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ORGANIC LABORATORY ANALYSIS REPORT
Part 2, amended October 27th 2011

JOB NUMBER C0BEE907
PO NUMBER Credit Card

for

Joe Cerniglia
The International Group for Historic Aircraft Recovery

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ORGANIC LABORATORY ANALYSIS REPORT

Requester:	Joe Cerniglia
Job Number:	C0BEE907
Analysis Date:	24 Oct 2011

Purpose:

The purpose was to determine the identity of three additional materials in a glass bottle, labeled "Campana's Italian Balm" (apparently meant to be used with the dispensing cap positioned below the glass). The additional materials were the liner / seal in the metal cap, the liquid-like material on the inner walls and the black-looking particles also on the inner walls of the bottle, see Table 2.

Reddish-brown particles stuck to the inner wall were analyzed previously in part 1 of this report (October 12, 2011).

A secondary purpose was to determine whether any of the Campana's Italian Balm ingredients listed in Table 1 (and underlined in the text) were present in the analyzed materials.

Table 1

Ingredients list for Campana's Italian Balm Cosmetic in *Clinical Toxicology of Commercial Products* by Marion N. Gleason, 1957, published by Williams and Wilkins
Essential oils
Alcohol
Phenol
Benzoic Acid
Gum Tragacanth
Glycerin
Sorbitol

A tertiary purpose was to compare the findings in this report with the previously analyzed flakey white residue in a report by Dr. Jennifer Mass, Scientific Analysis of Fine Art, Berwyn PA, Sept 2007.

Summary:

Table 2 summarizes the FTIR results of the materials from the Campana's Italian Balm bottle in parts 1 and 2 of the report, and Table 3 compares the materials analyzed in this report with the analysis of the flakey white residue by Dr. Mass in 2007.

Table 2

Sample description	Possible principal components	Other possible materials
Reddish-brown particle (see part 1 of this report, Oct 12th)	Organic acid salt similar to iron (II) oxalate dihydrate. Cellulose derivative similar to hydroxyethylcellulose.	Inorganic salts possibly containing sulfate, carbonate, hydroxide and / or silicate.
Liner / seal of the cap	Cellulose possibly paper, cotton or similar species. Saccharide (polyol) similar to corn starch.	Organic acid salts similar to iron (II) oxalate, copper (II) oxalate and/or nickel oxalate (probably as hydrates). Cellulose derivatives. Inorganic species.
Liquid-like material	Cellulose derivatives. Polyol similar to sodium alginate, sorbitol, glycerin, and/or corn starch. Organic acid salt similar to iron sodium oxalate, hydrate and / or iron potassium oxalate, trihydrate	Inorganic species. Cellulose. Ester.
Black particle – (blue features)	Aliphatic acid salt similar to copper stearate.	OH groups of moisture and/or of inorganic species.
Black particle – (brown features)	Organic acid salt similar to iron (II) oxalate, copper (II) oxalate and/or nickel oxalate (probably as hydrates). Aliphatic acid salt similar to copper stearate. Cellulose derivatives.	Inorganic species.

The compositions of the essential oils in the ingredients list (Table 1) are not known to EAG. Aromatic compounds such as phenol and benzoic acid were not observed in any of the samples. Alcohol would be expected to have evaporated prior to analysis. A portion (i.e., a possible component) of the reference spectrum of Tragacanth gum was possibly consistent with the cellulose derivative (carboxymethyl cellulose) identified in this report.

Table 3

Sample description (Campana's Italian Balm bottle)	Comparison to the white residue (analyzed in 2007 by Dr. Mass)
Reddish-brown particle	Not a good match (see part 1 of this report, Oct 12th 2011); possible oxalate bands appear to match
Liner / seal of the cap	Not a good match (spectra 26 and 27)
Liquid-like material	Not a good overall match; possible match to small ester component of the liquid (spectrum 28)
Black particle – (blue features)	Not a good match; possible chemical match of ester and acid salt groups (spectrum 29)
Black particle – (brown features)	**Partial spectral match**; possible chemical matches of OH, ester/acid salt and possible oxalate groups (spectra 30 and 31)

Experimental:

Representative samples of each of the materials were transferred to an infrared transmitting substrate and examined by Fourier Transform Infrared Spectroscopy (FTIR) with the FTIR microscope in transmission mode.

Results and Interpretations:

Liner / seal of the cap

The liner / seal material appeared to be a mixture, and the material shown in Spectrum 1 was possibly the majority component. Two measurements are shown in overlay format in spectrum 1 (the spectral match supports the designation of the majority component), and their spectral features suggest the presence of possible cellulosic material similar to cotton or paper (e.g., bands at ~ 3349, 2924, 1162, 1112, 1060 and 1038 cm^{-1}) in the liner / seal.

Spectrum 2 shows the FTIR spectrum of a third measurement of the liner / seal and was possibly a saccharide (polyol) similar to corn starch (e.g., largest C-O band at ~ 1029 cm^{-1} *vs* the C-O band of cellulose at ~ 1060 cm^{-1} in spectrum 1). The saccharide material appeared to be a minority component in the liner / seal.

Other possible components in spectra 1 and 2 were:

> possible organic acid salts similar to iron (II) oxalate, copper (II) oxalate and/or nickel (II) oxalate (possibly as hydrates), i.e., small sharp bands at ~ 1365 and 1320 cm^{-1} in spectrum 1;
>
> possible cellulose derivatives such as carboxymethyl cellulose (e.g., bands at ~ 3349, 2924, 1642 and 1060 cm^{-1} in spectrum 1), and
>
> possible inorganic species (e.g., bands at ~ 3365, 1647 and 1045 cm^{-1} in spectra 1 and 2).

Spectra 3, 4 and 5 show the overlays of the liner / seal measurements in spectra 1 and 2 with reference spectra of cellulose (cotton example), carboxymethyl cellulose (sodium salt) and corn starch, respectively. The matches in spectra 3 and 5 and the approximate match in spectrum 4 support the identifications discussed above.

Liquid-like material on the inner wall surface

Spectrum 6 shows the FTIR spectra, in overlay format, of two measurements of the liquid-like material on the surface of the inner walls. Additional measurements are shown in spectrum 7 (third measurement) and spectrum 8 (fourth and fifth measurements). The differences in spectra 6, 7 and 8 indicate that the liquid-like material was a mixture. Based on the approximate fits of the reference spectra, the components of the liquid may have included:

> cellulose derivatives similar to carboxymethyl cellulose (e.g., bands at ~ 3357, 2931, 1608, 1414, 1112 and 1051 cm^{-1} in spectrum 6);
>
> polyol similar to sodium alginate, sorbitol and/or glycerin (e.g., bands at ~ 3357, 2931, 1608, 1414, 1112 and 1051 cm^{-1} in spectrum 6),
>
> polyol similar to corn starch (e.g., bands at ~ 3333, 2928, 1600, 1411, 1112 and 1079, 1024 cm^{-1} in spectrum 7);
>
> possible cellulose (e.g., bands at ~ 3357, 2931 and 1051 cm^{-1} in spectrum 6);
>
> organic acid salt similar to iron sodium oxalate, hydrate and / or to iron potassium oxalate, trihydrate (e.g., bands at ~ 3533, 3447, 1677, 1415, 1334, 1279, 811 and 780 cm-1 in spectrum 8);
>
> ester (e.g., band at ~ 1747 cm^{-1}), and
>
> possible inorganic species (e.g., bands at ~ 3345, 1677/1605 and 1050 cm^{-1} in spectra 6, 7 and 8).

The possible components of the liquid-like materials in spectra 6, 7 and 8 are shown overlaid with appropriate library reference spectra in spectra 10 (reference: sodium alginate), 11 (reference: sorbitol), 12 (reference: glycerin), 13 (reference: cornstarch), 14 (reference: cotton), 15 (reference: iron sodium oxalate, hydrate) and 16 (reference: iron potassium oxalate, hydrate). The approximate match support the possible identification discussed above.

In addition to the possible components discussed above, the liquid-like material may have contained components or residue from Tragacanth gum (e.g., bands at ~ 3357, 2931, 1608, 1414, 1112 and 1051 cm^{-1} in spectrum 6). The partial match in spectrum 17 of the liquid-like material with the spectrum of a library reference spectrum of Tragacanth gum suggests that a component or residue of the gum cannot be ruled out as a component of the materials in the bottle.

Black particle – blue features

Spectrum 18 shows the FTIR spectra, in overlay format, of two measurements of the blue features of the black particles in the bottle. The blue portion was probably aliphatic acid salt, possibly a copper salt similar to copper stearate (e.g., bands at ~ 2917, 2850, 1586, 1471 and 1413 cm^{-1}). Note that copper stearate is blue-green in color (Handbook of Chemistry and Physics, CRC Press) and possibly matches the color of the blue feature in the black particle.

The match in spectrum 18 shows the spectral consistency of the blue feature.

The broad features at ~3387 cm^{-1} and ~1650 cm^{-1} in spectrum 18 suggest the presence of OH groups and possibly signify moisture or adsorbed water of an inorganic species.

Spectrum 19 shows the overlay of the blue feature in spectrum 18 with a reference spectrum of copper stearate. The match indicates that the blue feature contained aliphatic acid salt, possibly copper stearate.

Black particle – brown features

Spectrum 20 shows the FTIR spectrum, in overlay format, of two measurements of the brown feature in the black particle. The brown feature was a mixture, possibly consisting of:

one or more organic acid salts such as iron (II) oxalate hydrate, copper (II) oxalate hydrate and / or nickel (II) oxalate hydrate (e.g., bands at ~ 3389, 1651, 1362, 1319 and 823 cm-1);

aliphatic acid salt such as copper stearate (e.g., bands at ~ 2954, 2916, 2850, and 1586 cm-1);

cellulose derivatives such as carboxymethyl cellulose (e.g., bands at ~ 3389, 2916, 1651, 1413, and 1053 cm-1), and

inorganic species (e.g., bands at ~ 3389, 1651, and 1053 cm-1).

The approximate match in spectrum 20 shows a small variability of the components of the brown feature and/or show an incomplete separation of the brown and blue features in the FTIR samples.

Spectra 21, 22, 23, 24 and 25 show the overlays of the brown feature in spectrum 20 with reference spectra of iron (II) oxalate hydrate, copper (II) oxalate hydrate, nickel (II) oxalate hydrate, copper stearate and carboxymethyl cellulose, respectively. The approximate matches support the identifications discussed above.

Comparison of spectra (details of the summary in Table 3)

In this section, the materials in the Campana's Italian Balm bottle analyzed in parts 1 and 2 of this report (see Table 2 and discussion above) are spectrally compared to the flakey white residue from the center of the bottom of the bottle fragment (identified by Dr. Mass in 2007 as a mixture, which possibly contained ester such as lanolin, linseed oil or rapeseed oil).

Spectra 26 and 27 show the overlays of the liner / seal material in spectra 1 and 2, respectively, with the flakey white residue (spec 2) in Dr. Mass's report. The large differences (i.e., strong bands of the flakey residue at ~ 2918, 2850, 1735, 1512, and 1015 cm^{-1} were not apparent in the liner / seal material) outweigh the possible similarity (OH band at ~ 3368 cm^{-1} in both the cap and the flakey residue, possibly due to moisture), and hence the cap material was not a good match to the flakey residue.

Spectrum 28 shows the overlay of the liquid-like material in spectrum 6 with the flakey white residue (spec 2). The apparent differences (i.e., strong bands of the flakey residue at ~ 2918, 2850, 1512, 1172 and 1015 cm^{-1} were not apparent in the liquid-like material) suggest that the liquid-like material was not a good overall match to the white residue. However, a small ester band/shoulder at ~ 1747 cm^{-1} in the liquid-like material, possibly was related to the strong ester band in the white residue at ~ 1735 cm^{-1}, and hence the liquid-like material may have contained a small amount of ester possibly similar to some of the ester in the flakey residue.

Spectrum 29 shows the overlay of the blue feature in the black particle in spectrum 18 with the flakey white residue (spec 2). The differences (i.e., strong bands of the flakey residue at ~ 3385, 1735, 1512, 1172 and 1015 cm^{-1} were not apparent in the blue feature material) suggest that the blue feature was not a good match to the white residue.

Although there was not a good spectral match, there may be some chemical similarity of the flakey white residue and the blue feature (Spectrum 29). Both contained spectrally similar aliphatic hydrocarbon groups (bands at ~ 2920 and 2850 cm^{-1}). In addition, the ester of the flakey white residue (1735 cm^{-1}) and the aliphatic acid salt of the blue feature (1586 cm^{-1}) may have been related if ester of the Italian balm in the authentic Campana's Italian Balm bottle hydrolyzed to form carboxylic acid, which in turn reacted with the metals in the Campana's Italian Balm cap to form the observed aliphatic acid salt.

Spectra 30 and 31 show the overlays of the brown feature in the black particle in spectrum 20 with the flakey white residue (spec 2 and spec 1, respectively). The partial matches (e.g., OH band at 3389 cm^{-1}, CH bands at ~ 2920 and 2850 cm^{-1} and possible oxalate bands at ~ 1362 and 1319 cm^{-1} suggest that one or more components of the brown feature and of the flakey white residue may be related (e.g., the CH bands may be related via an ester to aliphatic acid salt mechanism suggested in the paragraph above). The possibility that the flakey white residue may have also contained oxalate is tantalizing.

Suggestions for additional analyses:

Other techniques may be useful, e.g., SEM-EDX to obtain the atomic elements (Z >= B) and Raman spectroscopy to complement the FTIR analysis, to help determine the full identity of the materials in the bottle.

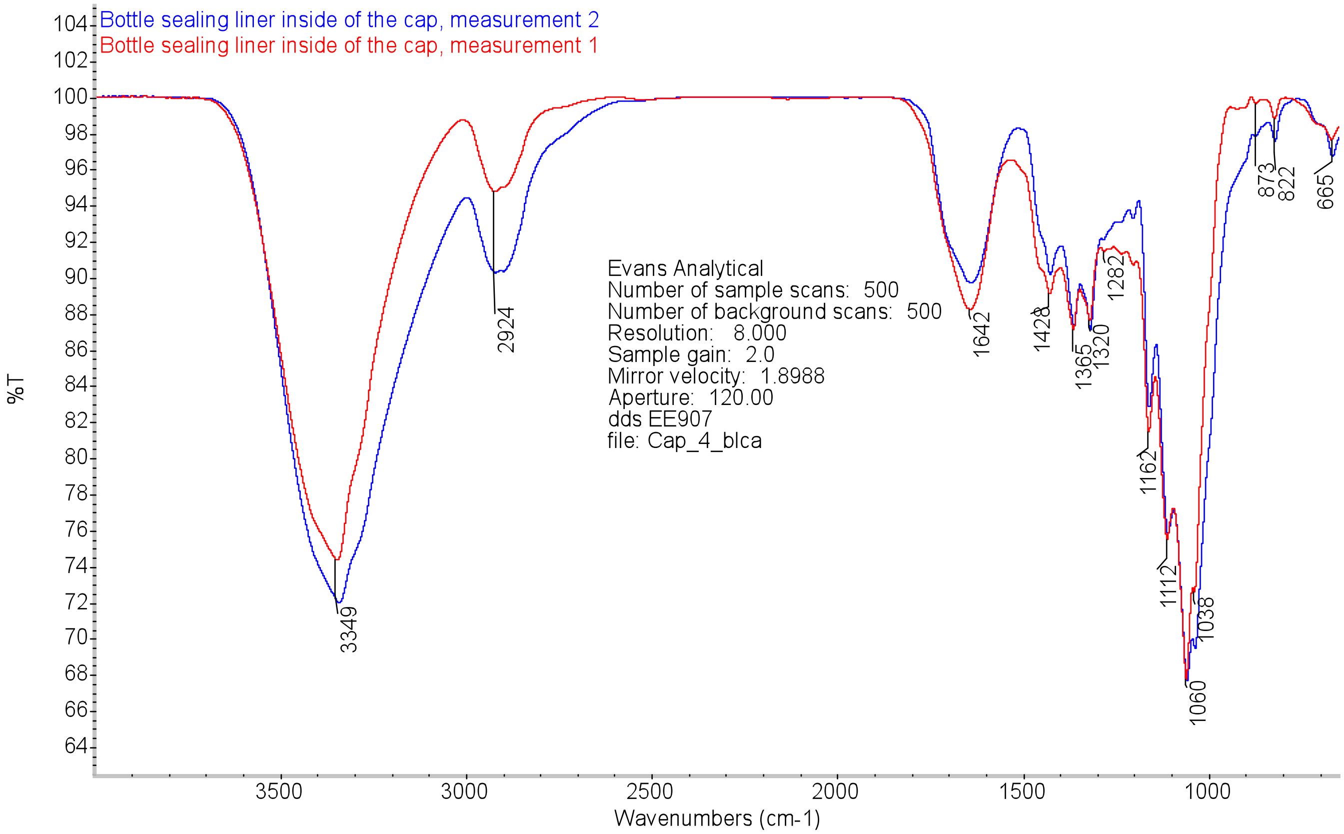
FTIR is often used for the qualitative identification of functional groups or for the identification of entire organic compounds, typically with the aid of spectral databases. Assignment of spectral features to functional groups or the identification of a compound can be made with relative certainty, in some instances. However in many cases the presence of spectral features and functional groups cannot be traced unambiguously to one specific compound, especially in the analysis of mixtures. Where identification is relatively certain, the report will so state. Where identification is ambiguous, the report will provide possible compounds or classes of materials that may be present in the sample.

