Supporting Information

A Highly Hydroxylated 6-Tin Oxide Cluster Serves as An Efficient E-beam and EUV-Photoresists to Reach High-resolution Patterns

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Content:

1. Representative synthetic procedures

Unless otherwise noted, all reactions were carried out under nitrogen atmosphere inoven-dried glassware using standard syringe, cannula and septa apparatus. Dichloromethane and toluene were dried over CaH_2 and distilled. Reagents were purchased from commercial sources and used without purification, unless otherwise stated. ^{1}H NMR and ^{13}C NMR spectra were recorded on a Bruker 400 MHz and Bruker 500 MHz spectrometers using chloroform-d ($CDCl_3$) as the internal standard. The ESI-Mass were performed using JEOL JMS-700. The EA analysis was performed by elementar vario EL cube. The TGA were performed using Mettler-Toledo 2-HT. FTIR Spectroscopy of power samples was in a Bruker Vertex 80v spectrometer. The AFM measurements were using SEIKO SPA-300HV. Electron-beam lithography was done by utilizing Elionix ELS-7800 with an accelerating voltage of 80 kV and a beam current of 200 pA. The EUV-IL system at the Swiss Light Sources (SLS), Paul Scherrer Institute, utilizes 13.5 nm EUV light. HRXPS measurements were performed in a ULVAC-PHI Quantera II, with a monochromatic Al Kα source (energy of 1486.7 eV).

2. Powder X-ray diffraction pattern

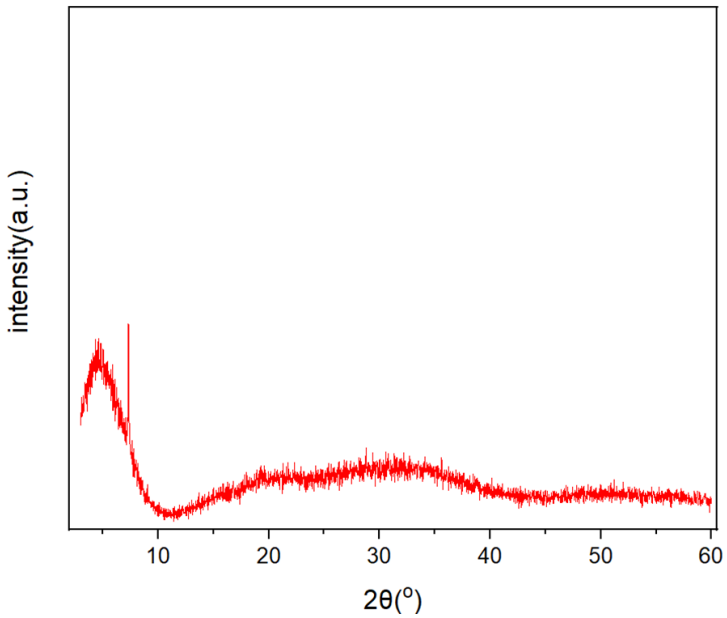


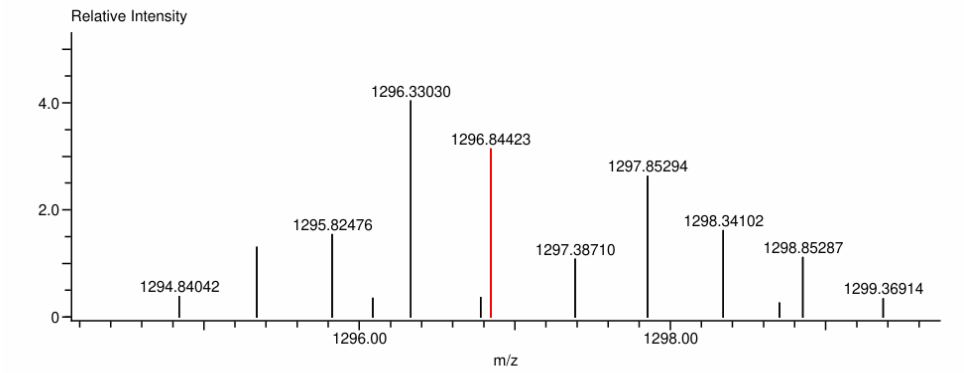
Figure s1A. Powder X-ray diffraction : photoresist 2

3. ESI-LC-MS specturm

Ionization Mode:ESI+
History:Average(MS[1] 0.95..1.09)

Created:2025/1/6
Created by:AccuTOF

Charge number:1
Tolerance:500.00[ppm], 500.00 .. 500....
Unsaturation Number:-500.5 .. 500.0 (...
Element:^{12}C:24 .. 24, ^{1}H:64 .. 65, ^{23}Na:0 .. 1, ^{16}O:14 .. 14, ^{120}Sn:6 .. 6



