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Artificial plant cell walls as multi-catalyst systems for enzymatic cooperative asymmetric catalysis in non-aqueous media

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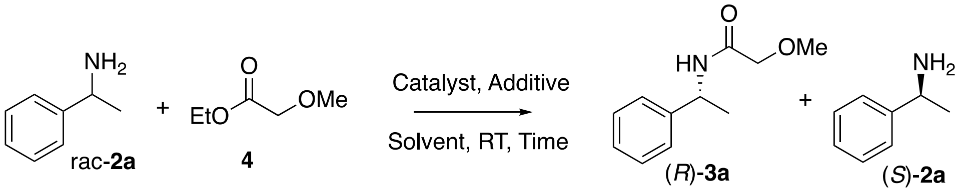
General methods:

Chemicals and solvents were either purchased from commercial suppliers or purified by standards techniques. Avicel® PH-101 (~50 μm particle size), Lipase B Candida antarctica recombinant from Aspergillus oryzae (beige powder, ~9 U/mg), Brij® C10 (average Mn ~683) were purchased from Aldrich and used as received. Dry toluene was column-dried directly before use by a VAC: Solvent Purifier system. ^{1}H NMR spectra were recorded on a Bruker Avance 500 (500 MHz) spectrometer. Chemical shifts are reported in ppm from tetramethylsilane with the solvent resonance resulting from incomplete deuterium incorporation as the internal standard (CDCl3: δ 7.26 ppm). Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, q = quartet, br = broad, m = multiplet), and coupling constants (Hz), integration. ^{13}C NMR spectra were recorded on a Bruker Avance 500 (125.8 MHz) spectrometer with complete proton decoupling. Chemical shifts are reported in ppm from tetramethylsilane with the solvent resonance as the internal standard (CDCl3: δ 77.26 ppm). High-resolution mass spectrometry was performed on an Agilent Technologies 6520- Q-TOF ESI-MS (positive mode) at the Mid-Sweden University Mass Spectrometry Facility. Enantiomer ratios were determined by HPLC (Chiral Agilent Technologies Chiralpak OD-H, OJ-H, AS-H, AM-H column (4.6 mm x 250 mm)) in comparison with authentic racemic materials. Optical rotations were measured on a Perkin-Elmer 341 Polarimeter. Unless otherwise noted, all reactions were performed with distilled solvents in oven- dried (160ºC) glassware. X-ray photoelectron spectroscopy was used to determine the structure and oxidation states of the Pd nanoparticles. Elemental analyses on the Pd content were carried out by Medac LTD Analytical and chemical consultancy services (United Kingdom) by ICP-OES. Infrared spectra were recorded by Thermo Scientific NICOLET 6700 FT-IR, Smart orbit, Diamond 30000-200 cm^{-1}. Scanning transmission electron microscopy (STEM) was carried out using a 200 kV JEOL 2100F microscope, which equips with a Schottky field-emission gun and ultrahigh-resolution pole-piece (Cs=0.5 mm). The samples in vials were shaken, in order to have small pieces. Then the samples were dispersed onto Cu TEM supporting grid with holey carbon films without using solvent. High-angle annular dark-field (HAADF) and bright-field (BF)-STEM images were acquired simultaneously using Gatan Microscopy Suite with the JEOL ADF and Gatan BF detectors, respectively. The camera length used was 8 cm.

Table S1. Kinetic resolution studies.[a]



Entry	Catalyst (Assembled Components)	**4** [eq]	Additive (equiv)]	Time [h]	Yield **3a** [%][b]	*Ee* **3a** [%][c]	*E*[d]
1	-	10	Na_2CO_3 (3)	140	0	-	-
2[e,f]	CALB	10	Na_2CO_3 (3)	140	3	ND	ND
3[g,h]	CALB/Buffer	10	Na_2CO_3 (3)	68	37	94	56
4[i,j]	CALB/Brij/H_2O	10	Na_2CO_3 (3)	30	45	99	>400
5[k]	CALB/Brij/buffer	10	Na_2CO_3 (3)	68	34	92	39
6	**APCW1**(MCC/CALB/buffer)	5	Na_2CO_3 (1)	47	14	99	ND
7	**APCW1**	10	Na_2CO_3 (3)	68	41	95	81
8[g,i]	**APCW2**(MCC/CALB/H_2O)	10	Na_2CO_3 (3)	68	41	96	102
9	**APCW3**(MCC/CALB/Brij/buffer)	2	Na_2CO_3 (1)	47	27	99	302
10[l]	**APCW3**	2	Na_2CO_3 (1)	47	31	91	34
11[m]	**APCW3**	2	Na_2CO_3 (1)	47	31	99	340
12	**APCW3**	5	Na_2CO_3 (1)	47	39	99	>400
13[n]	**APCW3**	5	Na_2CO_3 (1)	47	20	17	ND
14	**APCW3**	5	Na_2CO_3 (3)	47	46	99	>400
15	**APCW3**	5	K_2CO_3 (3)	47	27	97	99
16[o]	**APCW3**	5	MS 4Å	29	49	99	>400
17	**APCW3**	10	Na_2CO_3 (3)	23	46	99	>400
18[g,i]	**APCW4**(MCC/CALB/Brij/H_2O)	10	Na_2CO_3 (3)	27	44	99	>400
19[p]	**APCW3**	10	Na_2CO_3 (3)	21	47	99	>400
20[q]	**APCW3**	10	Na_2CO_3 (3)	28	46	99	>400
21	**APCW5**(NFC/CALB/Brij/buffer)	10	Na_2CO_3 (3)	53	46	94	92
22	**APCW6**(Chit./CALB/Brij/buffer)	10	Na_2CO_3 (3)	53	39	93	52
23	**APCW7**(CNC/CALB/Brij/buffer)	10	Na_2CO_3 (3)	53	50	94	115
24	**APCW8**(MCC-Amp /CALB/Brij/buffer)	10	Na_2CO_3 (3)	30	40	99	>400
25	**APCW9**(MCC-Amp-Pd^0/CALB/Brij/buffer)	10	Na_2CO_3 (3)	31	46	99	>400
26	CALB/Brij/Pd^0/buffer	10	Na_2CO_3 (3)	72	30	87	21

[a] Reaction conditions: **2a** (0.25 mmol, 1equiv), **4**, Na_2CO_3, Catalyst (9 mg), toluene: 1 mL, room temperature. [b] Isolated yield. [c] Determined by chiral HPLC. [d] E = Enantiomeric ratio, selectivity factor as determined by Chen et al..[52] [e] Lyophilized CALB (2.1 mg) was used. [f] Yield determined by ^1H NMR. [g] 5 mg of catalyst. [h] Lyophilized CALB was freeze dried in sodium phosphate buffer. [i] The catalyst was assembled by freeze drying in MQ-H_2O. [j] 2 mg of catalyst. [k] 2 mg of catalyst. [l] Reaction performed at 70 °C. [m] Catalyst (MCC/CALB/Brij/buffer) = 18 mg. [n] 2,2,2-Trifluoroethyl butyrate was used as acyl donor. [o] Molecular sieves (4Å) = 125 mg. [p] 1,4-Dioxane used as solvent. [q] 3-Methyl 3-pentanol used as solvent. ND stands for not determined. CALB = *Candida antarctica* Lipase B, APCW = Artificial cell wall, Chit. = Chitosan, MCC = Microcrystalline cellulose, CNC = cellulose nanocrystals, NFC = Nanofibrilated cellulose, Amp = aminopropyl, Brij = polyethylene glycol hexadecyl ether (Mn = 683).

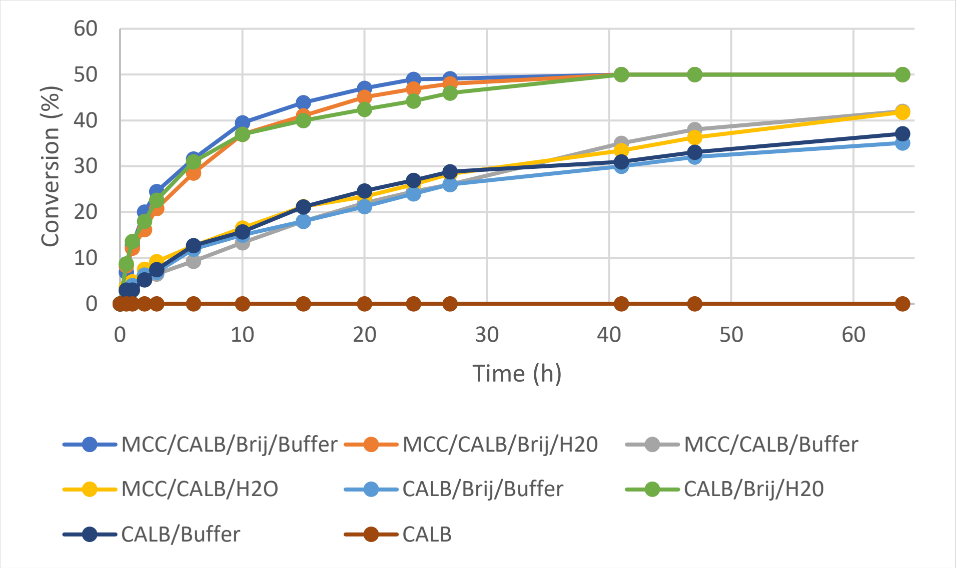


Figure S1. Monitoring the formation of amid (*R*)-**3a** as a function of time for the amidation of (*rac*)-**2a** using CALB and modified CALB with different structural components in toluene. **APCW1** = MCC/CALB/buffer, **APCW2** = MCC/CALB/H_2O, **APCW3** = MCC/CALB/Brij/buffer, **APCW4** = MCC/CALB/Brij/H_2O.

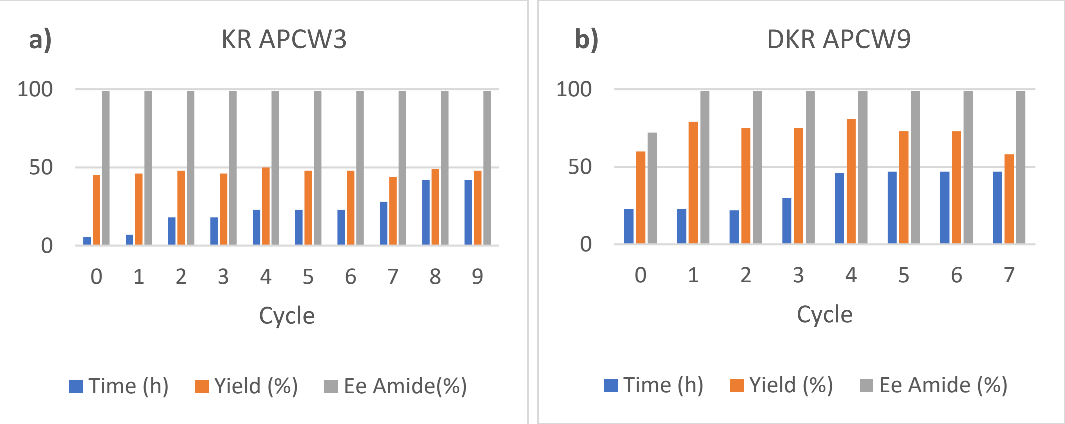


Figure S2. a) Multiple **APCW3**-catalyzed KRs of racemic **2a**. b) Multiple **APCW9**-catalyzed DKRs of racemic **2a**.

General procedure for the assembling of an artificial primary cell walls (APCWs).

In a plastic beaker was added polysaccharide component (60 mg), sodium phosphate buffer (6 mL, 0.1 M, pH 7.2) or deionized H_2O (6 mL) and Brij C10 (20 mg). The suspension was stirred with a spatula until Brij C10 had been completely solubilized. Next, CALB (20 mg) was added and the mixture was stirred with a spatula until complete solubilization of the enzyme and then rapidly frozen in liquid nitrogen. The catalyst was lyophilized for 70 hours to give a solid white foam. APCW was stored in a desiccator containing a saturated LiCl solution to obtain the water activity (aw) of 0.5.

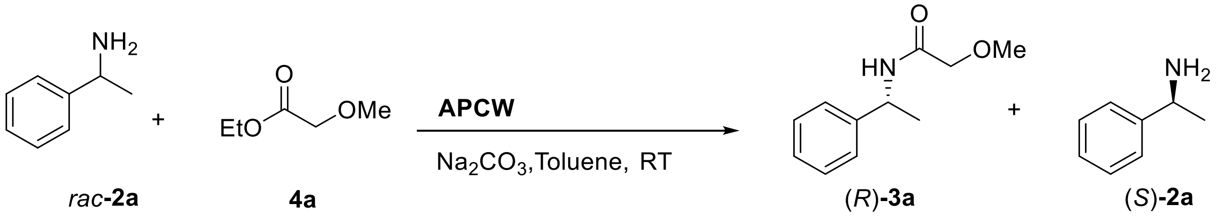
Table S2. Reagents for the assembling of APCW.

$$\text{CALB} + \text{Cellulose} + \text{Brij} \xrightarrow[\text{Freeze dry}]{\substack{\text{Phosphate} \\ \text{Buffer} \\ \text{(0.1M, pH 7.2)}}} \text{APCW}$$

Catalyst	**CALB (mg)**	**Polysaccharide (mg)**	**Brij (mg)**
CALB/buffer[a]	20	-	-
CALB/Brij/buffer[a]	20	-	20
CALB/Brij/H_2O[b]	20	-	20
APCW1 (MCC/CALB/buffer)[a]	20	60	-
APCW2 (MCC/CALB/H_2O)[b]	20	60	-
APCW3 (MCC/CALB/Brij/buffer)[a]	20	60	20
APCW4 (MCC/CALB/Brij/H_2O)[b]	20	60	20
APCW5 (NFC/CALB/Brij/buffer)[a]	20	60	20
APCW6 (Chitosan/CALB/Brij\buffer)[a]	20	60	20
APCW7 (CNC/CALB/Brij/buffer)[a]	20	60	20
APCW8 (MCC-Amp/CALB/Brij/buffer)[a]	20	60	20

[a] Sodium phosphate buffer (6 mL, 0.1 M, pH 7.2) used as solvent. [b] Deionized H_2O (6 mL) used as solvent.

General procedure for KR of *rac*-2a using APCW.



In a microwave vial were added the **APCW** (9 mg), dry Na_2CO_3 (80 mg, 0.75 mmol, 3 equiv), dry toluene (1 mL), *rac*-**2a** (30mg, 0.25 mmol, 1 equiv) and **4** (295 mg, 2.5 mmol, 10 equiv). The vial was capped and flushed with nitrogen. The reaction was stirred at room temperature for the time reported. The crude reaction mixture was directly loaded on a silica-gel column and chromatography (hexane/ ethyl acetate 2:1, ethyl acetate/ methanol 6:1) afforded (*R*)-**3a** and (*S*)-**2a**. Enantiomeric excess of amine (*S*)-**2a** was measured after derivatization into (*S*)-**3a** by treatment with methoxyacetyl chloride in dichloromethane.

Recycling procedure of APCW3 MCC/CALB/Brij/buffer catalyst for the KR of *rac*-2a.

In a microwave vial were added **APCW3** ((MCC/CALB/Brij/buffer), 36 mg), dry Na_2CO_3 (80 mg, 0.75 mmol, 3 equiv), toluene (1 mL), *rac*-**2a** (30 mg, 0.25 mmol, 1 equiv) and ethyl 2-methoxyacetate **4** (295 mg, 2.5 mmol, 10 equiv). The vial was capped and flushed with nitrogen. The reaction was stirred at room temperature for the time reported in the table (table 2S). Next, dry toluene was added to the vial and the reaction mixture was centrifuged 3 times collecting the supernatant after each cycle. After the last centrifuge cycle, 1 mL of toluene was left in the vial and fresh Na_2CO_3 (27 mg, 0.25 mmol, 1 equiv) and fresh substrate were added. The collected supernatant was concentrated under reduced pressure and the crude reaction mixture was directly loaded on a silica-gel column and chromatography (hexane/ ethyl acetate 2:1, ethyl acetate/ methanol 6:1) afforded (*R*)-**3a** and (*S*)-**2a** in the reported yield and ee. The cycle was repeated.

Table S3. Recycling studies of APCW3 MCC/CALB/Brij/buffer catalyst for the KR of *rac*-2a.

Cycle	Time (h)	Yield (%)[c]	Ee **3a** (%)[d]	Ee **2a** (%)[d]	*E*
0	5.5	45	99	70	>400
1	7	46	99	94	>400
2	18	48	99	89	>400
3	18	46	99	82	>400
4	23	50	99	85	>400
5	23	48	99	81	>400
6	23	48	99	77	>400
7	28	44	99	73	>400
8	42	49	99	82	>400
9	42	48	99	83	>400

[a] Reaction conditions: *rac*-**2** (0.25 mmol, 1equiv), **4** (2.5 mmol, 10 equiv), Na_2CO_3 (0.75 mmol, 3 equiv), **APCW3** MCC/CALB/Brij/buffer (36 mg), toluene (1 mL), room temperature. Na_2CO_3 (0.25 mmol, 1equiv) was added after each cycle. [b] Determined by H^1-NMR. [c] Isolated yield. [d] Determined by chiral HPLC.

Procedure for monitoring the formation of amide (*R*)-3a as a function of time for the amidation of *rac*-2a using CALB and modified CALB with different structural components in toluene.

In a microwave vial were added the catalyst (0.996 mg of lyophilized CALB content), dry Na_2CO_3 (80 mg, 0.75 mmol, 3 equiv), dry toluene (1 mL), *rac*-**2a** (30 mg, 0.25 mmol, 1 equiv) and **4** (295 mg, 2.5 mmol, 10 equiv). The vial was capped, flushed with nitrogen and the reaction was stirred at room temperature. At short intervals a small aliquot was taken from the crude mixture and analyzed by H^1-NMR to determine the degree of conversion for amide (*R*)-**3a** as function of time (see figure 2S).

MCC-Amp synthetic procedure.

To a suspension of Avicel PH-101 (500 mg, 3.08 mmol, 1 equiv) and L-(+)-tartaric acid (73 mg, 0.46 mmol, 5 mol%), in dry toluene (20 mL), was added 3-(Trimethoxysilyl)-propylamine (1.64 g, 9.2 mmol, 3 equiv). The reaction was stirred 48 hours at 80°C under nitrogen. Next, the solution was cooled at room temperature, transferred in an extraction thimble and washed by Soxhlet extraction with acetone for 18 hours. MCC-amp was dried under vacuum to give a white powder (650 mg).

MCC-Amp-Pd^{II} synthetic procedure.

To a suspension of MCC-Amp (183 mg) in distilled H_2O (5.5 mL) was added, under vigorous stirring, a solution of Li_2PdCl_4 (101 mg, 0.39 mmol) in distilled H_2O (3.7 mL, pH 9 adjusted with LiOH 0.1 M). The reaction was stirred for 24 hours at room temperature. Next, the MCC-Amp-Pd^{II} suspension was transferred to a centrifuge vial and washed with deionized H2O (3 x 15 mL) and acetone (3 x 15 mL) by repeated resuspension and centrifugation. MCC-Amp-Pd^{II} was dried under vacuum to give a brown powder (170 mg).

MCC-Amp-Pd^0 synthetic procedure.

To a suspension of MCC-Amp-Pd^{II} (170 mg) in distilled H_2O (5.5 mL) was added dropwise, under vigorous stirring, a solution of $NaBH_4$ (170 mg, 4.50 mmol) in distilled H_2O (1.8 mL) and the reaction was continued to stir for 1 hour at room temperature. Next, the MCC-Amp-Pd^0 suspension was transferred to a centrifuge vial and washed with deionized H2O (3 x 15 mL) and acetone (3 x 15 mL) by repeated resuspension and centrifugation. MCC-Amp-Pd^0 was dried under vacuum to give a grey powder (155 mg). The Pd content determined by elemental analysis was 19.17 wt%. The Pd^0/Pd^{II} ratio based on XPS analysis was 3.5:1.

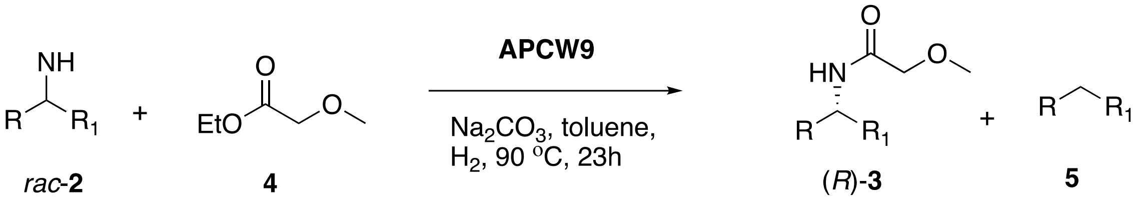
APCW9 (MCC-Amp-Pd^0/CALB/Brij/buffer) assembling procedure.

In a plastic beaker was added MCC-Amp-Pd^0 (60 mg), sodium phosphate buffer (6 mL, 0.1 M, pH= 7.2) and Brij C10 (20 mg). The solution was stirred with a spatula until completely solubilization of Brij. Next, CALB (20 mg) was added and the mixture was rapidly frozen in liquid nitrogen. The catalyst was lyophilized for 70 hours to give a solid grey foam (181 mg). The catalyst was stored in a desiccator containing drierite as drying agent. The Pd content determined by elemental analysis was 3.16 wt%.

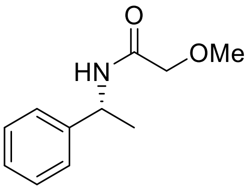
CALB/Brij/Pd^0 synthetic procedure.

To a suspension of CALB/Brij (40 mg) in CH_2Cl_2 (1.5 mL) was added $PdCl_2$ (10 mg, 0.056 mmol). The vial was capped, evacuated and a hydrogen balloon was connected to the reaction vessel. The reaction was stirred for 2 days at room temperature. Next, the solution was centrifuged, the supernatant removed, and CALB/Brij/Pd^0 dried under vacuum to give a grey powder (35 mg). The catalyst was stored in a desiccator containing drierite as drying agent. The Pd content determined by elemental analysis was 18.30 wt%.

General procedure for the DKR of *rac*-2 in toluene using APCW9 as catalyst.

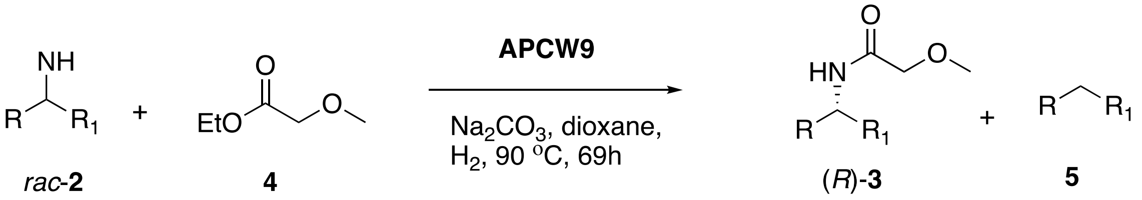


In a microwave vial, were added **APCW9** ((MCC-Amp-Pd^0/CALB/Brij/buffer), 9 mg, 1.1 mol% Pd) and dry Na_2CO_3 (80 mg, 0.75 mmol, 3 equiv). The vial was flushed with nitrogen and hydrogen. Next, toluene (1 mL), *rac*-**2a** (0.25 mmol, 1 equiv) and **4** (295 mg, 2.5 mmol, 10 equiv) were added. The vial was capped, evacuated and a hydrogen balloon was connected to the reaction vessel. The reaction was stirred at 90°C for 23 hours. The reaction mixture was directly purified by column chromatography (hexane/ ethyl acetate 9:1 to 2:1) to afford the corresponding product (*R*)-**3**.

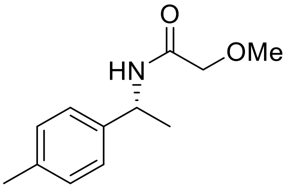


(*R*)-2-methoxy-N-(1-phenylethyl)acetamide 3a: 39 mg, 81% yield; white solid; R_f=0.30 (Hexane/EtOAc 2:1); **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.41 – 7.30 (m, 4H), 7.27 (dd, *J* = 6.3, 4.2 Hz, 1H), 6.75 (s, 1H), 5.28 – 5.10 (m, 1H), 3.90 (q, *J* = 15.0 Hz, 2H), 3.40 (s, 3H), 1.52 (d, *J* = 6.9 Hz, 3H). ppm; **^{13}C NMR (126 MHz, $CDCl_3$)** δ 168.6, 143.1, 128.8, 127.5, 126.3, 72.1, 59.3, 48.1, 22.0. ppm; $[\alpha]_D^{25}$=+105.5 (c=1.0, $CHCl_3$). The enantiomeric excess was determined by HPLC analysis in comparison with authentic racemic material (ODH-column, n-hexane/i-PrOH = 95/5, λ = 210 nm, 1,0 ml/min) tr (major enantiomer) = 12.6 min, tr (minor enantiomer) = 17.3 min. **HRMS (ESI):** calculated for $C_{11}H_{16}NO_2$ [M+H]$^+$ 194.1176; found 194.1171.

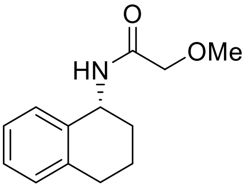
General procedure for the DKR of *rac*-2 in 1,4-dioxane using APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer.



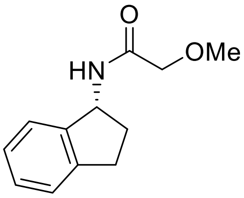
In a microwave vial were added **APCW9** MCC-Amp-Pd^0/CALB/Brij/buffer (9 mg, 1.1 mol% Pd) and dry Na_2CO_3 (80 mg, 0.75 mmol, 3 equiv). The vial was flushed with nitrogen and hydrogen. Next, 1,4-dioxane (1 mL), *rac*-**2** (0.25 mmol, 1 equiv) and **4** (295 mg, 2.5 mmol, 10 equiv) were added. The vial was capped, evacuated and a hydrogen balloon was connected to the reaction vessel. The reaction was stirred at 90°C for 69 hours. The crude reaction mixture was directly loaded on a silica-gel column and chromatography (hexane/ ethyl acetate 9.1 to 2:1) afforded the corresponding product (*R*)-**3**.



(*R*)-2-methoxy-N-(1-(p-tolyl)ethyl)acetamide 3b: 39 mg, 75% yield; white solid; R_f=0.37 (Hexane/EtOAc 2:1); **^{1}H NMR (500 MHz, CDCl$_3$)** δ 7.22 (d, *J* = 8.1 Hz, 2H), 7.15 (d, *J* = 8.1 Hz, 2H), 6.70 (s, 1H), 5.27 – 5.02 (m, 1H), 3.89 (q, *J* = 15.0 Hz, 2H), 3.40 (d, *J* = 5.0 Hz, 3H), 2.33 (s, 3H), 1.50 (d, *J* = 6.9 Hz, 3H). ppm; **^{13}C NMR (126 MHz, CDCl$_3$)** δ 168.6, 140.2, 137.2, 129.5, 126.2, 72.2, 59.2, 47.9, 22.0, 21.1.ppm; $[\alpha]_D^{25}$=+110.5 (c=1.0, CHCl$_3$). The enantiomeric excess was determined by HPLC analysis in comparison with authentic racemic material (ODH-column, n-hexane/i-PrOH = 95/5, λ = 210 nm, 1,0 ml/min) tr (major enantiomer) = 10.2 min, tr (minor enantiomer) = 13.1 min. **HRMS (ESI):** calculated for $C_{12}H_{18}NO_2$ $[M+H]^+$ 208.1332; found 208.1328.

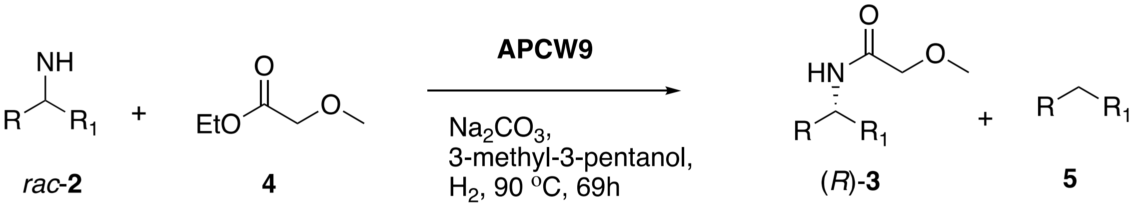


(*R*)-2-methoxy-N-(1,2,3,4-tetrahydronaphthalen-1-yl)acetamide 3e: 41 mg, 75% yield; white solid; R_f=0.23 (Hexane/EtOAc 2:1); **^{1}H NMR (500 MHz, CDCl$_3$)** δ 7.29 (t, *J* = 4.4 Hz, 1H), 7.23 – 7.17 (m, 2H), 7.15 – 7.10 (m, 1H), 6.75 (s, 1H), 5.27 (dd, *J* = 8.6, 6.1 Hz, 1H), 3.98 (s, 2H), 3.41 (s, 3H), 2.83 (qd, *J* = 16.8, 10.8 Hz, 2H), 2.18 – 2.02 (m, 1H), 1.88 (qd, *J* = 11.1, 7.1 Hz, 3H). ppm; **^{13}C NMR (126 MHz, CDCl$_3$)** δ 168.9, 137.7, 136.7, 129.3, 128.8, 127.4, 126.4, 72.3, 59.3, 47.0, 30.4, 29.4, 20.2.ppm; $[\alpha]_D^{25}$=+75.0 (c=1.0, CHCl$_3$). The enantiomeric excess was determined by HPLC analysis in comparison with authentic racemic material (ODH-column, n-hexane/i-PrOH = 95/5, λ = 210 nm, 1,0 ml/min) tr (major enantiomer) = 10.9 min, tr (minor enantiomer) = 15.9 min. **HRMS (ESI):** calculated for $C_{13}H_{18}NO_2$ $[M+H]^+$ 220.1332; found 220.1327.

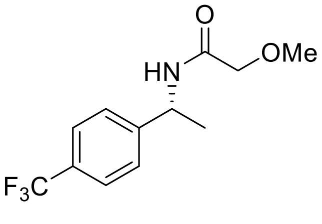


(*R*)-N-(2,3-dihydro-1H-inden-1-yl)-2-methoxyacetamide 3f: 38 mg, 74% yield; white solid; R_f=0.22 (Hexane/EtOAc 2:1); **^{1}H NMR (500 MHz, CDCl$_3$)** δ 7.31 (d, *J* = 6.9 Hz, 1H), 7.30 – 7.22 (m, 3H), 6.77 (s, 1H), 5.56 (q, *J* = 7.8 Hz, 1H), 3.98 (s, 2H), 3.42 (s, 3H), 3.03 (ddd, *J* = 15.9, 8.8, 3.7 Hz, 1H), 2.91 (dt, *J* = 16.1, 8.2 Hz, 1H), 2.64 (dtd, *J* = 11.9, 7.9, 3.8 Hz, 1H), 1.86 (ddd, *J* = 16.3, 13.0, 8.1 Hz, 1H) ppm; **^{13}C NMR (126 MHz, CDCl$_3$)** δ 169.4, 143.5, 143.0, 128.1, 126.9, 124.9, 124.1, 72.1, 59.2, 53.9, 34.1, 30.3 ppm; $[\alpha]_D^{25}$=+63.4 (c=1.0, CHCl$_3$). The enantiomeric excess was determined by HPLC analysis in comparison with authentic racemic material (ODH-column, n-hexane/i-PrOH = 95/5, λ = 210 nm, 1,0 ml/min) tr (major enantiomer) = 13.6 min, tr (minor enantiomer) = 24.8 min. **HRMS (ESI):** calculated for $C_{12}H_{16}NO_2$ $[M+H]^+$ 206.1176; found 206.1167.

General procedure for the DKR of *rac*-2 in 3-methyl 3-pentanol using APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer.