If questions arise as you review the results of this analysis, the report author or any other member of our technical staff will be available for consultation.

After reviewing this report, you may assess our services using an electronic service evaluation form. This can be done by clicking on the link below, or by pasting it into your internet browser. Your comments and suggestions allow us to determine how to better serve you in the future. http://www.eaglabs.com/evaluate.htm?job=C0BEE907

Appendix 1

Infrared Spectroscopy (IR) is the study of molecular vibrations. It is an extremely useful analytical technique, providing specific information about chemical bonding and molecular structure, most suitably for organic materials. The technique is based on the fact that bonds and groups of bonds vibrate at characteristic frequencies. When exposed to infrared radiation, a molecule selectively absorbs infrared frequencies that match those of its allowed vibrational modes. Therefore, the infrared absorption spectrum of a material reveals which vibrations, and thus functional groups, are present in its structure. It should be noted that vibrations that do not involve a change in dipole moment, as in O_2 and N_2, do not absorb infrared radiation. Thus, IR spectra can be collected in air.


Bottle sealing liner inside of the cap, measurement 2
Bottle sealing liner inside of the cap, measurement 1
Evans Analytical
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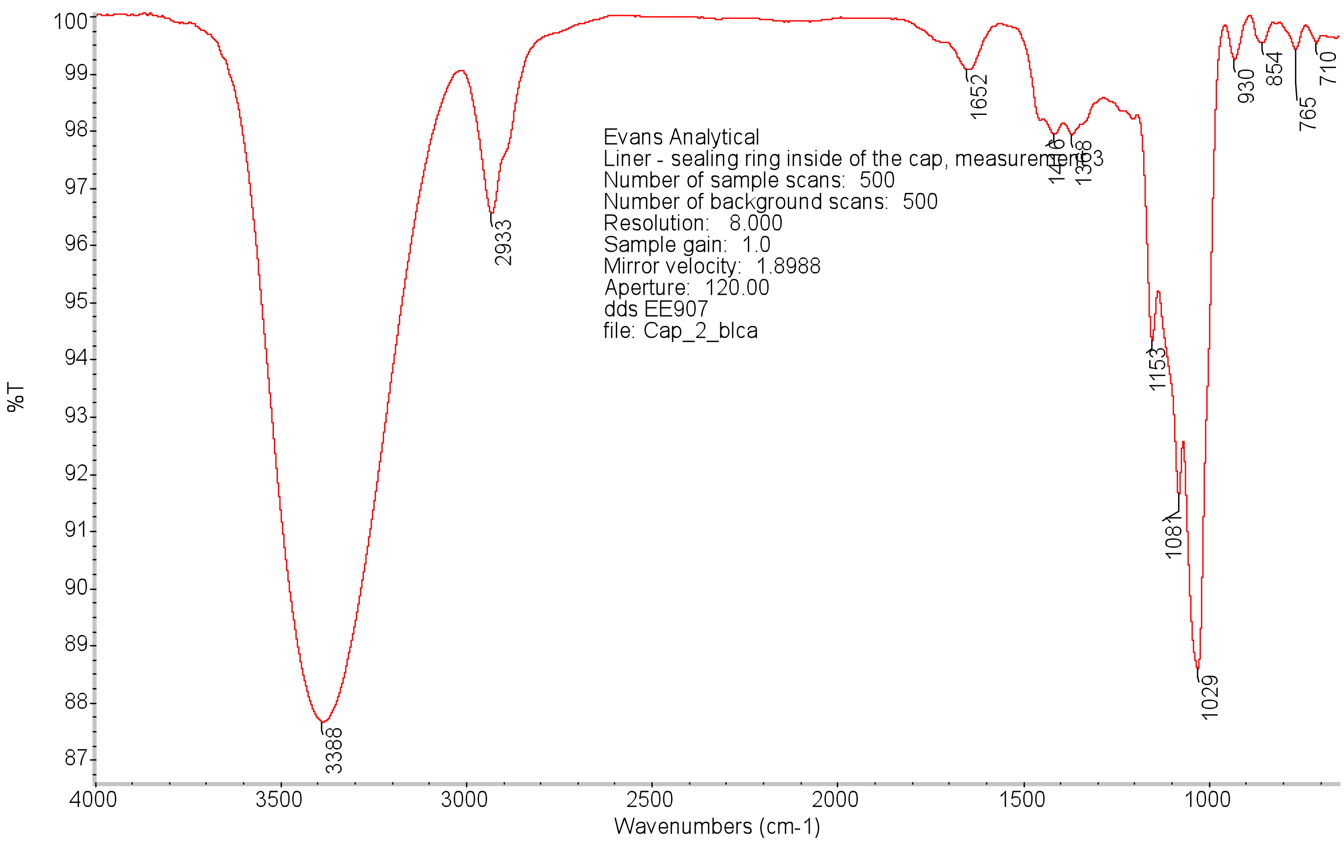
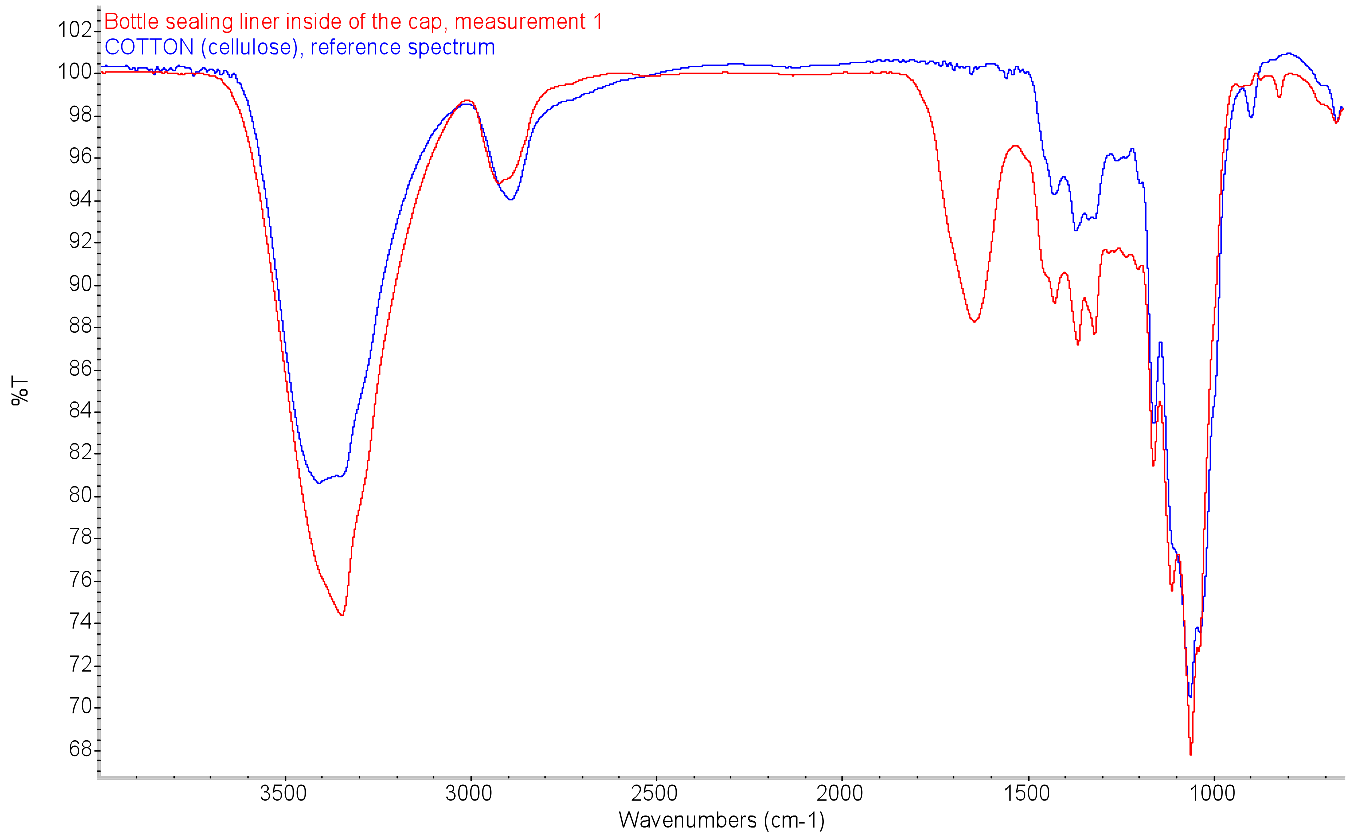
Number of background scans: 500
Resolution: 8.000
Sample gain: 2.0
Mirror velocity: 1.8988
Aperture: 120.00
dds EE907
file: Cap_4_blca
%T
Wavenumbers (cm-1)
3349
2924
1642
1428
1365
1320
1282
1162
1112
1060
1038
873
822
665
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
3500
3000
2500
2000
1500
1000

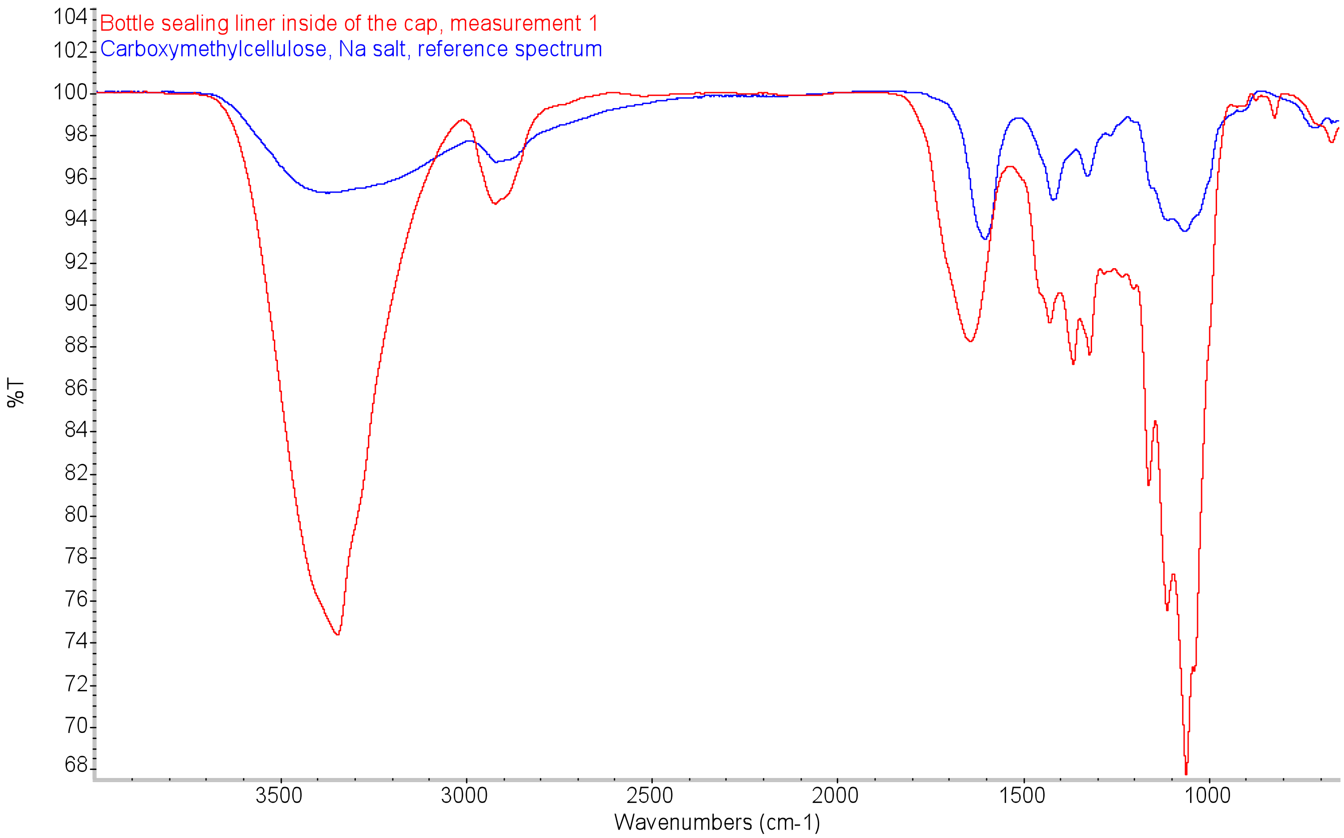
Spectrum 1


Evans Analytical
Liner - sealing ring inside of the cap, measurement 3
Number of sample scans: 500
Number of background scans: 500
Resolution: 8.000
Sample gain: 1.0
Mirror velocity: 1.8988
Aperture: 120.00
dds EE907
file: Cap_2_blca
%T
Wavenumbers (cm-1)
3388
2933
1652
1153
1081
1029
930
854
765
710

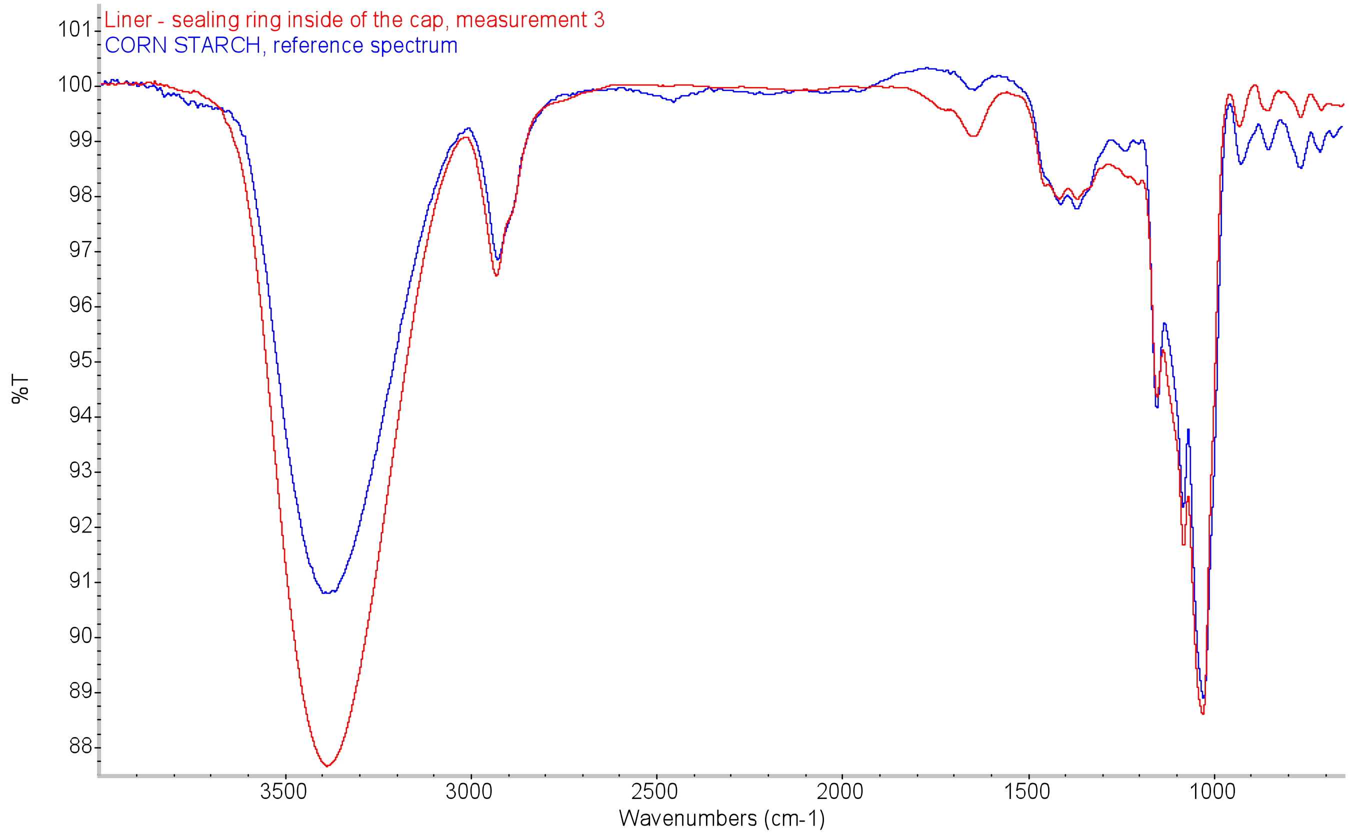
Spectrum 2


Bottle sealing liner inside of the cap, measurement 1
COTTON (cellulose), reference spectrum
102
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
68
%T
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