Mass	Intensity	Calc. Mass	Mass Difference [mDa]	Mass Difference [ppm]	Possible Formula
1296.84423	313.73	1296.85062	-6.39	-4.92	$^{12}C_{24}{}^{1}H_{65}{}^{16}O_{14}{}^{120}Sn_{6}$

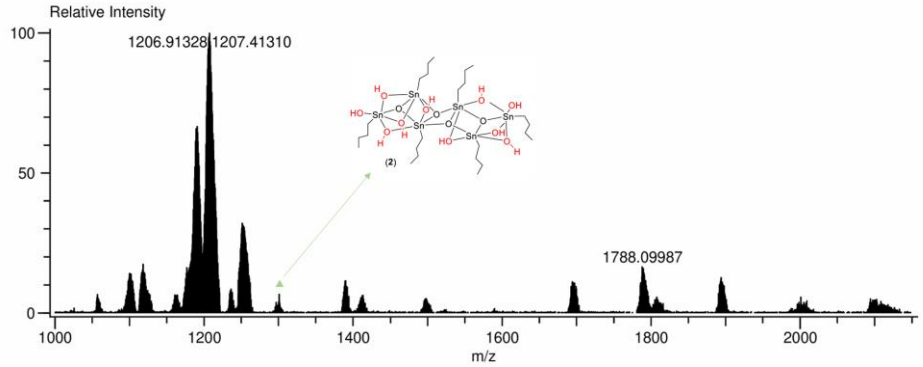


Figure s1B. ESI(+)-MS of photoresist 2

4. SEM images for cluster 1 EUV lithography patterns

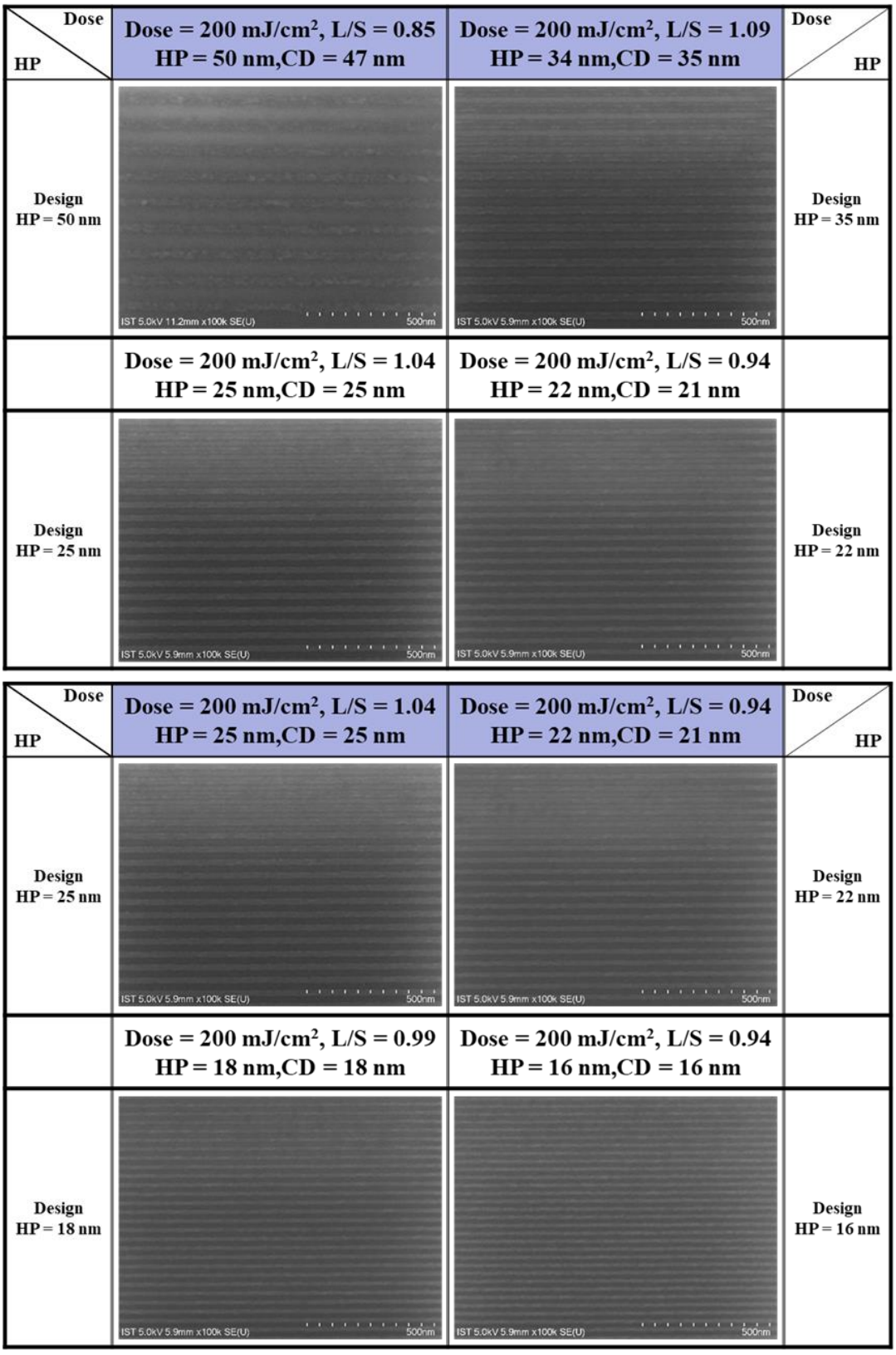


Figure s2. SEM images of EUV lithography patterns on photoresist 1 HP= 50-16 nm at different dose. Process parameter: 1.2wt%, THK= 18.2 nm, Developer: Acetone 60 s, PAB=60 ℃ for 60s, PEB=

80℃ for 60 s.