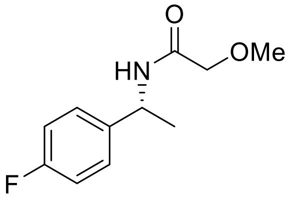


In a microwave vial were added **APCW9** MCC-Amp-Pd^0/CALB/Brij/buffer (9 mg, 1.1 mol% Pd) and dry Na$_2$CO$_3$ (80 mg, 0.75 mmol, 3 equiv). The vial was flushed with nitrogen and hydrogen. Next, 3-methyl 3-pentanol (1 mL), *rac*-**2** (0.25 mmol, 1 equiv) and **4** (295 mg, 2.5 mmol, 10 equiv) were added. The vial was capped, evacuated and a hydrogen balloon was connected to the reaction vessel. The reaction was stirred at 90°C for 69 hours. The crude reaction mixture was directly loaded on a silica-gel column and chromatography (hexane/ ethyl acetate 9.1 to 2:1) afforded the corresponding product (*R*)-**3**.

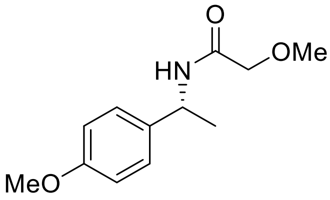


(*R*)-2-methoxy-N-(1-(4-(trifluoromethyl)phenyl)ethyl)acetamide 3c: 46 mg, 70% yield; white solid; R_f=0.20 (Hexane/EtOAc 2:1); **^{1}H NMR (500 MHz, CDCl$_3$)** δ 7.59 (d, *J* = 8.2 Hz, 2H), 7.43 (d, *J* = 8.0 Hz, 2H), 6.78 (s, 1H), 5.29 – 5.06 (m, 1H), 4.02 – 3.81 (m, 2H), 3.42 (s, 3H), 1.52 (d, *J* = 7.0 Hz, 3H). ppm; **^{13}C NMR (126 MHz, CDCl$_3$)** δ 168.9, 147.3, 129.9, 129.7, 126.6, 125.81 (q, *J* = 3.8 Hz), 72.1, 59.3, 47.9, 22.0 ppm; $[\alpha]_D^{25}$=+69.6 (c=1.0, CHCl$_3$). The enantiomeric excess was determined by HPLC analysis in comparison with authentic racemic material (AMH-column, n-hexane/i-PrOH = 95/5, λ =

210 nm, 1,0 ml/min) tr (major enantiomer) = 10.6 min, tr (minor enantiomer) = 16.8 min. **HRMS (ESI):** calculated for $C_{12}H_{15}F_3NO_2$ $[M+H]^+$ 262.1049; found 262.1048.

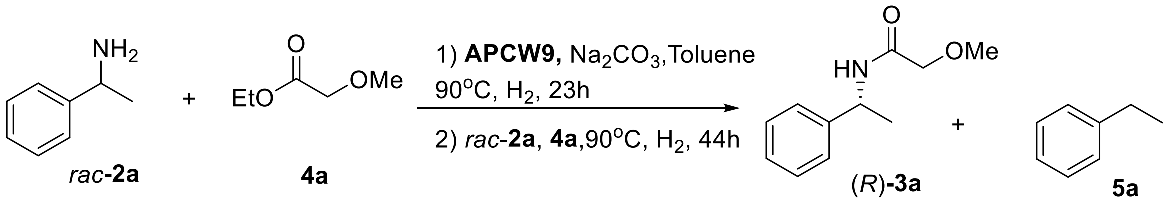


(*R*)-N-(1-(4-fluorophenyl)ethyl)-2-methoxyacetamide 3d: 33 mg, 63% yield; white solid; R_f=0.18 (Hexane/EtOAc 1:1); **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.29 (dd, *J* = 8.8, 5.3 Hz, 2H), 7.01 (t, *J* = 8.7 Hz, 2H), 6.68 (s, 1H), 5.25 – 5.05 (m, 1H), 3.88 (q, *J* = 15.0 Hz, 2H), 3.40 (s, 3H), 1.50 (d, *J* = 6.9 Hz, 3H) ppm; **^{13}C NMR (126 MHz, $CDCl_3$)** δ 168.6, 163.2, 161.2, 139.06 (d, *J* = 3.2 Hz), 127.92 (d, *J* = 8.1 Hz), 115.7, 115.5, 72.2, 59.2, 47.6, 22.0 ppm; $[\alpha]_D^{25}$=+90.8 (c=1.0, $CHCl_3$). The enantiomeric excess was determined by HPLC analysis in comparison with authentic racemic material (ODH-column, n-hexane/i-PrOH = 95/5, λ = 210 nm, 1,0 ml/min) tr (major enantiomer) = 12.0 min, tr (minor enantiomer) = 16.8 min. **HRMS (ESI):** calculated for $C_{11}H_{15}FNO_2$ $[M+H]^+$ 212.1081; found 212.1077.



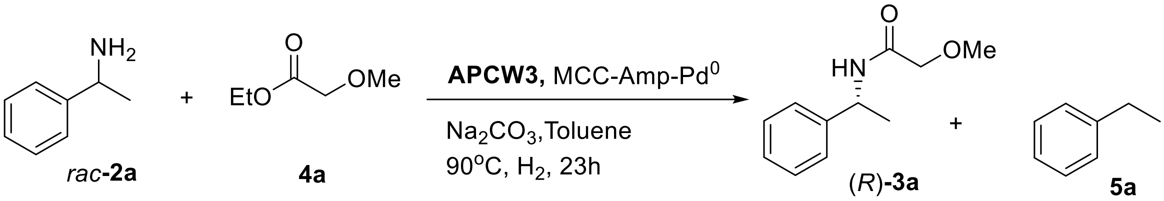
(*R*)-2-methoxy-N-(1-(4-methoxyphenyl)ethyl)acetamide 3g: 39 mg, 70% yield; white solid; R_f=0.11 (Hexane/EtOAc 2:1); **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.28 (d, *J* = 8.7 Hz, 2H), 6.90 (d, *J* = 8.6 Hz, 2H), 6.69 (s, 1H), 5.22 – 5.10 (m, 1H), 3.91 (q, *J* = 15.0 Hz, 2H), 3.82 (s, 3H), 3.42 (s, 3H), 1.53 (d, *J* = 6.9 Hz, 3H). ppm; **^{13}C NMR (126 MHz, $CDCl_3$)** δ 168.6, 159.0, 135.3, 127.5, 114.2, 72.1, 59.2, 55.4, 47.6, 21.9. ppm; $[\alpha]_D^{25}$=+87.8 (c=1.0, $CHCl_3$). The enantiomeric excess was determined by HPLC analysis in comparison with authentic racemic material (ODH-column, n-hexane/i-PrOH = 95/5, λ = 210 nm, 1,0 ml/min) tr (major enantiomer) = 16.9 min, tr (minor enantiomer) = 21.7 min. **HRMS (ESI):** calculated for $C_{12}H_{18}NO_3$ $[M+H]^+$ 224.1281; found 224.1274.

General procedure for the DKR of *rac*-2a using pre-activated APCW 9 MCC-Amp-Pd^0/CALB/Brij/buffer.



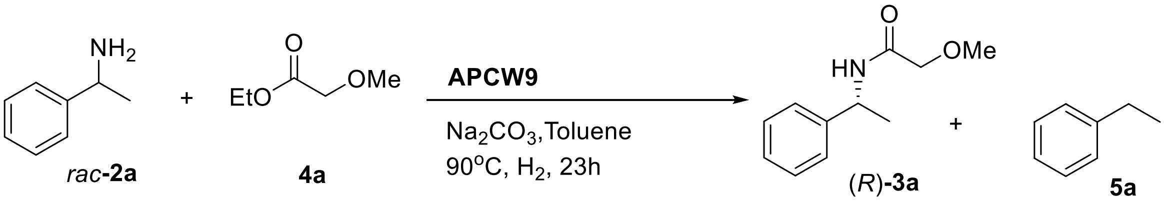
In a microwave vial were added **APCW9** MCC-Amp-Pd^0/CALB/Brij/buffer (18 mg, 2.2 mol% Pd) and dry Na_2CO_3 (80 mg, 0.75 mmol, 3 equiv). The vial was capped, evacuated and a hydrogen balloon was connected to the reaction vessel. Toluene (1 mL) was added and the mixture was stirred at 90°C under hydrogen atmosphere for 23 hours. Next, *rac*-**2a** (0.25 mmol, 1 equiv) and **4** (295 mg, 2.5 mmol, 10 equiv) were added and the reaction was continued to stir at 90°C under hydrogen atmosphere for the 44 hours. The crude reaction mixture was directly loaded on a silica-gel column and chromatography (hexane/ ethyl acetate 9.1 to 2:1) afforded (*R*)-**3a** (34 mg, 70% yield).

General procedure for the DKR of *rac*-2a using MCC-Amp-Pd^0 and APCW3 MCC/CALB/Brij/buffer.



In a microwave vial were added MCC-Amp-Pd^0 (16.5 mg, 12 mol% Pd), **APCW3** MCC/CALB/Brij/buffer (9 mg), dry Na_2CO_3 (80 mg, 0.75 mmol, 3 equiv). The vial was flushed with nitrogen and hydrogen. Next, toluene (1 mL), *rac*-**2a** (0.25 mmol, 1 equiv) and **4** (295 mg, 2.5 mmol, 10 equiv) were added. The vial was capped, evacuated and a hydrogen balloon was connected to the reaction vessel. The reaction was stirred at 90°C for 23 hours. The crude reaction mixture was directly loaded on a silica-gel column and chromatography (hexane/ ethyl acetate 9.1 to 2:1) afforded (*R*)-**3a** (37 mg, 77% yield).

Recycling procedure of APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer for the DKR of *rac*-2a.



In a microwave vial were added **APCW9** MCC-Amp-Pd^0\CALB\Brij\buffer (36 mg, 4.4 mol% Pd) and dry Na_2CO_3 (80 mg, 0.75 mmol, 3 equiv). The vial was flushed with nitrogen and hydrogen. Next, toluene (1 mL), *rac*-**2a** (30 mg, 0.25 mmol, 1 equiv) and **4** (295 mg, 2.5 mmol, 10 equiv) were added. The vial was capped, evacuated and a hydrogen balloon was connected to the reaction vessel. The reaction was stirred at 90°C for the time reported in the table (Table 4S). Next, dry toluene was added to the vial and the reaction mixture was centrifuged 3 times collecting the supernatant after each cycle. After the last centrifuge cycle, 1 mL of toluene was left in the vial and fresh Na_2CO_3 (0.25 mmol, 1 equiv) and fresh substrate were added. The collected supernatant was concentrated under reduced pressure and the crude reaction mixture was directly loaded on a silica-gel column and chromatography (hexane/ ethyl acetate 2:1) afforded (*R*)-**3a** in the reported yield and ee. The cycle was repeated.

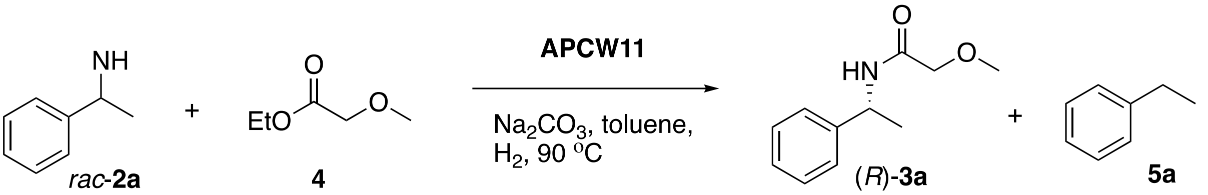
Table S4. Recycling studies of **APCW9** MCC-Amp-Pd^0/CALB/Brij/buffer for the DKR of *rac*-**2a**.

Cycle	Time (h)	**3a**:**5a**:**2a**[b]	Yield (%)[c]	Ee (%)[d]
0	23	58:42:0	60	72
1	23	75:25:0	79	99
2	22	83:17:0	75	99
3	30	85:15:0	75	99
4	46	86:14:0	81	99
5	47	72:10:18	73	99
6	47	71:11:18	73	99
7	47	58:8:35	58	99

[a] Reaction conditions: *rac*-**2a** (0.25 mmol, 1 equiv), **4** (2.5 mmol, 10 equiv), **APCW9** MCC-Amp-Pd^0/CALB/Brij/buffer (36 mg, 4.4 mol% Pd), Na_2CO_3 (0.75 mmol, 3 equiv), toluene (1 mL), 90°C, H_2. Na_2CO_3 (26 mg, 1 equiv) was added after each cycle. [b] Determined by H^1-NMR. [c] Isolated yield. [d] Determined by chiral HPLC.

Recycling of APCW11 (MCC-Amp-Pd^{II}/CALB/Brij/buffer).[a]

Table S5. Recycling studies of MCC-Amp-Pd^{II}/CALB/Brij/buffer for the DKR of *rac*-**2a**.

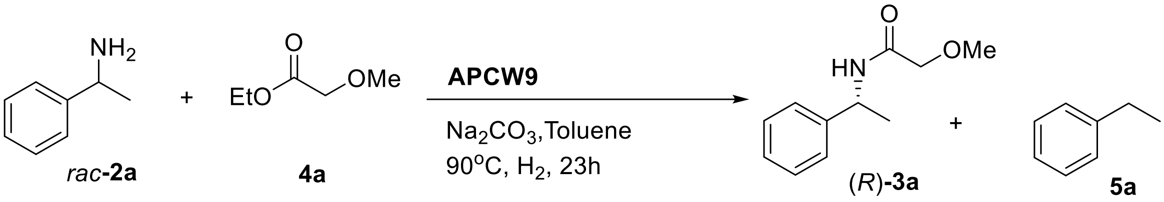


Cycle	Time (h)	**3a**:**5a**:**2a**[b]	Yield (%)[c]	Ee (%)[d]
0	22	52:48:0	54	57
1	23	20:80:0	27	60

[a] Reaction conditions: *rac*-**2a** (0.25 mmol, 1 equiv), **4** (2.5 mmol, 10 equiv), **APCW11**, MCC-Amp-Pd^{II}/CALB/Brij (36 mg, 4.4 mol% Pd), Na_2CO_3 (0.75 mmol, 3 equiv), toluene (1 mL), 90°C, H_2. Na_2CO_3 (26 mg, 1 equiv) was added after each cycle. [b] Determined by H^1-NMR. [c] Isolated yield. [d] Determined by chiral HPLC.

Recycling of pre-activated APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer.

Table S6. Recycling studies of APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer for the DKR of *rac*-**2a**.

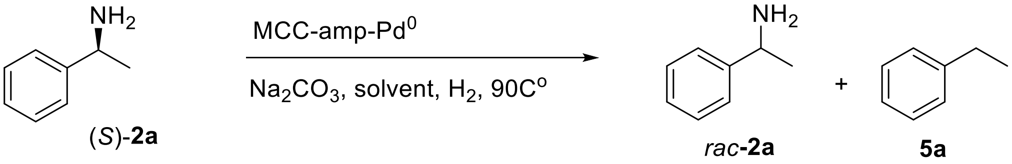


Cycle	Time (h)	**3a**:**5a**:**2a**[b]	Yield (%)[c]	Ee (%)[d]
0	20	55:45:0	56	98
1	21	33:67:0	33	97
2	46	49:51:0	46	98
3	69	54:27:19	54	99

[a] Reaction conditions: **APCW9** MCC-Amp-Pd^0/CALB/Brij/buffer (36 mg, 4.4 mol% Pd) and Na_2CO_3 (0.75 mmol, 3 equiv) in toluene (1 mL) were stirred under H_2 at 90°C for 24 hours. Next, *rac*-**2a** (0.25 mmol, 1 equiv) and **4** (2.5 mmol, 10 equiv) were added. Na_2CO_3 (26 mg, 1 equiv) was added after each cycle. [b] Determined by H^1-NMR. [c] Isolated yield. [d] Determined by chiral HPLC.

Racemization of (*S*)-2a with MCC-Amp-Pd^0.

Table S7. Solvent screening for the racemization of (*S*)-**2a** with Avicel-Amp-Pd^0.

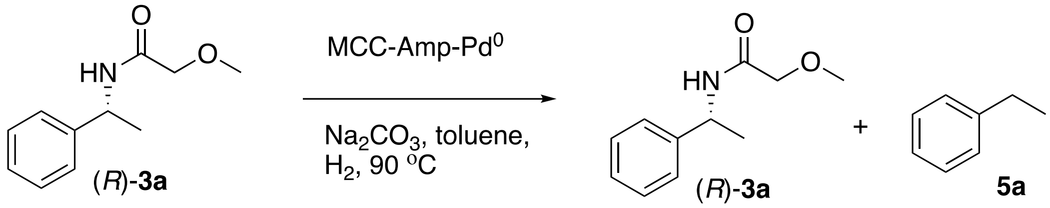


Entry	Solvent	Time (h)	**2**:**5a**[b]	Ee **2** (%)[c]
1	Toluene	5	32:68	0
2	3-methyl 3-pentanol	4	67:33	3

[a] Reaction conditions: (*S*)-**2a** (0.25 mmol, 1 equiv), Na_2CO_3 (0.26 mmol, 1.04 equiv), MCC-Amp-Pd^0 (16.5 mg, 12 mol% Pd), solvent (1 mL), 90°C, H_2. [b] Determined by H^1-NMR. [c] Determined by chiral HPLC.

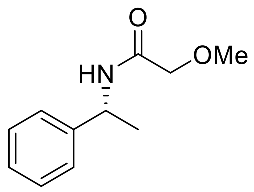
Racemization of (*R*)-3a with MCC-Amp-Pd^0.

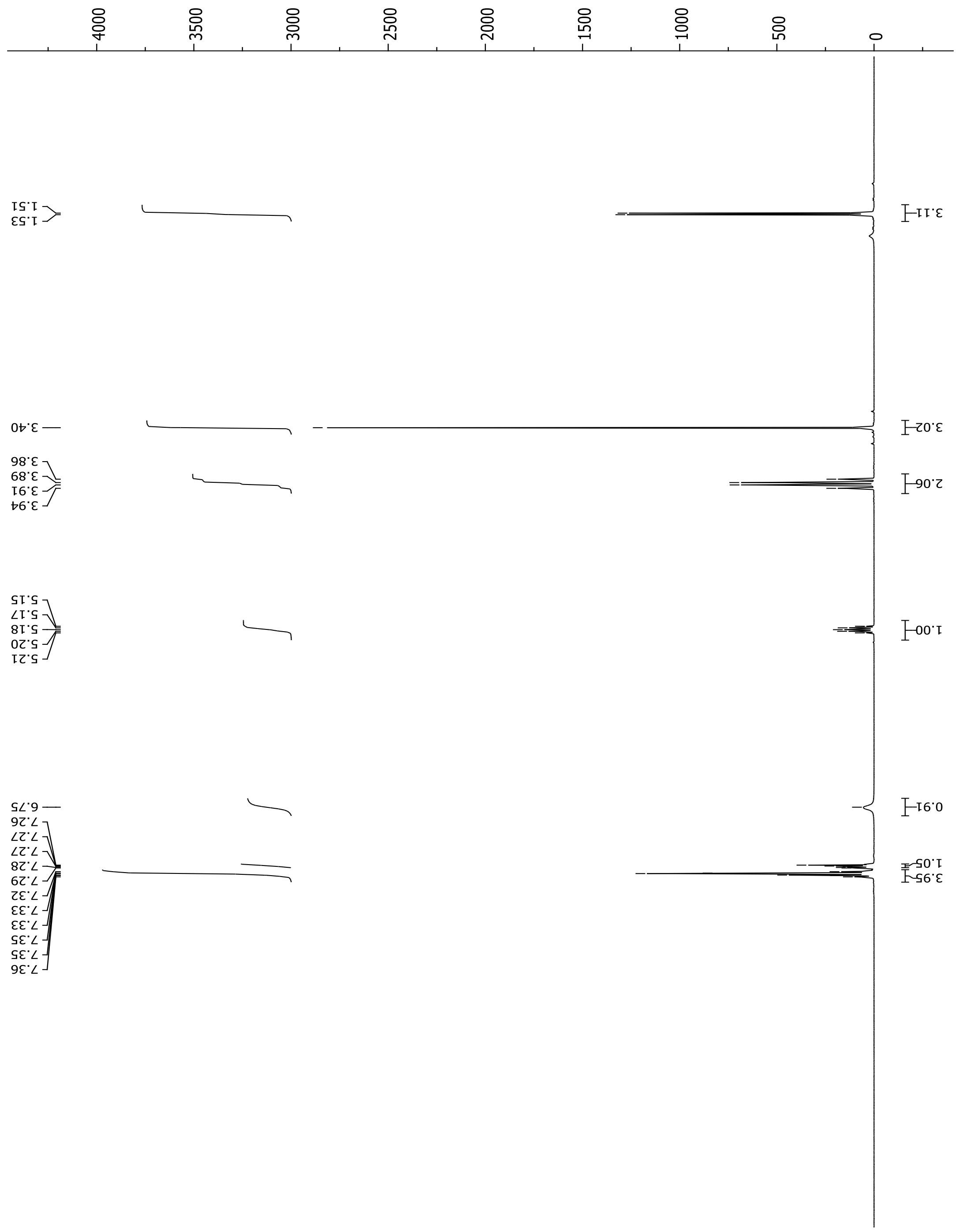
Table S8. Racemization (*R*)-**3a** with MCC-Amp-Pd^0.



Entry	Time (h)	**3a**:**5a**	Ee **3a** (%)[b]
1	21	100:0	99

[a] Reaction conditions: (*R*)-**3a** (0.1 mmol, 1 equiv), Na_2CO_3 (0.75 mmol, 7.5 equiv), MCC-Amp-Pd^0 (18 mg, 13 mol% Pd), toluene: 1 mL, 90 °C, H_2. [b] Determined by chiral HPLC.


O
HN
OMe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7.27
7.28
7.29
7.32
7.33
7.33
7.35
7.35
7.36
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3000
2500
2000
1500
1000
500
0
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3.02
2.06
1.00
0.91
1.05
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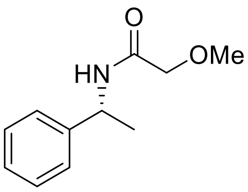
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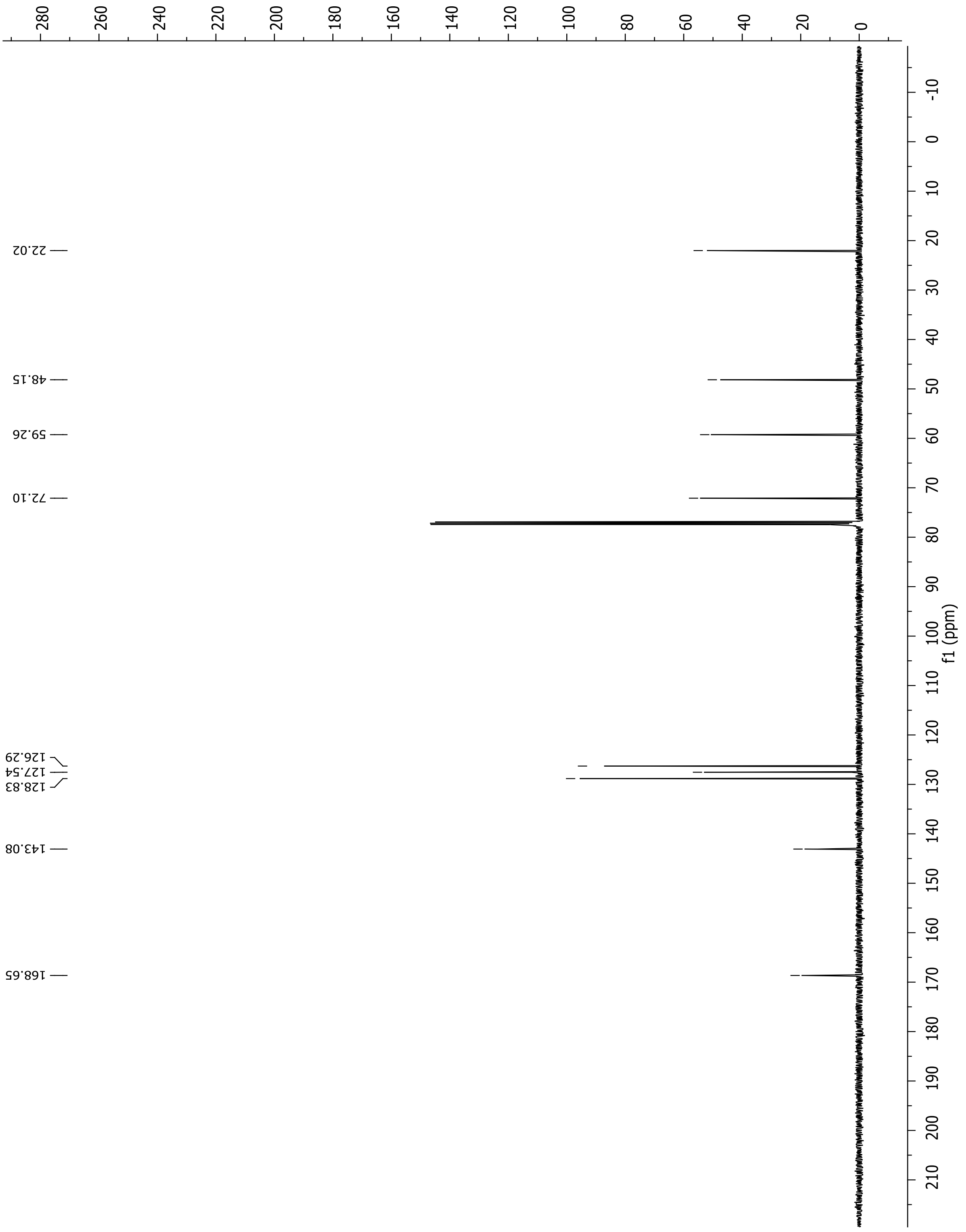
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60
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90
100
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120
130
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150
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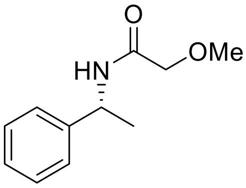

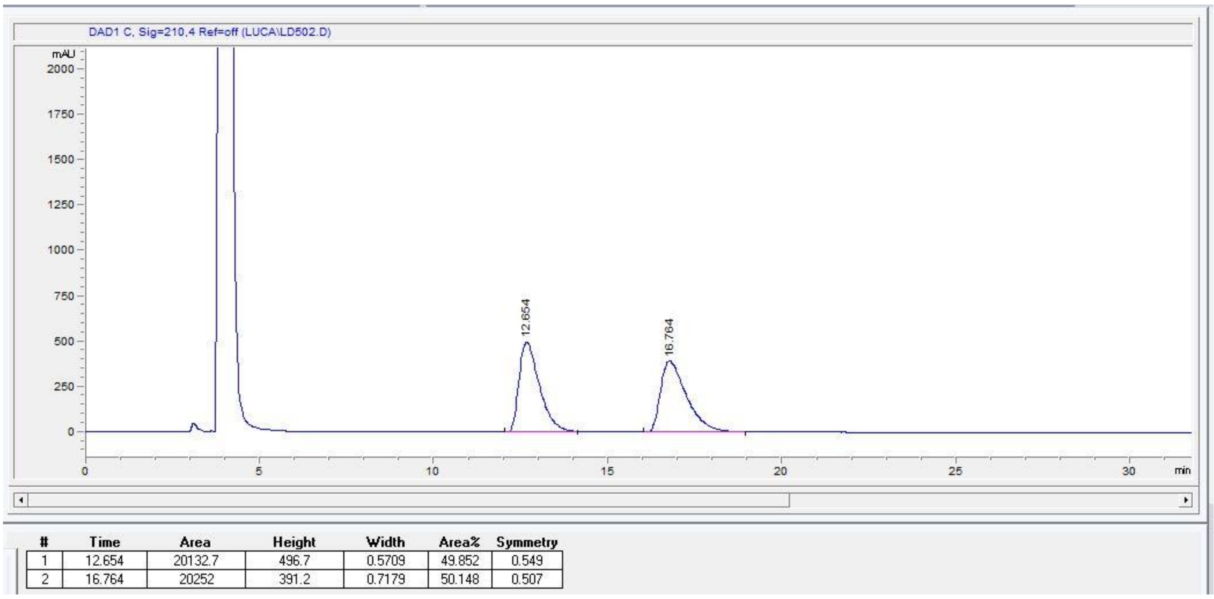

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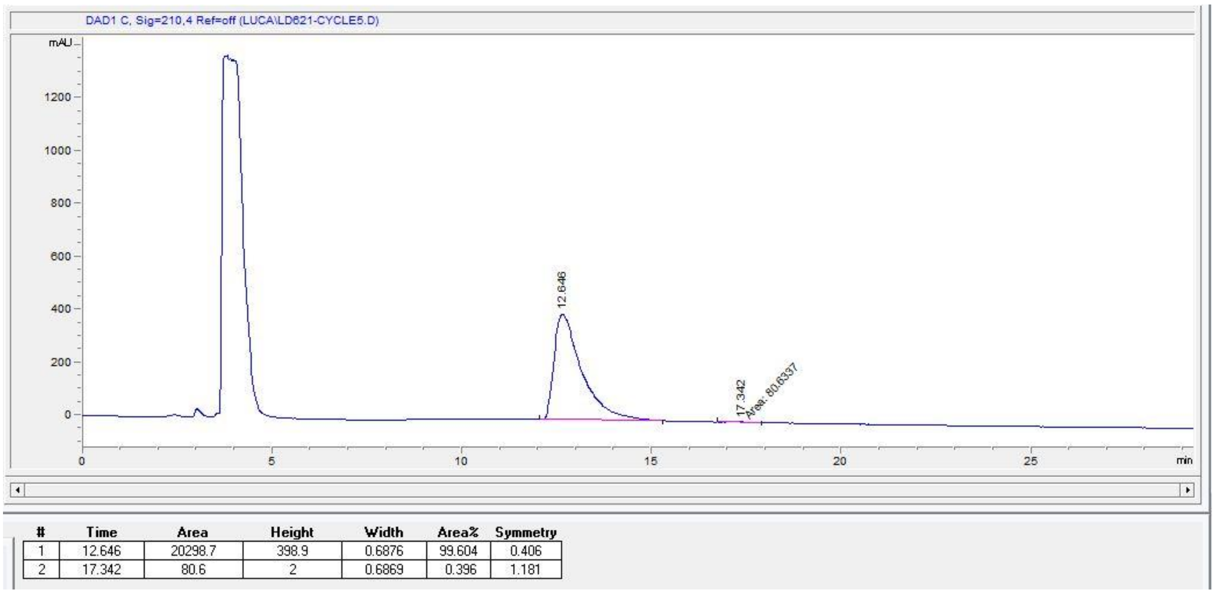

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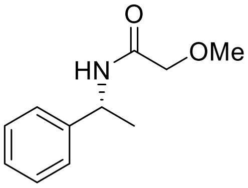