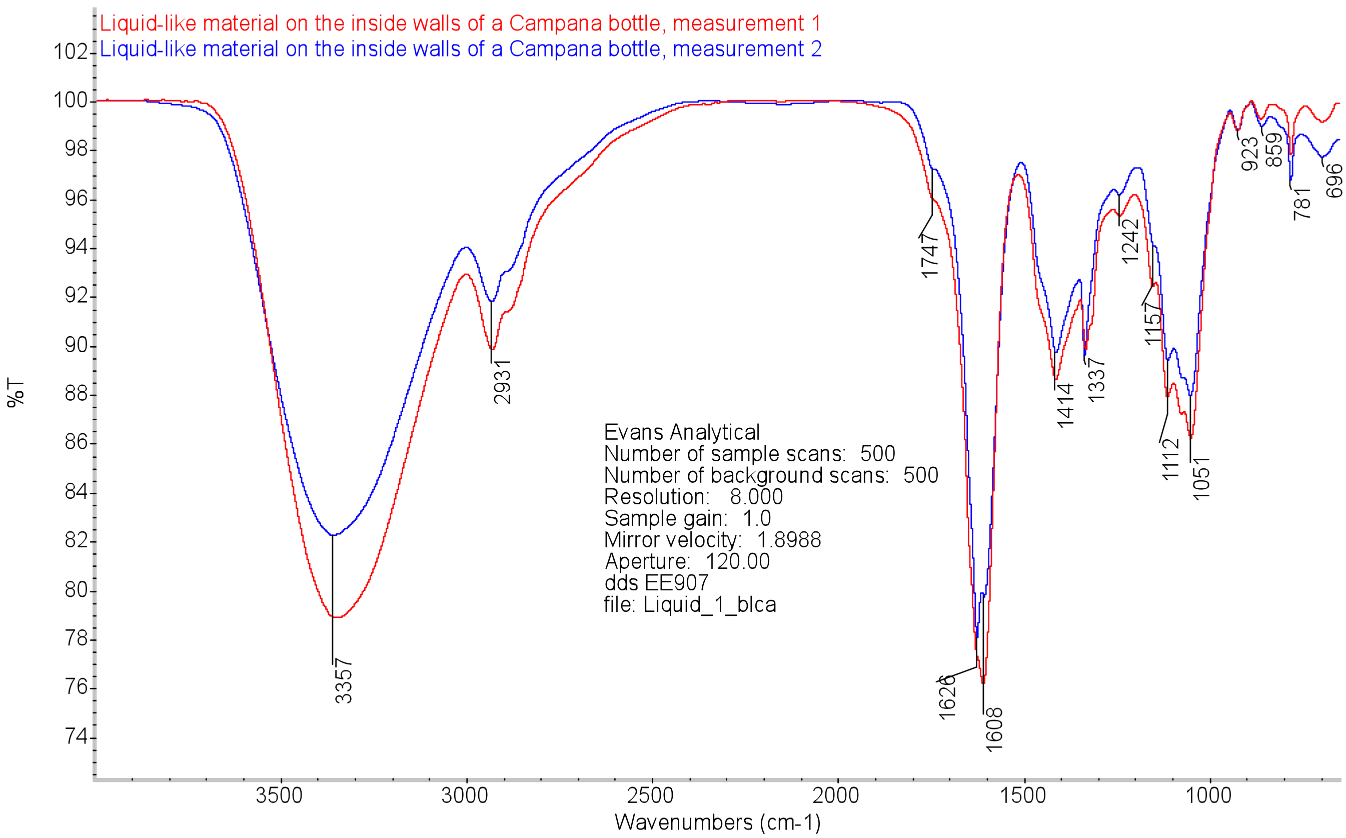
Spectrum 3


Bottle sealing liner inside of the cap, measurement 1
Carboxymethylcellulose, Na salt, reference spectrum
%T
104
102
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
68
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

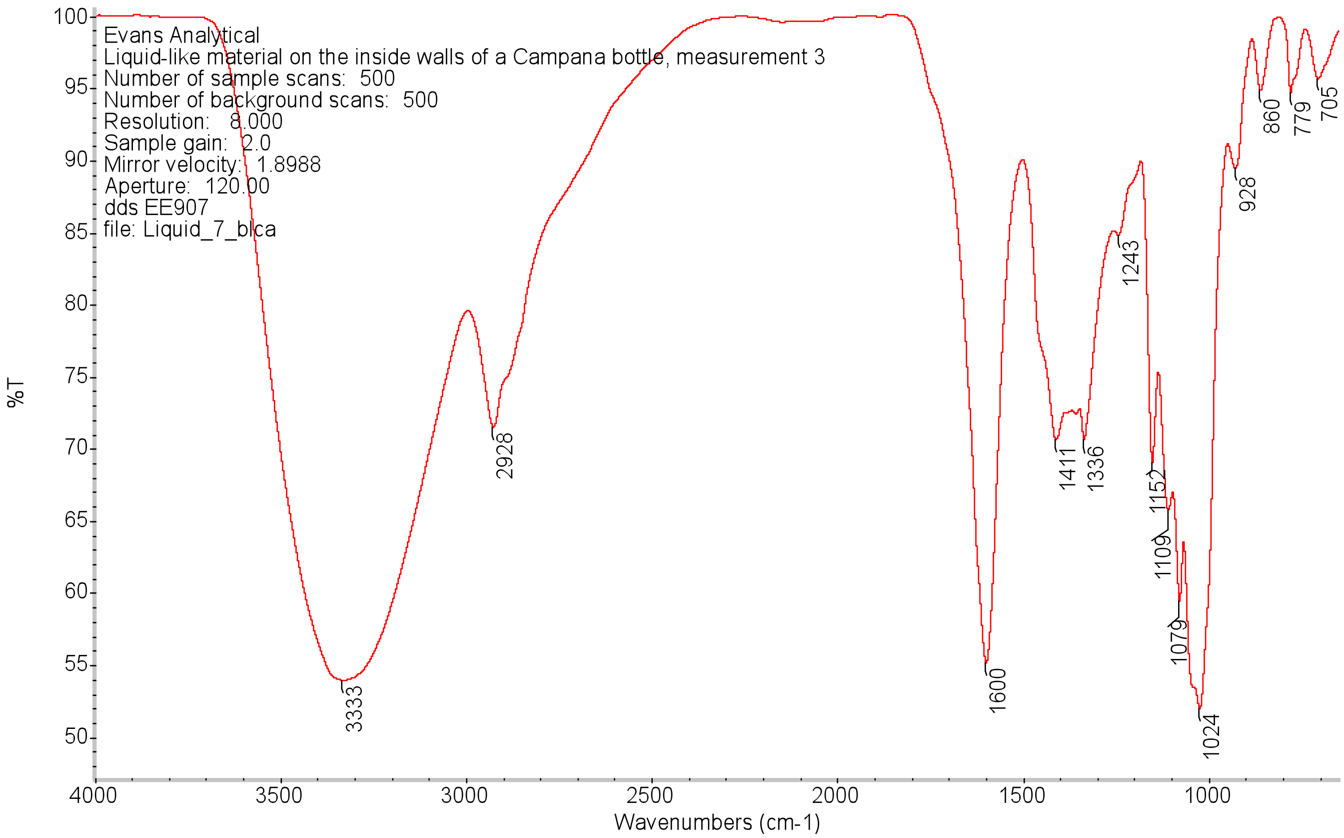
Spectrum 4


Liner - sealing ring inside of the cap, measurement 3
CORN STARCH, reference spectrum
%T
101
100
99
98
97
96
95
94
93
92
91
90
89
88
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

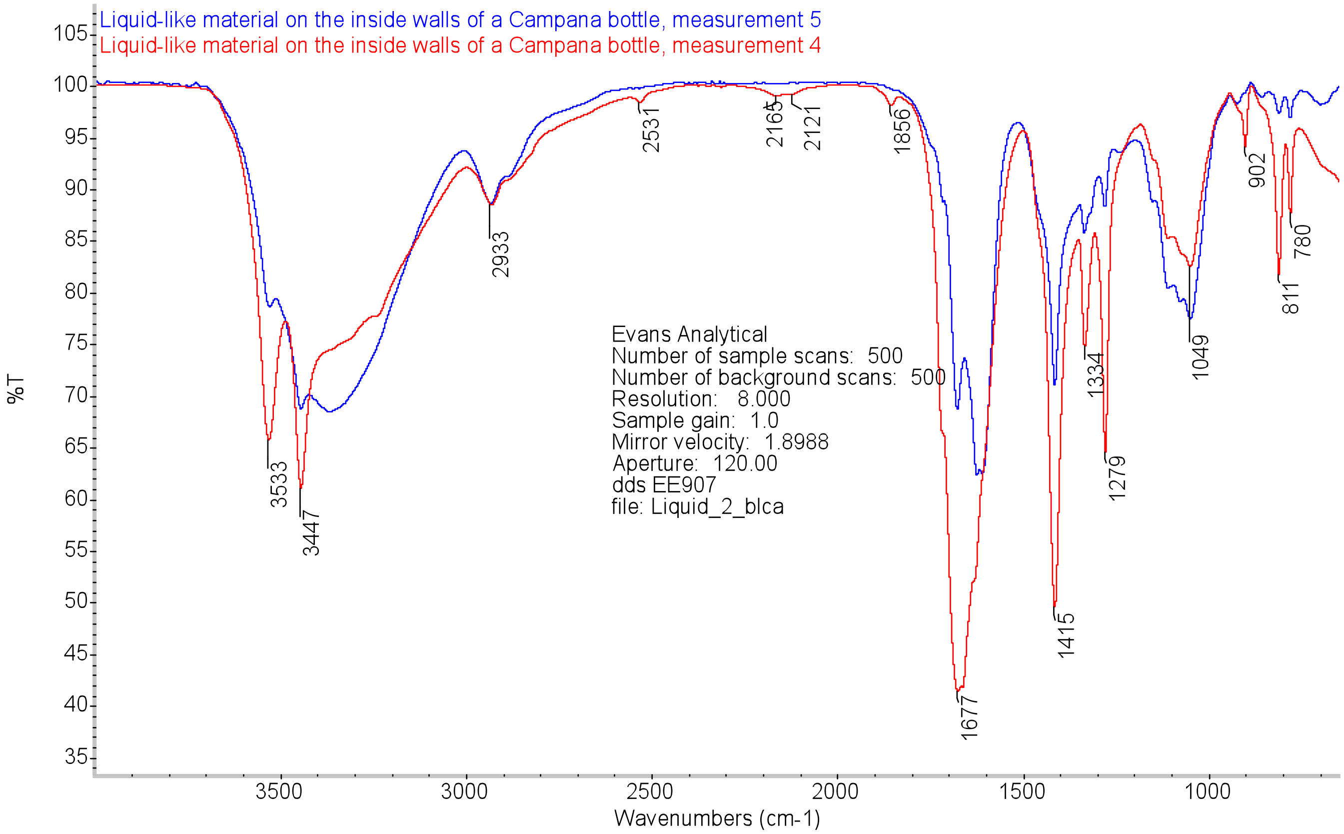
Spectrum 5


Liquid-like material on the inside walls of a Campana bottle, measurement 1
Liquid-like material on the inside walls of a Campana bottle, measurement 2
%T
Wavenumbers (cm-1)
3357
2931
1747
1626
1608
1414
1337
1242
1157
1112
1051
923
859
781
696
Evans Analytical
Number of sample scans: 500
Number of background scans: 500
Resolution: 8.000
Sample gain: 1.0
Mirror velocity: 1.8988
Aperture: 120.00
dds EE907
file: Liquid_1_blca

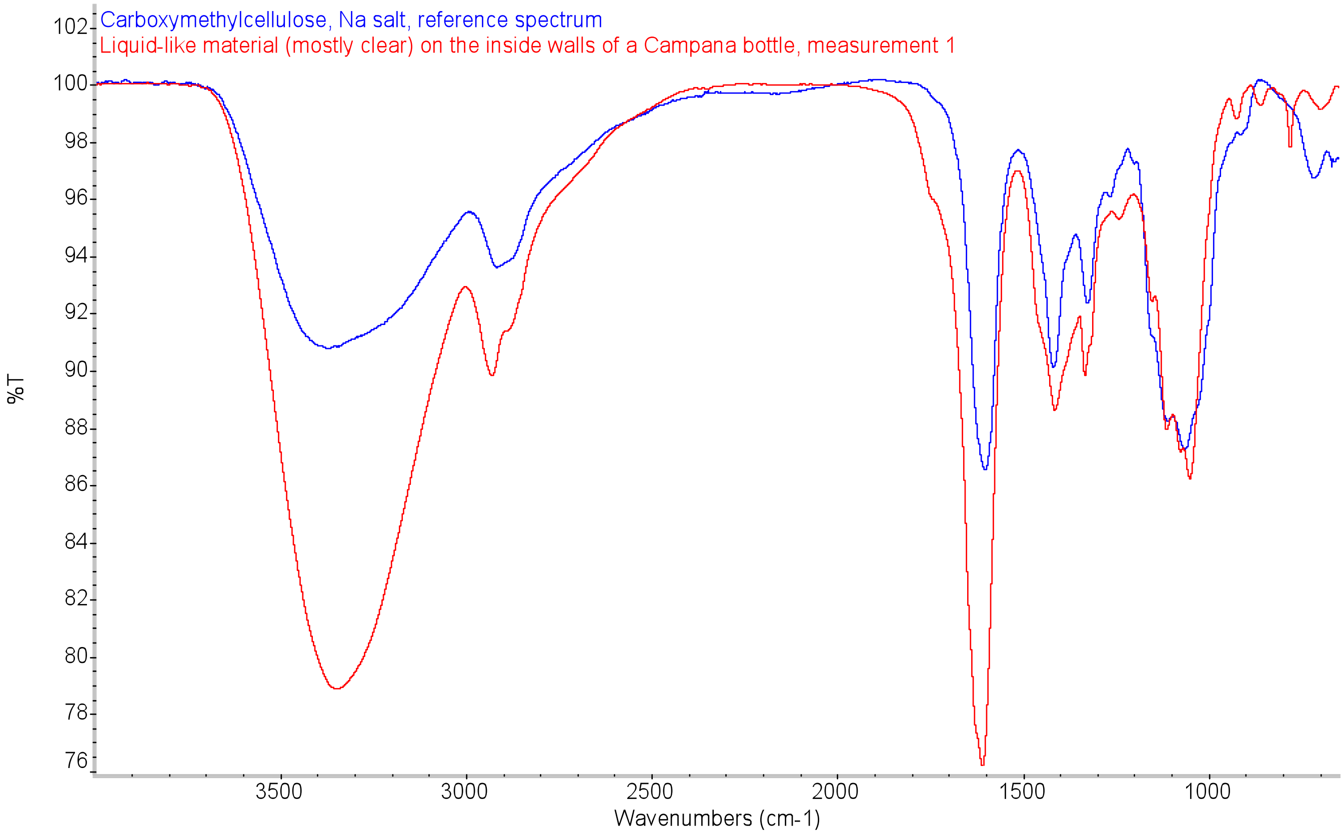
Spectrum 6


Evans Analytical
Liquid-like material on the inside walls of a Campana bottle, measurement 3
Number of sample scans: 500
Number of background scans: 500
Resolution: 8.000
Sample gain: 2.0
Mirror velocity: 1.8988
Aperture: 120.00
dds EE907
file: Liquid_7_blca
%T
Wavenumbers (cm-1)
3333
2928
1600
1411
1336
1243
1152
1109
1079
1024
928
860
779
705