5.SEM image of E-beam lithography patterns

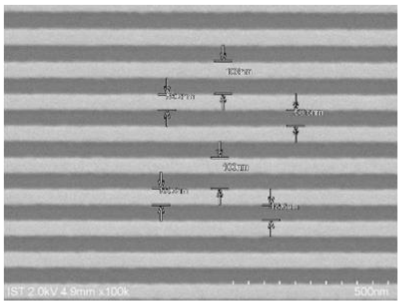
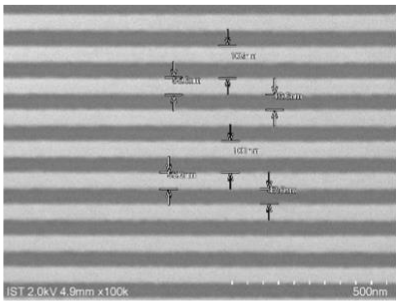
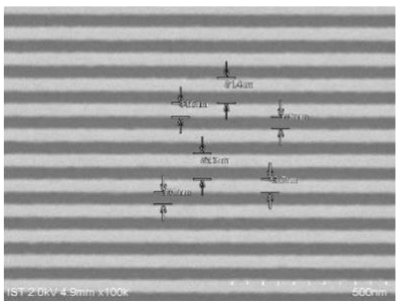
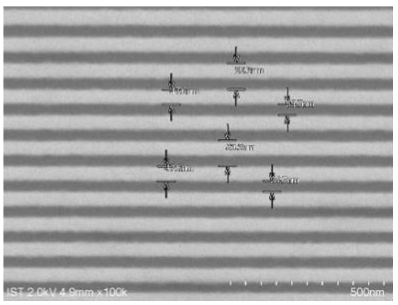
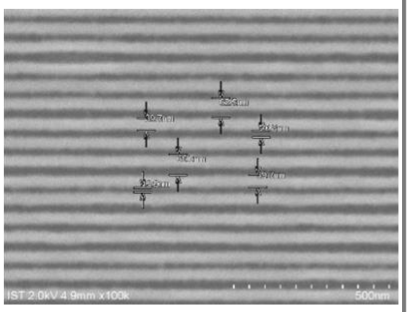
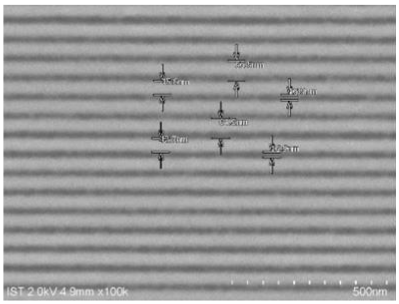
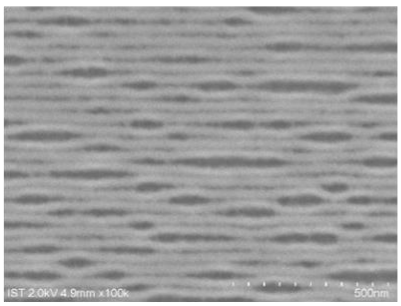
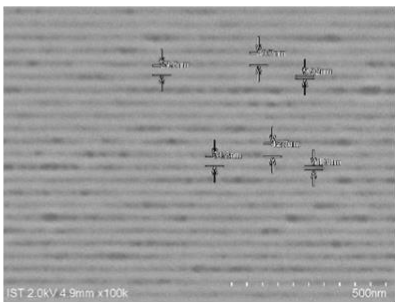
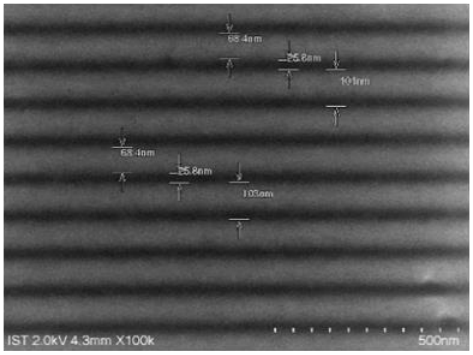
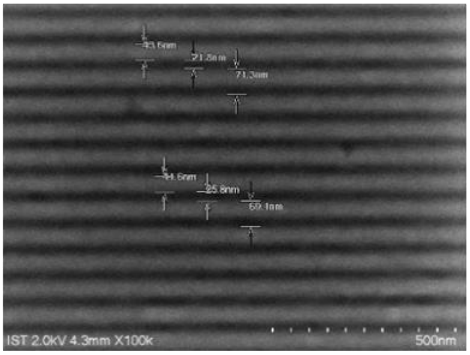
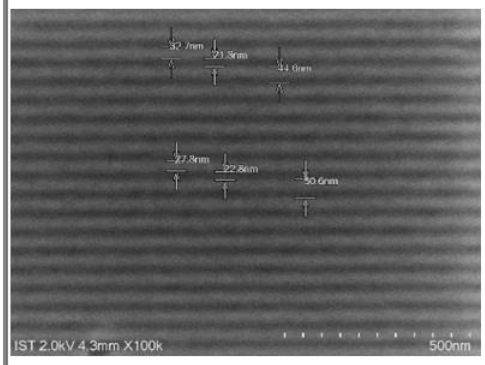
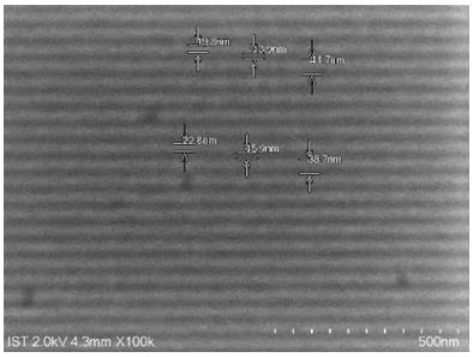
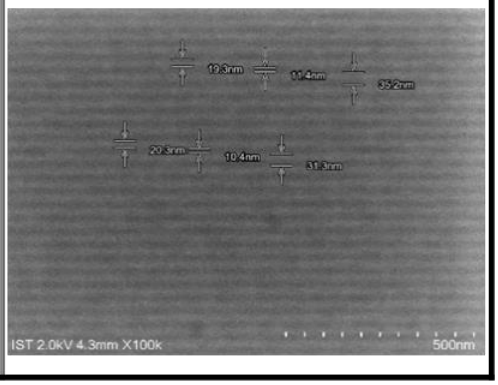
Dose / HP	Dose = 1440 μC/cm², HP = 51 nm	Dose = 1760 μC/cm², HP = 52 nm
Design HP = 50 nm		
	Dose = 1440 μC/cm², HP = 41 nm	Dose = 1760 μC/cm², HP = 42 nm
Design HP = 40 nm		
	Dose = 1440 μC/cm², HP = 30 nm, LWR=2.9 nm	Dose = 1760 μC/cm², HP = 31 nm
Design HP = 30 nm		
	Dose = 1440 μC/cm²,	Dose = 1760 μC/cm²,
Design HP = 20 nm		

Figure S3. SEM images of E-beam lithography patterns on photoresist 2. Process parameter: 1.75

wt%, THK= 27.8 nm, PAB=90 ℃ for 60s, PEB=110 ℃ for 60s Development: Acetone, 10s. (Dose = 1440, 1760 and μC/cm^2).

6. SEM image of cluster 2 EUV lithography patterns

Dose / HP	Dose = 73 mJ/cm², HP = 50 nm	Dose = 66 mJ/cm², HP = 35 nm	Dose / HP
Design HP = 50 nm			Design HP = 35 nm
	Dose = 60 mJ/cm², HP = 25 nm	Dose = 68 mJ/cm², HP = 19 nm	
Design HP = 25 nm			Design HP = 20 nm
	Dose = 56 mJ/cm², HP = 16 nm		
Design HP = 16 nm			