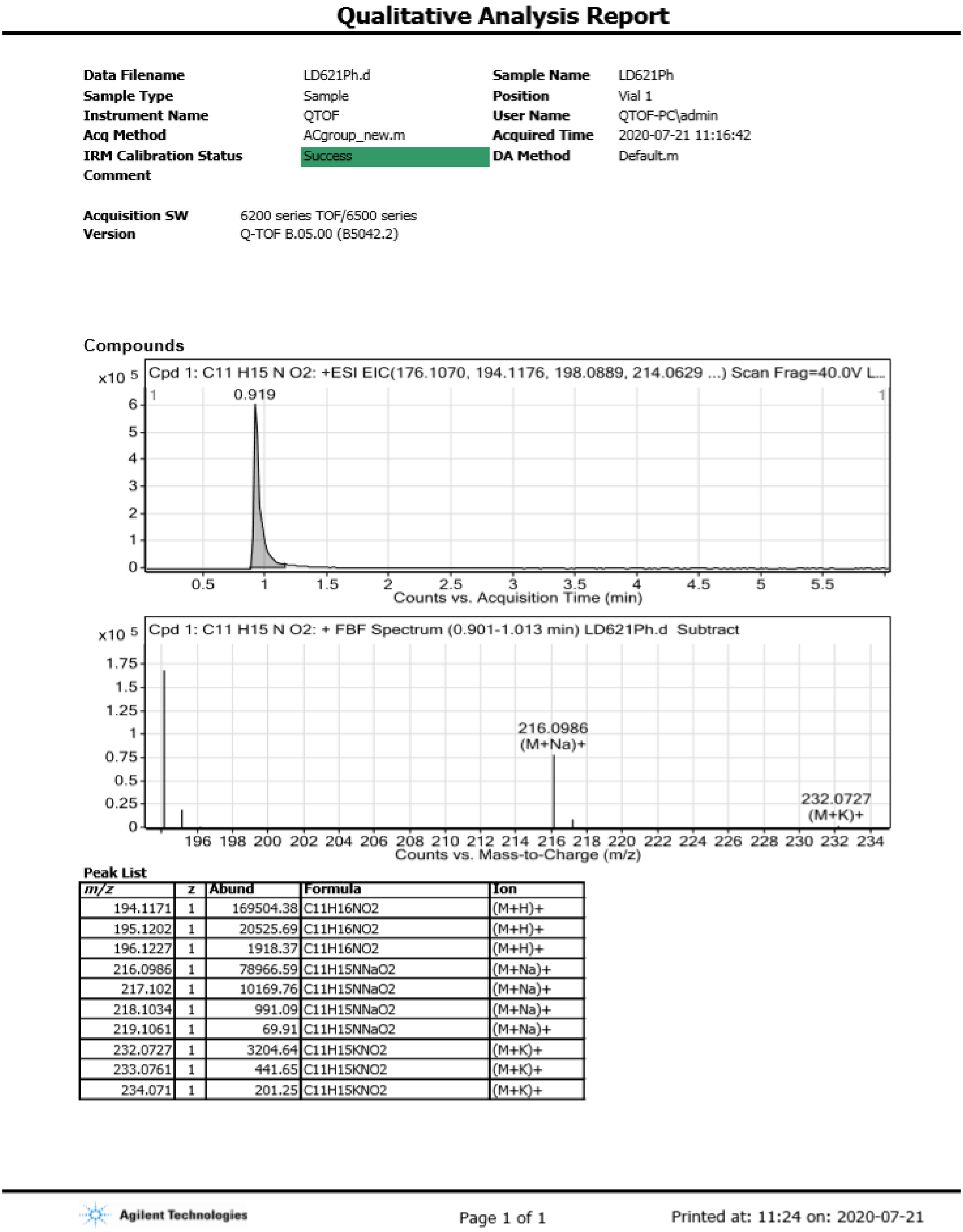

Qualitative Analysis Report

Data Filename	LD621Ph.d	**Sample Name**	LD621Ph
Sample Type	Sample	**Position**	Vial 1
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IRM Calibration Status	Success	**DA Method**	Default.m
Comment			

Acquisition SW Version	6200 series TOF/6500 series Q-TOF B.05.00 (B5042.2)

Compounds

Peak List

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196.1227	1	1918.37	C11H16NO2	(M+H)+
216.0986	1	78966.59	C11H15NNaO2	(M+Na)+
217.102	1	10169.76	C11H15NNaO2	(M+Na)+
218.1034	1	991.09	C11H15NNaO2	(M+Na)+
219.1061	1	69.91	C11H15NNaO2	(M+Na)+
232.0727	1	3204.64	C11H15KNO2	(M+K)+
233.0761	1	441.65	C11H15KNO2	(M+K)+
234.071	1	201.25	C11H15KNO2	(M+K)+

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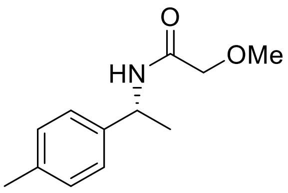
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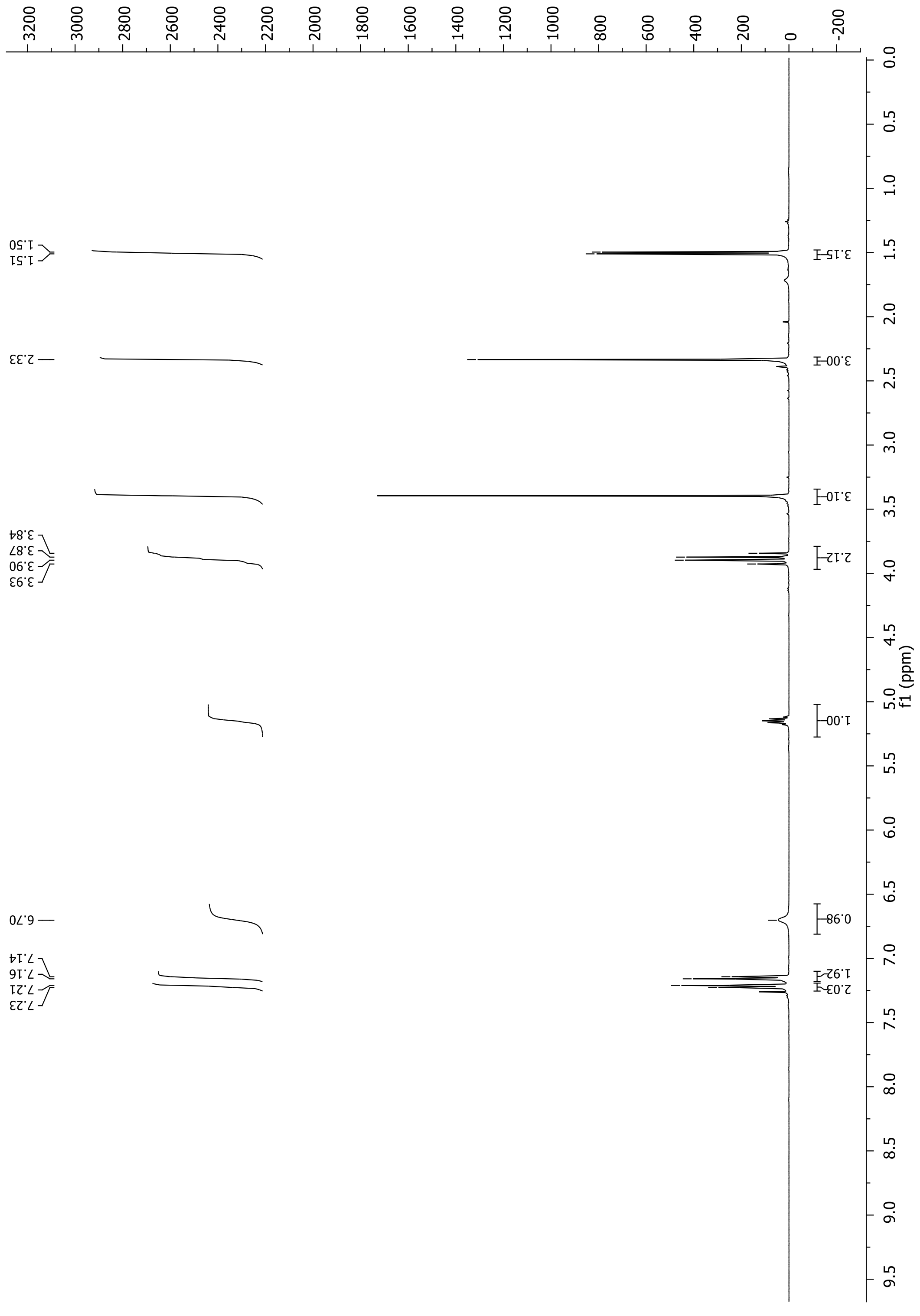
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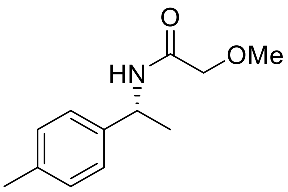
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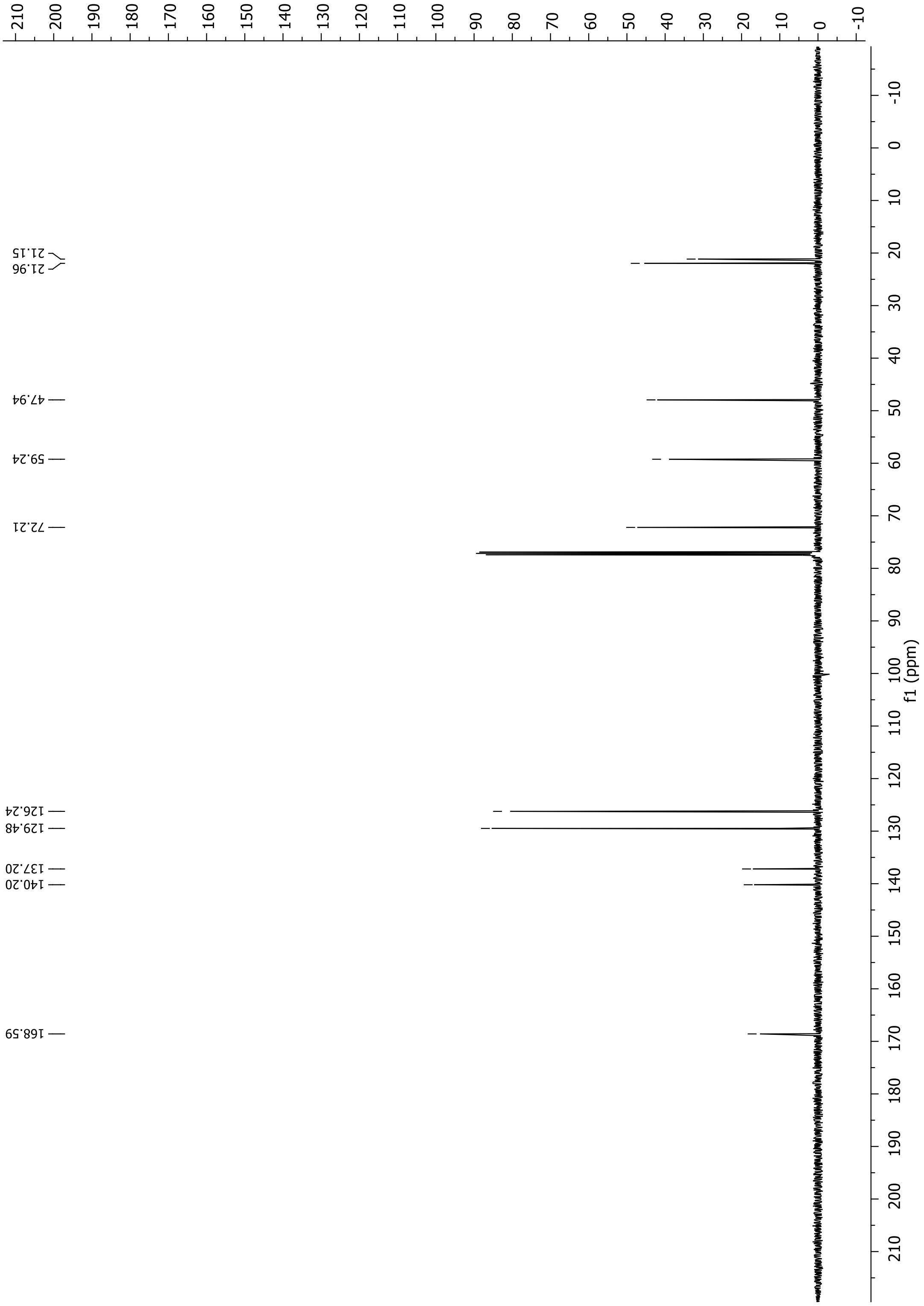
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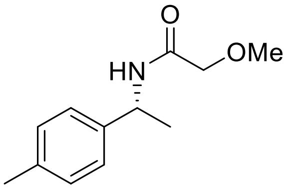

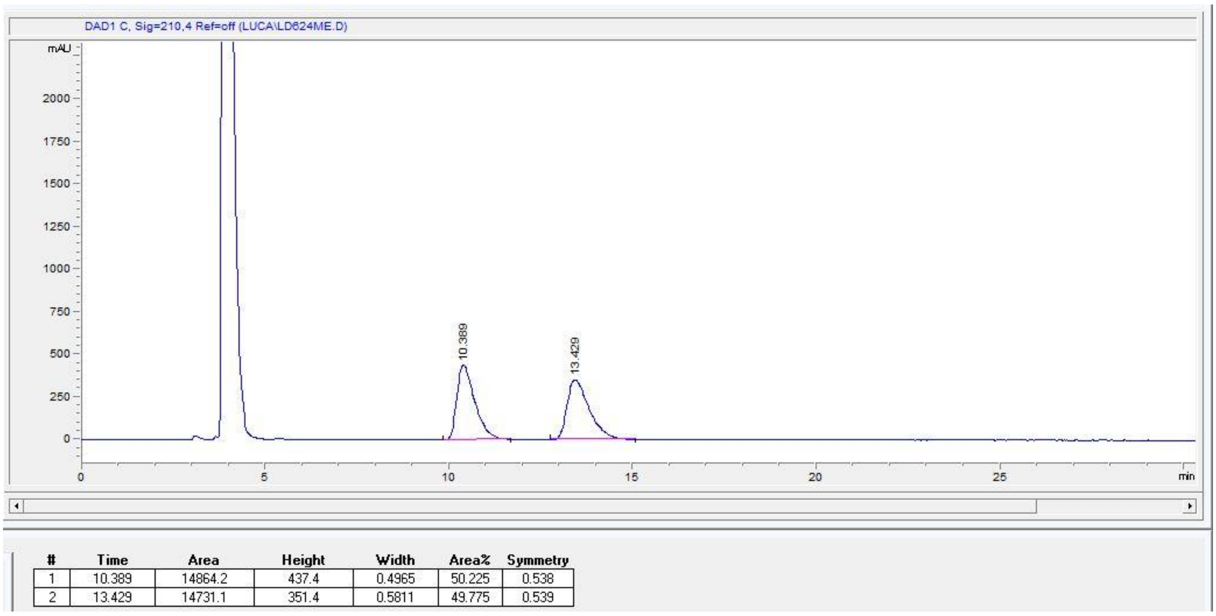

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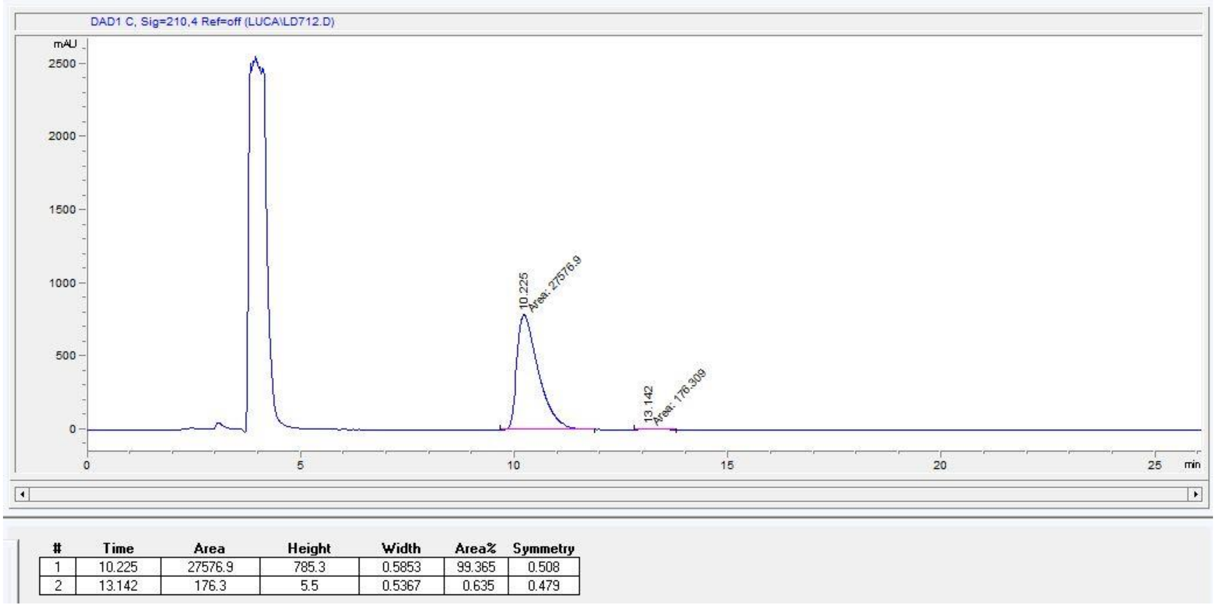

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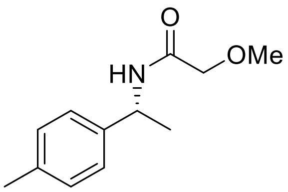

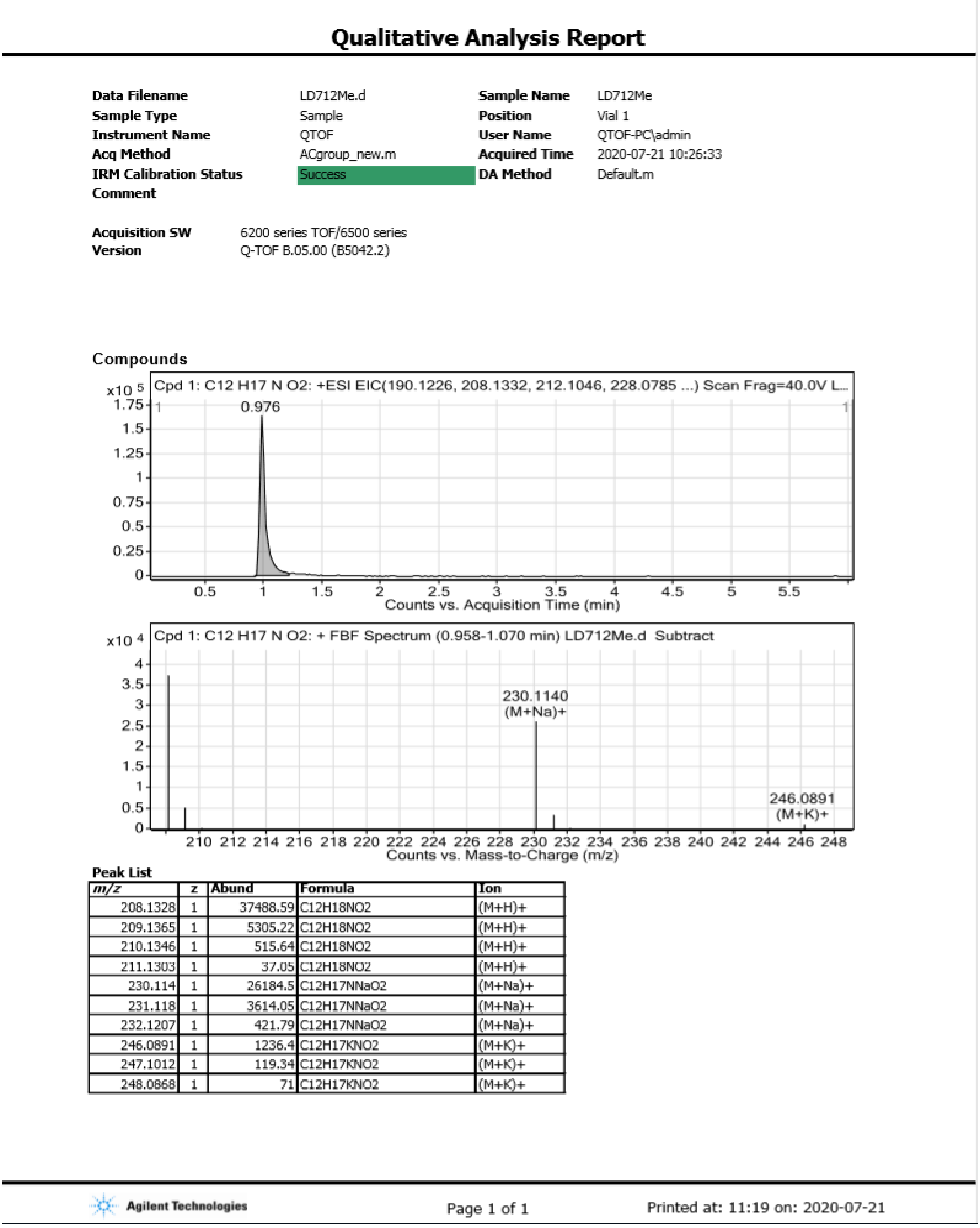

Qualitative Analysis Report

Data Filename	LD712Me.d	**Sample Name**	LD712Me
Sample Type	Sample	**Position**	Vial 1
Instrument Name	QTOF	**User Name**	QTOF-PC\admin
Acq Method	ACgroup_new.m	**Acquired Time**	2020-07-21 10:26:33
IRM Calibration Status	Success	**DA Method**	Default.m
Comment			

Acquisition SW 6200 series TOF/6500 series
Version Q-TOF B.05.00 (B5042.2)

Compounds

Peak List

m/z	z	Abund	Formula	Ion
208.1328	1	37488.59	C12H18NO2	(M+H)+
209.1365	1	5305.22	C12H18NO2	(M+H)+
210.1346	1	515.64	C12H18NO2	(M+H)+
211.1303	1	37.05	C12H18NO2	(M+H)+
230.114	1	26184.5	C12H17NNaO2	(M+Na)+
231.118	1	3614.05	C12H17NNaO2	(M+Na)+
232.1207	1	421.79	C12H17NNaO2	(M+Na)+
246.0891	1	1236.4	C12H17KNO2	(M+K)+
247.1012	1	119.34	C12H17KNO2	(M+K)+
248.0868	1	71	C12H17KNO2	(M+K)+

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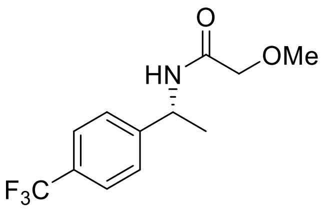
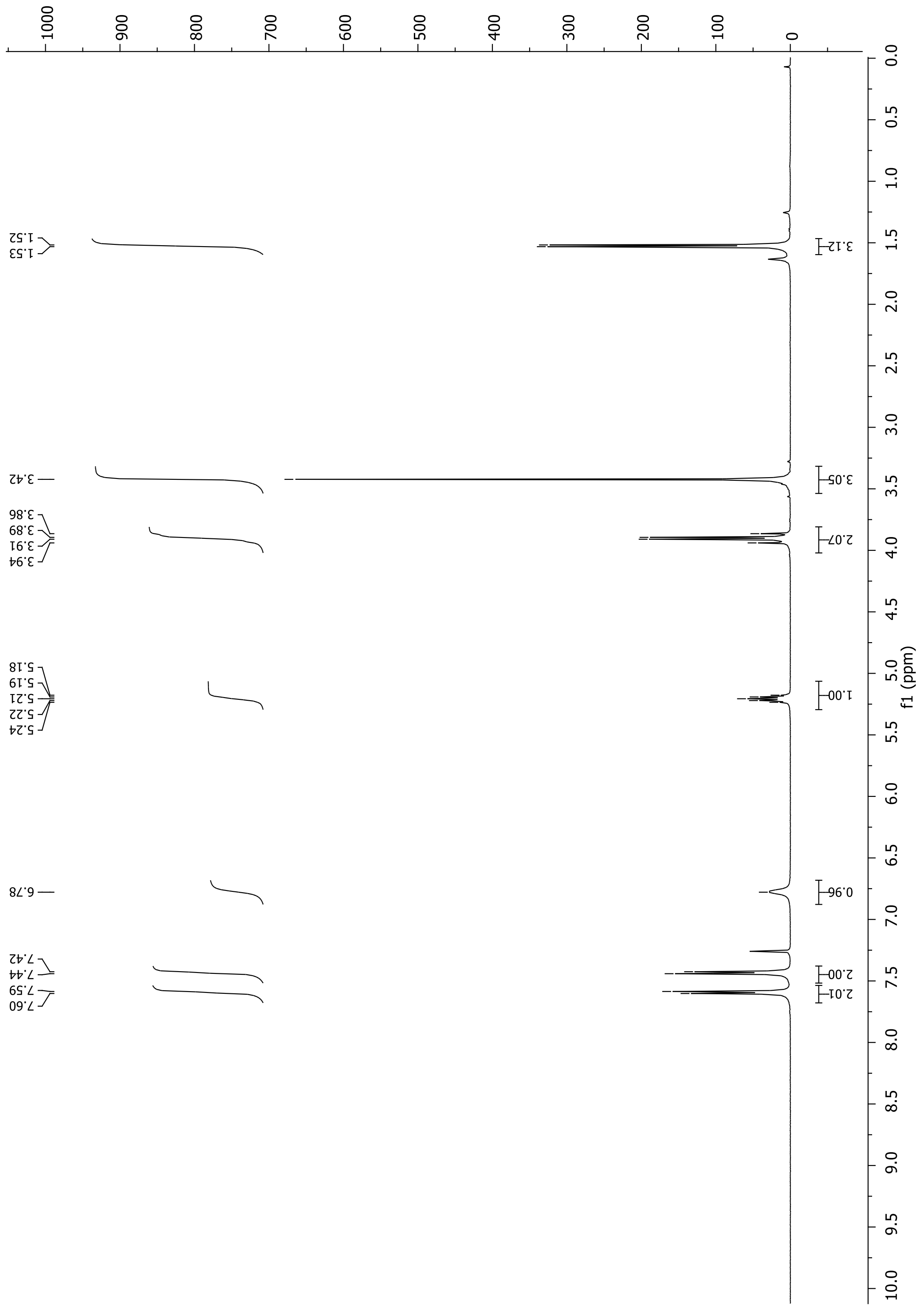

O
HN
OMe
F3C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3.86
3.89
3.91
3.94
5.18
5.19
5.21
5.22
5.24
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7.42
7.44
7.59
7.60
3.12
3.05
2.07
1.00
0.96
2.00
2.01
1000
900
800
700
600
500
400
300
200
100
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
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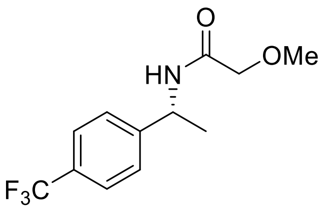
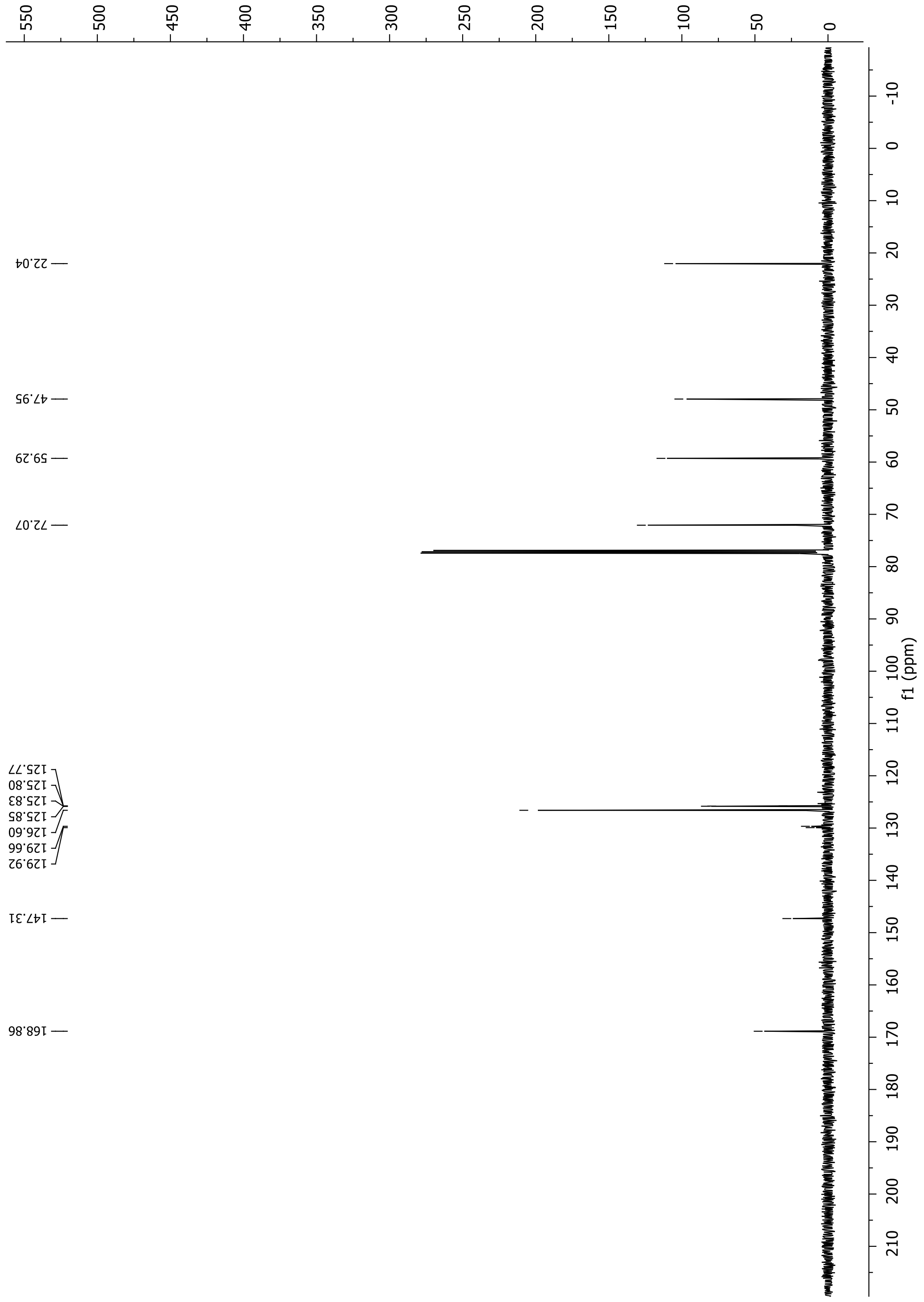
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
f1 (ppm)


O
HN
OMe
F3C


22.04
47.95
59.29
72.07
125.77
125.80
125.83
125.85
126.60
129.66
129.92
147.31
168.86
f1 (ppm)
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
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180
190
200
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550
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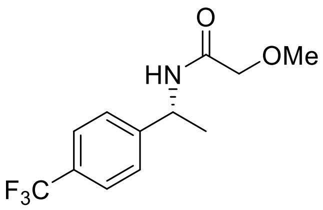
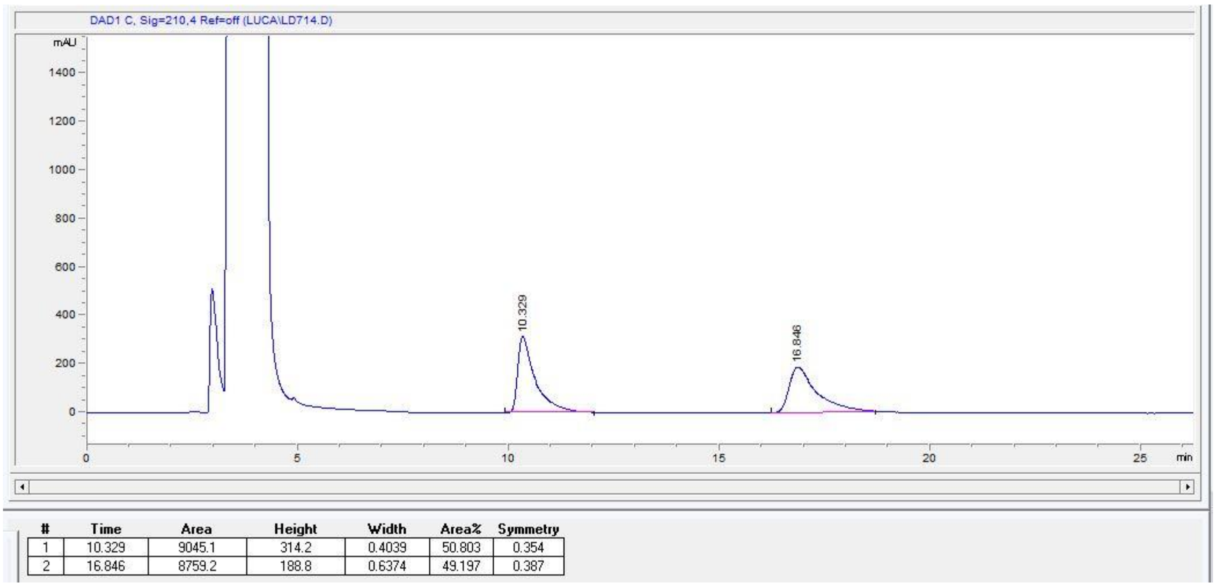
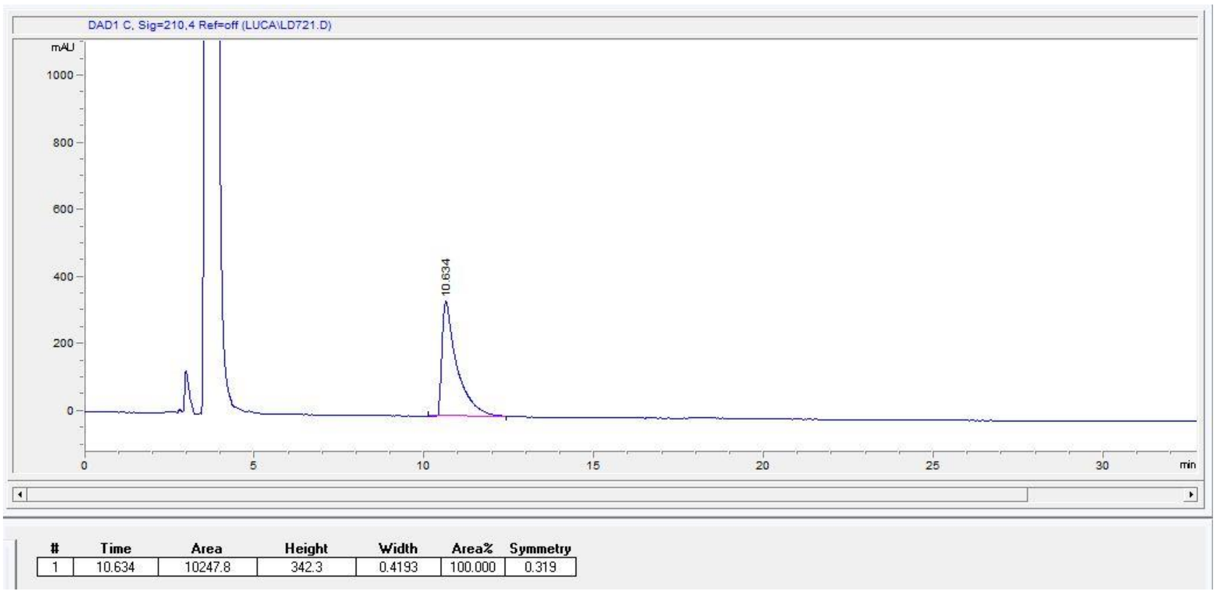
250
200
150
100
50
0