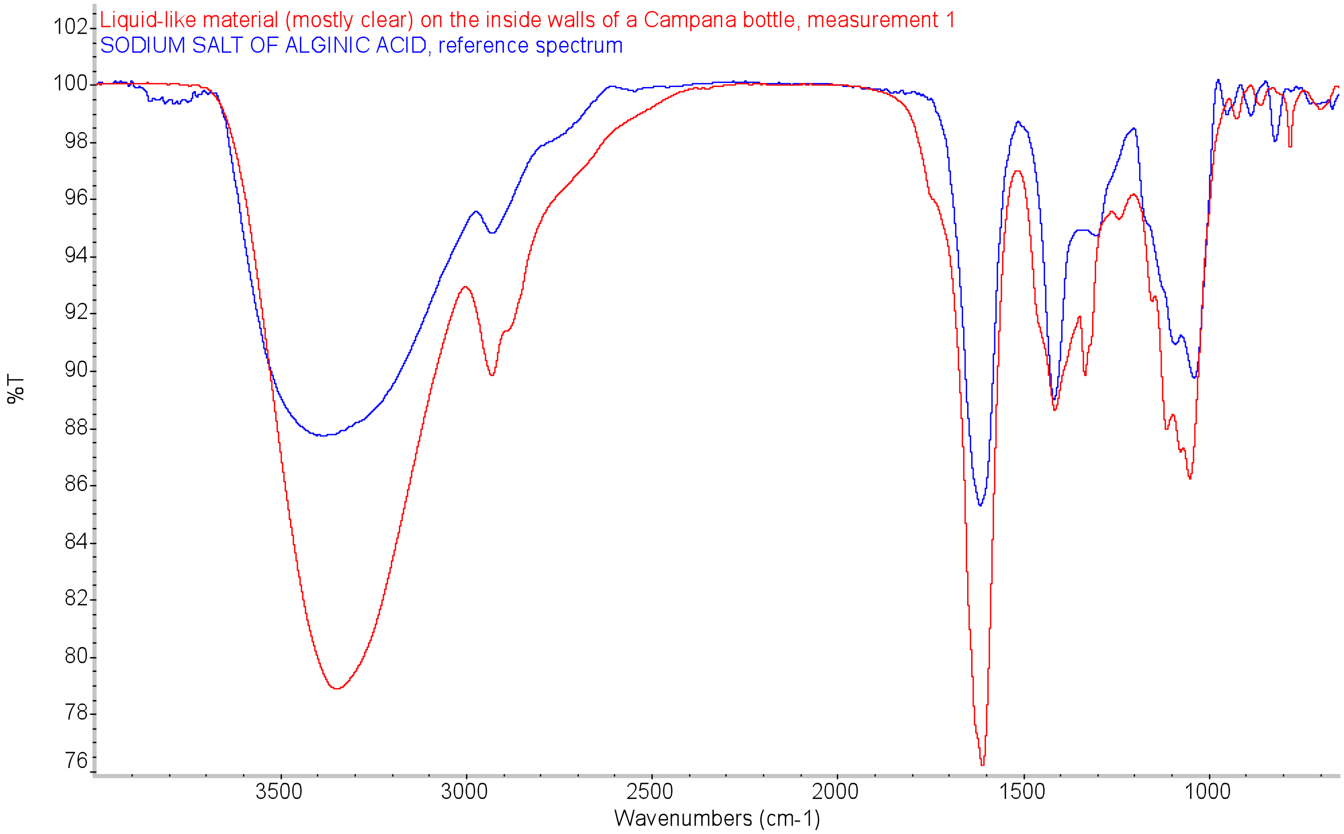
Spectrum 7


Liquid-like material on the inside walls of a Campana bottle, measurement 5
Liquid-like material on the inside walls of a Campana bottle, measurement 4
%T
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
3533
3447
2933
2531
2165
2121
1856
1677
1415
1334
1279
1049
902
811
780
Evans Analytical
Number of sample scans: 500
Number of background scans: 500
Resolution: 8.000
Sample gain: 1.0
Mirror velocity: 1.8988
Aperture: 120.00
dds EE907
file: Liquid_2_blca
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

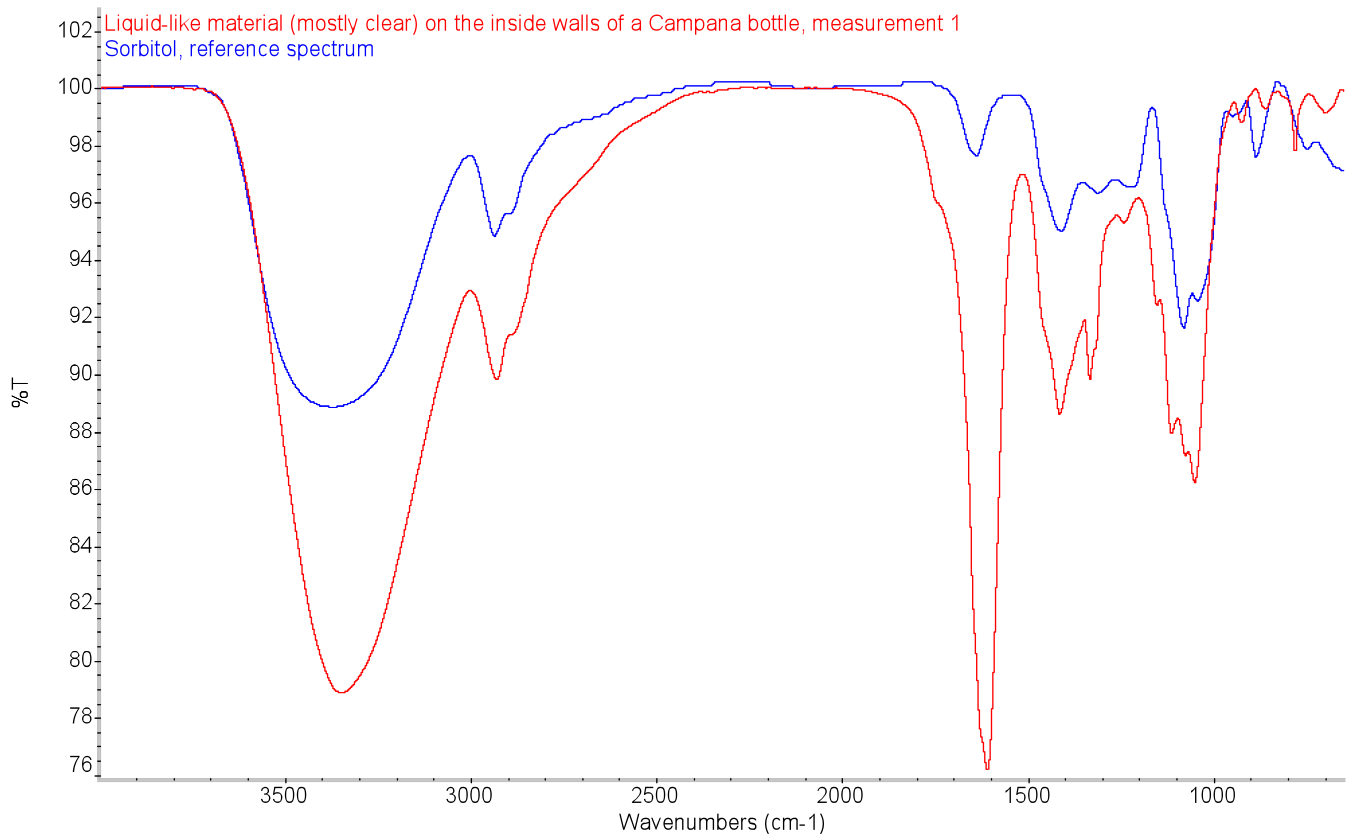
Spectrum 8


Carboxymethylcellulose, Na salt, reference spectrum
Liquid-like material (mostly clear) on the inside walls of a Campana bottle, measurement 1
%T
102
100
98
96
94
92
90
88
86
84
82
80
78
76
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

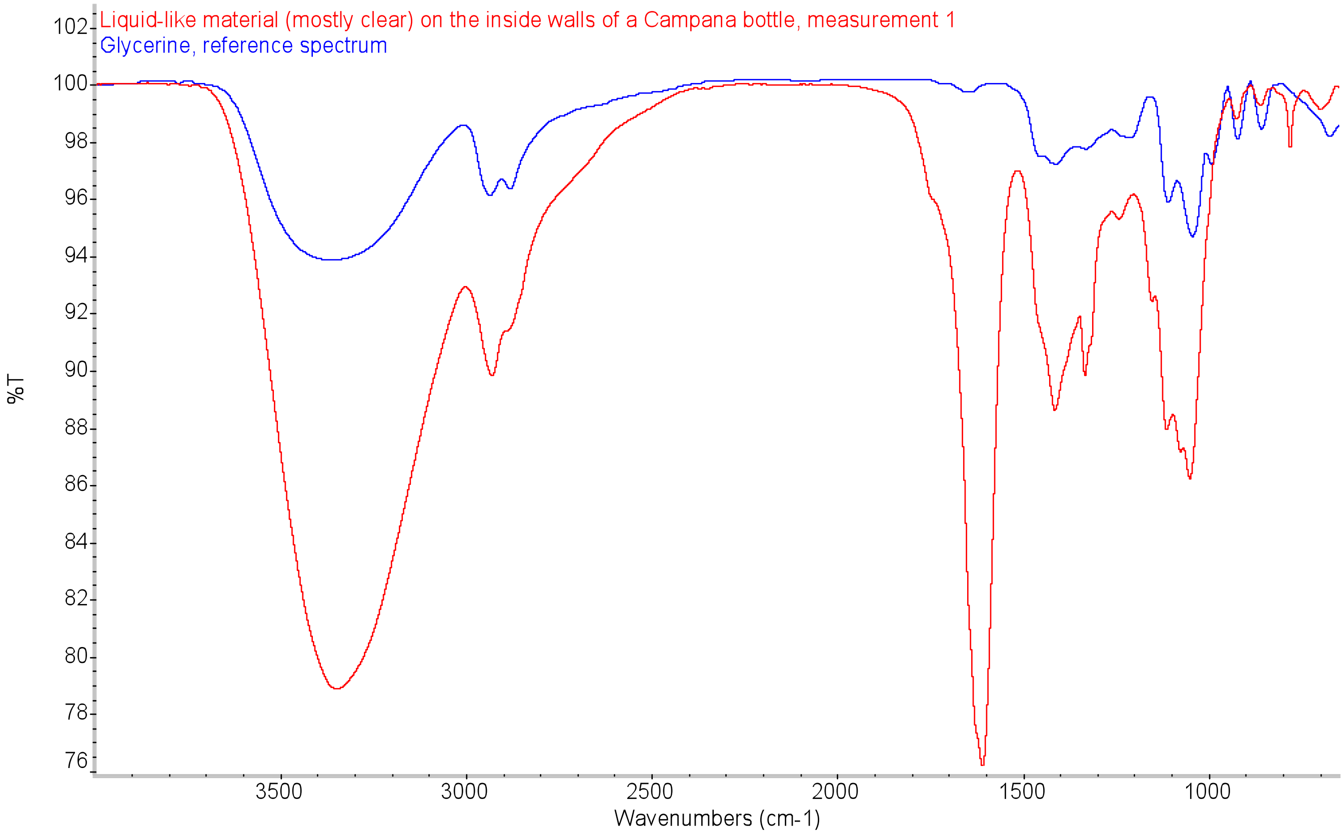
Spectrum 9


Liquid-like material (mostly clear) on the inside walls of a Campana bottle, measurement 1
SODIUM SALT OF ALGINIC ACID, reference spectrum
%T
102
100
98
96
94
92
90
88
86
84
82
80
78
76
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

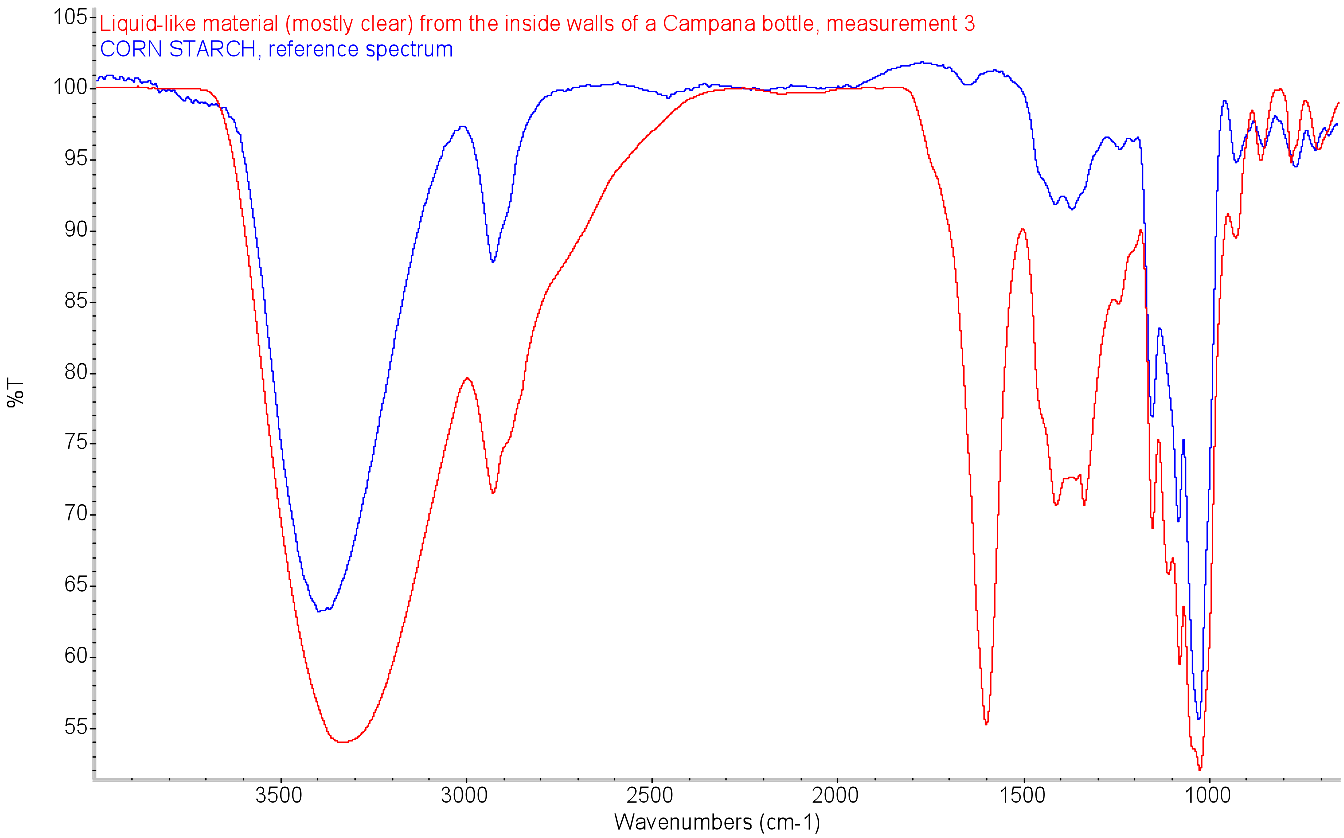
Spectrum 10


Liquid-like material (mostly clear) on the inside walls of a Campana bottle, measurement 1
Sorbitol, reference spectrum
%T
102
100
98
96
94
92
90
88
86
84
82
80
78
76
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

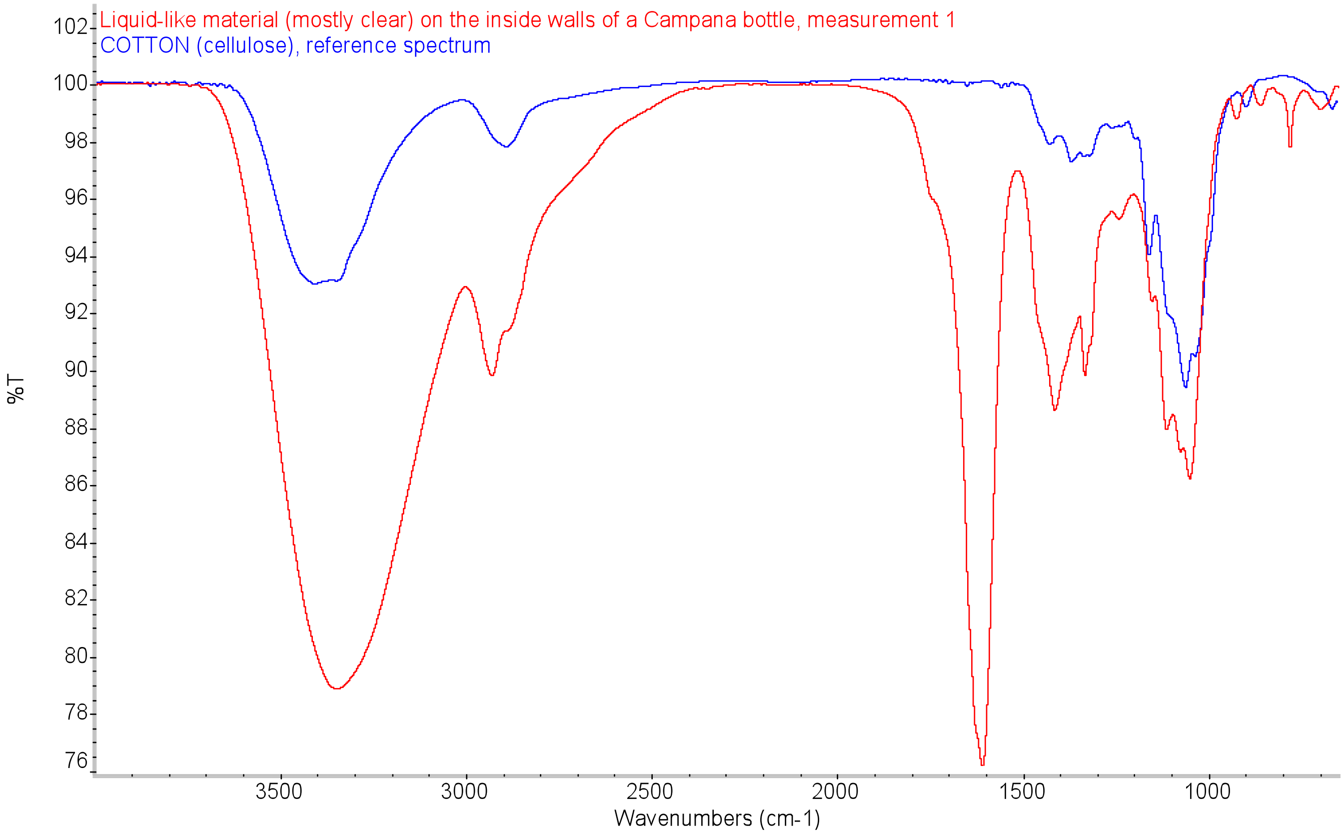
Spectrum 11


Liquid-like material (mostly clear) on the inside walls of a Campana bottle, measurement 1
Glycerine, reference spectrum
%T
102
100
98
96
94
92
90
88
86
84
82
80
78
76
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

