 Total Source, As receiv
11973.sp	0.9730	0.9456	Pass (>0.000000)	07P1289-J, Pedestal #10 Base - Front
12568.sp	0.9714	0.9313	Pass (>0.000000)	09P1162 - Sears - Sample F - S25717 JV, Polypropylene
11946.sp	0.9713	1.0933	Pass (>0.000000)	07P1289-E, Charles Industries Pedestal #5 Base A/R
13486 .sp	0.9706	0.9305	Pass (>0.000000)	11P1039, IPCC Barrel lid material - As received
11878.sp	0.9703	1.1522	Pass (>0.000000)	07P1249 Sinterco Polymer Pellets
11972.sp	0.9702	1.0227	Pass (>0.000000)	07P1289-J, Pedestal #10 Dome
pp.sp	0.9696	0.9300	Pass (>0.000000)	Polypropylene
13679b1.sp	0.9694	2.1315	Pass (>0.000000)	11P1259 #2 Pellet Sample
11974.sp	0.9691	1.0466	Pass (>0.000000)	07P1289-J, Pedestal #10 Base - Back
13679a.sp	0.9685	2.8583	Pass (>0.000000)	11P1259 #1 Pellet Sample
13226_Label.sp	0.9685	0.9184	Pass (>0.000000)	10P1123-B, Soil Control Lab SCL-0030883-02 - Containe
13445.sp	0.9683	0.8985	Pass (>0.000000)	10P1366 - Translucent Plastic Corrugated Material
13734.sp	0.9681	0.8603	Pass (>0.000000)	11P1350-A, SpillGuard film - Printed side, As receive
12452.sp	0.9673	1.1394	Pass (>0.000000)	09P1061-N, Sears Mfg S16697 - Weight indicator - Natu
12326.sp	0.9670	0.8552	Pass (>0.000000)	08P1332-B, Sears Mfg S2002 5500 side cover - Blac
13697C2_Outer.sp	0.9668	0.9051	Pass (>0.000000)	11P1296-C2, Triple Hearts - #ACT2 film - Outer, As re
13682a.sp	0.9656	0.8701	Pass (>0.000000)	11P1266-A, AEP film - Print side, As received
13697a2_Outer.sp	0.9654	0.9047	Pass (>0.000000)	11P1296-A2, Italian - #ACI2 film - Outer, As receivec
13631.sp	0.9653	2.0717	Pass (>0.000000)	11P1195- Polybond 3000 Transparent Crystalline Pellet
13697B1_Outer.sp	0.9650	0.9097	Pass (>0.000000)	11P1296-B1, Salsa - #ACI1 film - Outer, As received 2
11964.sp	0.9648	1.0175	Pass (>0.000000)	07P1289, Pedestal #3 - Base - Back
12455.sp	0.9647	0.8847	Pass (>0.000000)	09P1062, Sears Manufacturing S25618, Book back cover
13697C3_Outer.sp	0.9646	0.8905	Pass (>0.000000)	11P1296-C3, Triple Hearts - #AYT1 film - Outer, As re
13385c.sp	0.9643	0.9967	Pass (>0.000000)	09P1373 - PGI Mexico - Unoxidized Sample H - S015A12