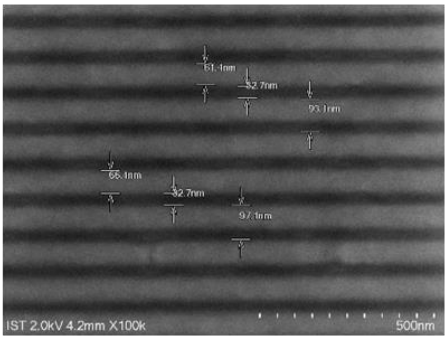
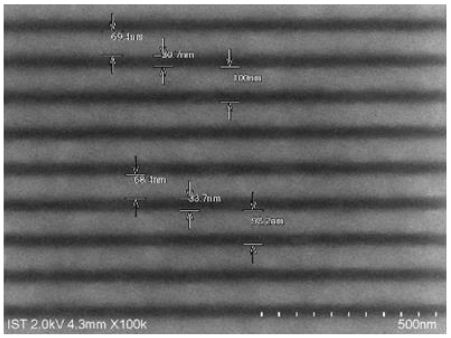
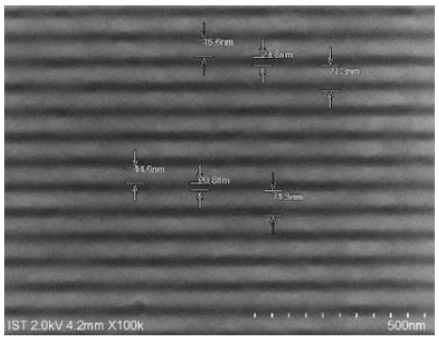
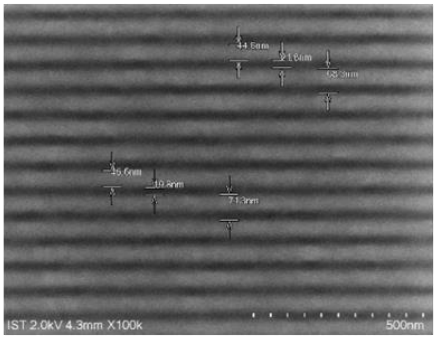
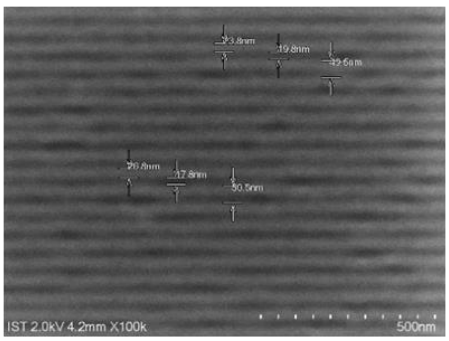
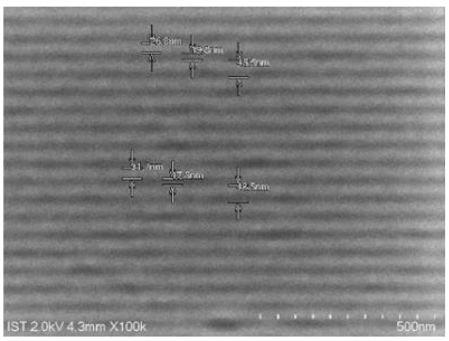
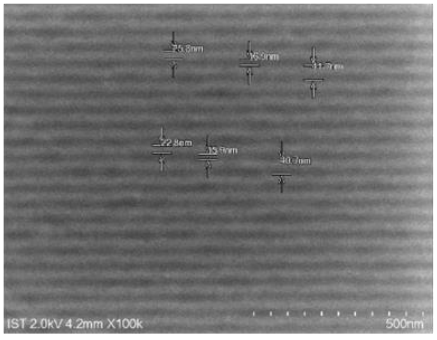
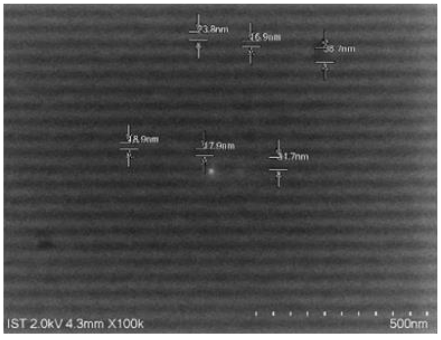
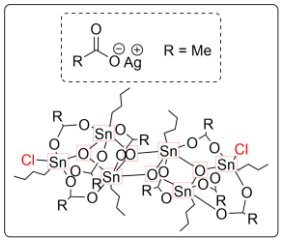
Dose / HP	Dose = 66 mJ/cm², HP = 50 nm	Dose = 70 mJ/cm², HP = 50 nm
Design HP = 50 nm		
	Dose = 60 mJ/cm², HP = 35 nm	Dose = 63 mJ/cm², HP = 35 nm
Design HP = 35 nm		
	Dose = 55 mJ/cm², HP = 25 nm	Dose = 58 mJ/cm², HP = 24 nm
Design HP = 25 nm		
	Dose = 62 mJ/cm², HP = 20 nm	Dose = 65 mJ/cm², HP = 19 nm
Design HP = 20 nm		

Figure S4. SEM images of EUV lithography patterns on photoresist 2 HP= 50, 35, 25, 20, 16 nm at different dose. Process parameter: 1.75 wt%, THK= 27.8 nm, Developer: Acetone:Hexane=6:1 , 10s , PEB= 110°C, 90 s.(dose = 55-73 mJ/cm^2).