Spectrum 12

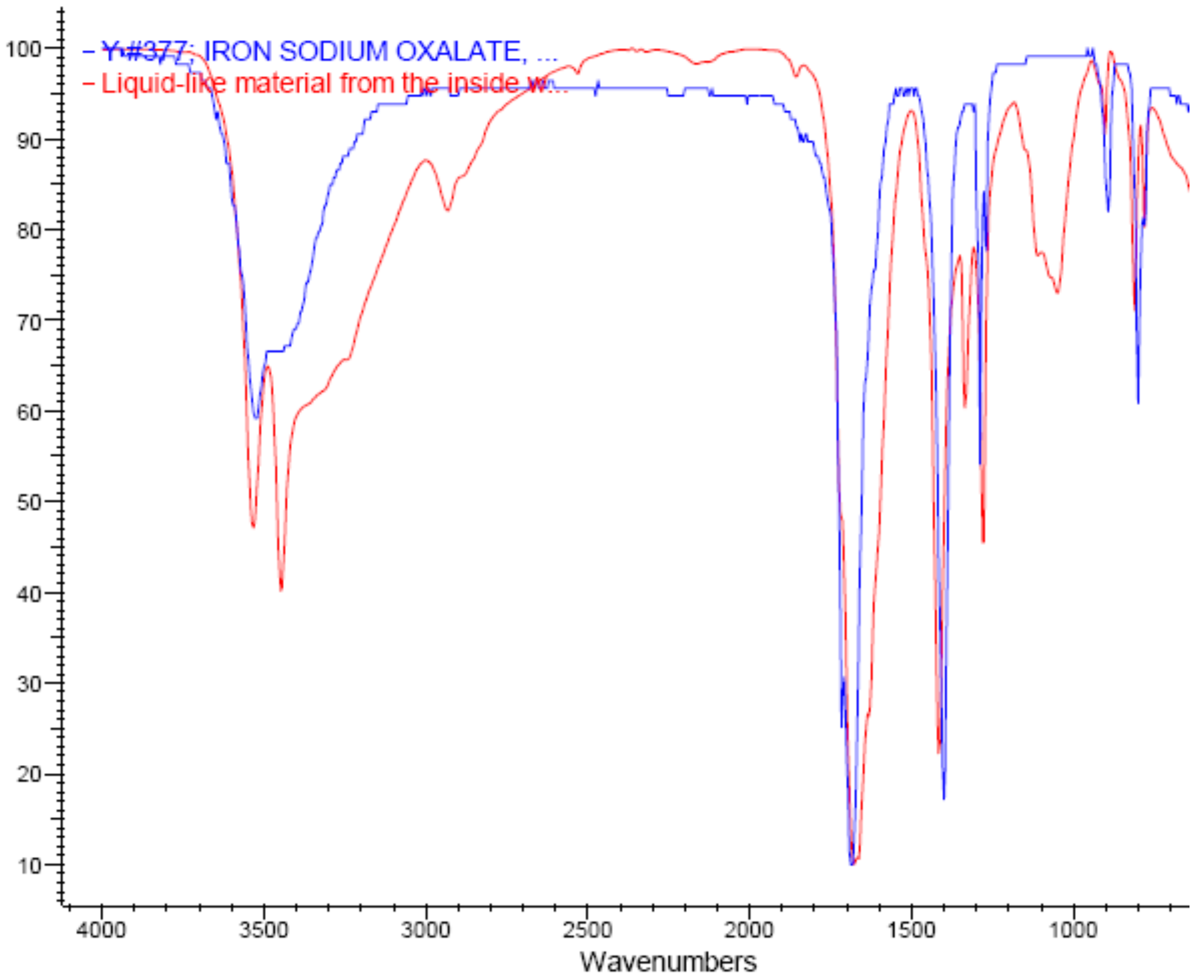

Liquid-like material (mostly clear) from the inside walls of a Campana bottle, measurement 3
CORN STARCH, reference spectrum
%T
105
100
95
90
85
80
75
70
65
60
55
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

Spectrum 13


Liquid-like material (mostly clear) on the inside walls of a Campana bottle, measurement 1
COTTON (cellulose), reference spectrum
%T
102
100
98
96
94
92
90
88
86
84
82
80
78
76
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