100.0
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96
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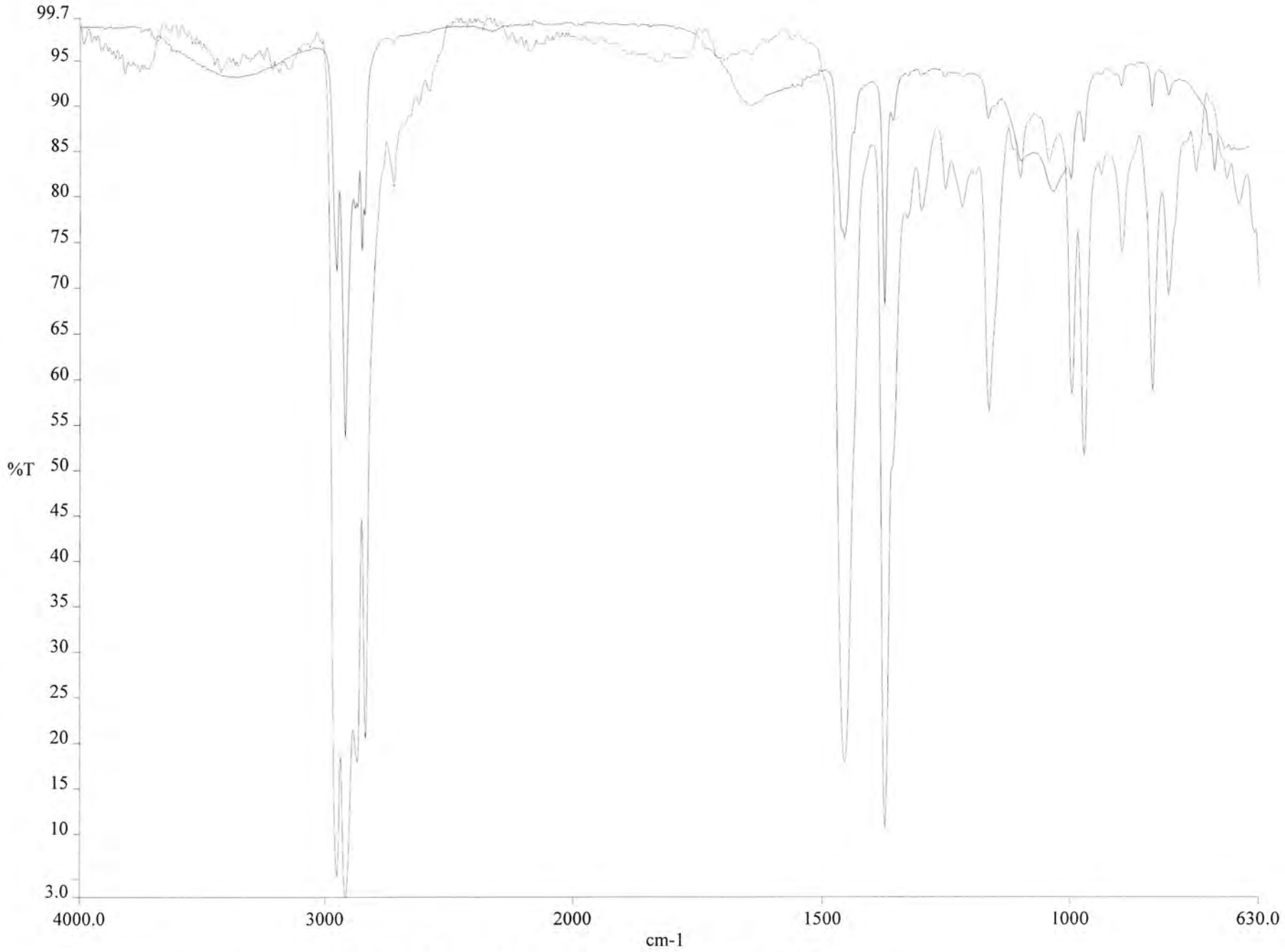
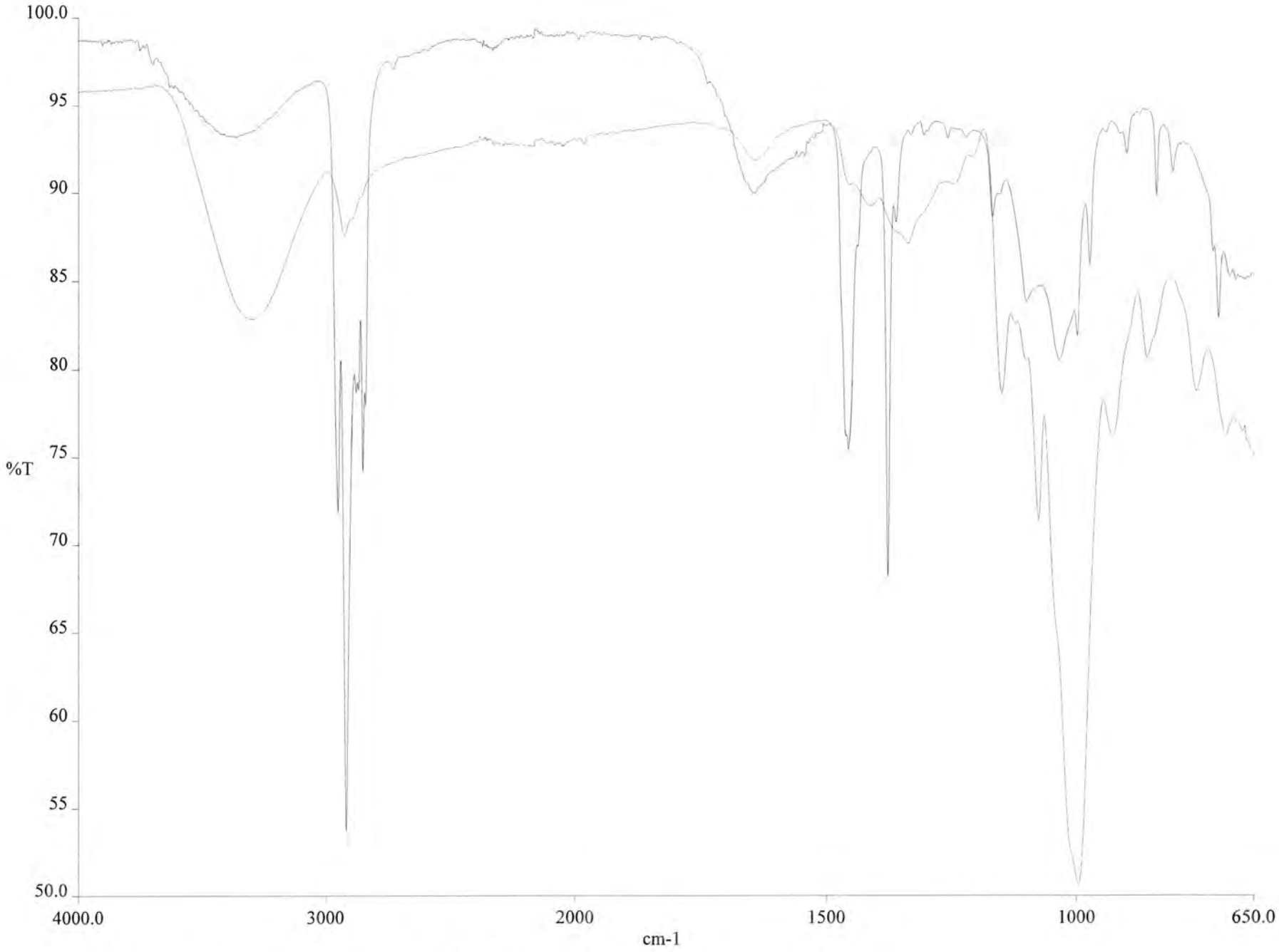