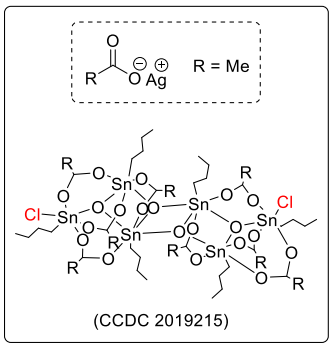
7. Spectral data of key compounds.



Cluster 1 was purified on recrystallization using DCM/hexane in low temperature. ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.07 (s, 24H), 1.70-1.60 (m, 12H), 1.36-1.22 (m, 24H), 0.89(t, J=7.3, 18H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 182.9, 180.4, 179.6, 179.4, 27.6, 27.3, 27.0, 26.7, 26.5, 26.3, 26.1, 26.0, 24.2, 14.0, 13.8, 13.7, 13.6, 13.5, 13.5, 13.5; ^{119}Sn NMR (186.362 MHz, $CDCl_3$): δ -521.27, -525.42, -557.05. HRMS (ESI^+) m/z calculated for $Sn_6O_{20}C_{40}H_{78}Cl_2Na_2$ [1/2M+Na]x2: 1713.8390, found: 1713.8438.

8. X-ray crystallographic structures and data.

1.1 X-ray structure of (1)



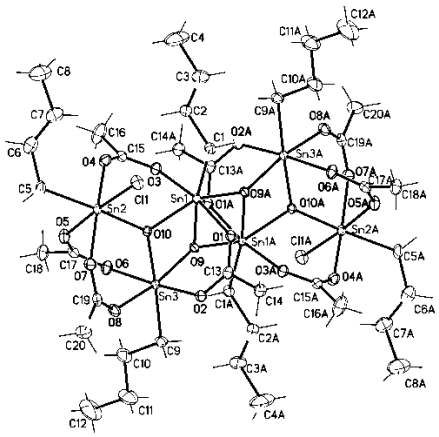


Table 1. Crystal data and structure refinement for 190807LT_0M.

Identification code	190807LT_0m	
Empirical formula	C20 H39 Cl O10 Sn3	
Formula weight	831.03	
Temperature	100(2) K	
Wavelength	0.71073 Å	
Crystal system	Triclinic	
Space group	P-1	
Unit cell dimensions	a = 8.5238(3) Å	α= 86.917(2)°.
	b = 12.4341(5) Å	β= 80.685(2)°.

	c = 14.2811(6) Å γ = 81.456(2)°.
Volume	1476.37(10) Å ^{3}
Z	2
Density (calculated)	1.869 Mg/m^3
Absorption coefficient	2.653 mm^{-1}
F(000)	812
Crystal size	0.10 x 0.03 x 0.03 mm^3
Theta range for data collection	1.657 to 26.407°.
Index ranges	-10<=h<=10, -15<=k<=15, -17<=l<=17
Reflections collected	19788
Independent reflections	6033 [R(int) = 0.0266]
Completeness to theta = 25.242°	99.7 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.7454 and 0.6523
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	6033 / 0 / 314
Goodness-of-fit on F^2	1.126
Final R indices [I>2sigma(I)]	R1 = 0.0210, wR2 = 0.0575
R indices (all data)	R1 = 0.0240, wR2 = 0.0593
Extinction coefficient	n/a
Largest diff. peak and hole	1.445 and -0.582 e.Å $^{-3}$

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters (Å ^{2}x 10^3) for 190807LT_0M. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
Sn(1)	6396(1)	3815(1)	6663(1)	13(1)
Sn(2)	5278(1)	6309(1)	7987(1)	11(1)
Sn(3)	6091(1)	4138(1)	9241(1)	10(1)
Cl(1)	8994(1)	2935(1)	7004(1)	24(1)
O(1)	4055(2)	4714(2)	6411(1)	19(1)
O(2)	3152(2)	5934(2)	7539(1)	17(1)
O(3)	6207(2)	4707(2)	7809(1)	12(1)
O(4)	4706(2)	5642(2)	9318(1)	12(1)
O(5)	3990(2)	3440(2)	9053(1)	15(1)
O(6)	4888(3)	2801(2)	7592(1)	19(1)
O(7)	6317(2)	6603(2)	6528(1)	18(1)