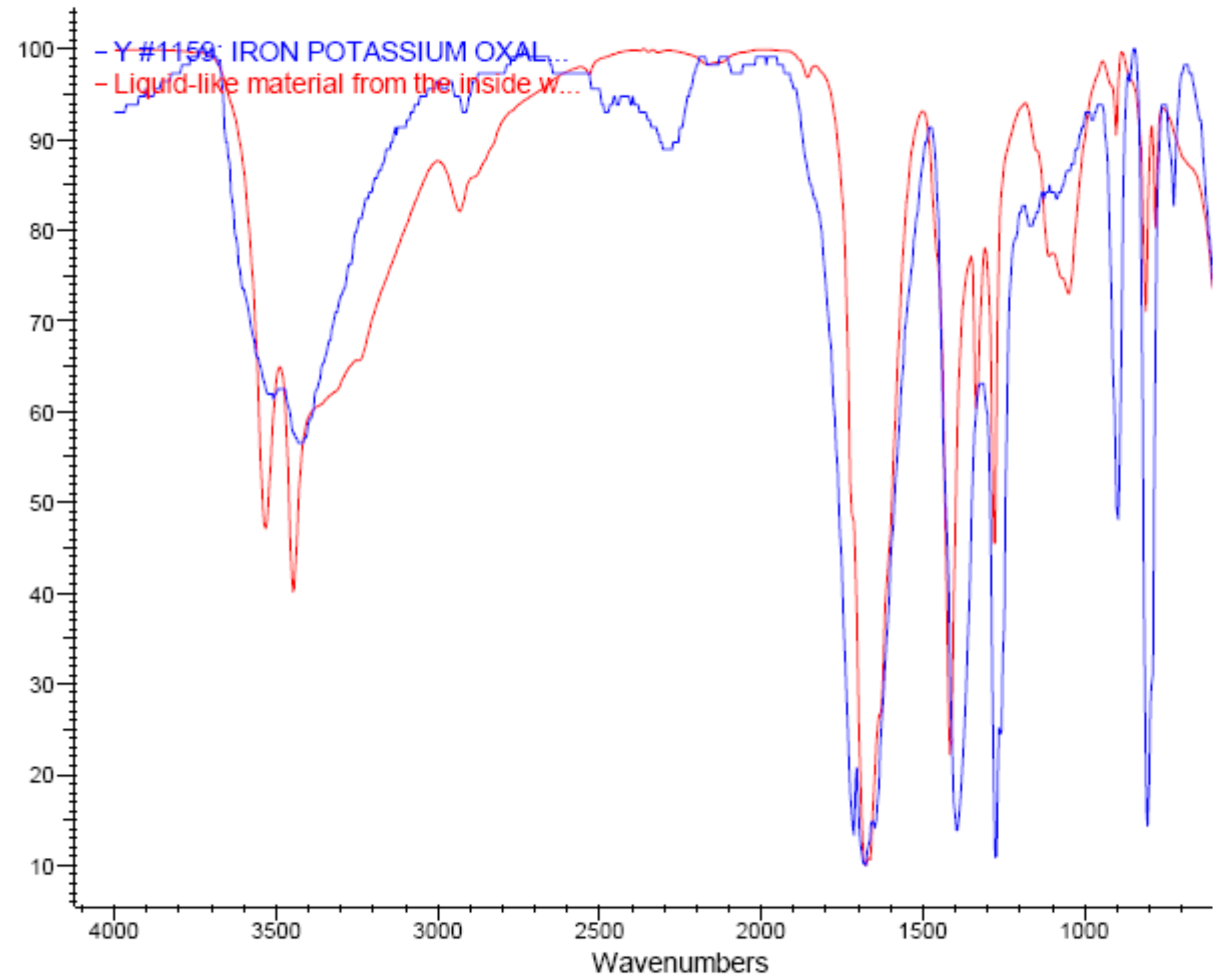
Spectrum 14

Reference (blue trace) is iron sodium oxalate, hydrate



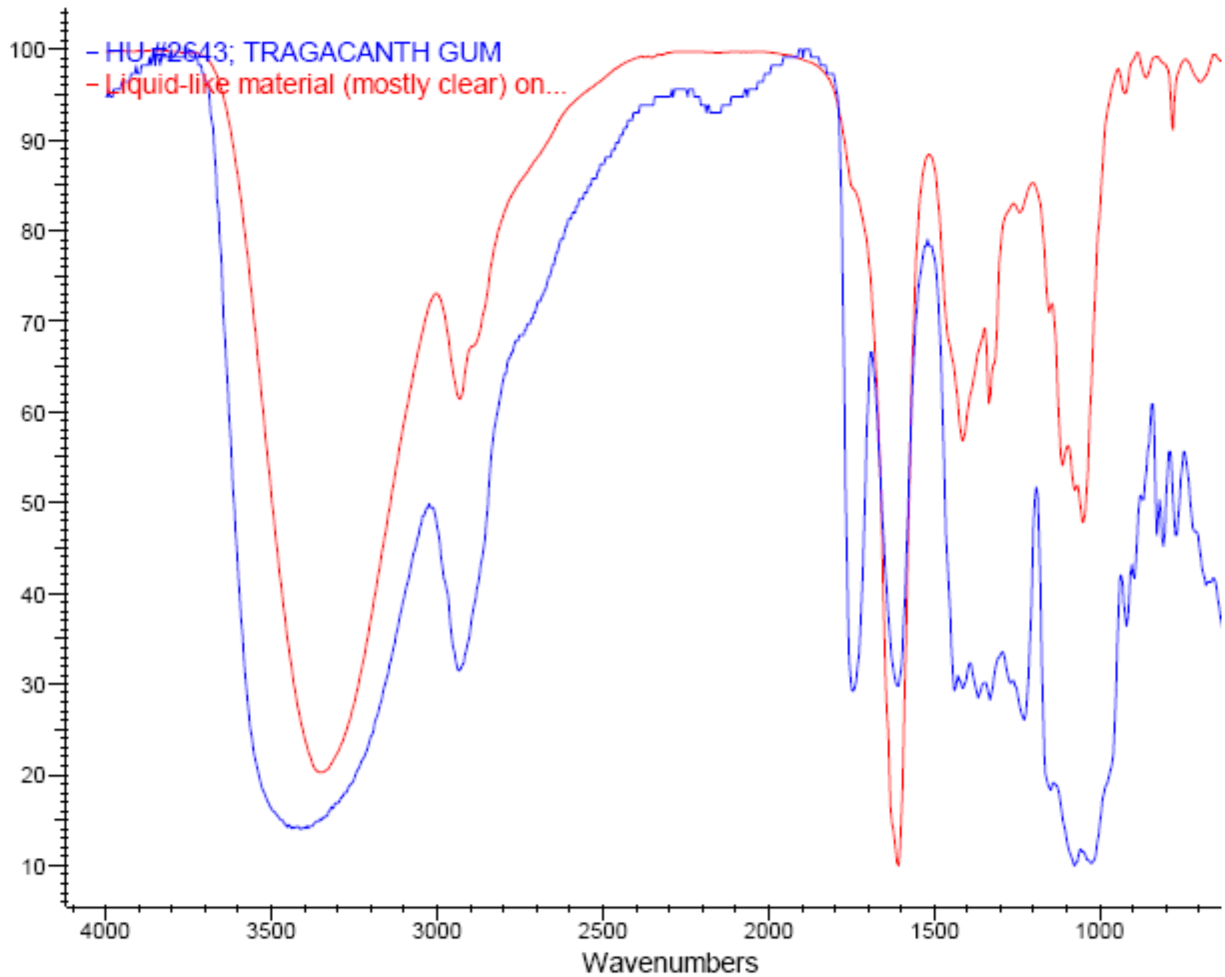
Spectrum 15

Reference (blue trace) is iron potassium oxalate, trihydrate

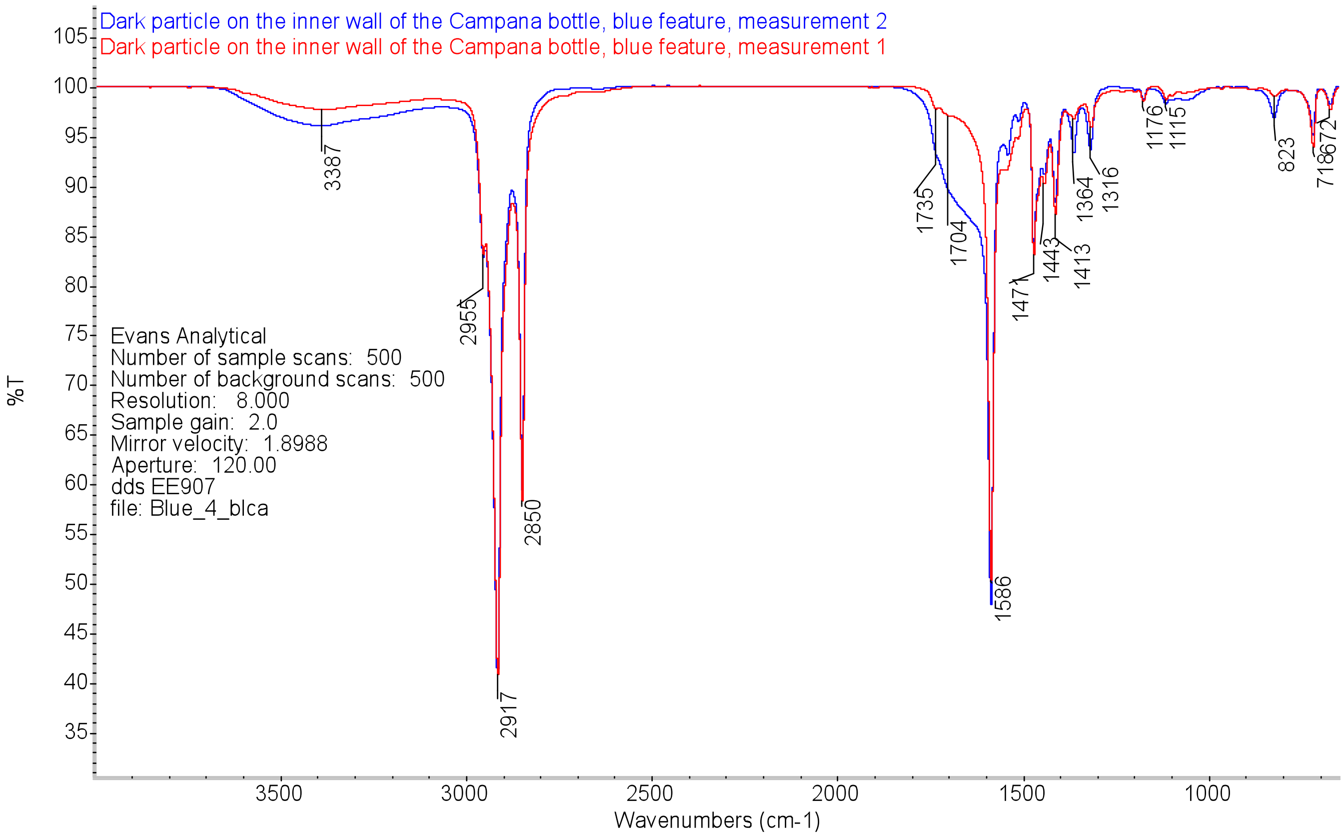


Spectrum 16

Reference (blue trace) is the dried sap of Astragalus species

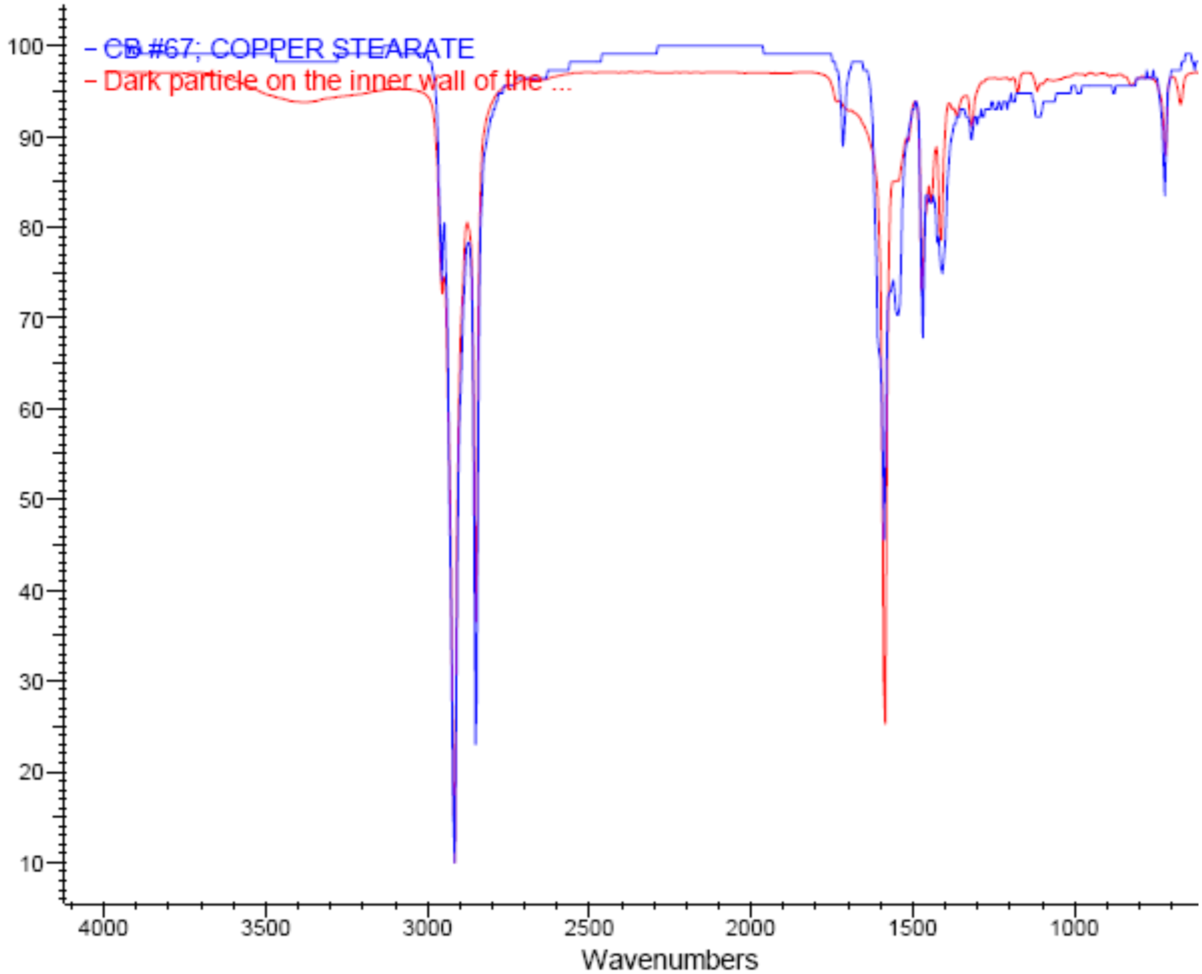


Spectrum 17

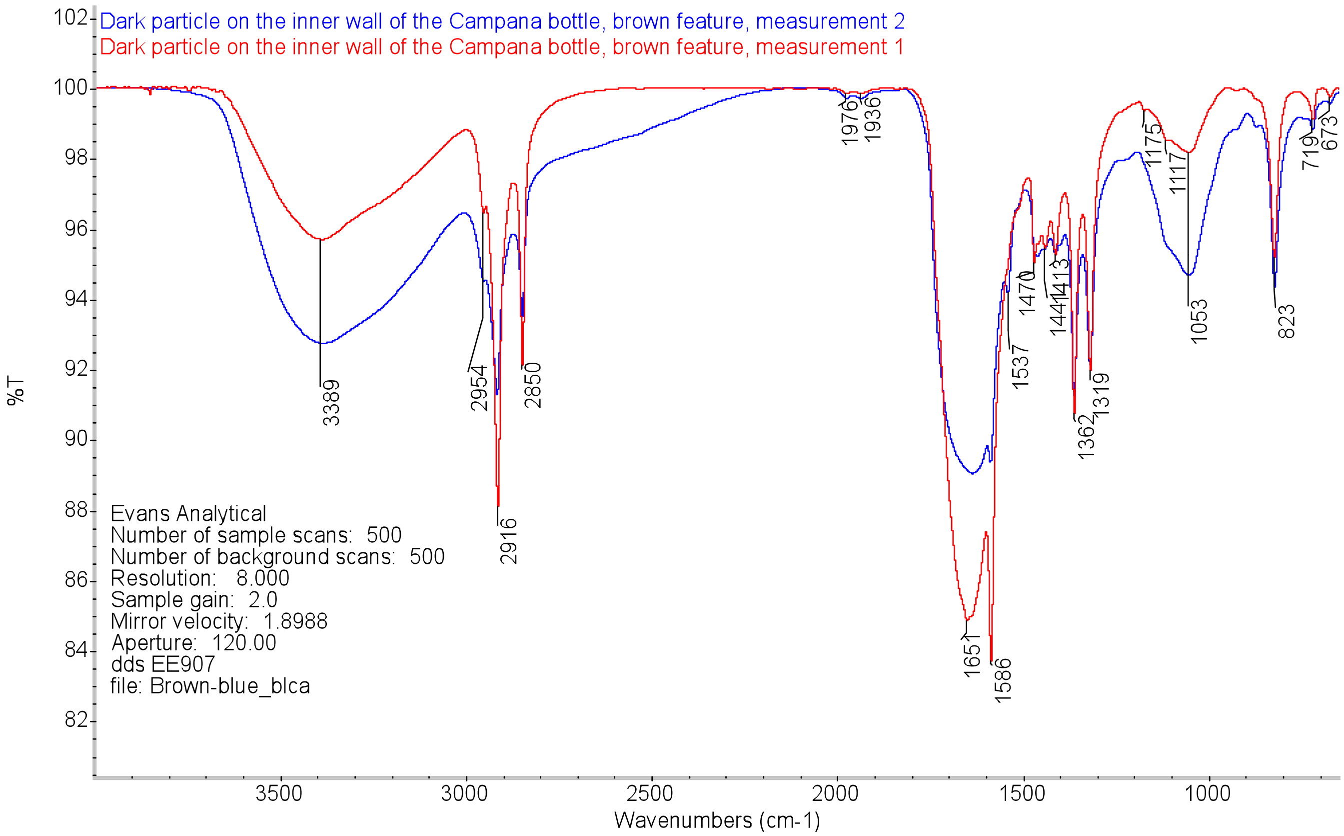

Dark particle on the inner wall of the Campana bottle, blue feature, measurement 2
Dark particle on the inner wall of the Campana bottle, blue feature, measurement 1
Evans Analytical
Number of sample scans: 500
Number of background scans: 500
Resolution: 8.000
Sample gain: 2.0
Mirror velocity: 1.8988
Aperture: 120.00
dds EE907
file: Blue_4_blca
%T
Wavenumbers (cm-1)
3387
2955
2917
2850
1735
1704
1586
1471
1443
1413
1364
1316
1176
1115
823
718
672

Spectrum 18

Reference (blue trace) is copper stearate

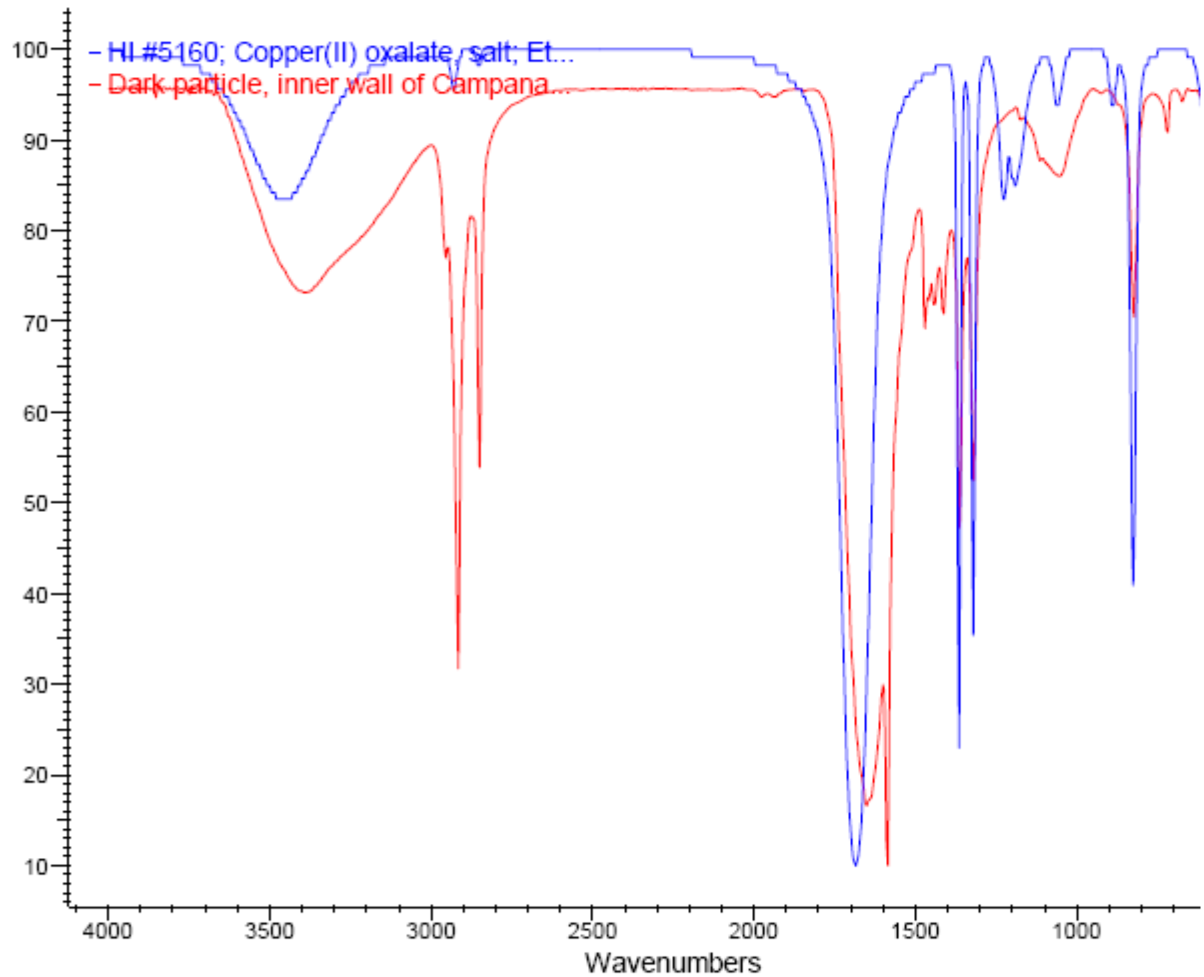


Spectrum 19


Dark particle on the inner wall of the Campana bottle, brown feature, measurement 2
Dark particle on the inner wall of the Campana bottle, brown feature, measurement 1
%T
Wavenumbers (cm-1)
Evans Analytical
Number of sample scans: 500
Number of background scans: 500
Resolution: 8.000
Sample gain: 2.0
Mirror velocity: 1.8988
Aperture: 120.00
dds EE907
file: Brown-blue_blca
3389
2954
2916
2850
1976
1936
1651
1586
1537
1470
1441
1413
1362
1319
1175
1117
1053
823
719
673