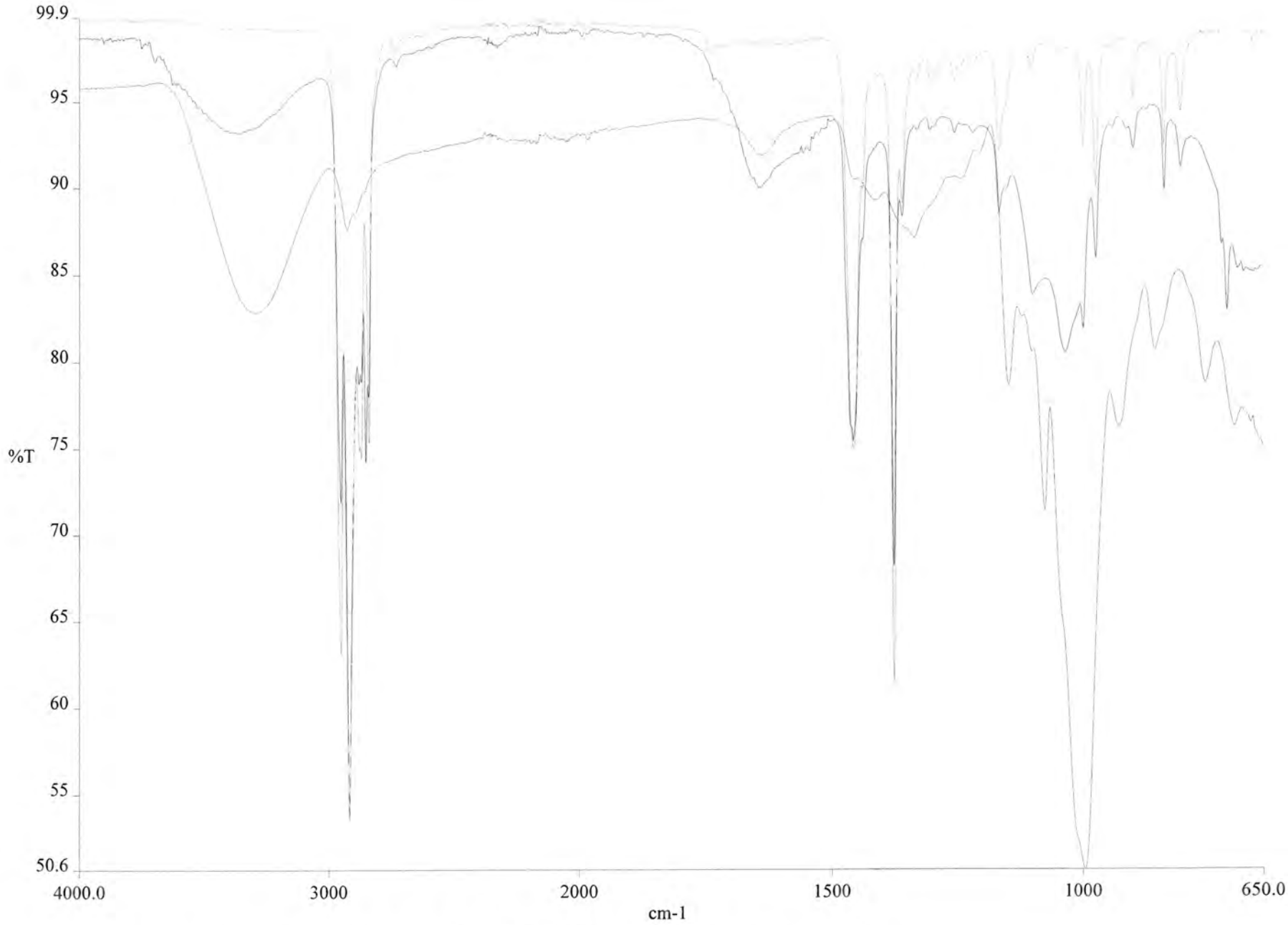
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
58
56
53.0
%T
3696.20
3363.21
2950.61
2917.14
2850.19
1644.89
1456.17
1376.10
1166.97
1100.00
1035.16
998.87
973.31
900.28
840.97
806.74
718.70
4000.0
3000
2000
1500
1000
650.0
cm-1
starch + PP
c:\pel_data\spectra\13838p.sp - 12P1135 - BPI - Bag #16 (P) - PRC Possible Compostables Middles - Spoon