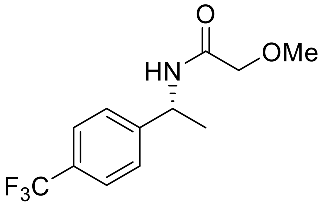




#	Time	Area	Height	Width	Area%	Symmetry
1	10.329	9045.1	314.2	0.4039	50.803	0.354
2	16.846	8759.2	188.8	0.6374	49.197	0.387



#	Time	Area	Height	Width	Area%	Symmetry
1	10.634	10247.8	342.3	0.4193	100.000	0.319

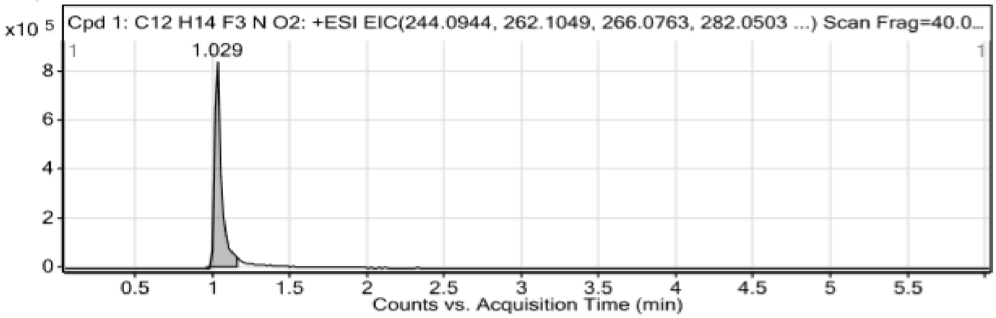


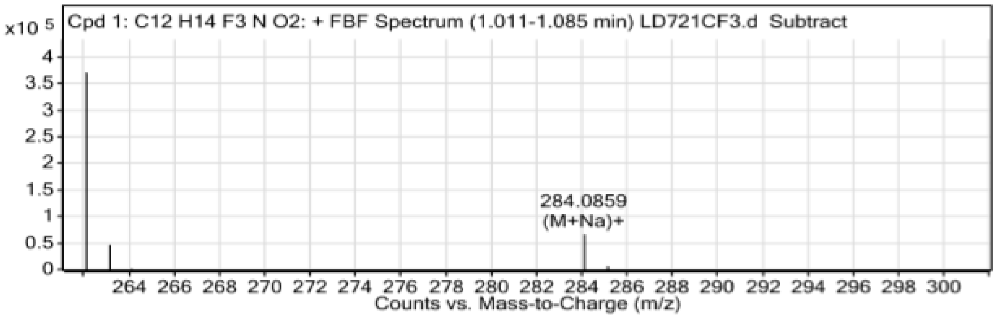
Qualitative Analysis Report

Data Filename	LD721CF3.d	**Sample Name**	LD721CF3
Sample Type	Sample	**Position**	Vial 1
Instrument Name	QTOF	**User Name**	QTOF-PC\admin
Acq Method	ACgroup_new.m	**Acquired Time**	2020-07-21 10:47:46
IRM Calibration Status	Success	**DA Method**	Default.m
Comment			

Acquisition SW	6200 series TOF/6500 series
Version	Q-TOF B.05.00 (B5042.2)

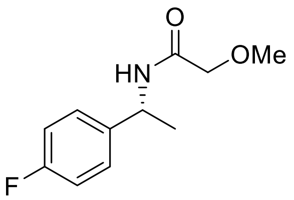
Compounds

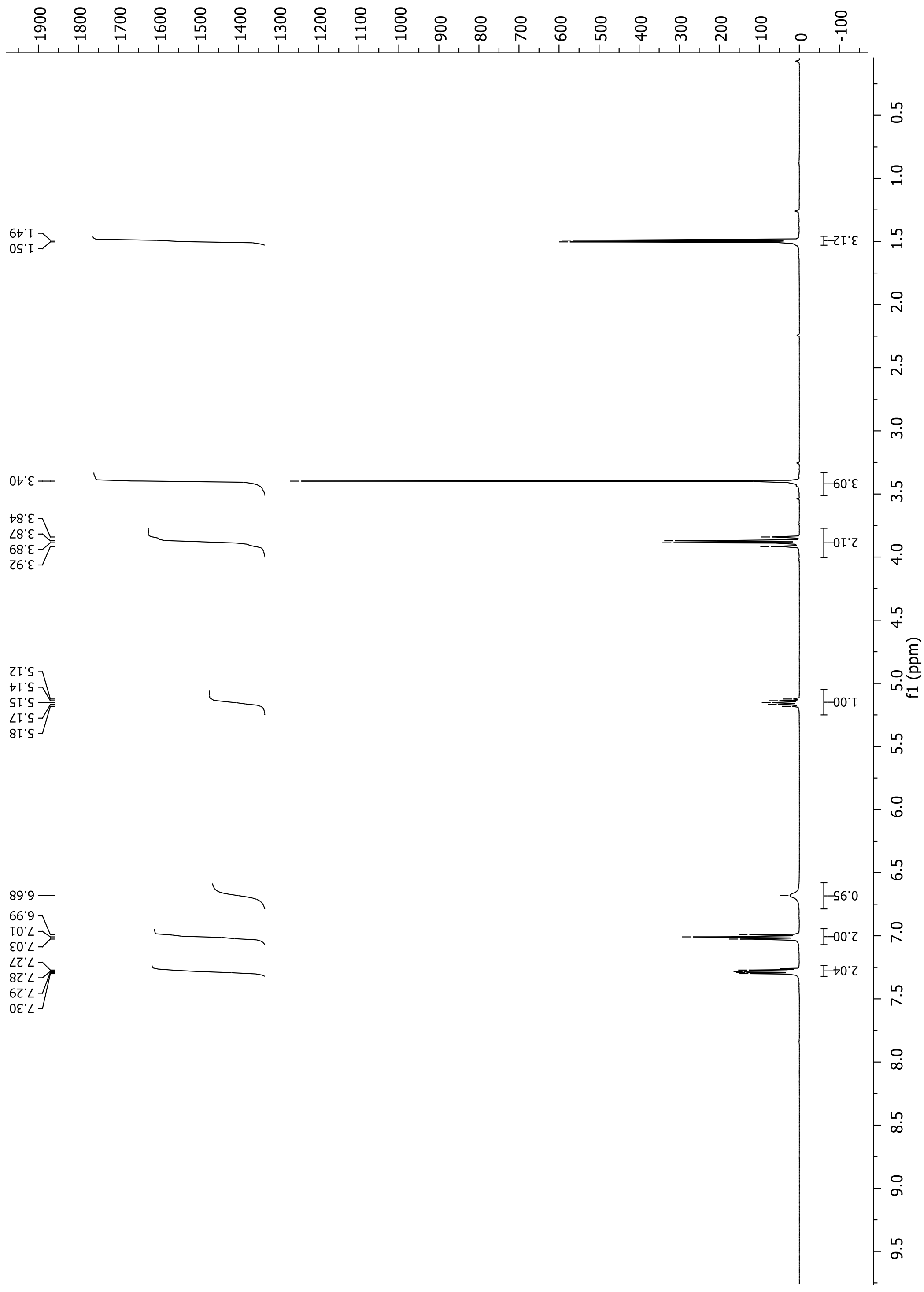




Peak List

m/z	z	Abund	Formula	Ion
262.1048	1	372965.09	C12H15F3NO2	(M+H)+
263.1078	1	49009.17	C12H15F3NO2	(M+H)+
264.1097	1	4953.46	C12H15F3NO2	(M+H)+
265.1135	1	349.17	C12H15F3NO2	(M+H)+
284.0859	1	68739.27	C12H14F3NNaO2	(M+Na)+
285.0895	1	9284.67	C12H14F3NNaO2	(M+Na)+
286.0909	1	789.67	C12H14F3NNaO2	(M+Na)+
300.0605	1	2734.8	C12H14F3KNO2	(M+K)+
301.0664	1	599.71	C12H14F3KNO2	(M+K)+


O
HN
OMe
F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3.89
3.92
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5.14
5.15
5.17
5.18
6.68
6.99
7.01
7.03
7.27
7.28
7.29
7.30
3.12
3.09
2.10
1.00
0.95
2.00
2.04
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
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6.0
6.5
7.0
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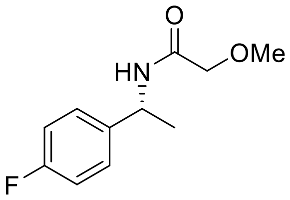
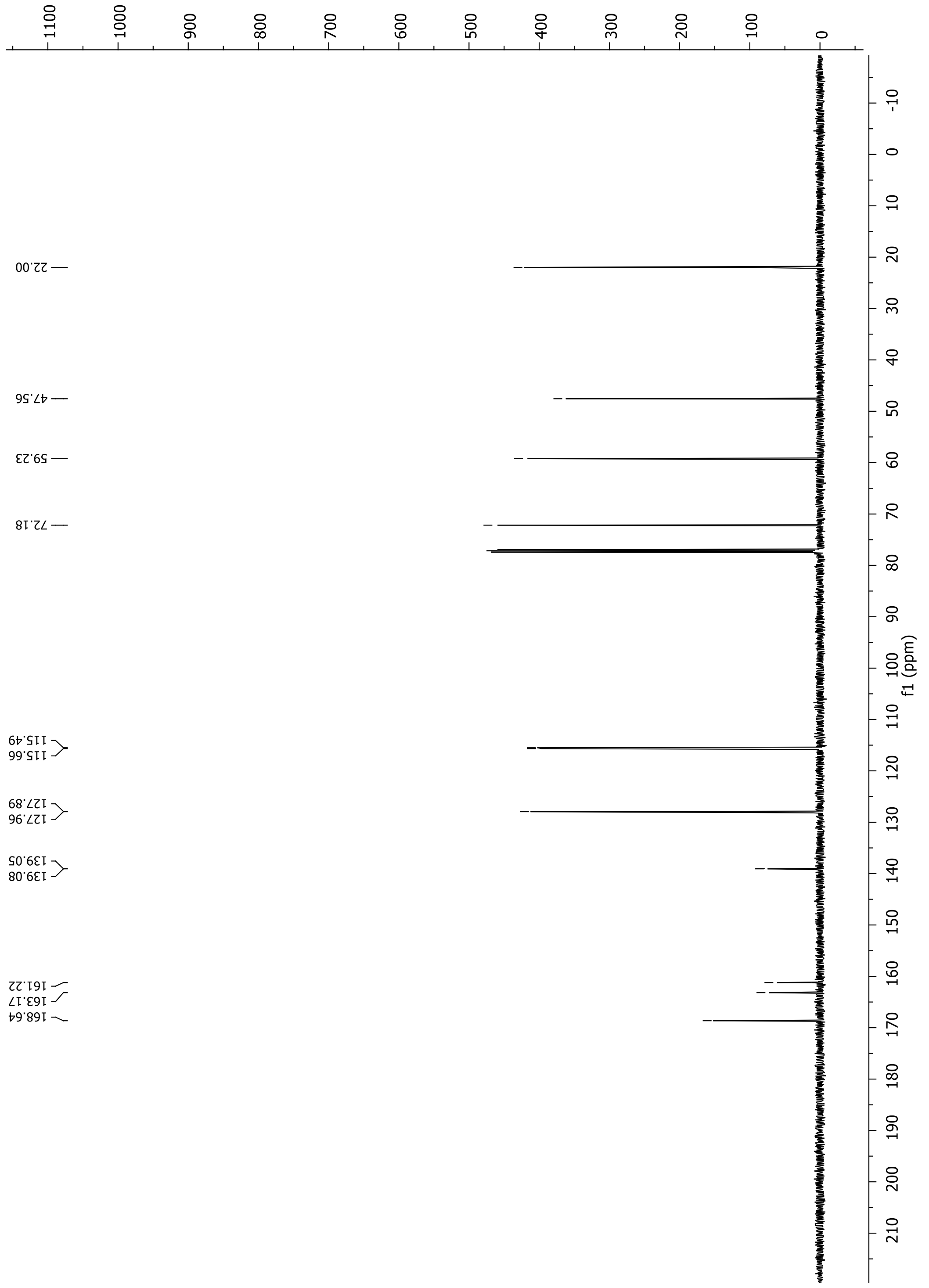
8.5
9.0
9.5
f1 (ppm)




22.00
47.56
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115.66
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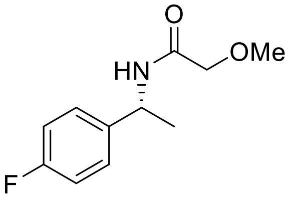
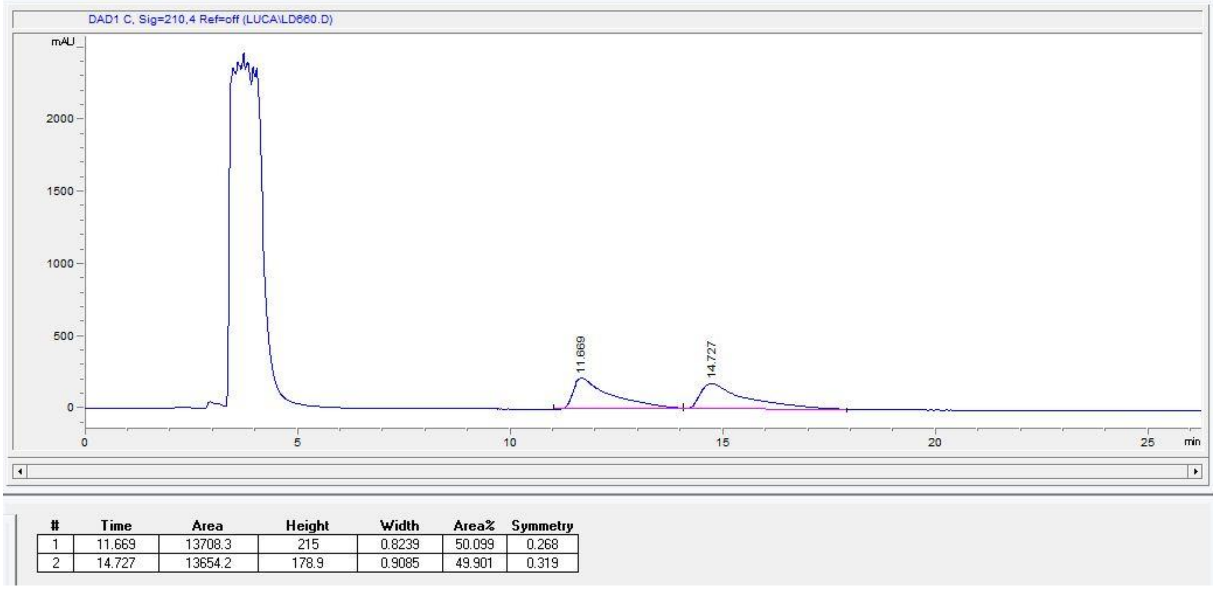
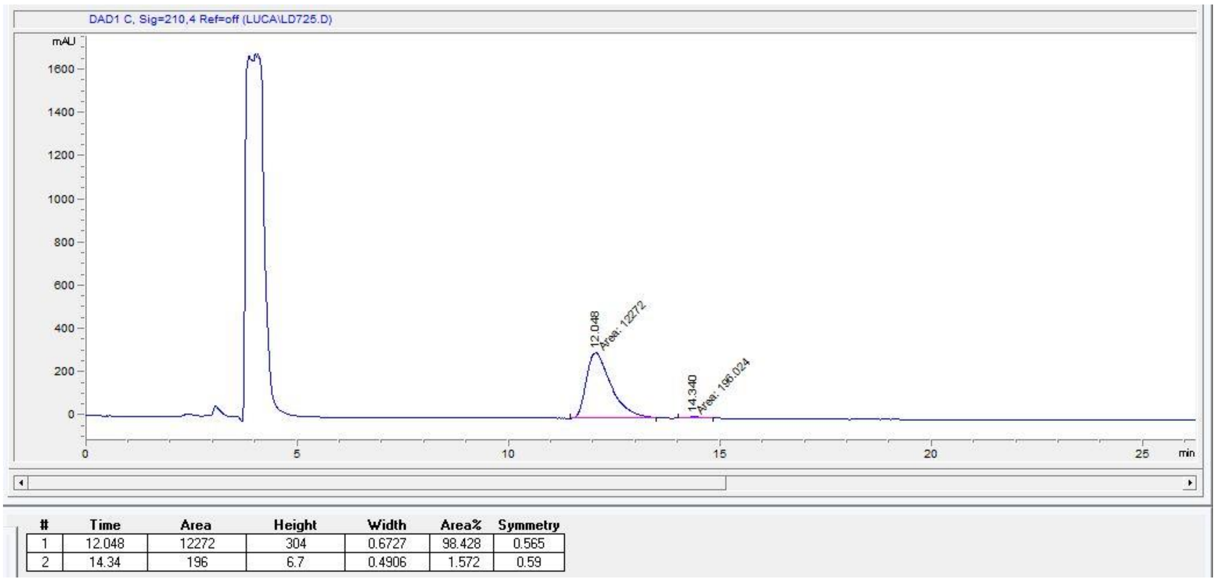
127.96
139.05
139.08
161.22
163.17
168.64
f1 (ppm)

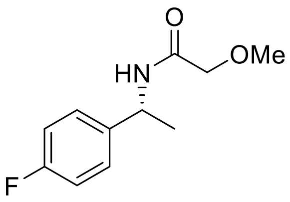




#	Time	Area	Height	Width	Area%	Symmetry
1	11.669	13708.3	215	0.8239	50.099	0.268
2	14.727	13654.2	178.9	0.9085	49.901	0.319



#	Time	Area	Height	Width	Area%	Symmetry
1	12.048	12272	304	0.6727	98.428	0.565
2	14.34	196	6.7	0.4906	1.572	0.59

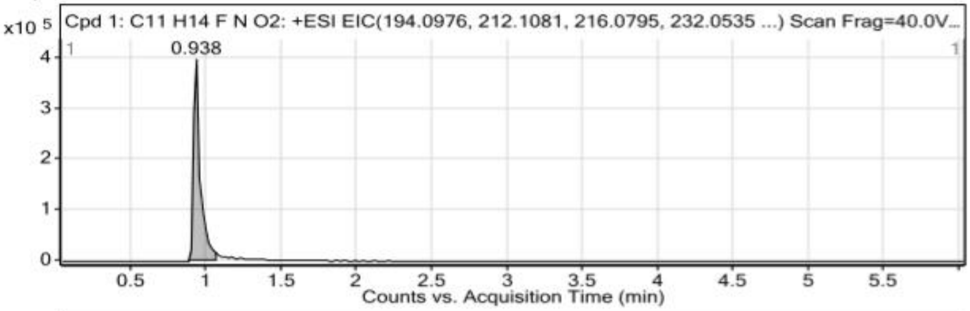


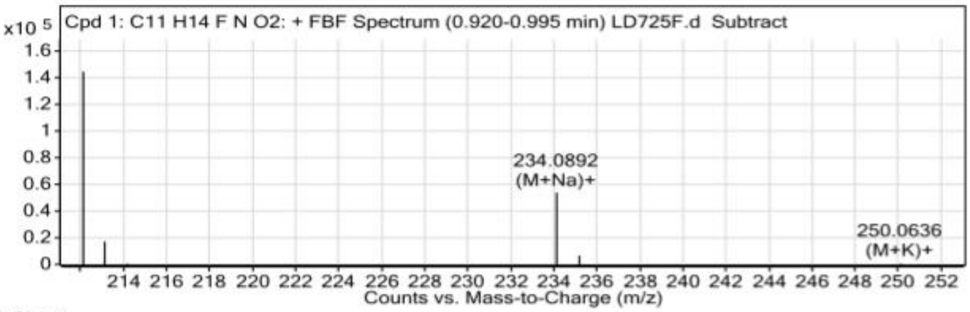
Qualitative Analysis Report

Data Filename	LD725F.d	**Sample Name**	LD725F
Sample Type	Sample	**Position**	Vial 1
Instrument Name	QTOF	**User Name**	QTOF-PC\admin
Acq Method	ACgroup_new.m	**Acquired Time**	2020-07-21 10:40:50
IRM Calibration Status	Success	**DA Method**	Default.m
Comment			

Acquisition SW	6200 series TOF/6500 series
Version	Q-TOF B.05.00 (B5042.2)

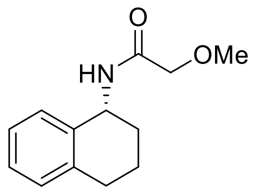
Compounds

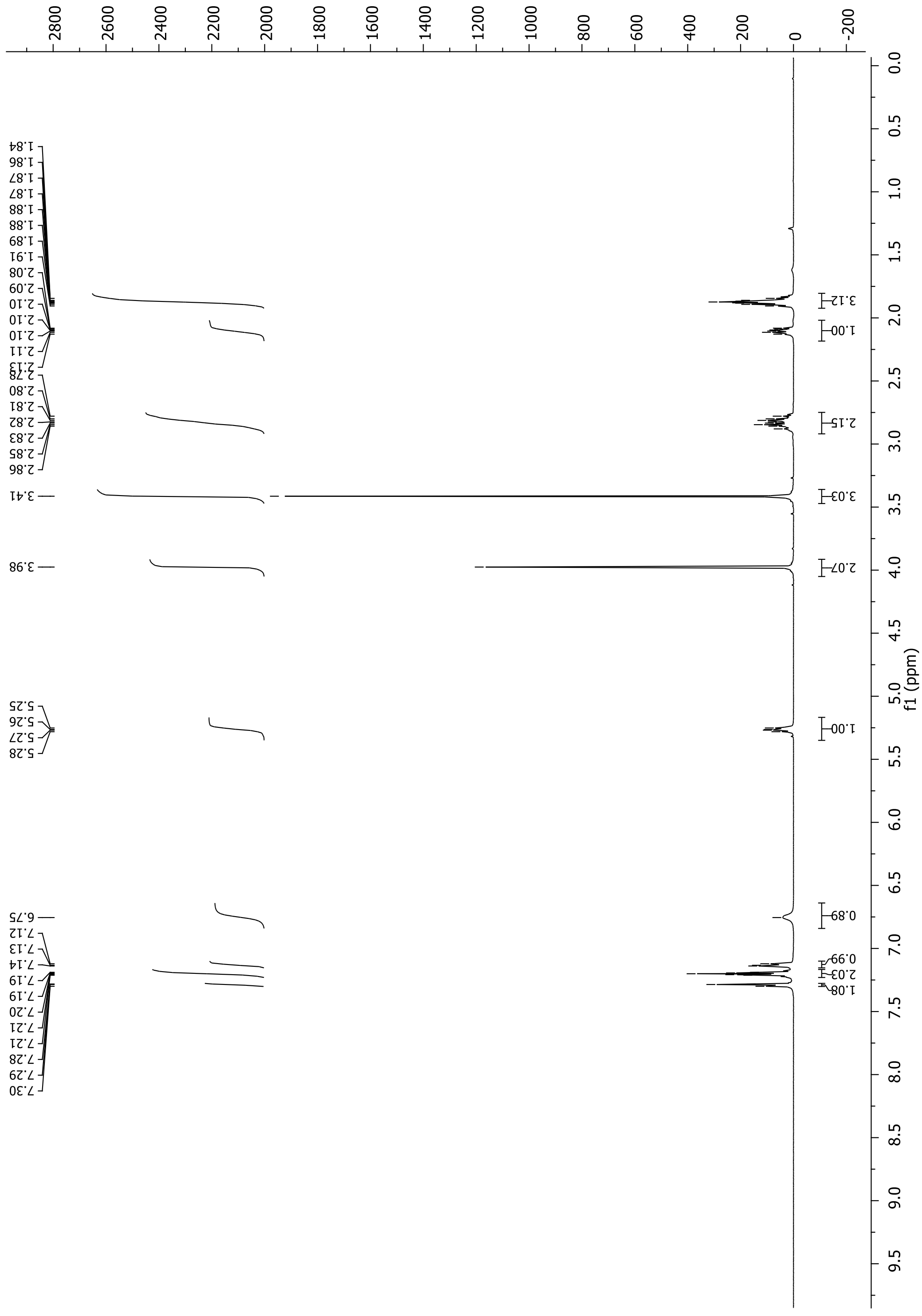




Peak List

m/z	z	Abund	Formula	Ion
212.1077	1	145155.36	C11H15FNO2	(M+H)+
213.1109	1	18180.68	C11H15FNO2	(M+H)+
214.114	1	1645.57	C11H15FNO2	(M+H)+
234.0892	1	54477.98	C11H14FNNaO2	(M+Na)+
235.0923	1	7558.8	C11H14FNNaO2	(M+Na)+
236.0946	1	651.03	C11H14FNNaO2	(M+Na)+
250.0636	1	2023.65	C11H14FKNO2	(M+K)+
251.0666	1	250.66	C11H14FKNO2	(M+K)+
252.067	1	80.88	C11H14FKNO2	(M+K)+


O
HN
OMe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1.88
1.88
1.89
1.91
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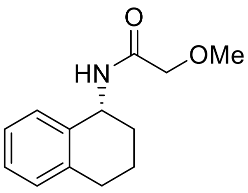
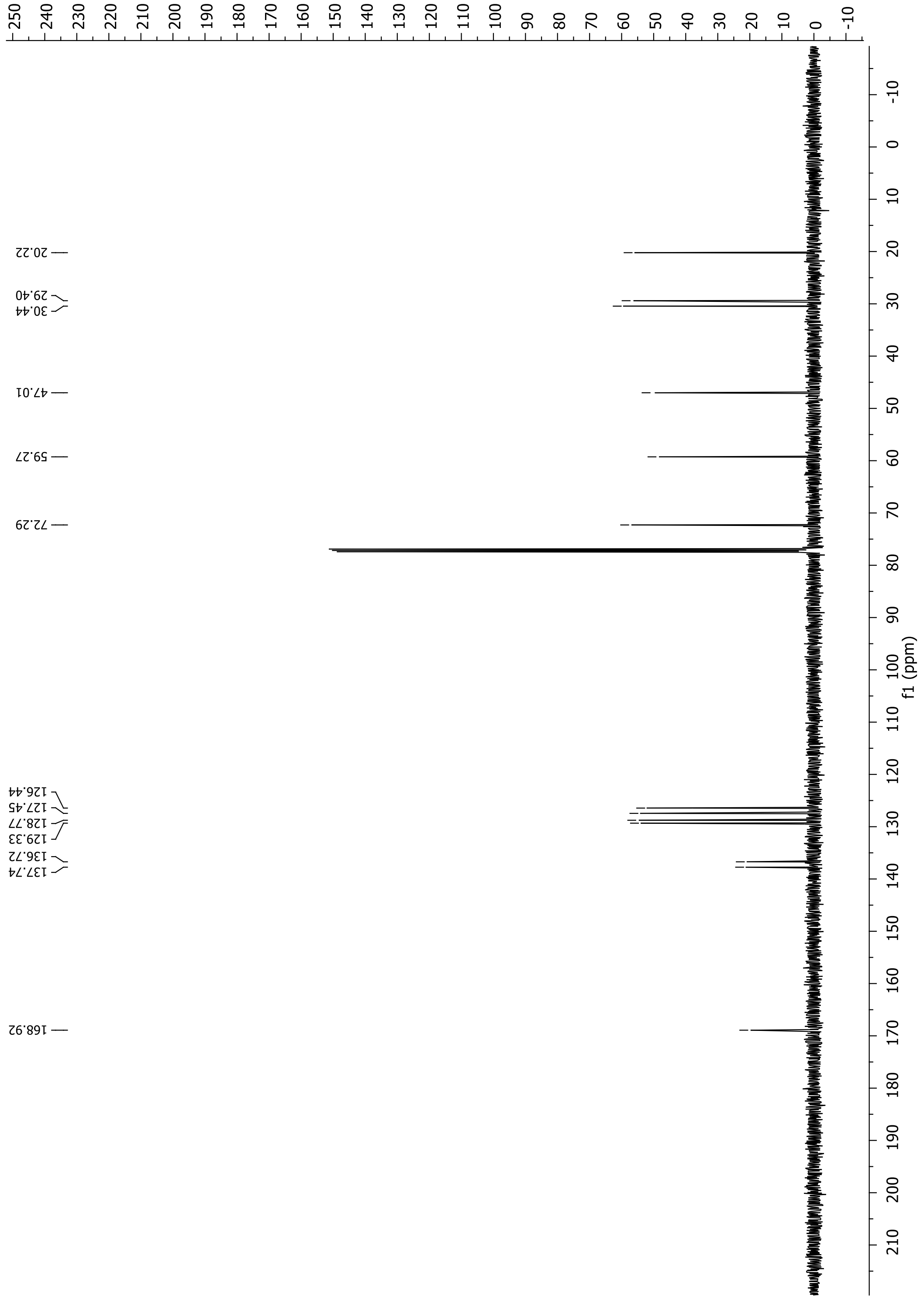
2.09
2.10
2.10
2.10
2.11
2.13
2.78
2.80
2.81
2.82
2.83
2.85
2.86
3.41
3.98
5.25
5.26
5.27
5.28
6.75
7.12
7.13
7.14
7.19
7.19
7.20
7.21
7.21
7.28
7.29
7.30
3.12
1.00
2.15
3.03
2.07
1.00
0.89
0.99
2.03
1.08
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
-200
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
f1 (ppm)