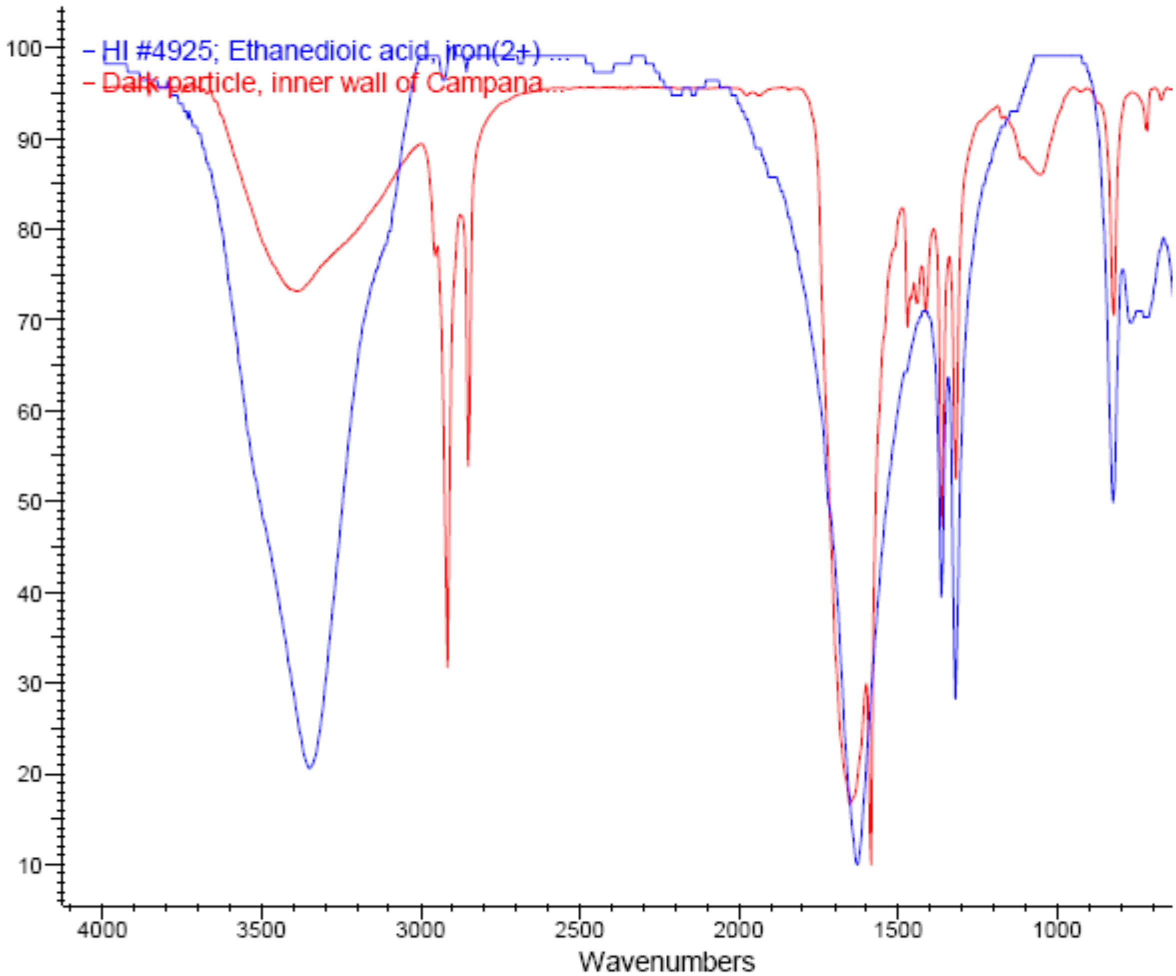
Spectrum 20

Reference (blue trace) is copper(II) oxalate



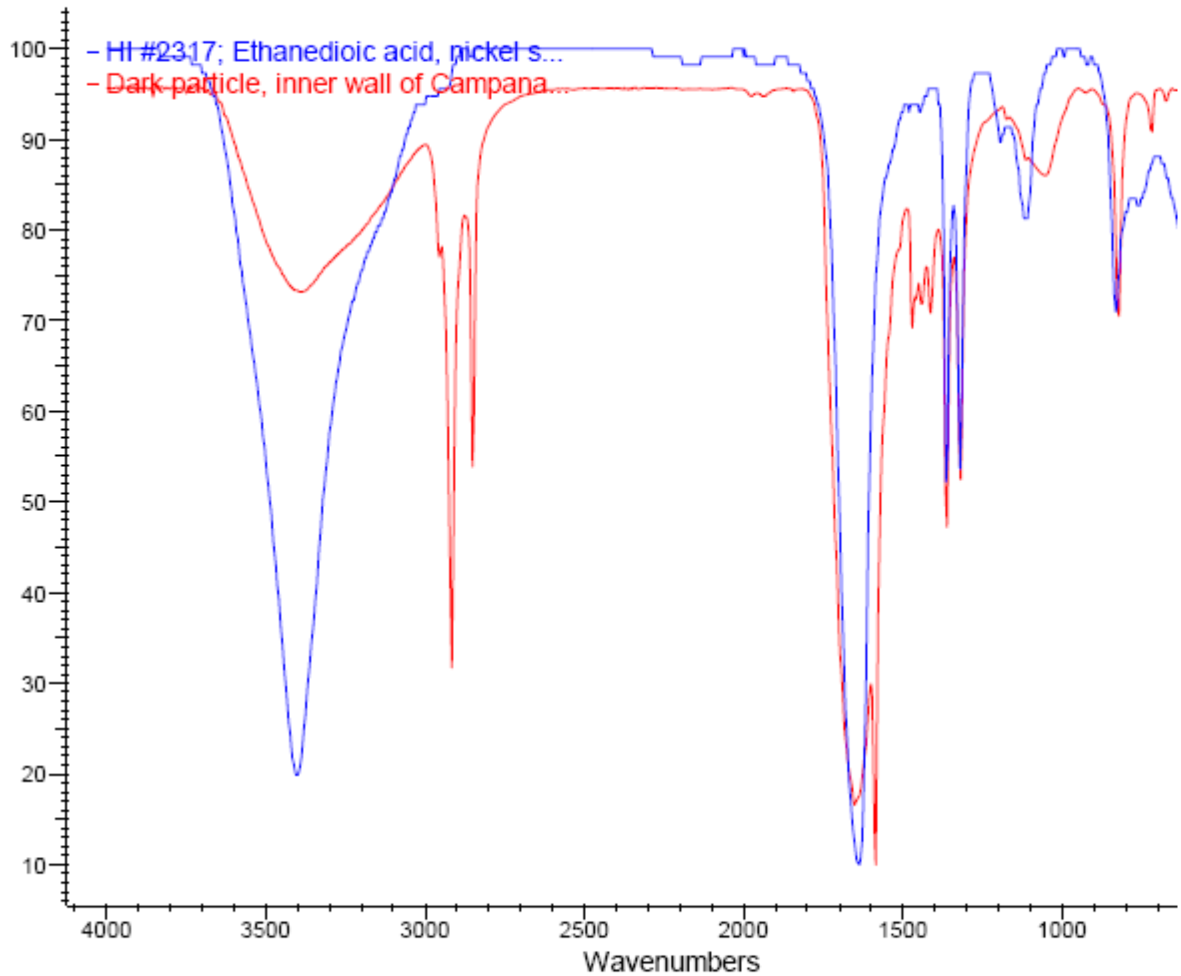
Spectrum 21

Reference (blue trace) is iron (II) oxalate



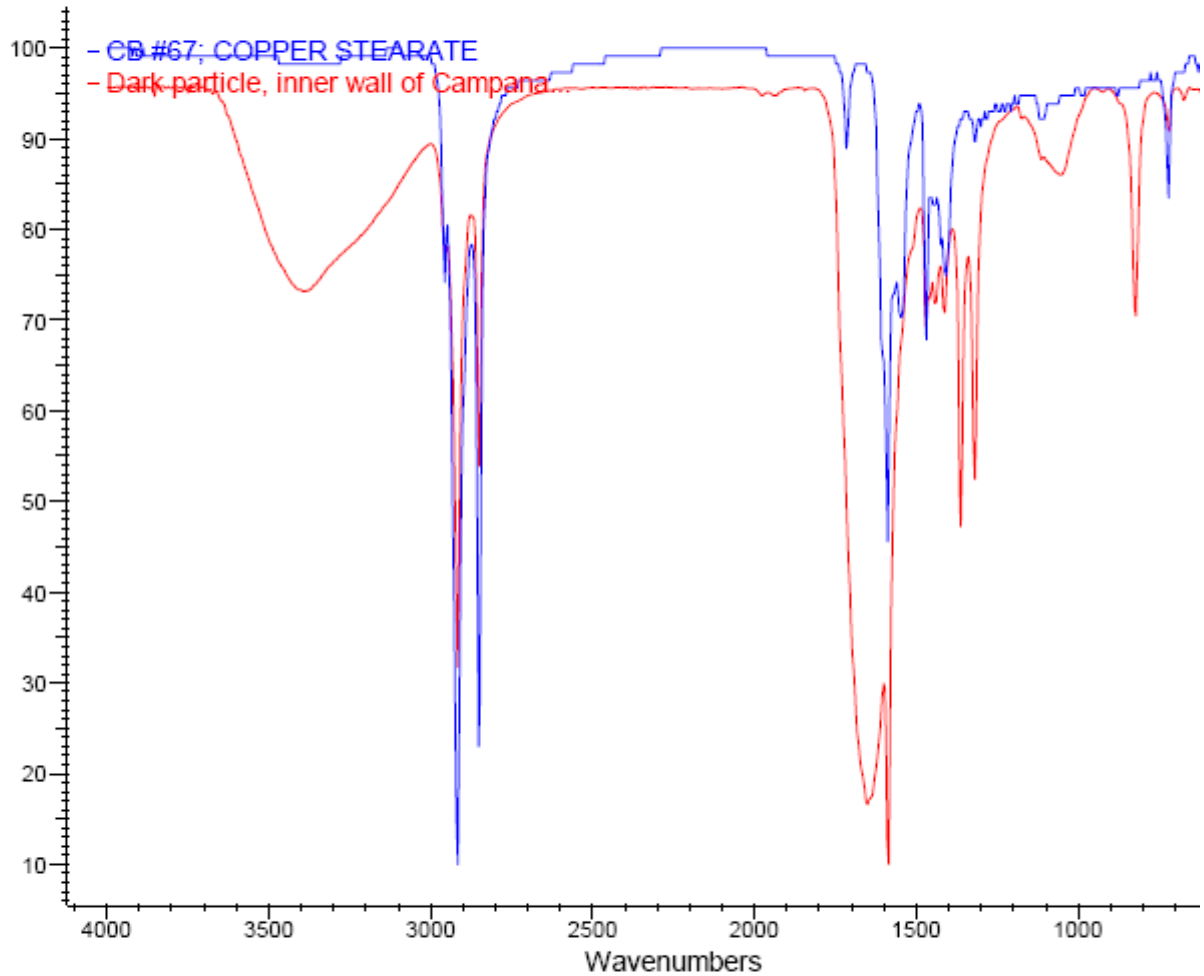
Spectrum 22

Reference (blue trace) is nickel oxalate

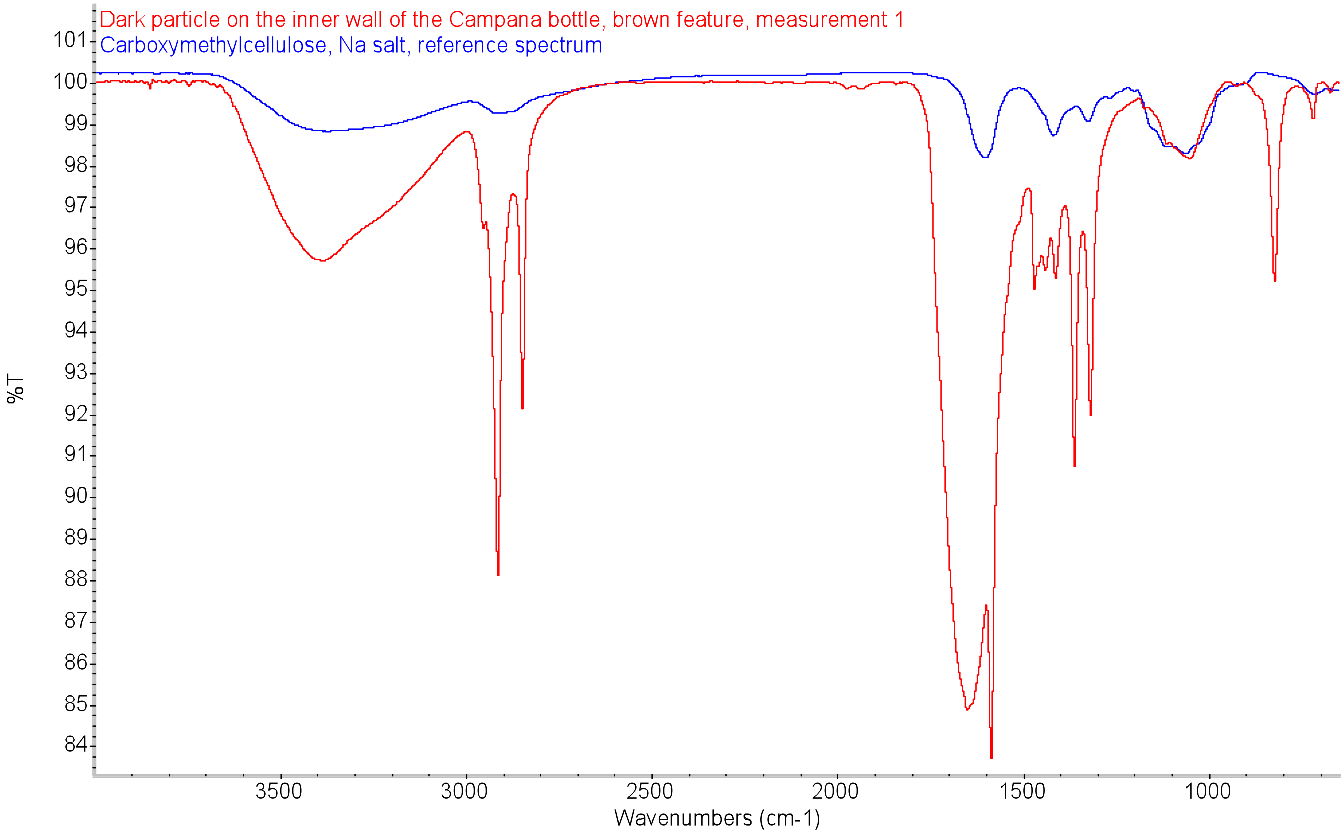


Spectrum 23

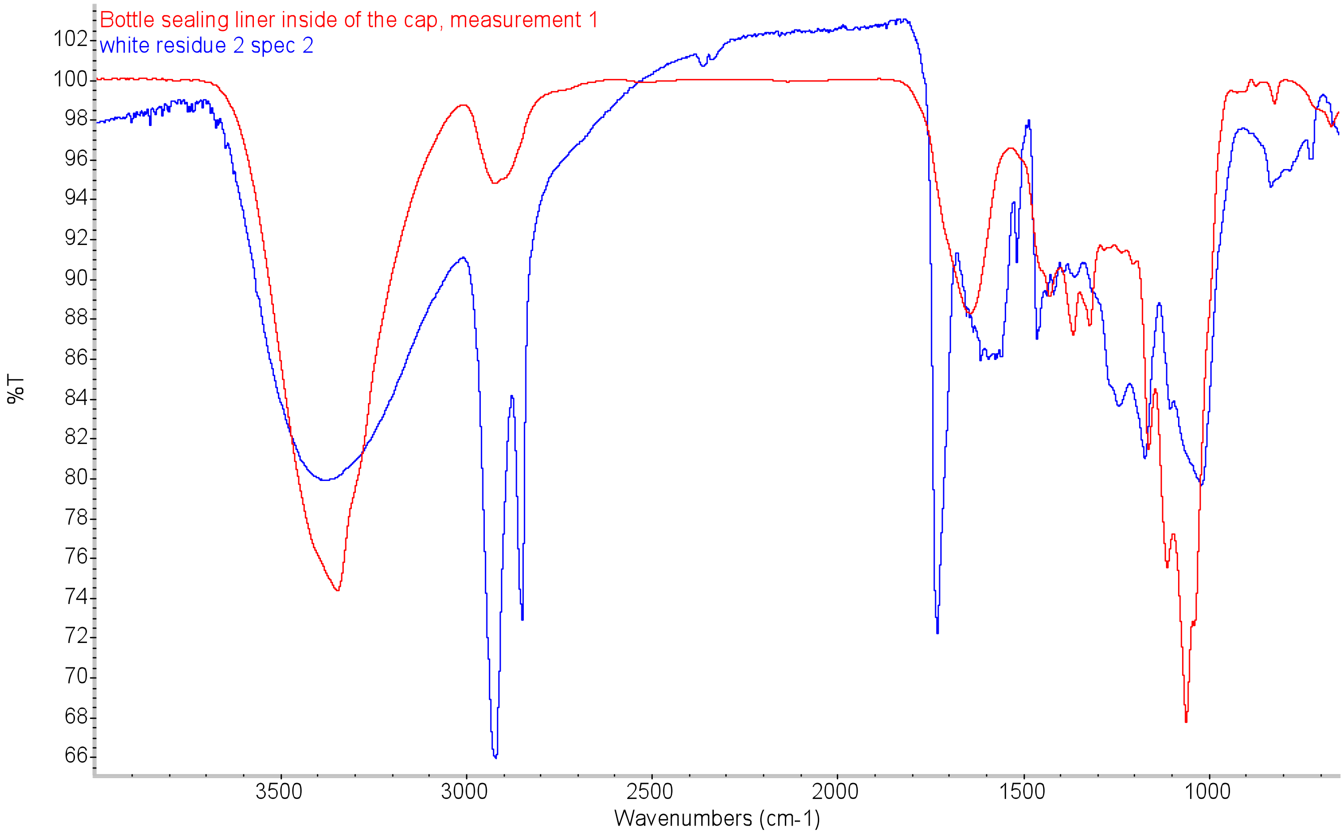
Reference (blue trace) is copper stearate



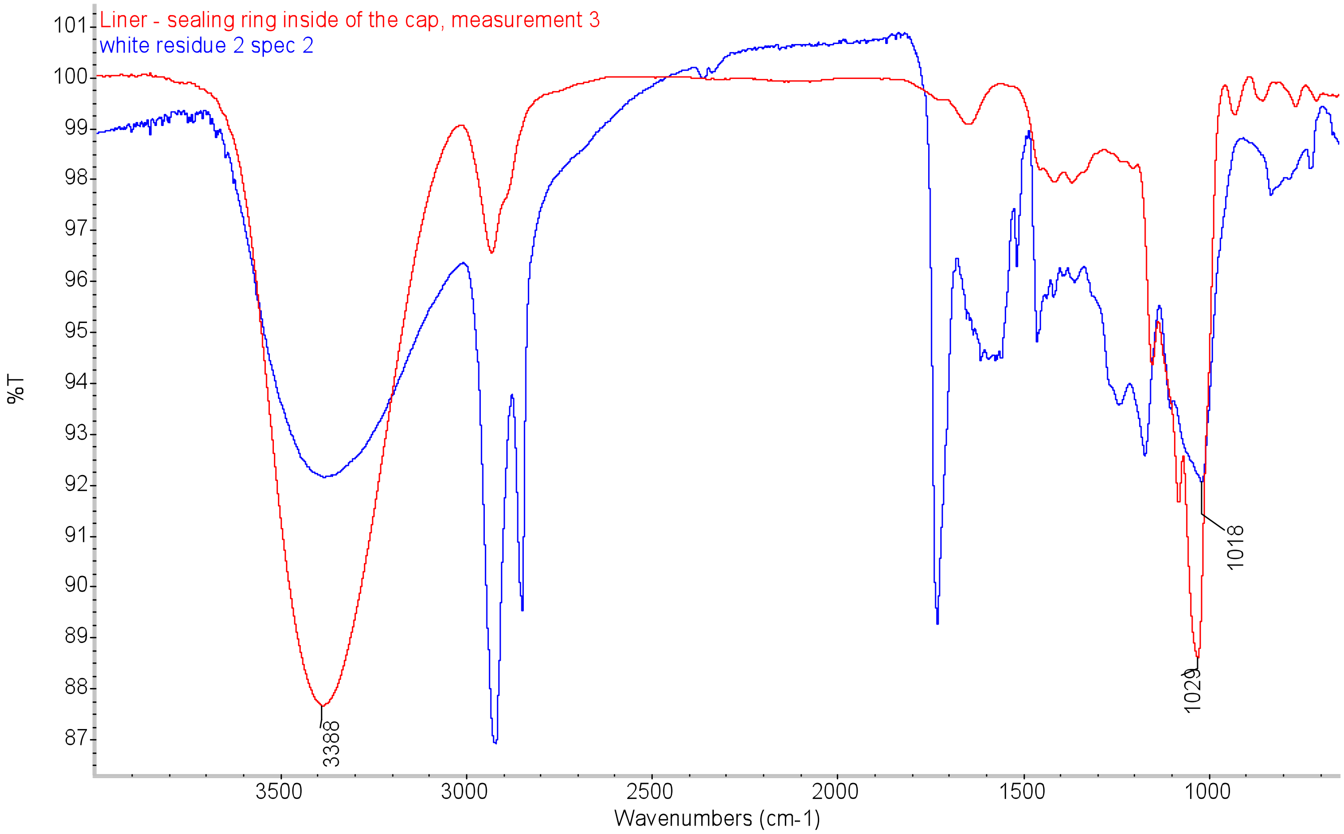
Spectrum 24


Dark particle on the inner wall of the Campana bottle, brown feature, measurement 1
Carboxymethylcellulose, Na salt, reference spectrum
%T
101
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