O(8)	7534(3)	5057(2)	5832(1)	20(1)
O(9)	7563(2)	6521(2)	8342(1)	16(1)
O(10)	8100(2)	5014(2)	9251(1)	15(1)
C(1)	2965(3)	5362(2)	6874(2)	16(1)
C(2)	3850(3)	2935(2)	8336(2)	17(1)
C(3)	1301(4)	5463(3)	6619(2)	24(1)
C(4)	7263(4)	6083(2)	5882(2)	16(1)
C(5)	8135(4)	6724(3)	5099(2)	28(1)
C(6)	8380(3)	5929(2)	8895(2)	14(1)
C(7)	9808(3)	6358(3)	9140(2)	19(1)
C(8)	4394(4)	8001(2)	8077(2)	20(1)
C(9)	3031(4)	8376(3)	7503(3)	32(1)
C(10)	2462(5)	9588(3)	7531(3)	42(1)
C(11)	1105(6)	9930(4)	6948(4)	66(2)
C(12)	6357(4)	2942(3)	5427(2)	22(1)
C(13)	5958(5)	1801(3)	5538(3)	40(1)
C(14)	7108(6)	963(3)	5956(3)	46(1)
C(15)	6860(7)	-194(3)	5903(4)	67(2)
C(16)	2343(4)	2446(4)	8362(3)	41(1)
C(17)	7638(3)	2642(2)	9382(2)	15(1)
C(18)	7052(4)	1593(2)	9193(2)	18(1)
C(19)	8240(4)	595(3)	9383(3)	30(1)
C(20)	7671(6)	-459(3)	9192(4)	57(1)

Table 3. Bond lengths [Å] and angles [°] for 190807LT_0M.

Sn(1)-O(3)	1.9980(19)
Sn(1)-C(12)	2.129(3)
Sn(1)-O(8)	2.147(2)
Sn(1)-O(6)	2.179(2)
Sn(1)-O(1)	2.2101(19)
Sn(1)-Cl(1)	2.4317(8)
Sn(2)-O(3)	2.0454(19)
Sn(2)-O(4)	2.0464(18)
Sn(2)-C(8)	2.129(3)
Sn(2)-O(2)	2.138(2)
Sn(2)-O(9)	2.146(2)

Sn(2)-O(7)	2.1632(19)
Sn(2)-Sn(3)	3.2096(3)
Sn(3)-O(4)	2.0568(19)
Sn(3)-O(4)#1	2.0798(18)
Sn(3)-O(3)	2.1187(18)
Sn(3)-C(17)	2.135(3)
Sn(3)-O(5)	2.162(2)
Sn(3)-O(10)	2.165(2)
Sn(3)-Sn(3)#1	3.2815(4)
O(1)-C(1)	1.260(3)
O(2)-C(1)	1.261(4)
O(4)-Sn(3)#1	2.0798(18)
O(5)-C(2)	1.260(3)
O(6)-C(2)	1.270(4)
O(7)-C(4)	1.260(3)
O(8)-C(4)	1.266(4)
O(9)-C(6)	1.270(3)
O(10)-C(6)	1.260(3)
C(1)-C(3)	1.506(4)
C(2)-C(16)	1.495(4)
C(3)-H(1)	0.9800
C(3)-H(2)	0.9800
C(3)-H(3)	0.9800
C(4)-C(5)	1.500(4)
C(5)-H(5)	0.9800
C(5)-H(6)	0.9800
C(5)-H(4)	0.9800
C(6)-C(7)	1.496(4)
C(7)-H(8)	0.9800
C(7)-H(7)	0.9800
C(7)-H(9)	0.9800
C(8)-C(9)	1.531(5)
C(8)-H(8A)	0.9900
C(8)-H(8B)	0.9900
C(9)-C(10)	1.514(5)
C(9)-H(10)	0.9900
C(9)-H(16)	0.9900
C(10)-C(11)	1.530(6)