O
HN
OMe


20.22
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72.29
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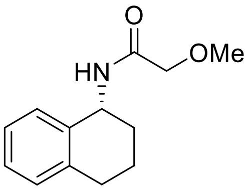
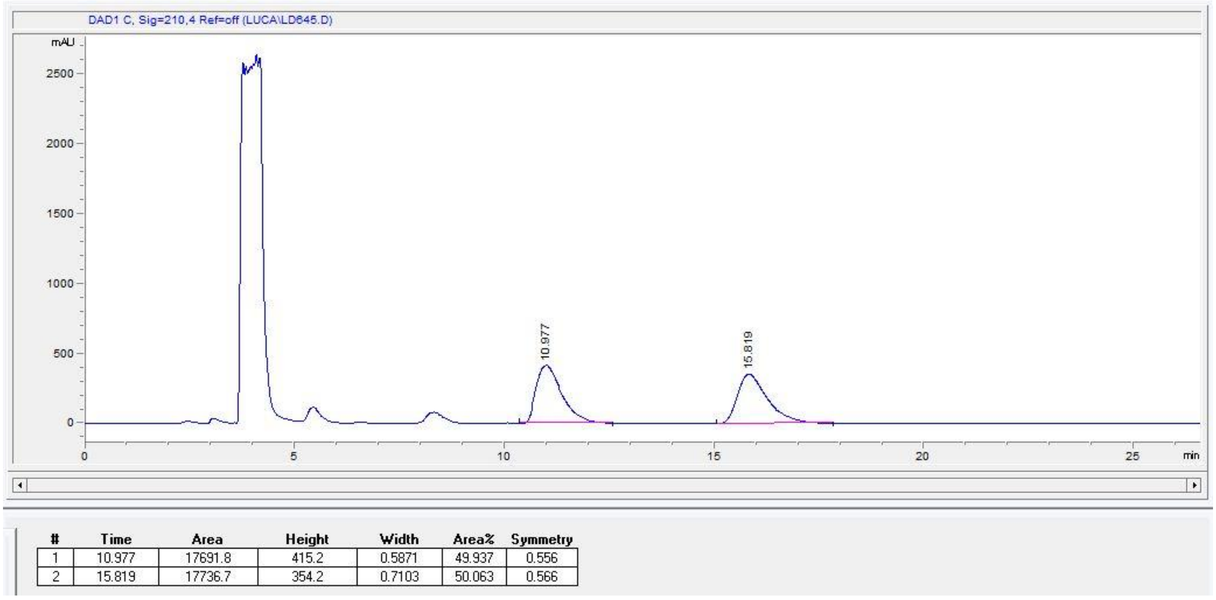
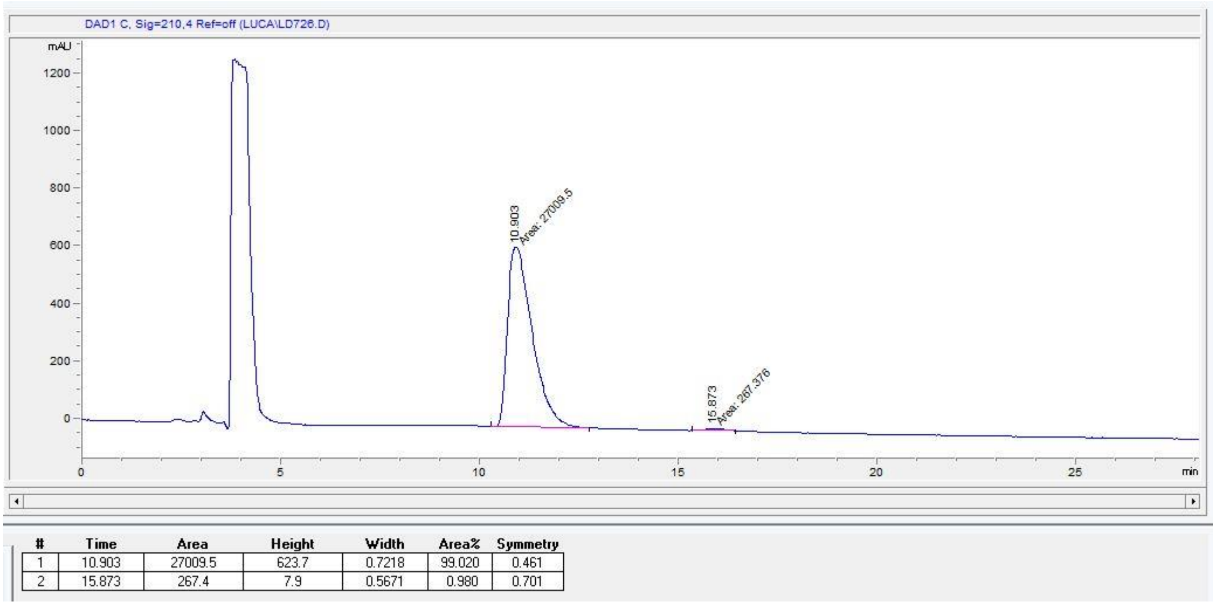
127.45
128.77
129.33
136.72
137.74
168.92
f1 (ppm)

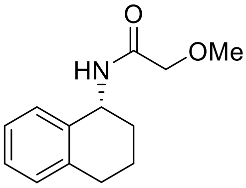


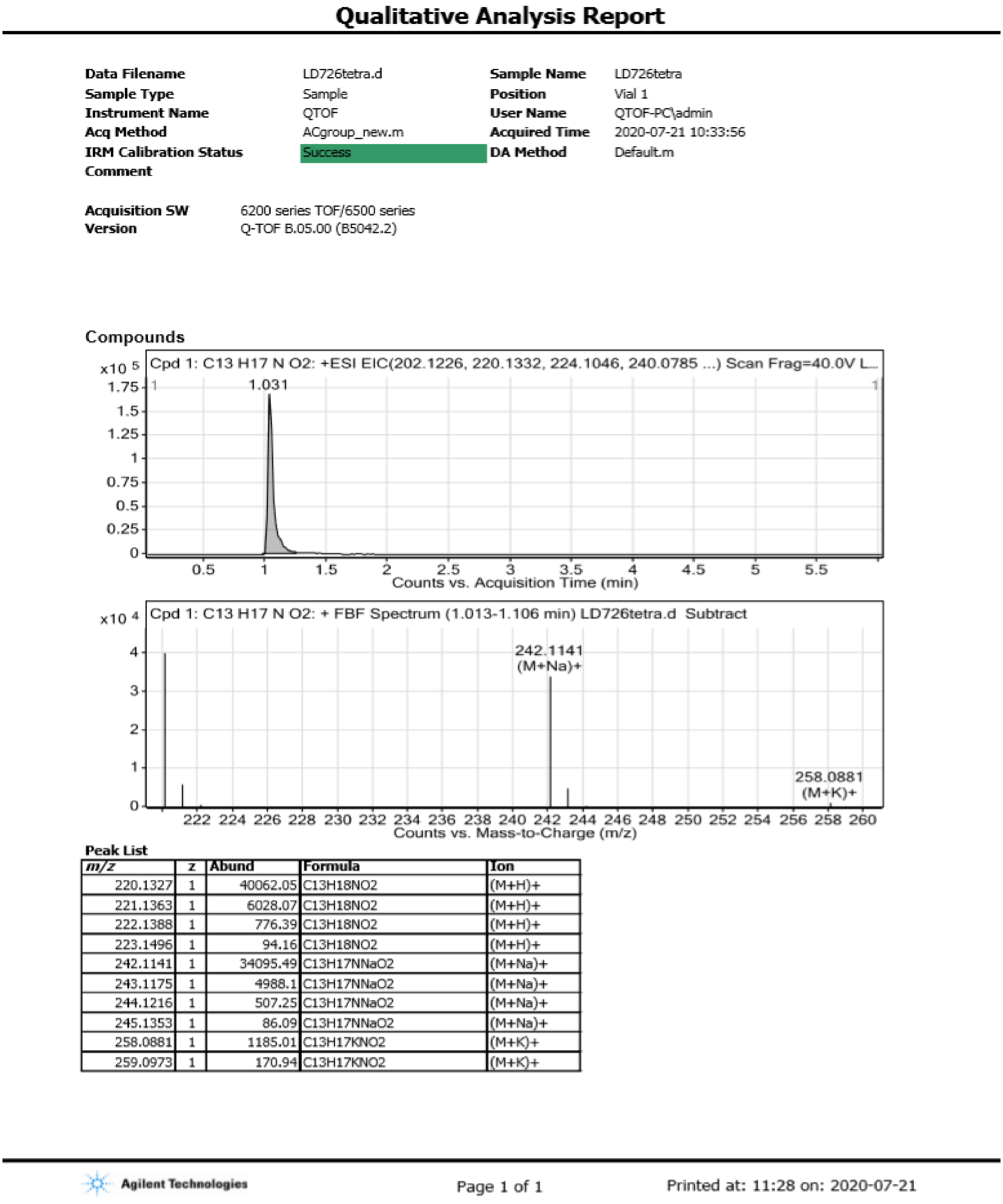


#	Time	Area	Height	Width	Area%	Symmetry
1	10.977	17691.8	415.2	0.5871	49.937	0.556
2	15.819	17736.7	354.2	0.7103	50.063	0.566



#	Time	Area	Height	Width	Area%	Symmetry
1	10.903	27009.5	623.7	0.7218	99.020	0.461
2	15.873	267.4	7.9	0.5671	0.980	0.701





Qualitative Analysis Report

Data Filename	LD726tetra.d	**Sample Name**	LD726tetra
Sample Type	Sample	**Position**	Vial 1
Instrument Name	QTOF	**User Name**	QTOF-PC\admin
Acq Method	ACgroup_new.m	**Acquired Time**	2020-07-21 10:33:56
IRM Calibration Status	Success	**DA Method**	Default.m
Comment			

Acquisition SW	6200 series TOF/6500 series
Version	Q-TOF B.05.00 (B5042.2)

Compounds

Peak List

m/z	z	Abund	Formula	Ion
220.1327	1	40062.05	C13H18NO2	(M+H)+
221.1363	1	6028.07	C13H18NO2	(M+H)+
222.1388	1	776.39	C13H18NO2	(M+H)+
223.1496	1	94.16	C13H18NO2	(M+H)+
242.1141	1	34095.49	C13H17NNaO2	(M+Na)+
243.1175	1	4988.1	C13H17NNaO2	(M+Na)+
244.1216	1	507.25	C13H17NNaO2	(M+Na)+
245.1353	1	86.09	C13H17NNaO2	(M+Na)+
258.0881	1	1185.01	C13H17KNO2	(M+K)+
259.0973	1	170.94	C13H17KNO2	(M+K)+

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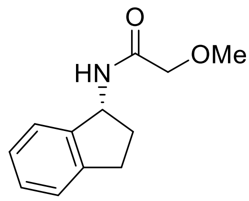
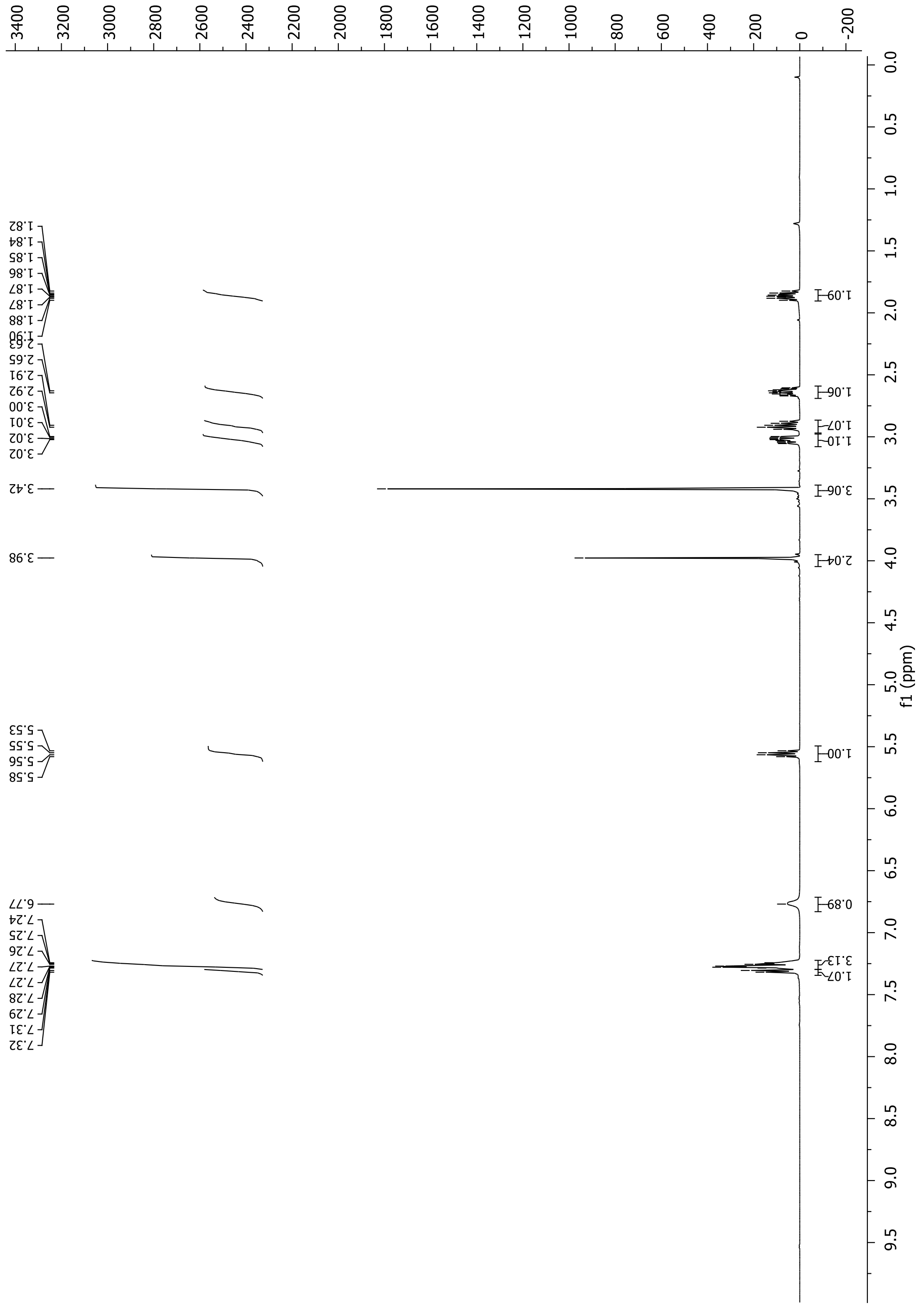

O
HN
OMe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1.87
1.88
1.90
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2.91
2.92
3.00
3.01
3.02
3.02
3.42
3.98
5.53
5.55
5.56
5.58
6.77
7.24
7.25
7.26
7.27
7.27
7.28
7.29
7.31
7.32
1.09
1.06
1.07
1.10
3.06
2.04
1.00
0.89
3.13
1.07
f1 (ppm)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
3400
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2000
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1200
1000
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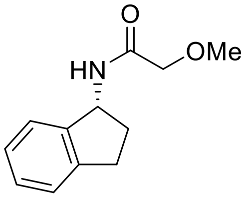
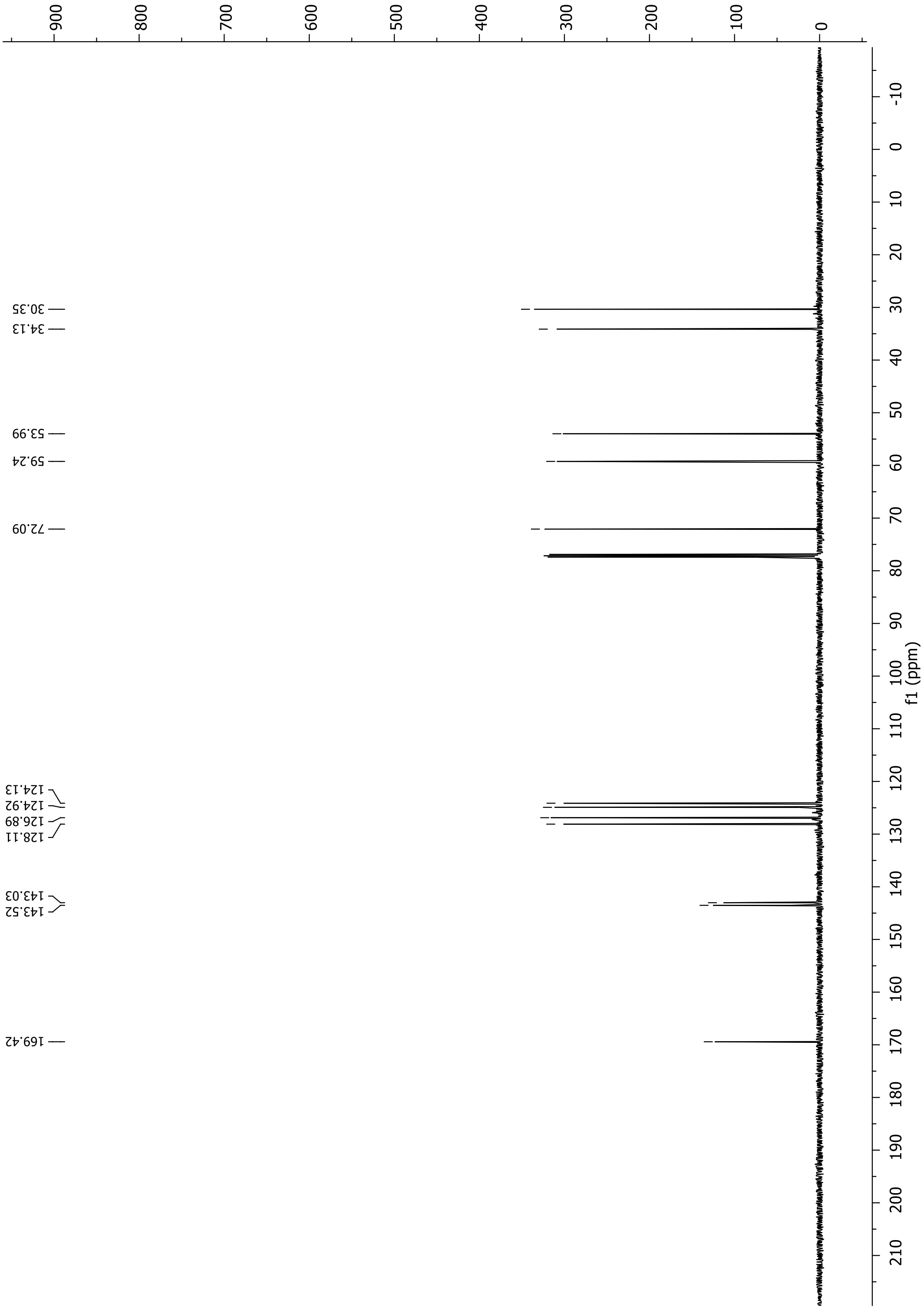
0
-200



O
HN
OMe



30.35
34.13
53.99
59.24
72.09
124.13
124.92
126.89
128.11
143.03
143.52
169.42
900
800
700
600
500
400
300
200
100
0
-10
0
10
20
30
40
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100
110
120
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160
170
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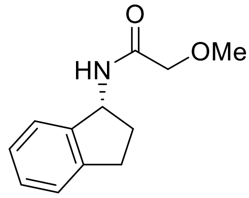
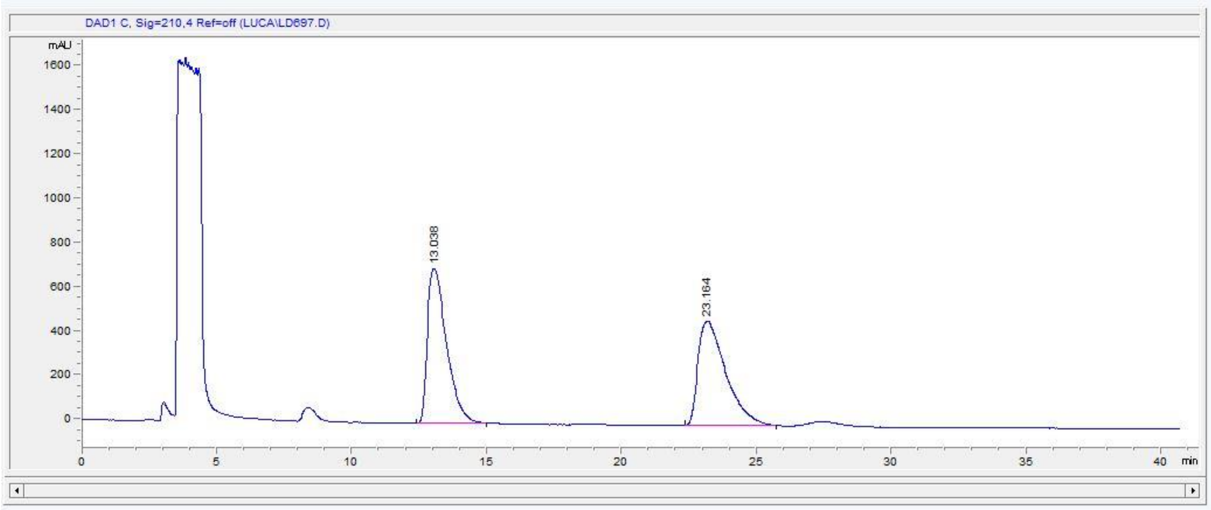
190
200
210
f1 (ppm)





#	Time	Area	Height	Width	Area%	Symmetry
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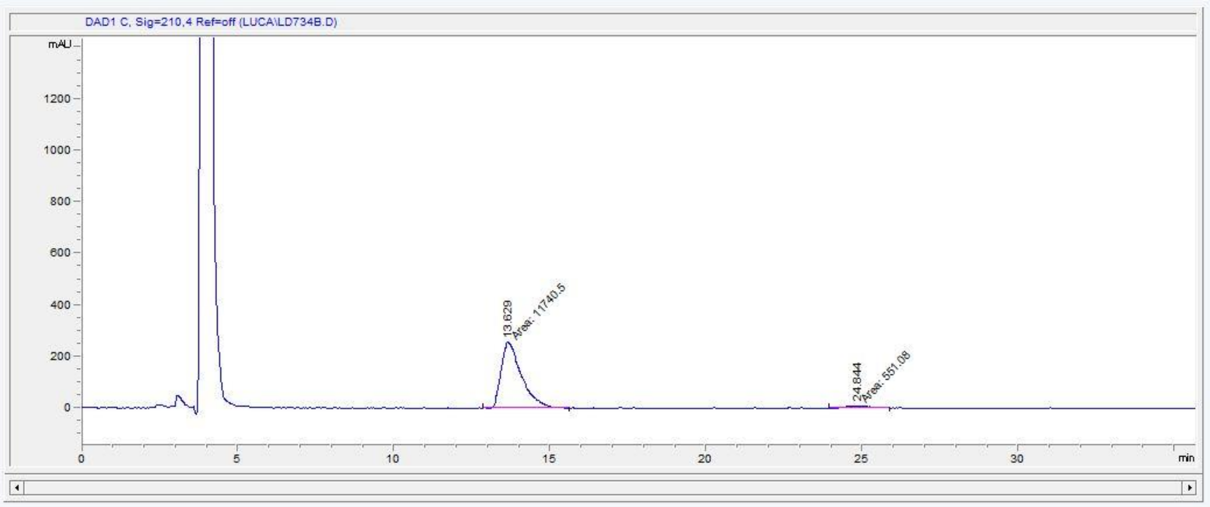
2	23.164	33983.9	472.1	0.8758	49.622	0.468



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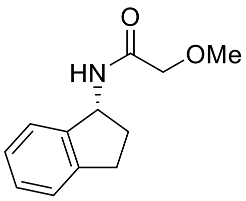
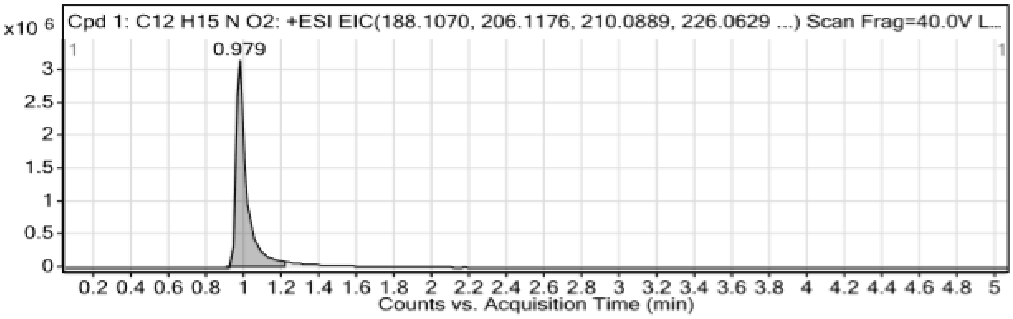
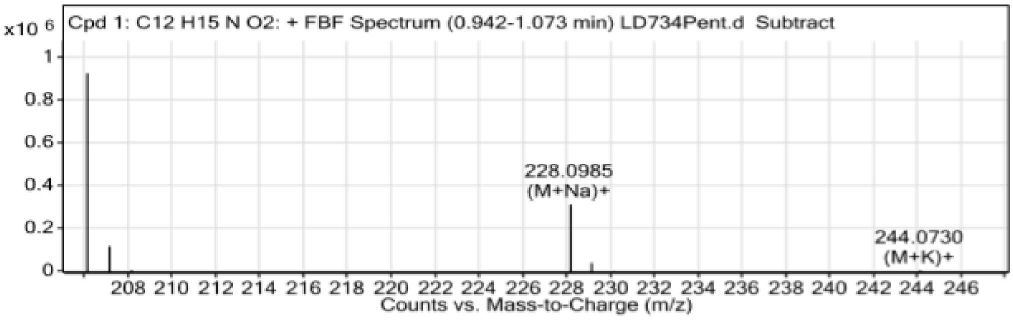


Qualitative Analysis Report

Data Filename	LD734Pent.d	**Sample Name**	Unavailable
Sample Type	Unavailable	**Position**	Unavailable
Instrument Name	Unavailable	**User Name**	Unavailable
Acq Method		**Acquired Time**	Unavailable
IRM Calibration Status	🟩 Success	**DA Method**	Default.m
Comment	Sample information is unavailable		

Compounds


Cpd 1: C12 H15 N O2: +ESI EIC(188.1070, 206.1176, 210.0889, 226.0629 ...) Scan Frag=40.0V L...


Cpd 1: C12 H15 N O2: + FBF Spectrum (0.942-1.073 min) LD734Pent.d Subtract

Peak List

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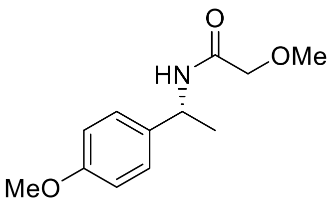
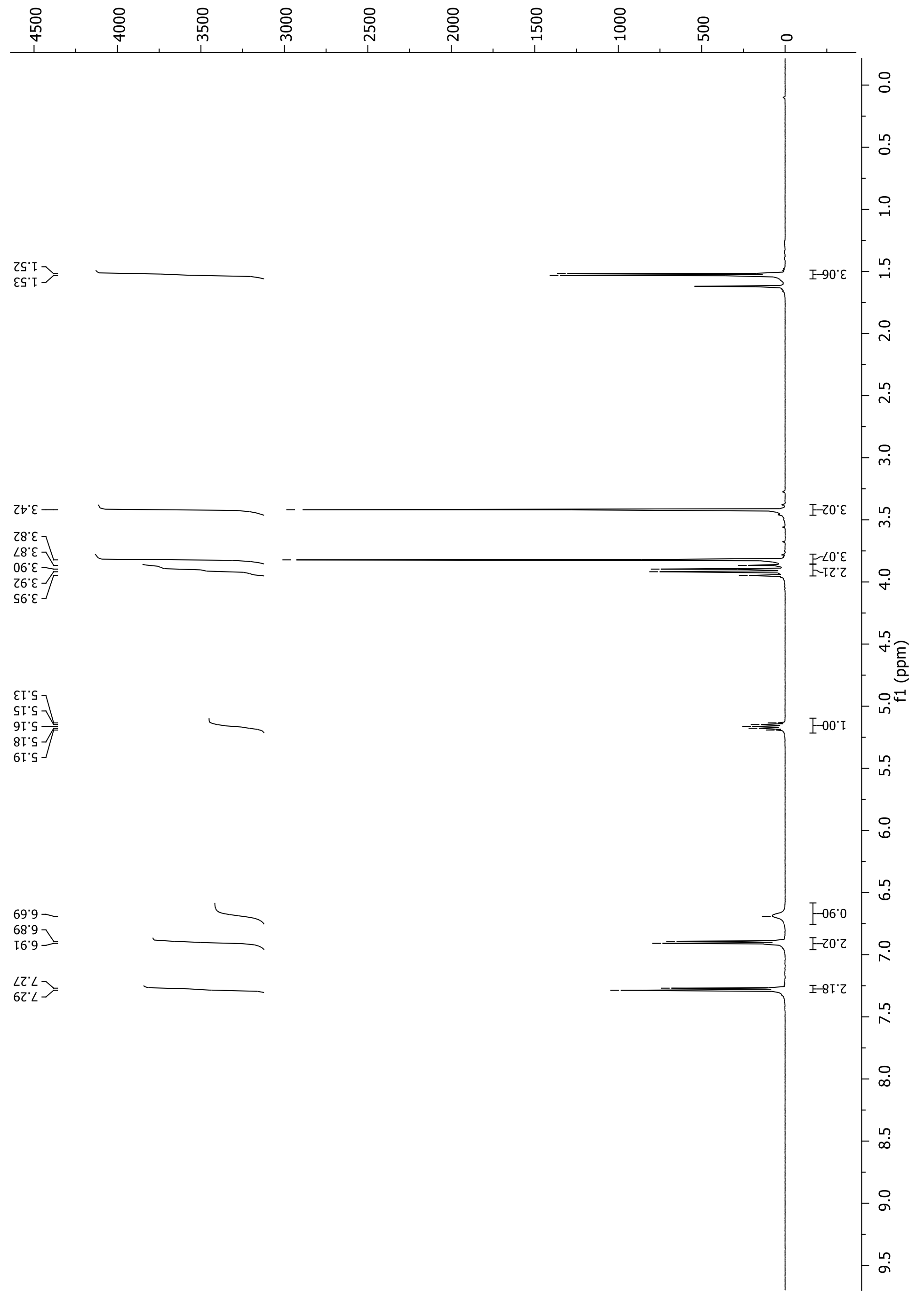
206.1167	1	926272.88	C12H16NO2	(M+H)+
207.1202	1	122494.77	C12H16NO2	(M+H)+
208.123	1	12143.27	C12H16NO2	(M+H)+
209.126	1	886.33	C12H16NO2	(M+H)+
228.0985	1	317460.72	C12H15NNaO2	(M+Na)+
229.1016	1	41668.57	C12H15NNaO2	(M+Na)+
230.1045	1	4101.17	C12H15NNaO2	(M+Na)+
244.073	1	8330.56	C12H15KNO2	(M+K)+
245.0767	1	1198.49	C12H15KNO2	(M+K)+
246.0727	1	662.19	C12H15KNO2	(M+K)+