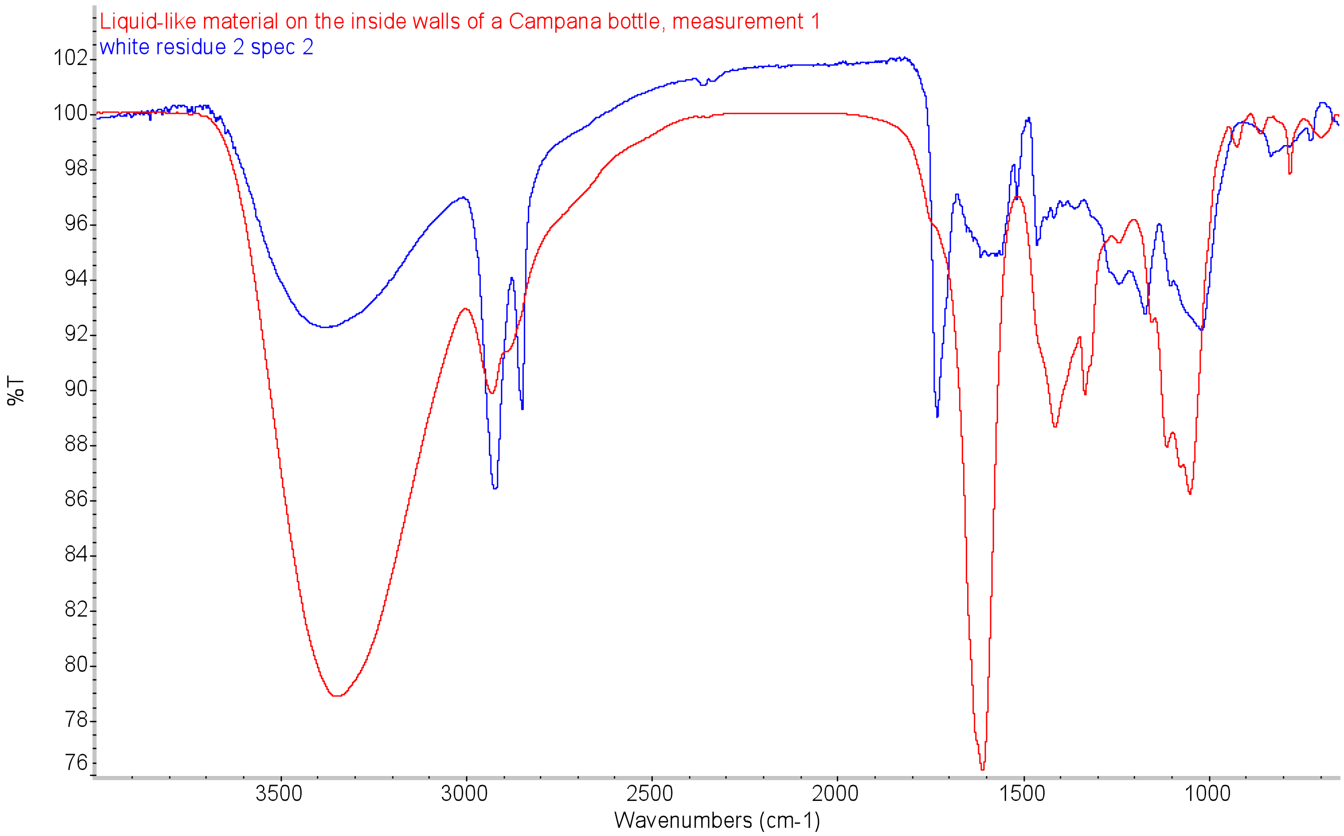
Spectrum 25


Bottle sealing liner inside of the cap, measurement 1
white residue 2 spec 2
%T
102
100
98
96
94
92
90
88
86
84
82
80
78
76
74
72
70
68
66
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

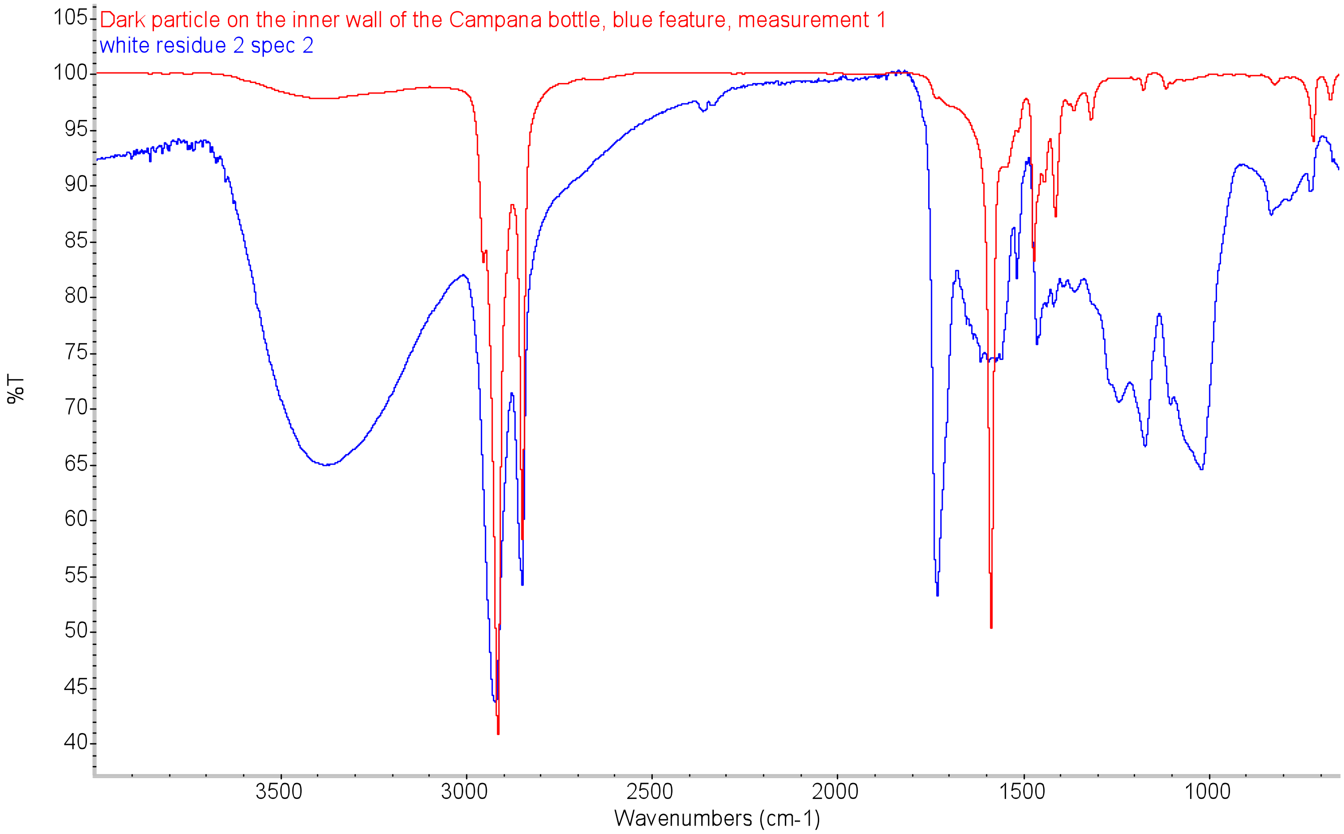
Spectrum 26


Liner - sealing ring inside of the cap, measurement 3
white residue 2 spec 2
%T
101
100
99
98
97
96
95
94
93
92
91
90
89
88
87
3388
1029
1018
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

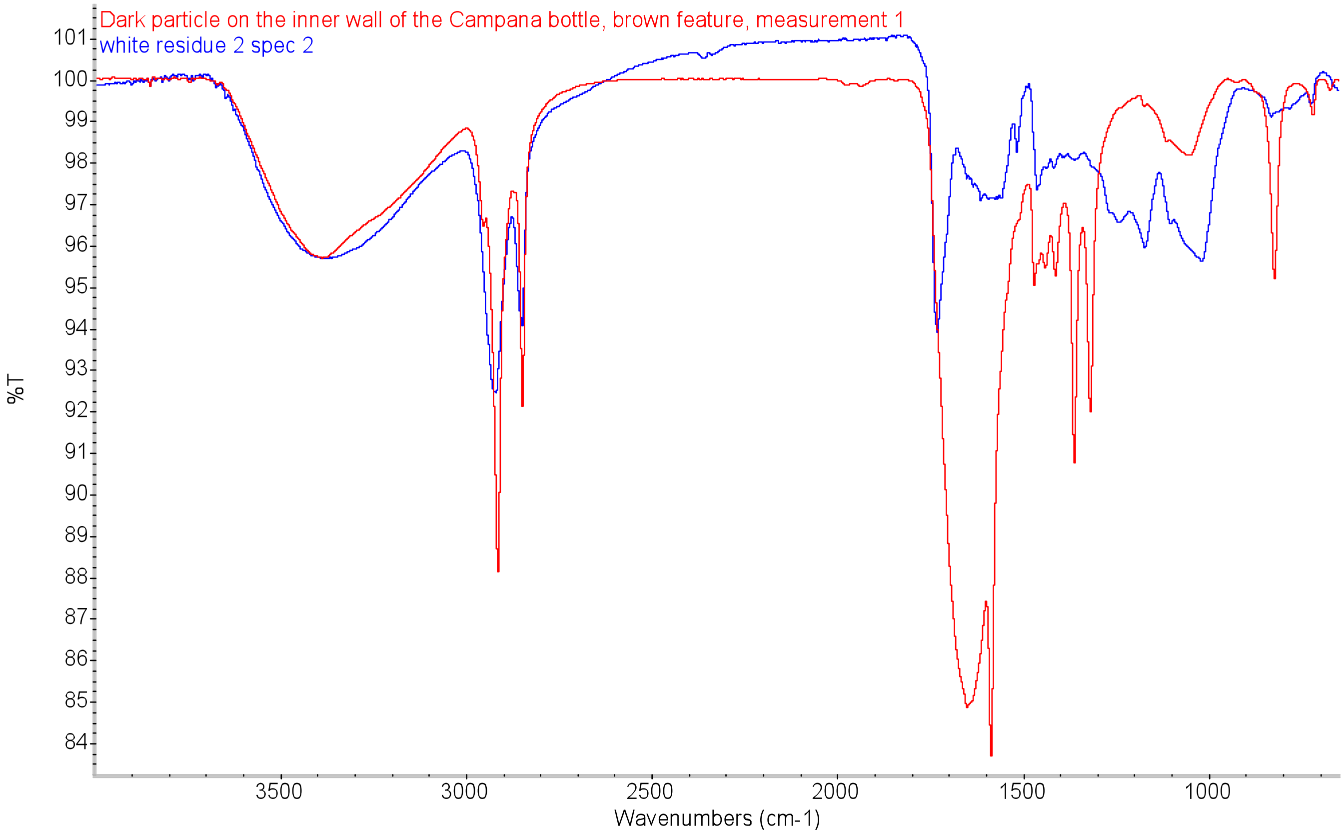
Spectrum 27


Liquid-like material on the inside walls of a Campana bottle, measurement 1
white residue 2 spec 2
%T
102
100
98
96
94
92
90
88
86
84
82
80
78
76
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

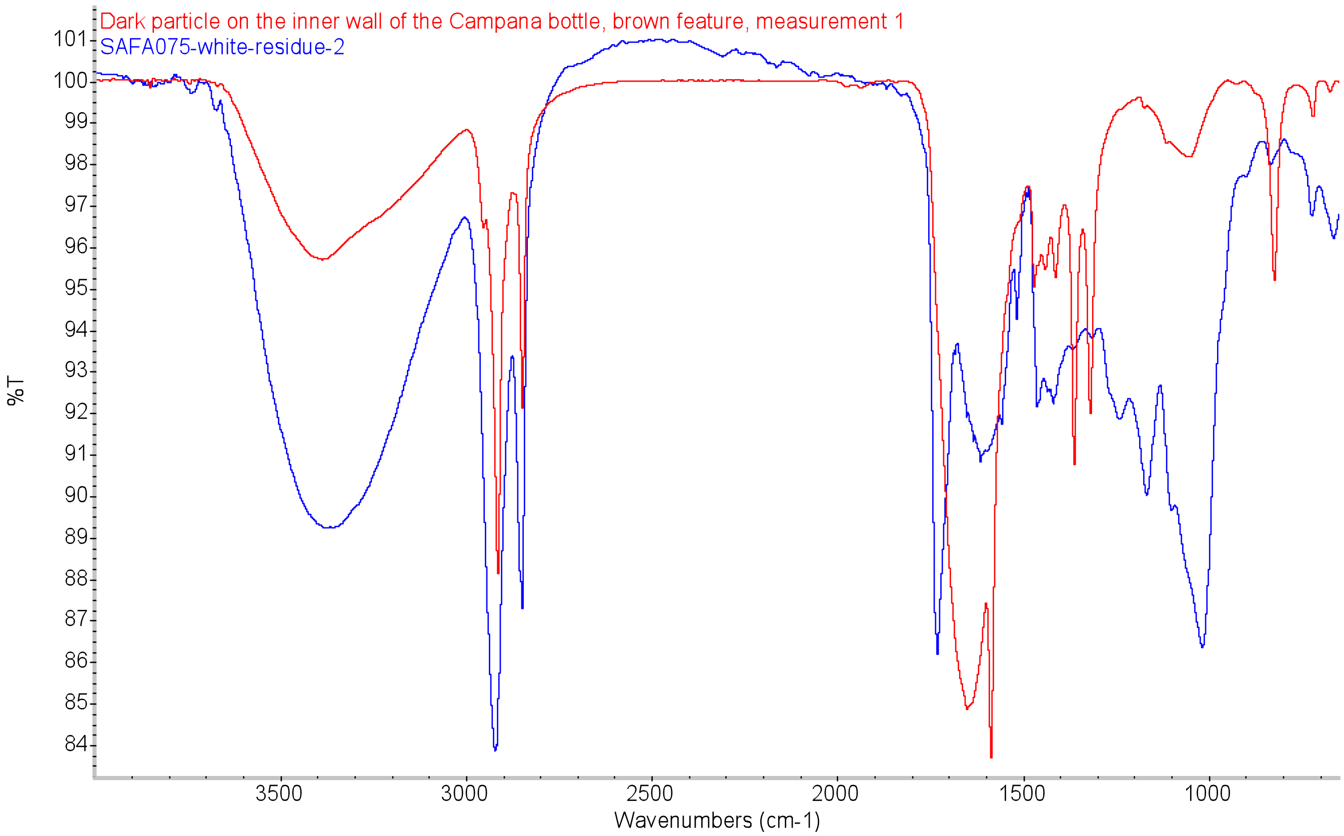
Spectrum 28


Dark particle on the inner wall of the Campana bottle, blue feature, measurement 1
white residue 2 spec 2
105
100
95
90
85
80
75
70
65
60
55
50
45
40
%T
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

Spectrum 29


Dark particle on the inner wall of the Campana bottle, brown feature, measurement 1
white residue 2 spec 2
%T
101
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

Spectrum 30


Dark particle on the inner wall of the Campana bottle, brown feature, measurement 1
SAFA075-white-residue-2
%T
101
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
3500
3000
2500
2000
1500
1000
Wavenumbers (cm-1)

Spectrum 31