99.7
95
90
85
80
75
70
65
60
55
%T 50
45
40
35
30
25
20
15
10
3.0
4000.0
3000
2000
1500
1000
630.0
cm-1
c:\pel_data\spectra\13838p.sp - 12P1135 - BPI - Bag #16 (P) - PRC Possible Compostables Middles - Spoon
ap0065.sp - AP0065 POLYPROPYLENE, ISOTACTIC


100.0
95
90
85
80
75
%T
70
65
60
55
50.0
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838p.sp - 12P1135 - BPI - Bag #16 (P) - PRC Possible Compostables Middles - Spoon
c:\pel_data\spectra\corn starch.sp


99.9
95
90
85
80
75
70
65
60
55
50.6
%T
4000.0
3000
2000
1500
1000
650.0
cm-1
c:\pel_data\spectra\13838p.sp - 12P1135 - BPI - Bag #16 (P) - PRC Possible Compostables Middles - Spoon
c:\pel_data\spectra\corn starch.sp
c:\pel_data\spectra\pp.sp - Polypropylene

Appendix B
FIELD DATA SHEETS

BIODEGRADABLE PRODUCTS INSTITUTE
PORTLAND OVERS SORTING STUDY

SITE NATURE'S NEEDS

DATE 7/25/12

SAMPLE	BUCKET WEIGHT	SAMPLE WEIGHT	NET WEIGHT	CONVERSION (Pounds per Cubic Yard)
1	1.8	19.6	17.8	712
2	1.8	17.8	16	640
3	2.0	18.2	16.2	648
4	2.0	18.2	16.2	648
5	2.0	20.6	18.6	744
6	1.8	16.0	14.2	568
7	1.8	16.8	15	600
8	1.8	20.6	18.8	752
9	1.8	22.2	20.4	816
10	1.8	20.6	18.8	752
11	1.8	20.0	18.2	728
12	1.8	18.2	16.4	656
13	1.8	18.0	16.2	648
14	1.8	21.6	19.8	792
15	1.8	20.0	18.2	728
16	1.8	22.4	20.6	824
17	1.8	20.0	18.2	728
18	1.8	21.2	19.4	776
19	1.8	18.0	16.2	648
20	1.8	19.2	17.4	696
TOTAL			352.6	

PRODUCT WEIGHT

FILM	1.8	5.0	3.2	128
HARD PLASTIC	1.8	3.0	1.2	48
OTHER	1.8	8.0	6.2	248

BIODEGRADABLE PRODUCTS INSTITUTE
PORTLAND OVERS SORTING STUDY

SITE PRC MIDDLES

DATE 7/24/12

SAMPLE	BUCKET WEIGHT	SAMPLE WEIGHT	NET WEIGHT	CONVERSION (Pounds per Cubic Yard)	NOTES
1	2.4	27.2	24.8	992	
2	2.4	26.8	24.4	976	
3	2.4	22.8	20.4	816	
4	2.0	30.2	28.2	1128	
5	2.0	28.4	26.4	1056	
6	2.0	26.6	24.6	984	
7	2.0	26.2	24.2	968	
8	1.8	25.0	23.2	928	
9	1.8	21.8	20	800	
10	2.0	26.0	24	960	
11	1.8	20.2	18.4	736	
12	1.8	24.2	22.4	896	
13	1.8	27.6	25.8	1032	
14	1.8	22.6	20.8	832	
15	1.8	18.0	16.2	648	
16	1.8	18.4	16.6	664	
17	1.8	21.4	19.6	784	
18	1.8	22.0	20.2	808	
19	1.8	22.6	20.8	832	
20	1.8	29.6	27.8	1112	
TOTAL			448.8		
PRODUCT WEIGHT					
FILM	1.8	6.0	4.2	168	
HARD PLASTIC	1.8	3.0	1.2	48	
OTHER	1.8	4.6	2.8	112	

BIODEGRADABLE PRODUCTS INSTITUTE
PORTLAND OVERS SORTING STUDY

SITE PRC GROSS OVERS

DATE 7/24/12

SAMPLE	BUCKET WEIGHT	SAMPLE WEIGHT	NET WEIGHT	CONVERSION (Pounds per Cubic Yard)	NOTES
1	1.8	16.2	14.4	576	
2	1.8	17.4	15.6	624	
3	1.8	16.4	14.6	584	
4	1.8	17.2	15.4	616	
5	1.8	18.2	16.4	656	
6	1.8	22.2	20.4	816	
7	1.8	23.0	21.2	848	
8	1.8	15.2	13.4	536	
9	1.8	14.0	12.2	488	
10	1.8	15.6	13.8	552	
11	1.8	19.0	17.2	688	
12	1.8	17.6	15.8	632	
13	1.8	14.2	12.4	496	
14	1.8	13.2	11.4	456	
15	1.8	14.6	12.8	512	
16	1.8	16.0	14.2	568	
17	1.8	13.2	11.4	456	
18	1.8	13.6	11.8	472	
19	1.8	14.6	12.8	512	
20	1.8	17.2	15.4	616	
TOTAL			292.6		

PRODUCT WEIGHT					%
FILM	1.8	6.4	4.6	184	1.57%
HARD PLASTIC	1.8	5.8	4.0	160	1.37%
OTHER	1.8	14.8	13.0	520	4.44%
TOTAL			21.6		7.38%