O
HN
OMe
MeO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4000
3500
3000
2500
2000
1500
1000
500
0
1.52
1.53
3.42
3.82
3.87
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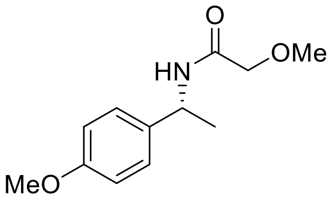
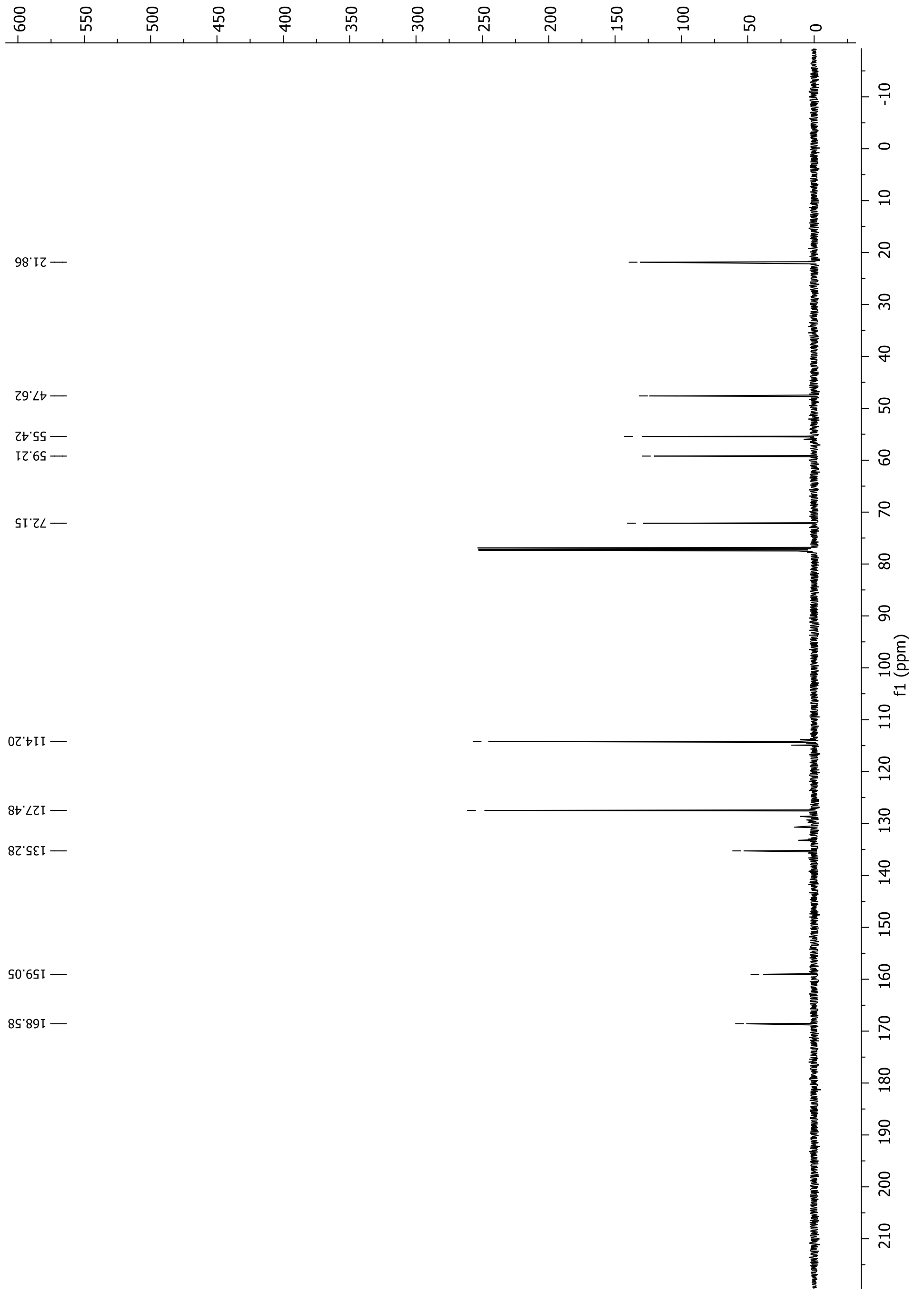
3.95
5.13
5.15
5.16
5.18
5.19
6.69
6.89
6.91
7.27
7.29
3.06
3.02
3.07
2.21
1.00
0.90
2.02
2.18
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
f1 (ppm)


O
HN
OMe
MeO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47.62
55.42
59.21
72.15
114.20
127.48
135.28
159.05
168.58
f1 (ppm)
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
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200
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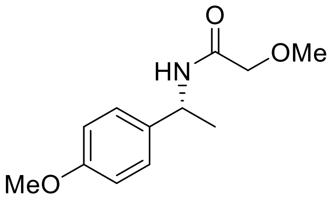
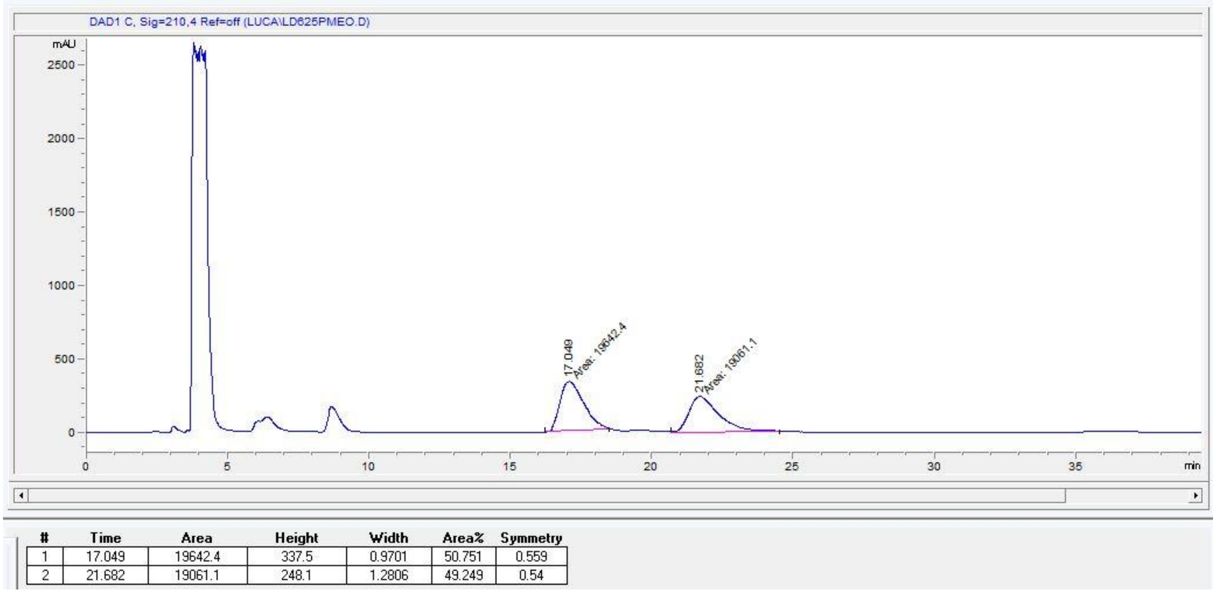
250
200
150
100
50
0





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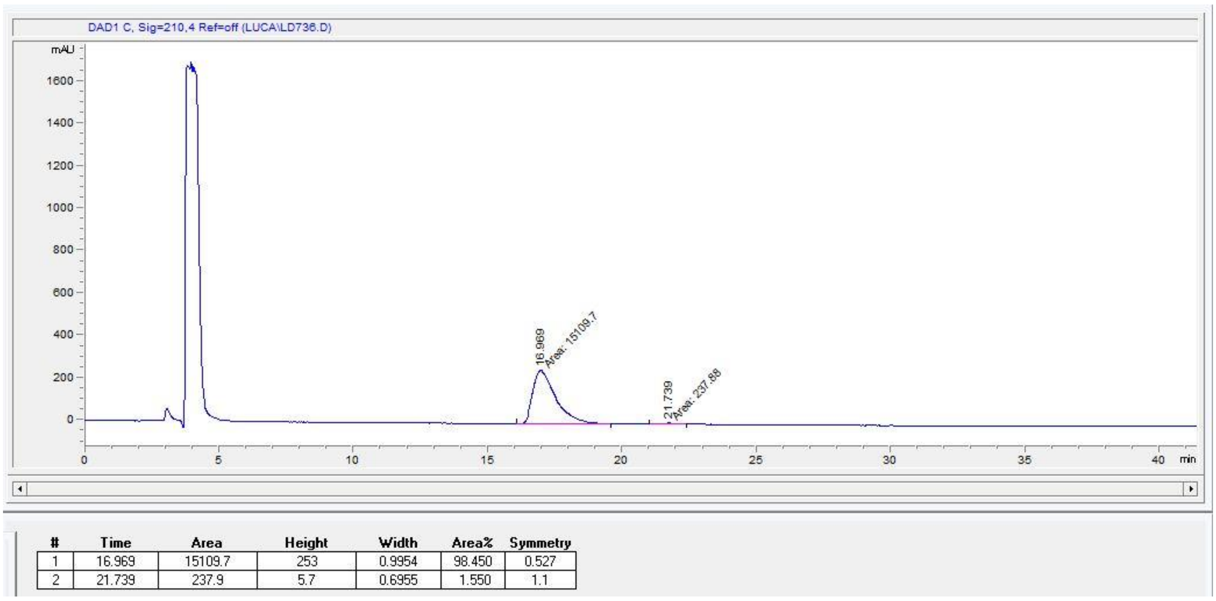

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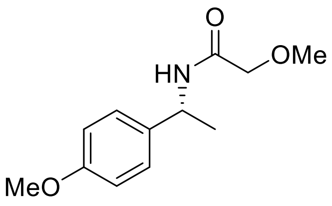
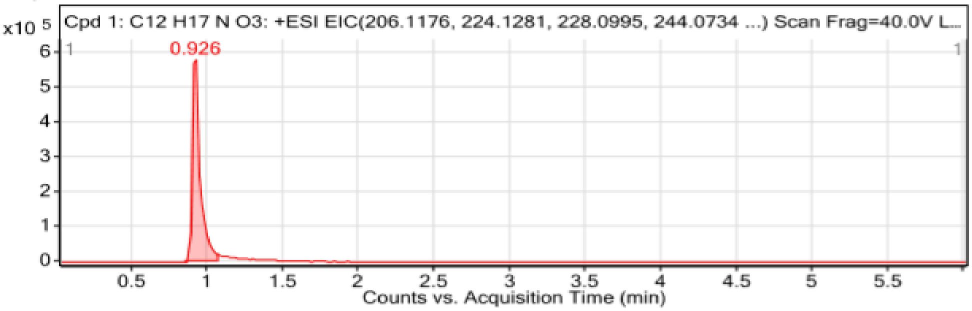


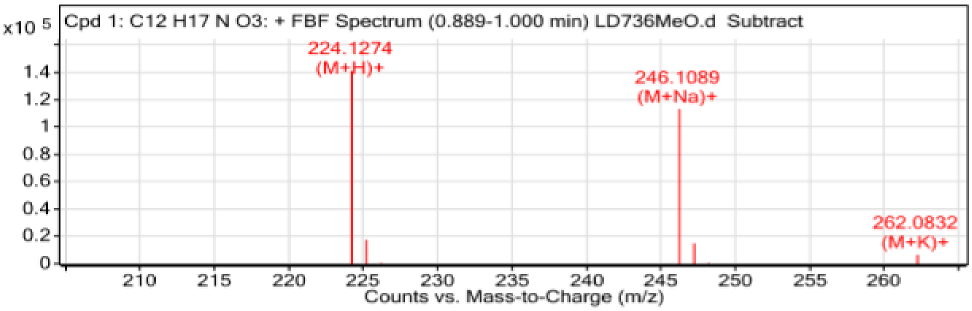
Qualitative Analysis Report

Data Filename	LD736MeO.d	**Sample Name**	LD736MeO
Sample Type	Sample	**Position**	Vial 1
Instrument Name	QTOF	**User Name**	QTOF-PC\admin
Acq Method	ACgroup_new.m	**Acquired Time**	2020-07-28 12:59:17
IRM Calibration Status	🟩 Success	**DA Method**	Default.m
Comment			

Acquisition SW	6200 series TOF/6500 series
Version	Q-TOF B.05.00 (B5042.2)

Compounds





Peak List

m/z	z	Abund	Formula	Ion
206.1221	1	73.73	C12H16NO2	(M+H)+[-H2O]
224.1274	1	141807.34	C12H18NO3	(M+H)+
225.1304	1	18948.74	C12H18NO3	(M+H)+
226.1328	1	2061.1	C12H18NO3	(M+H)+
246.1089	1	113550.31	C12H17NNaO3	(M+Na)+
247.112	1	15735.31	C12H17NNaO3	(M+Na)+
248.1139	1	1738.01	C12H17NNaO3	(M+Na)+
262.0832	1	7223.56	C12H17KNO3	(M+K)+
263.0865	1	1053.21	C12H17KNO3	(M+K)+
264.0842	1	613.45	C12H17KNO3	(M+K)+

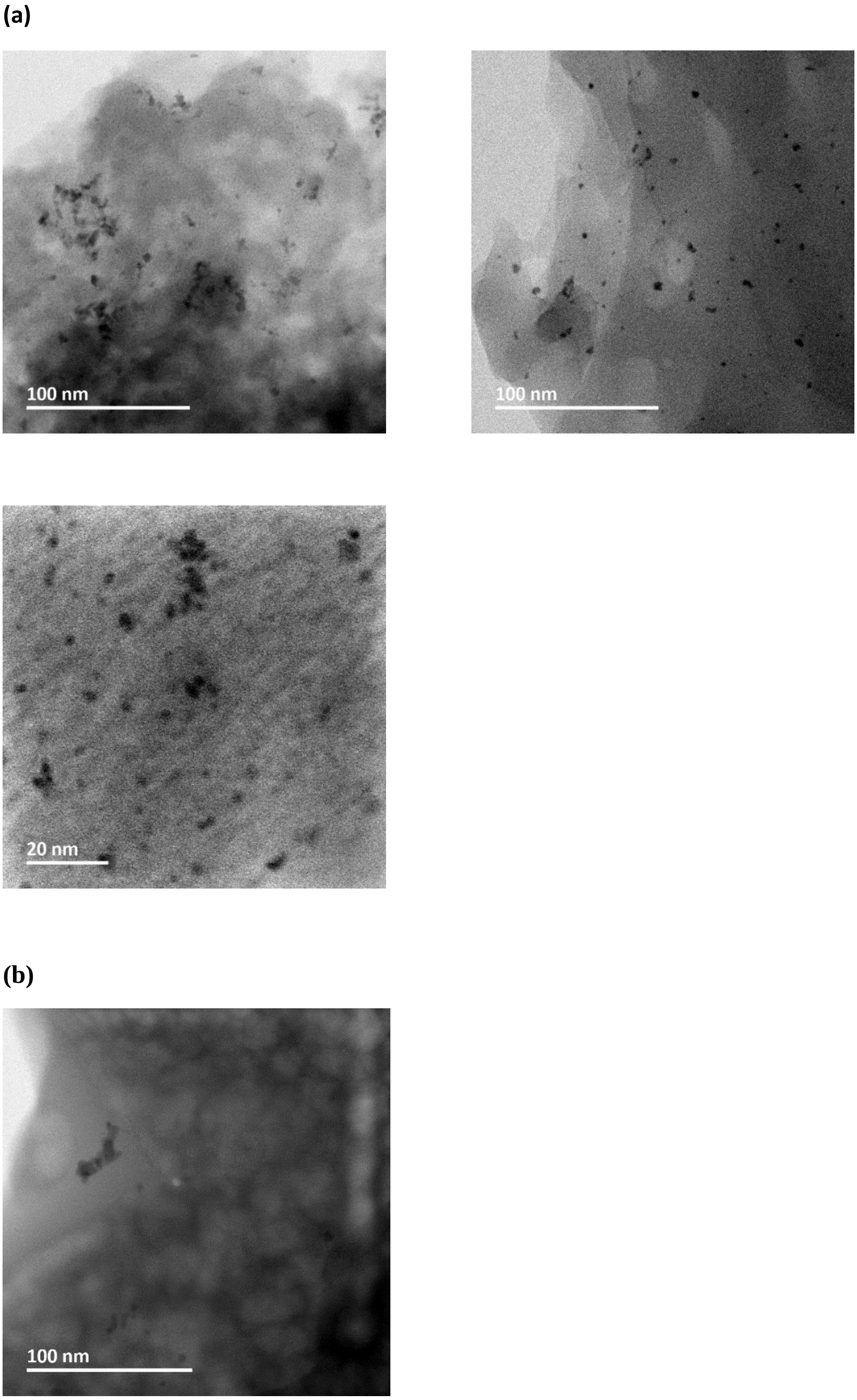


Figure 1S. (a) TEM images of well-dispersed Pd nanoparticles on APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer. (b) TEM image of Pd nanoparticles on APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer after the 7th catalytic cycle.

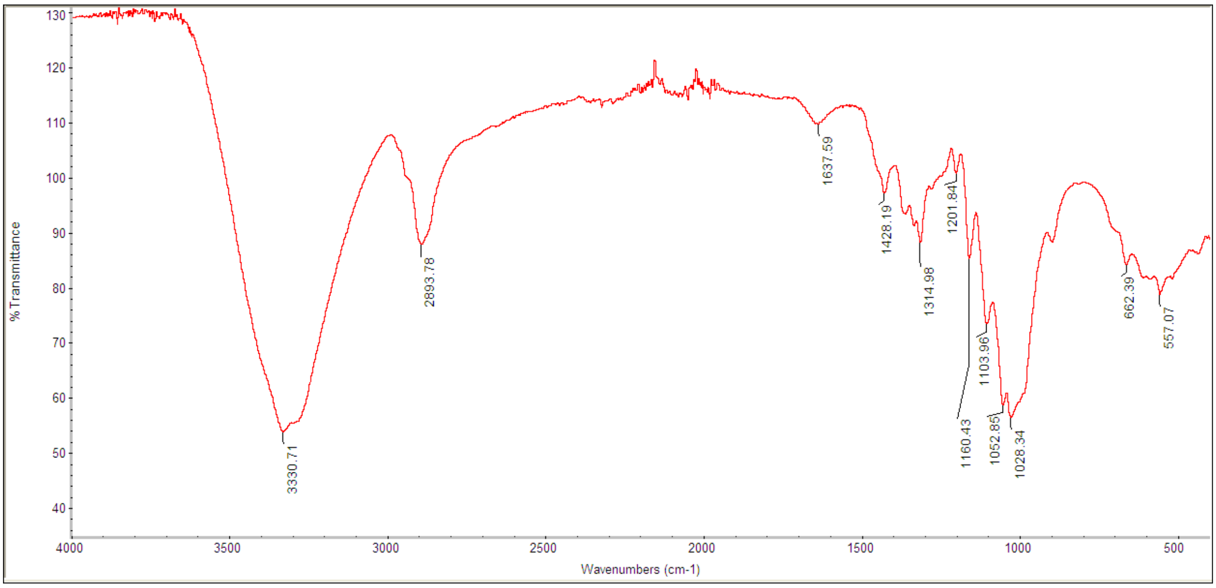


Figure 2S. FT-IR spectrum of MCC.

The broad absorption bands in all spectra at around 3330 cm^{-1} and 2898 cm^{-1} correspond to the O-H and C-H stretching vibrations, respectively. The bands at around 1636 cm^{-1} is attributed to the O-H bending vibrations of the hydroxyl groups of absorbed water. The absorption peaks at about 1160 cm^{-1} and 1104 cm^{-1} are attributed to the stretching vibrations of C–C and C–O, respectively. The absorption peaks about 1030 cm^{-1} comes from the vibration of C-O-C in the pyranose ring.

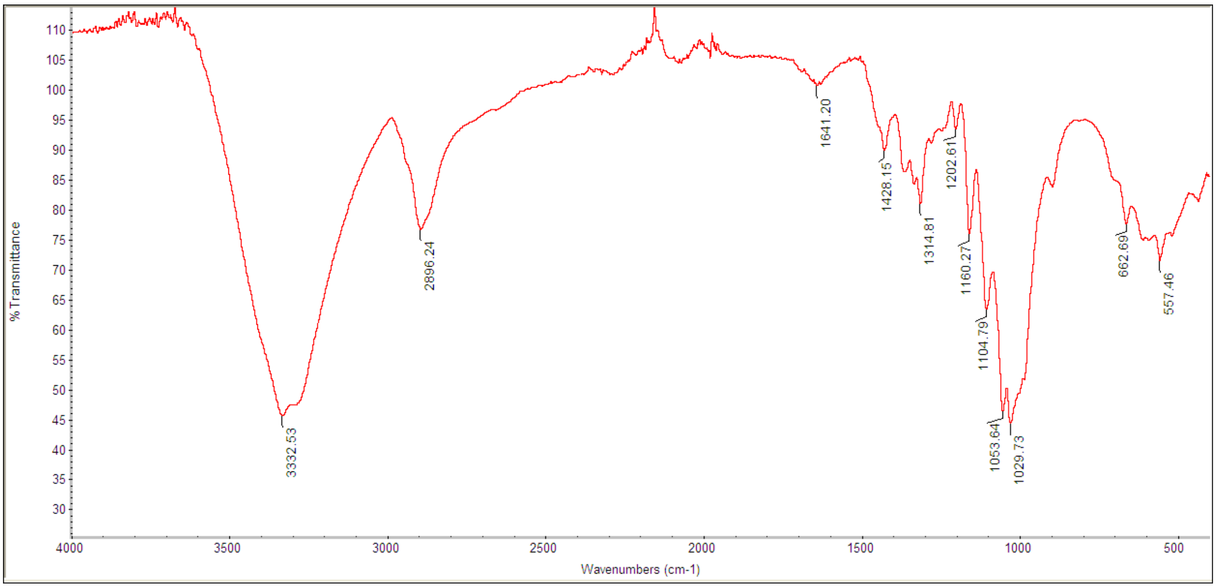


Figure 3S. FT-IR spectrum of MCC-Amp.

The broad absorption bands in all spectra at around 3330 cm^{-1} and 2898 cm^{-1} correspond to the O-H and C-H stretching vibrations, respectively. The bands at around 1636 cm^{-1} is attributed to the O-H bending vibrations of the hydroxyl groups of absorbed water. The absorption peaks at about 1160 cm^{-1} and 1104 cm^{-1} are attributed to the stretching vibrations of C–C and C–O, respectively. The absorption peaks about 1030 cm^{-1} comes from the vibration of C-O-C in the pyranose ring. Specific bands corresponding to the Si-O-Si and Si-O-Cellulose bridges (around 1135 and 1150 cm$^{−1}$, respectively) were overlapped with the large andintense C-O-C-vibration bands of cellulose in the same spectral region. The low degree of substitution did also show very small amount of the -NH band at 1150 cm−1.

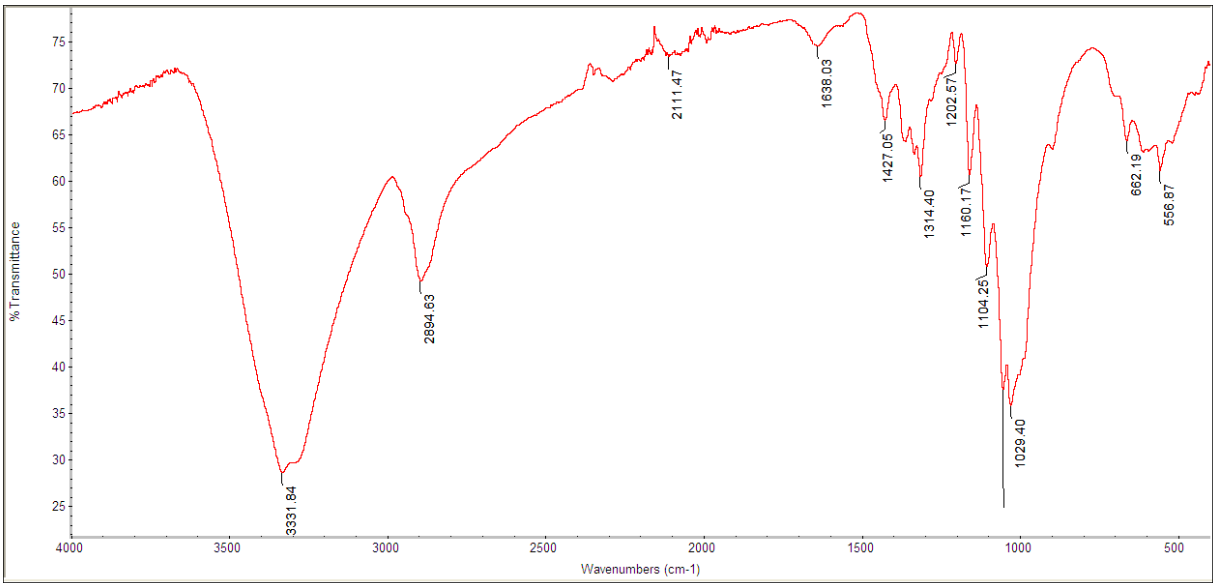


Figure 4S. FT-IR spectrum of MCC-Amp-Pd^0.

The broad absorption bands in all spectra at around 3330 cm^{-1} and 2898 cm^{-1} correspond to the O-H and C-H stretching vibrations, respectively. The bands at around 1636 cm^{-1} is attributed to the O-H bending vibrations of the hydroxyl groups of absorbed water. The absorption peaks at about 1160 cm^{-1} and 1104 cm^{-1} are attributed to the stretching vibrations of C–C and C–O, respectively. The absorption peaks about 1030 cm^{-1} comes from the vibration of C-O-C in the pyranose ring. Specific bands corresponding to the Si-O-Si and Si-O-Cellulose bridges (around 1135 and 1150 cm^{-1}, respectively) were overlapped with the large andintense C-O-C-vibration bands of cellulose in the same spectral region. The low degree of substitution did also show very small amount of the -NH band at 1150 cm−1.

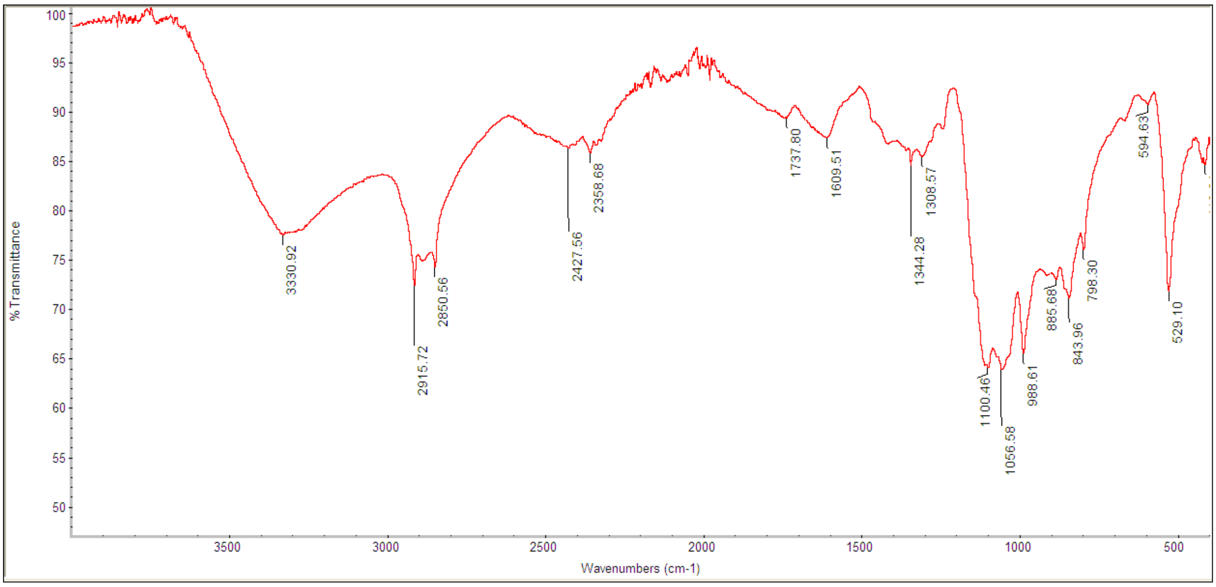


Figure 5S. FT-IR spectrum of APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer.

The IR spectra contains all of the characteristic cellulose absorptions bands such as the broad absorption bands in all spectra at around 3330 cm^{-1} and 2898 cm^{-1} correspond to the O-H and C-H stretching vibrations, respectively. The lower ratio of these to other absorption bands shows that the hydroxyl groups have been modified with Brij, Silane, buffer and enzyme. Characteristic carbonyl absorption bands at 1730 cm^{-1} are visible as well as the aromatic absorptions from the aryl groups of the peptide backbone at 300 cm^{-1}.

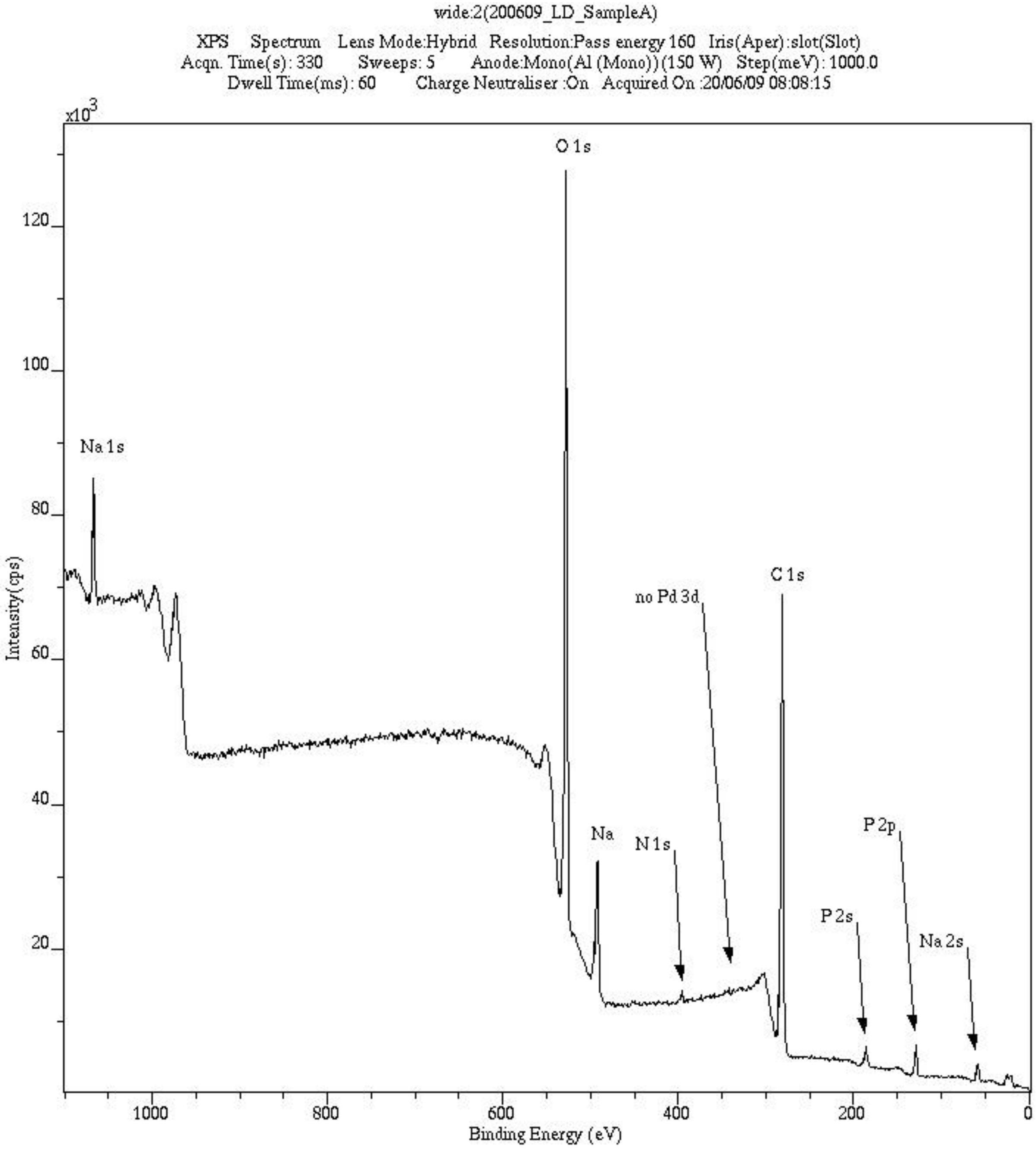


Figure 6S. XPS spectrum for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer.

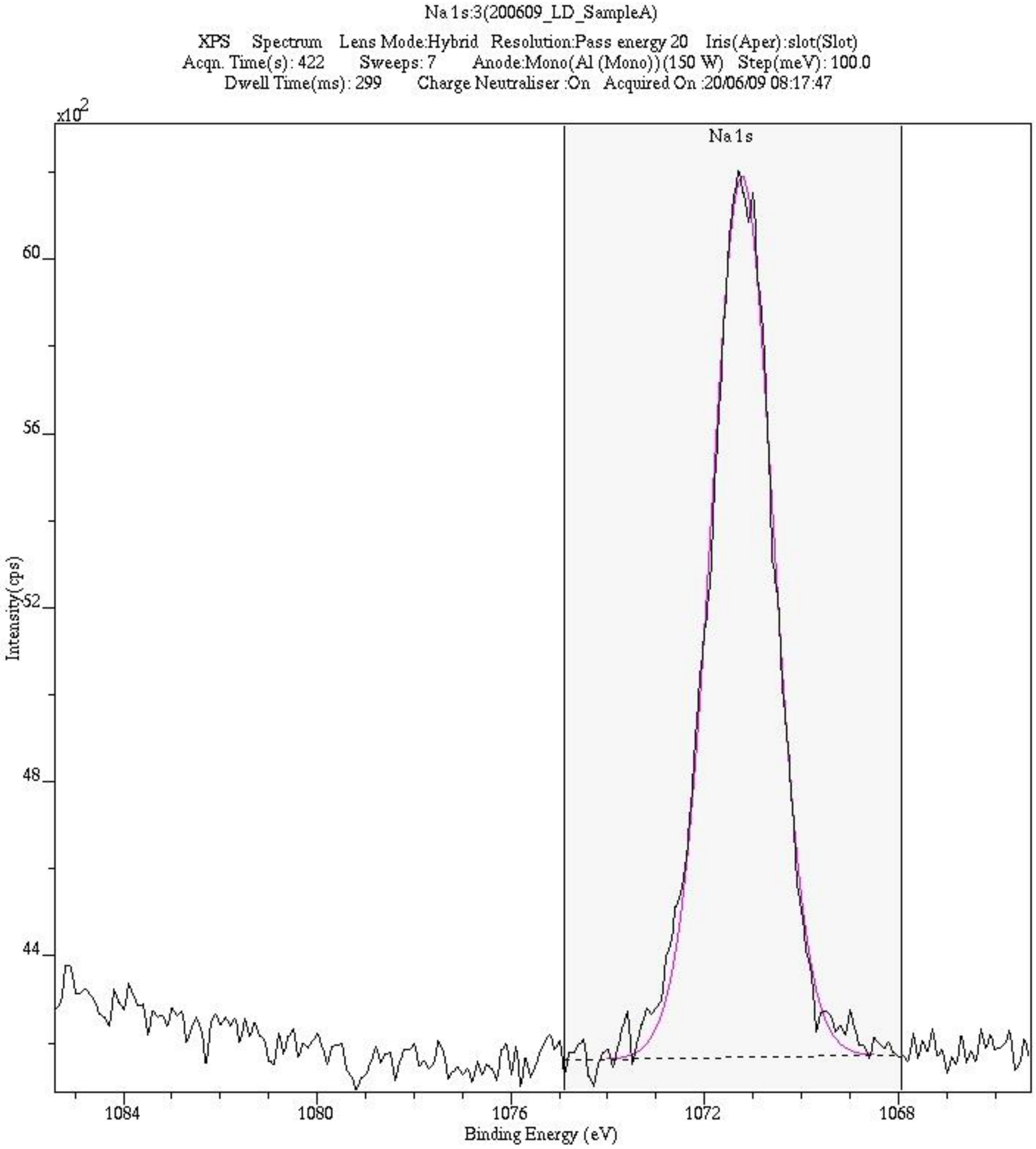


Figure 7S. XPS spectrum of Na1s for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer.

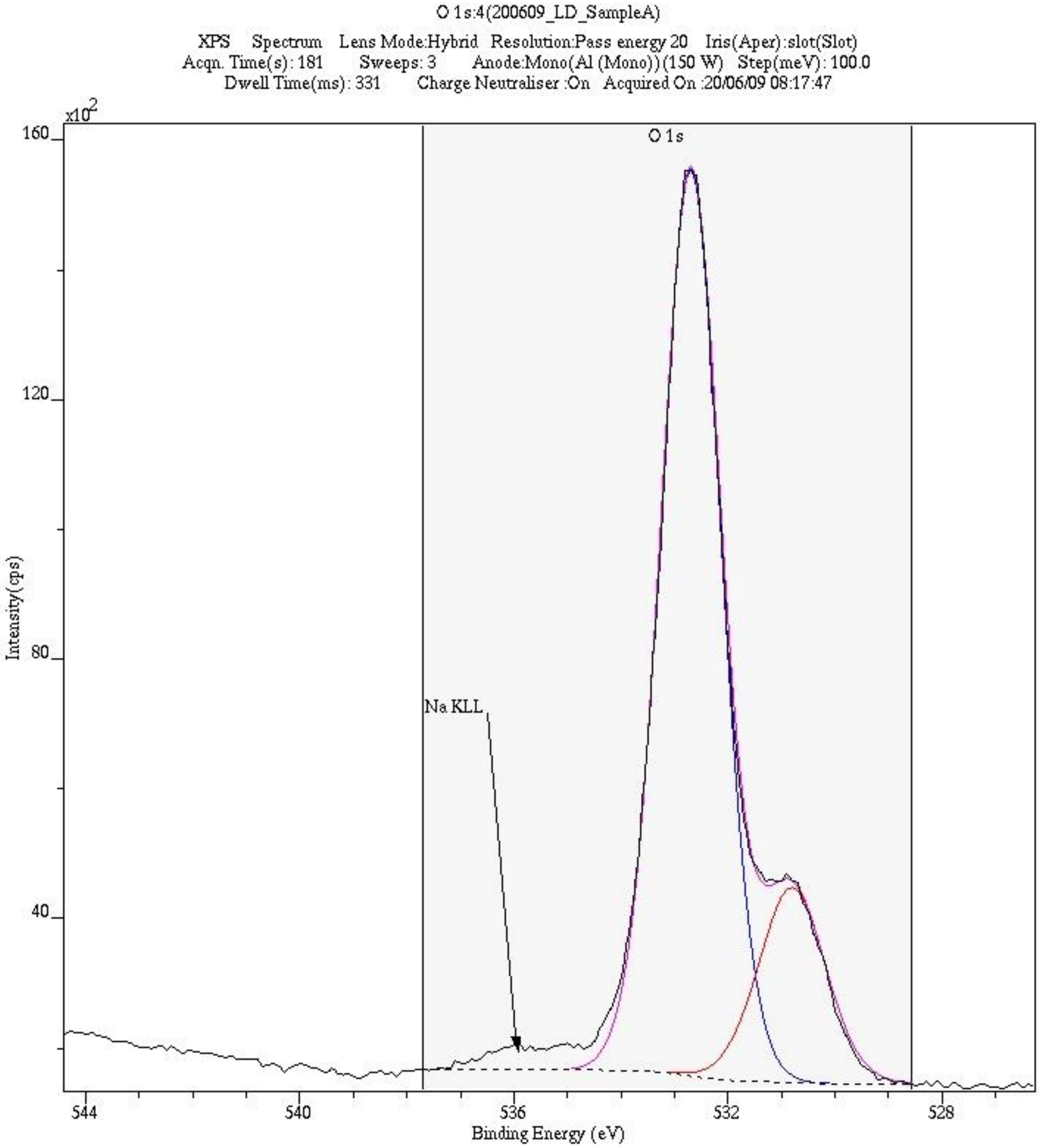


Figure 8S. XPS spectrum of O1s for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer.

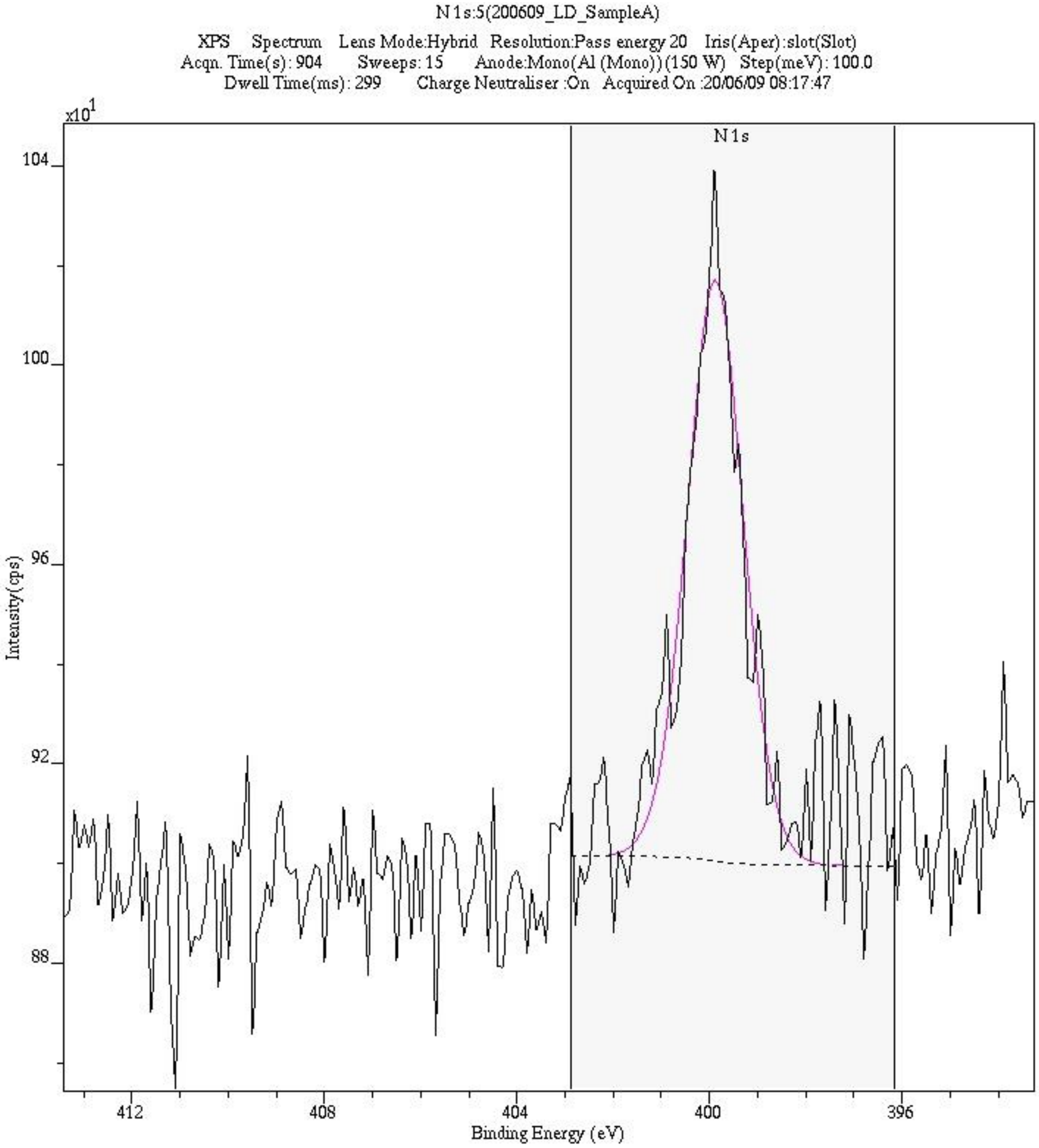


Figure 9S. XPS spectrum of N1s for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer.

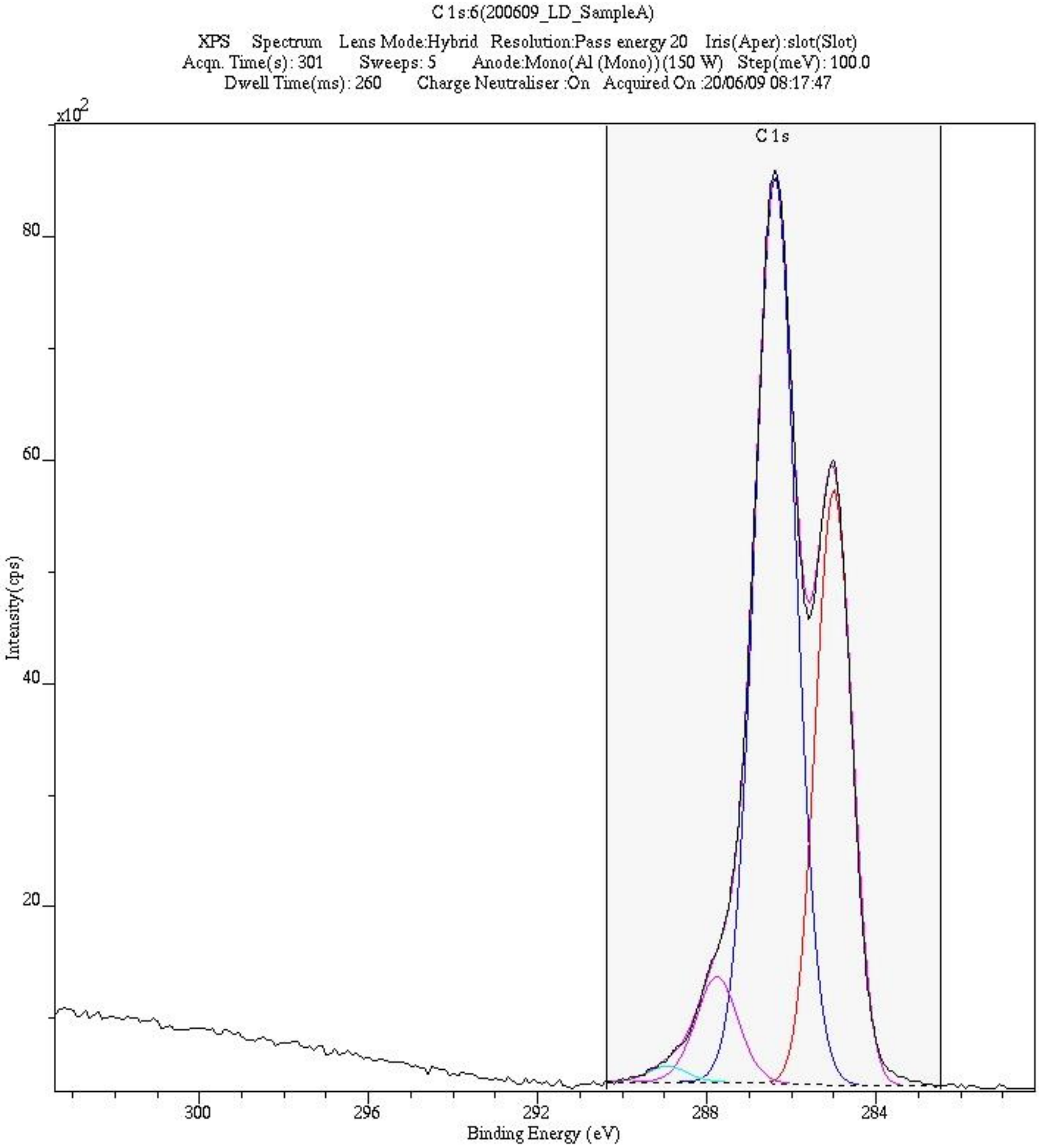


Figure 10S. XPS spectrum of C1s for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer.

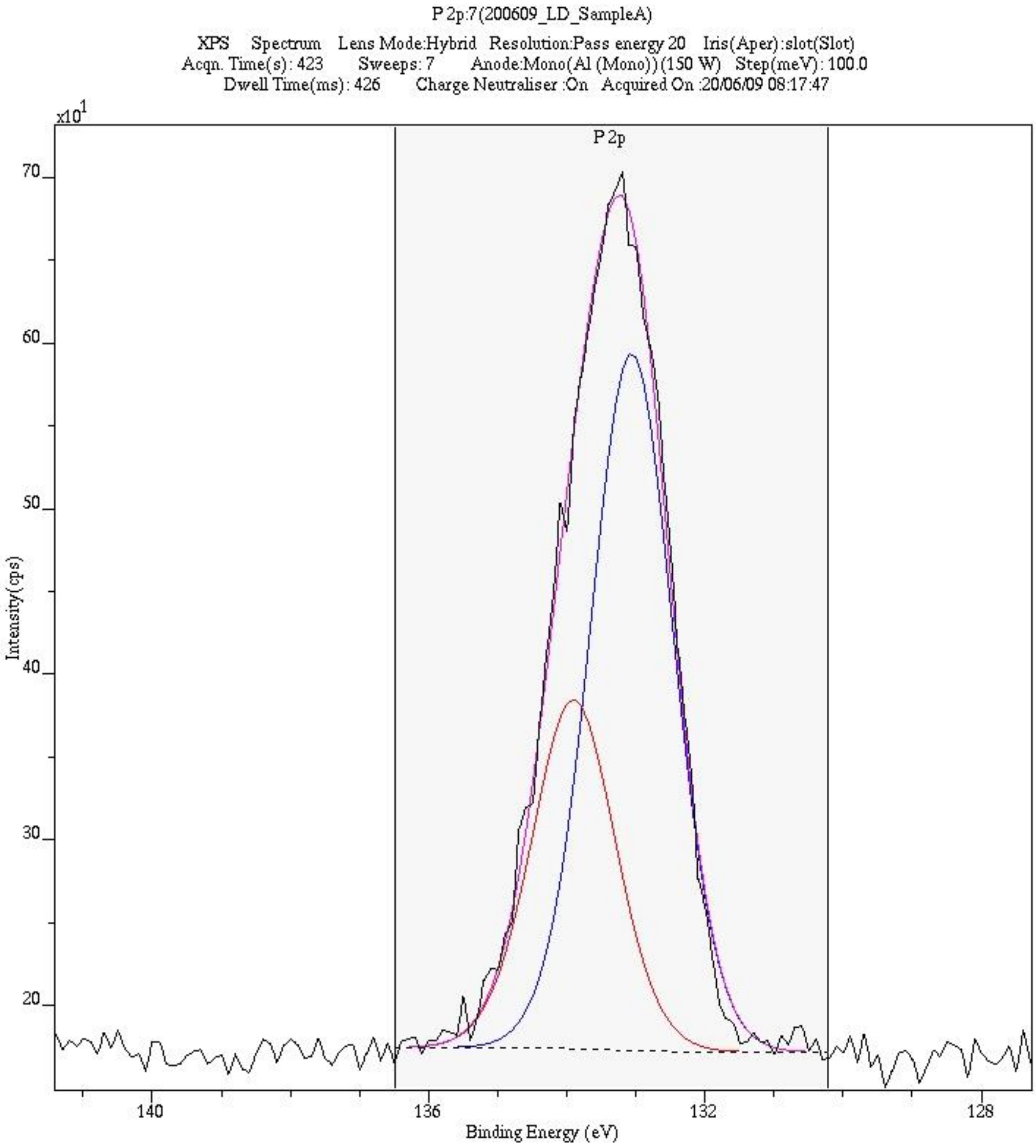


Figure 11S. XPS spectrum of P2p for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer.

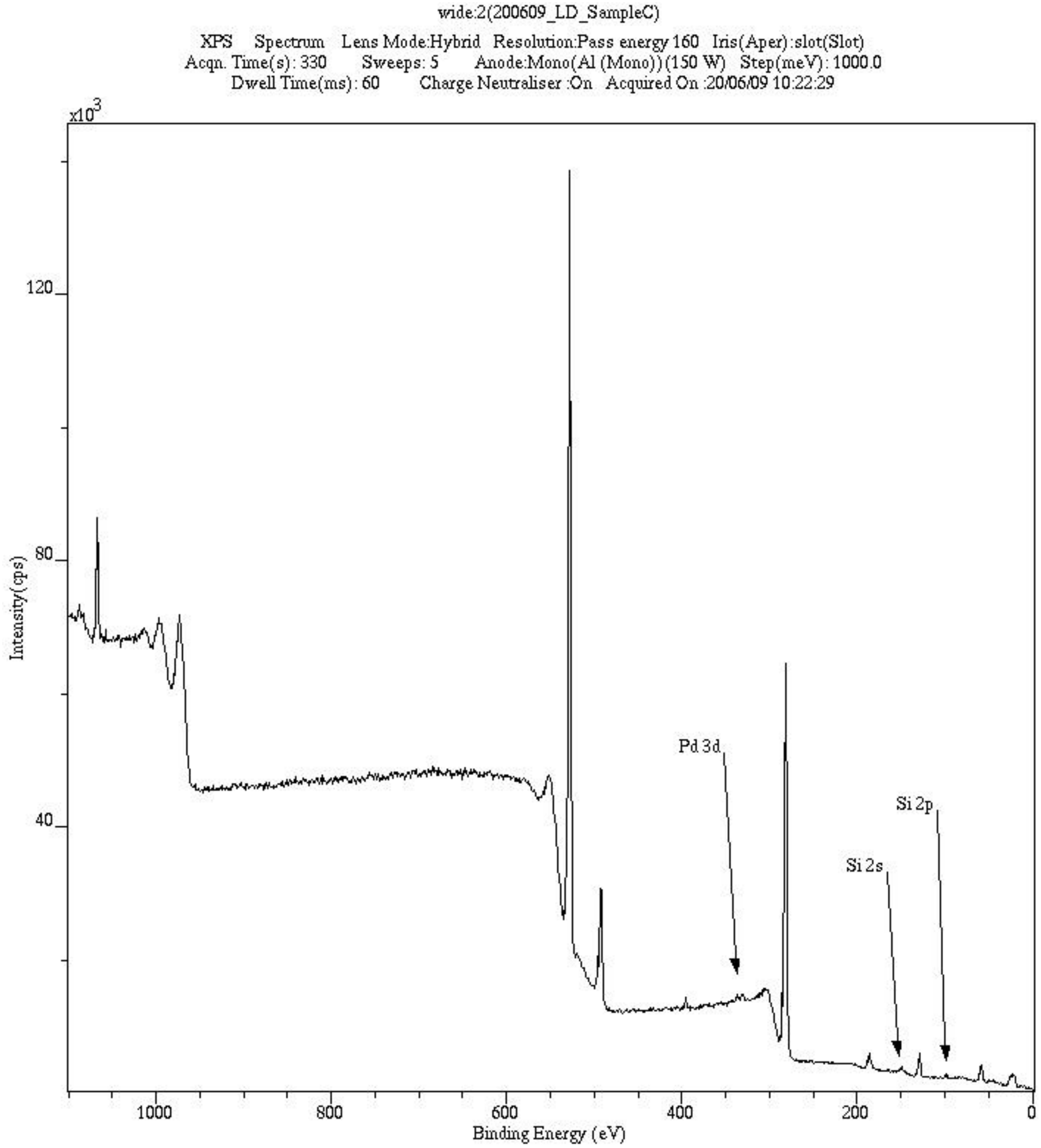


Figure 12S. XPS spectrum for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer after stirring 24 hours at 90C^o under H_2.

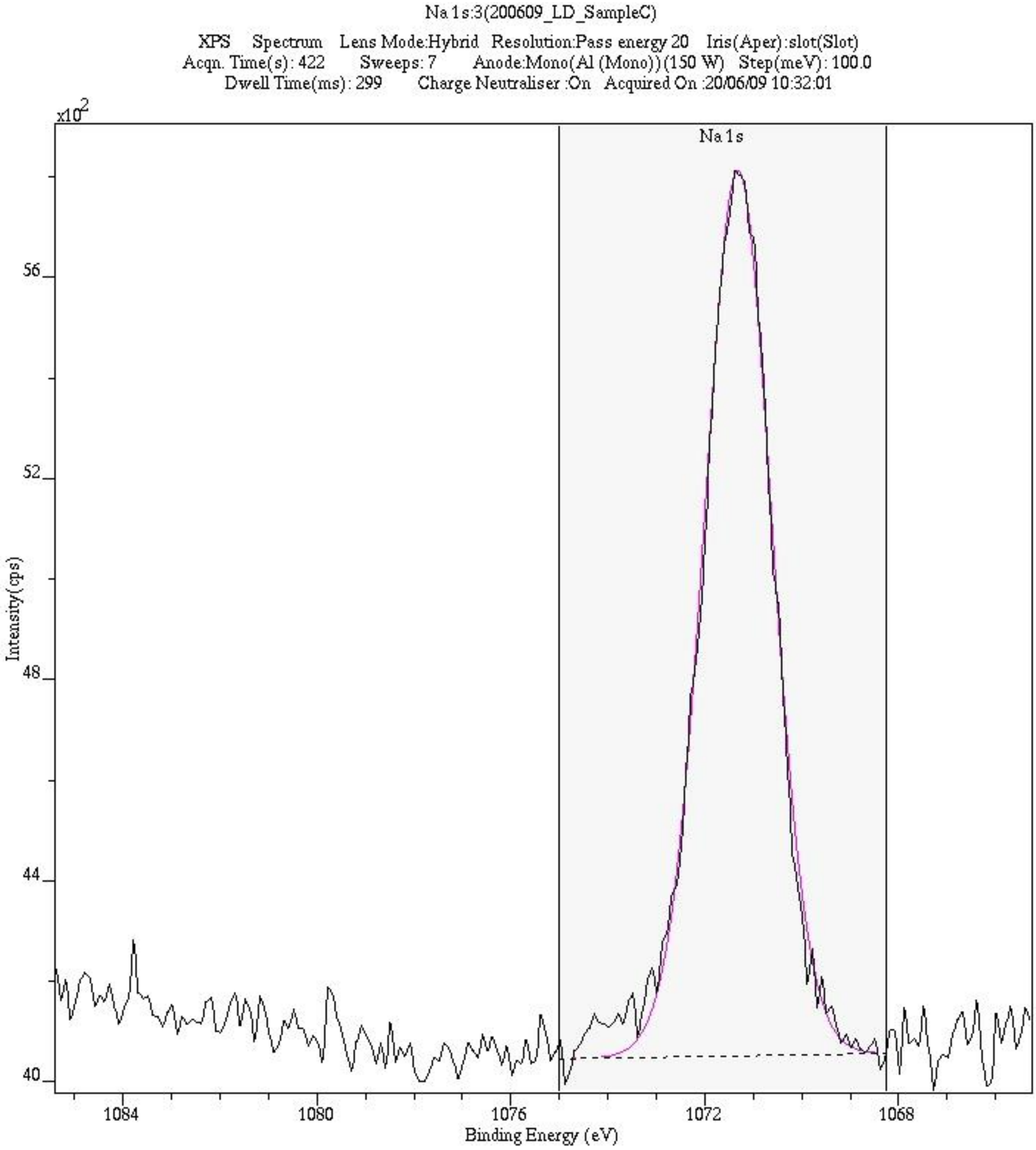


Figure 13S. XPS spectrum of Na1s for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer after stirring 24 hours at 90C^o under H_2.

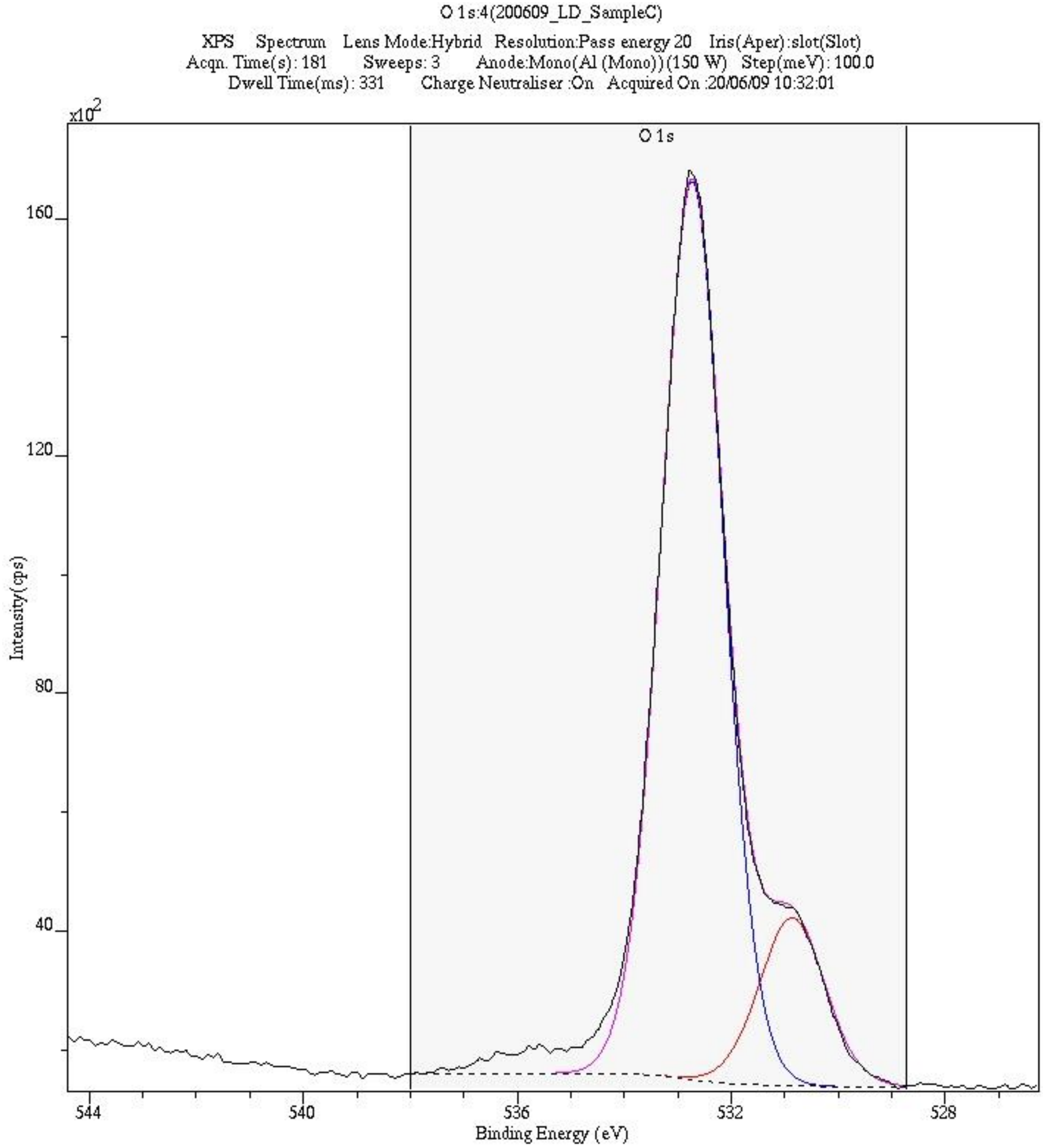


Figure 14S. XPS spectrum of O1s for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer after stirring 24 hours at 90C° under H_2.

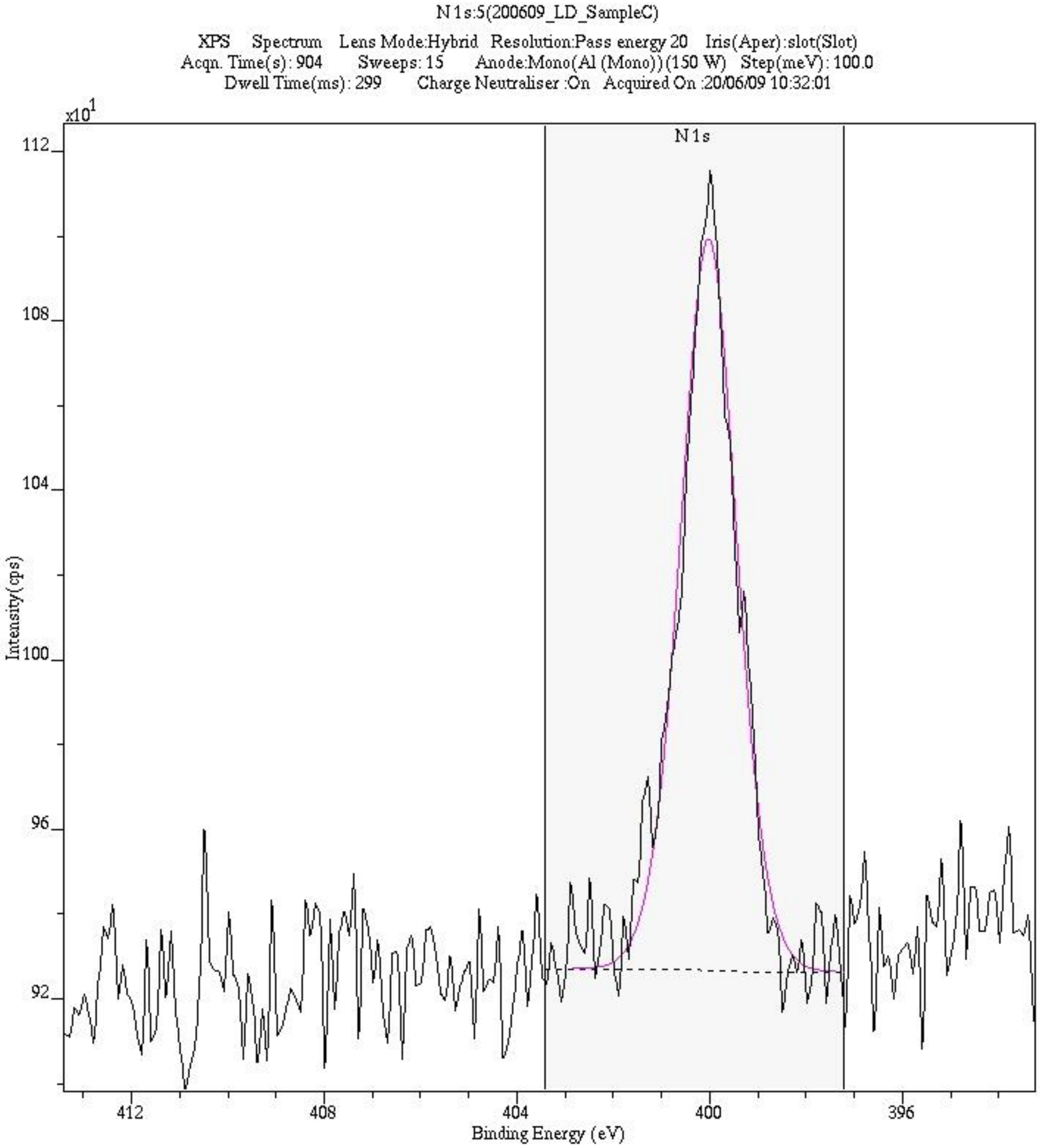


Figure 15S. XPS spectrum of N1s for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer after stirring 24 hours at 90C° under H_2.

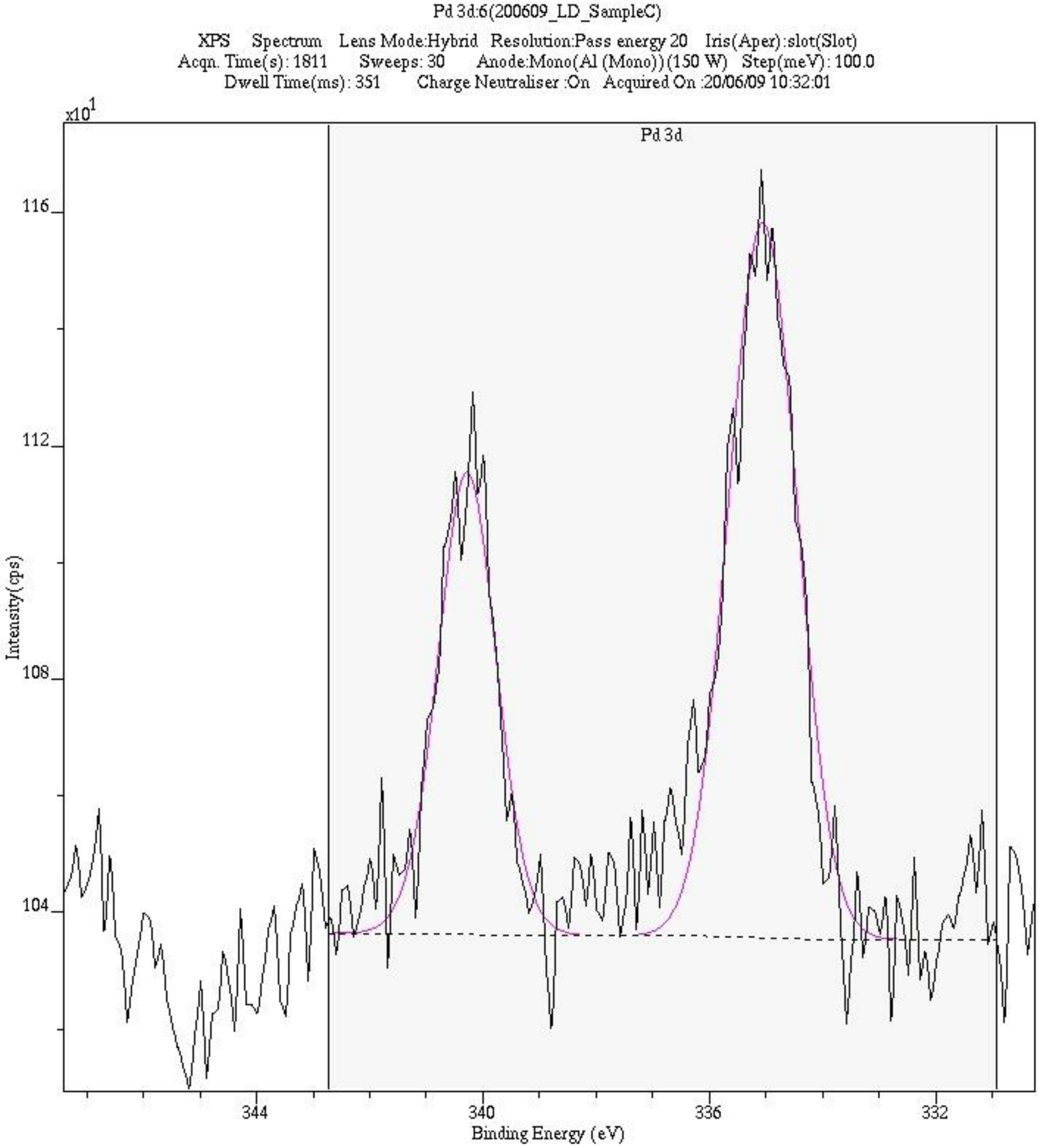


Figure 16S. XPS spectrum of Pd3d for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer after stirring 24 hours at 90C^o under H_2.

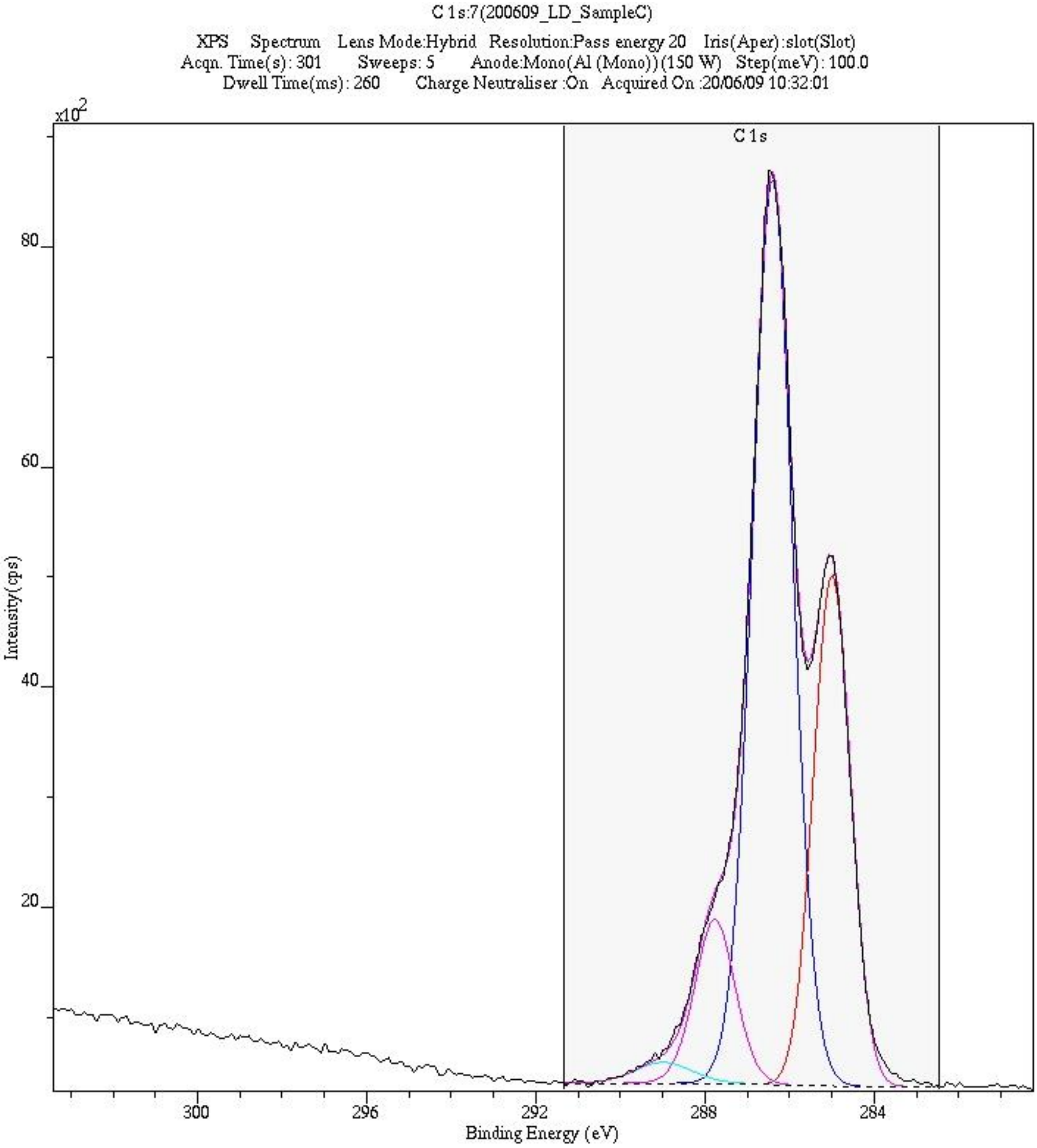


Figure 17S. XPS spectrum of C1s for APCW9 MCC-Amp-Pd^0/CALB/Brij/buffer after stirring 24 hours at 90C^o under H_2.

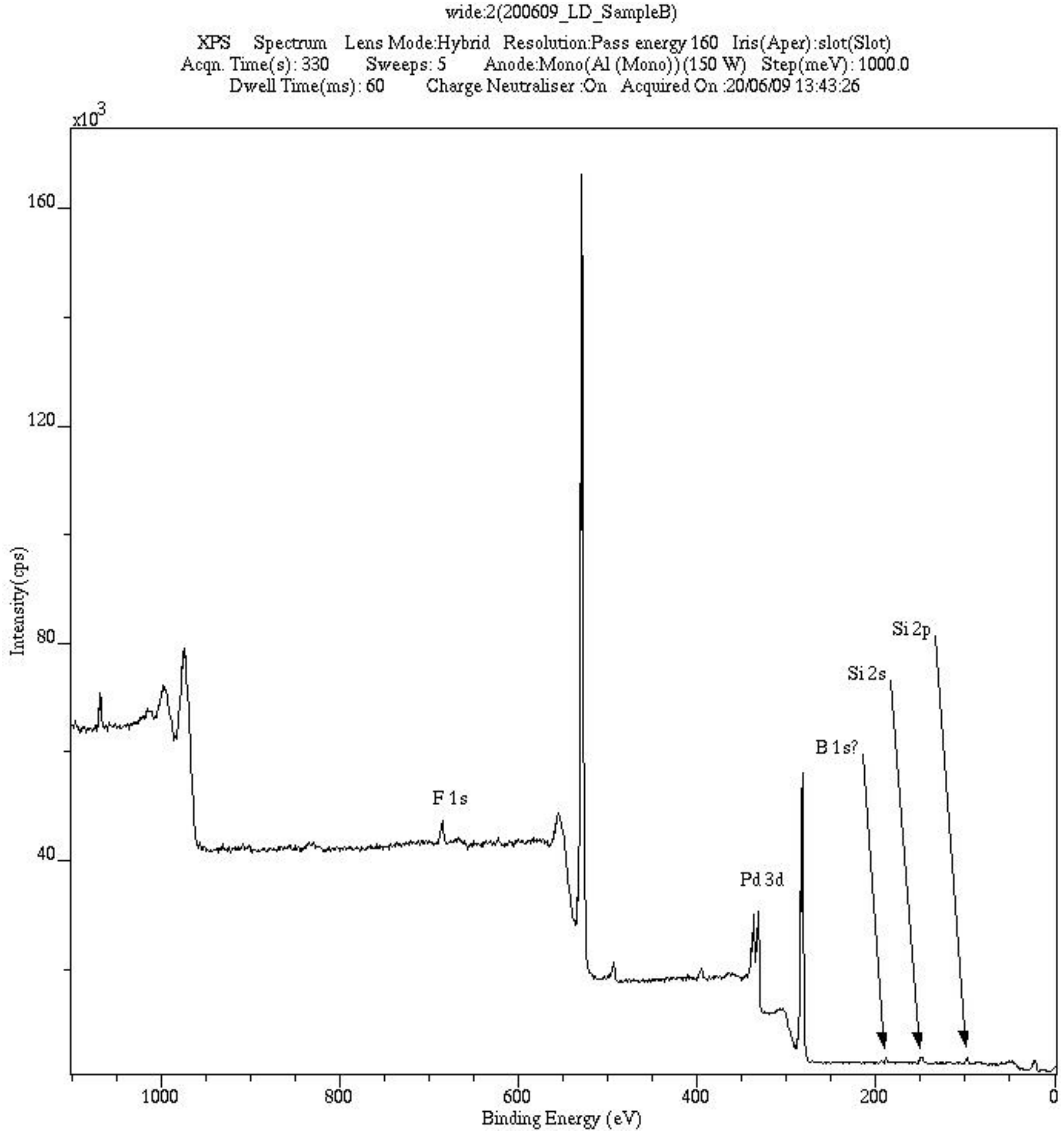


Figure 18S. XPS spectra for APCW9 MCC-Amp-Pd^0.

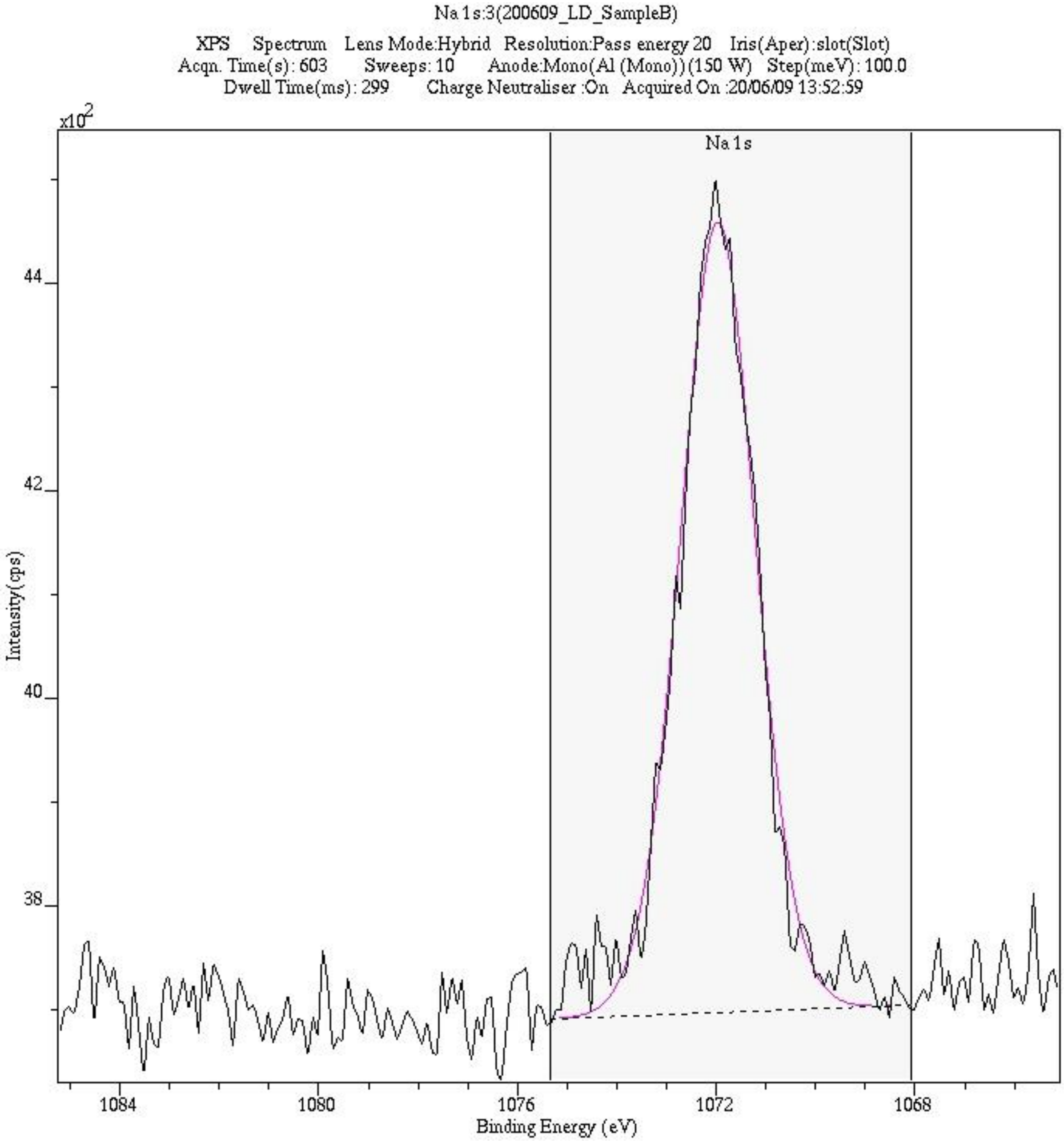


Figure 19S. XPS spectrum of Na1s for APCW9 MCC-Amp-Pd^0.

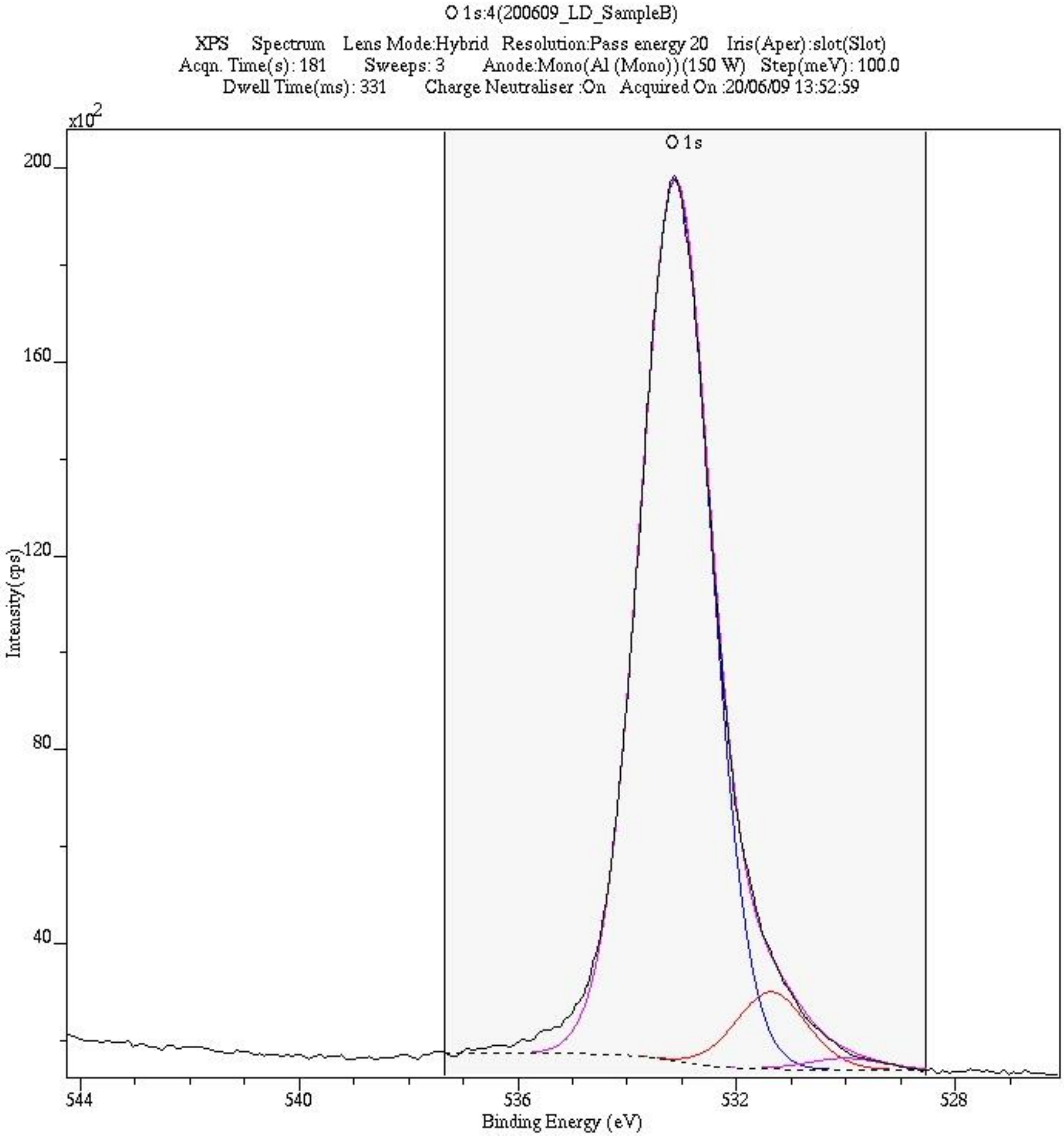


Figure 20S. XPS spectrum of O1s for APCW9 MCC-Amp-Pd^0.

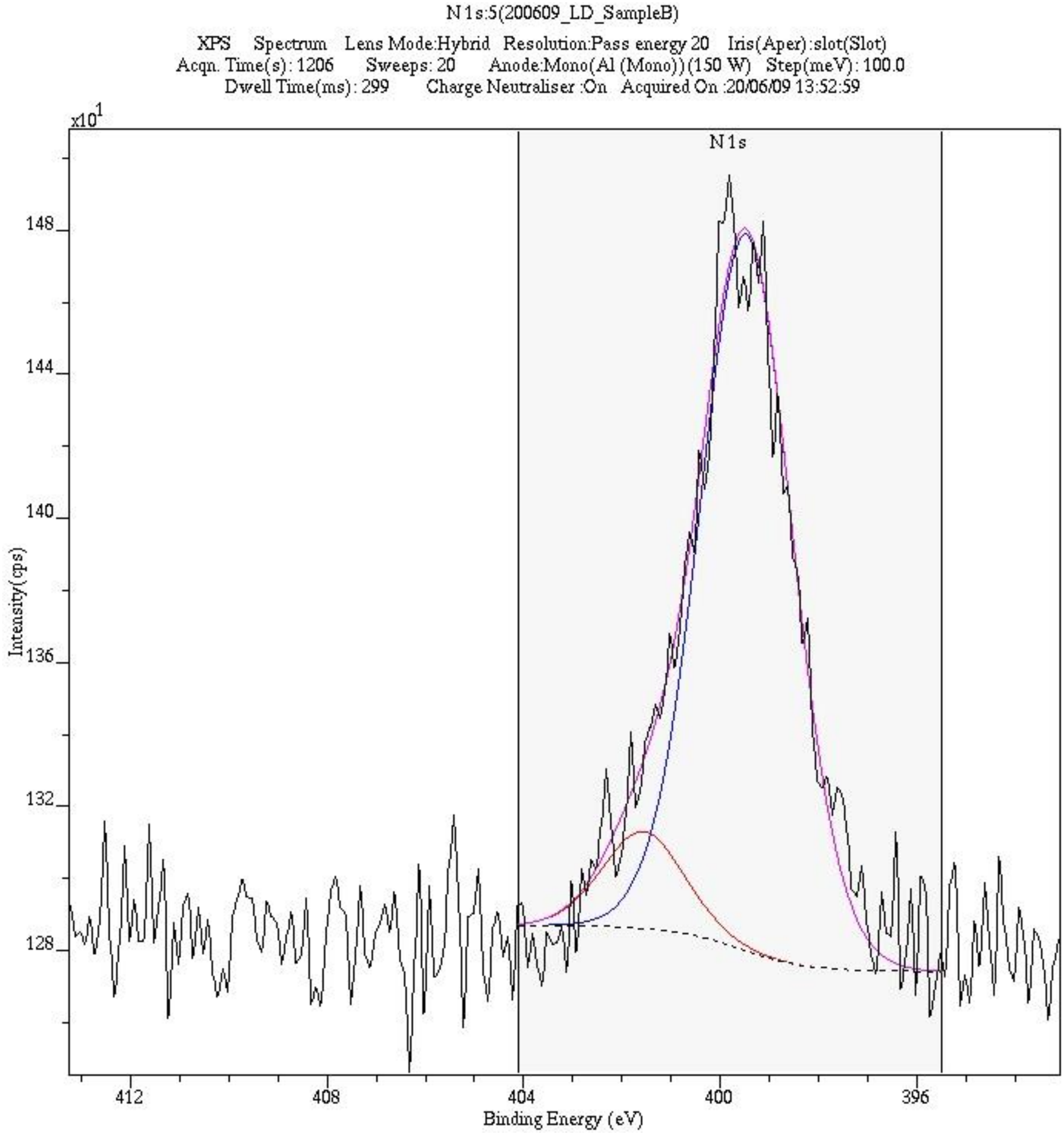


Figure 21S. XPS spectrum of N1s for APCW9 MCC-Amp-Pd^0.

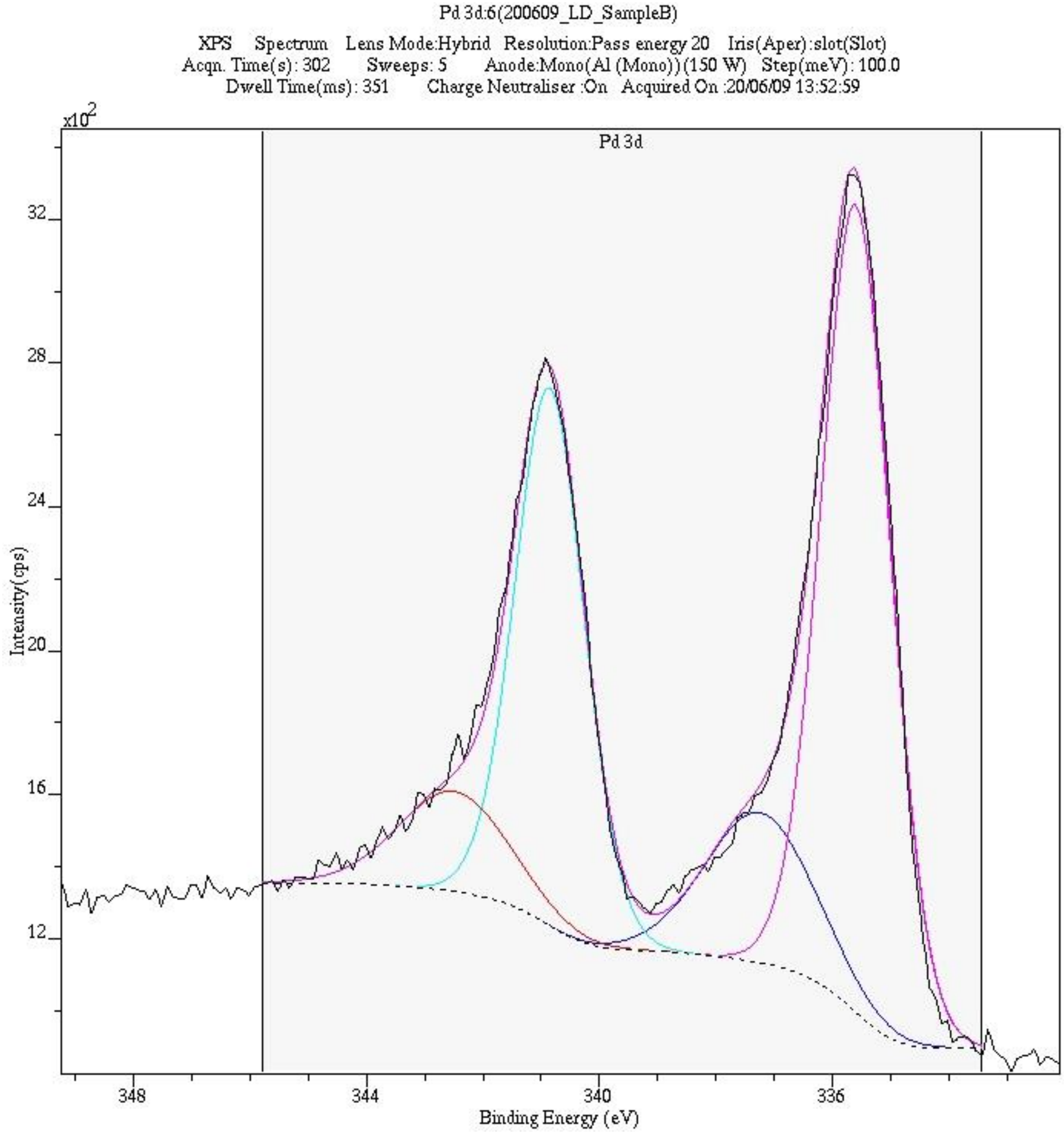


Figure 22S. XPS spectrum of Pd3d for APCW9 MCC-Amp-Pd^0.

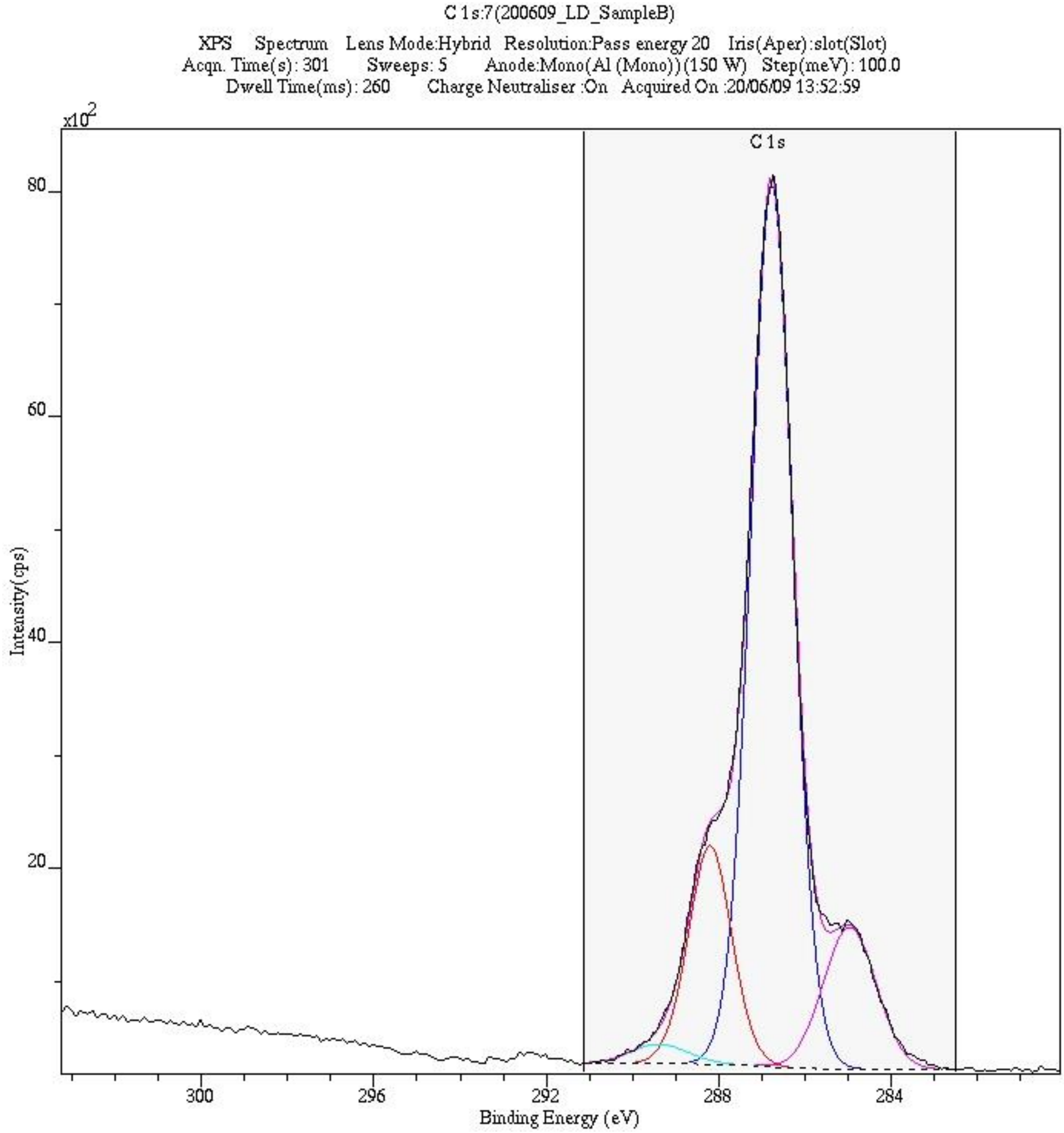


Figure 23S. XPS spectrum of C1s for APCW9 MCC-Amp-Pd^0.