C(10)-H(15)	0.9900
C(10)-H(11)	0.9900
C(11)-H(12)	0.9800
C(11)-H(13)	0.9800
C(11)-H(14)	0.9800
C(12)-C(13)	1.501(5)
C(12)-H(12A)	0.9900
C(12)-H(12B)	0.9900
C(13)-C(14)	1.491(5)
C(13)-H(17)	0.9900
C(13)-H(23)	0.9900
C(14)-C(15)	1.492(6)
C(14)-H(18)	0.9900
C(14)-H(19)	0.9900
C(15)-H(21)	0.9800
C(15)-H(20)	0.9800
C(15)-H(22)	0.9800
C(16)-H(24)	0.9800
C(16)-H(26)	0.9800
C(16)-H(25)	0.9800
C(17)-C(18)	1.516(4)
C(17)-H(17A)	0.9900
C(17)-H(17B)	0.9900
C(18)-C(19)	1.522(4)
C(18)-H(33)	0.9900
C(18)-H(27)	0.9900
C(19)-C(20)	1.515(5)
C(19)-H(31)	0.9900
C(19)-H(32)	0.9900
C(20)-H(28)	0.9800
C(20)-H(30)	0.9800
C(20)-H(29)	0.9800
O(3)-Sn(1)-C(12)	174.19(10)
O(3)-Sn(1)-O(8)	88.80(8)
C(12)-Sn(1)-O(8)	91.58(10)
O(3)-Sn(1)-O(6)	84.85(8)
C(12)-Sn(1)-O(6)	93.88(11)
O(8)-Sn(1)-O(6)	169.35(8)

O(3)-Sn(1)-O(1)	87.76(7)
C(12)-Sn(1)-O(1)	86.45(10)
O(8)-Sn(1)-O(1)	88.23(8)
O(6)-Sn(1)-O(1)	83.00(8)
O(3)-Sn(1)-Cl(1)	88.52(6)
C(12)-Sn(1)-Cl(1)	97.28(9)
O(8)-Sn(1)-Cl(1)	90.08(6)
O(6)-Sn(1)-Cl(1)	98.28(6)
O(1)-Sn(1)-Cl(1)	175.95(6)
O(3)-Sn(2)-O(4)	77.56(7)
O(3)-Sn(2)-C(8)	176.04(10)
O(4)-Sn(2)-C(8)	106.34(10)
O(3)-Sn(2)-O(2)	87.30(8)
O(4)-Sn(2)-O(2)	92.81(8)
C(8)-Sn(2)-O(2)	93.10(10)
O(3)-Sn(2)-O(9)	86.46(8)
O(4)-Sn(2)-O(9)	88.69(7)
C(8)-Sn(2)-O(9)	92.92(10)
O(2)-Sn(2)-O(9)	173.12(8)
O(3)-Sn(2)-O(7)	87.43(7)
O(4)-Sn(2)-O(7)	164.45(8)
C(8)-Sn(2)-O(7)	88.63(10)
O(2)-Sn(2)-O(7)	90.52(8)
O(9)-Sn(2)-O(7)	86.29(8)
O(3)-Sn(2)-Sn(3)	40.42(5)
O(4)-Sn(2)-Sn(3)	38.65(5)
C(8)-Sn(2)-Sn(3)	143.22(8)
O(2)-Sn(2)-Sn(3)	98.48(5)
O(9)-Sn(2)-Sn(3)	78.56(5)
O(7)-Sn(2)-Sn(3)	125.80(5)
O(4)-Sn(3)-O(4)#1	75.01(8)
O(4)-Sn(3)-O(3)	75.71(7)
O(4)#1-Sn(3)-O(3)	150.72(7)
O(4)-Sn(3)-C(17)	170.30(9)
O(4)#1-Sn(3)-C(17)	96.89(9)
O(3)-Sn(3)-C(17)	112.18(9)
O(4)-Sn(3)-O(5)	88.68(8)
O(4)#1-Sn(3)-O(5)	92.89(7)

O(3)-Sn(3)-O(5)	87.12(7)
C(17)-Sn(3)-O(5)	97.16(10)
O(4)-Sn(3)-O(10)	85.63(7)
O(4)#1-Sn(3)-O(10)	92.36(7)
O(3)-Sn(3)-O(10)	84.72(7)
C(17)-Sn(3)-O(10)	89.45(9)
O(5)-Sn(3)-O(10)	171.00(7)
O(4)-Sn(3)-Sn(2)	38.42(5)
O(4)#1-Sn(3)-Sn(2)	112.35(5)
O(3)-Sn(3)-Sn(2)	38.75(5)
C(17)-Sn(3)-Sn(2)	147.43(8)
O(5)-Sn(3)-Sn(2)	95.44(5)
O(10)-Sn(3)-Sn(2)	75.80(5)
O(4)-Sn(3)-Sn(3)#1	37.75(5)
O(4)#1-Sn(3)-Sn(3)#1	37.26(5)
O(3)-Sn(3)-Sn(3)#1	113.46(5)
C(17)-Sn(3)-Sn(3)#1	133.93(8)
O(5)-Sn(3)-Sn(3)#1	91.01(5)
O(10)-Sn(3)-Sn(3)#1	88.76(5)
Sn(2)-Sn(3)-Sn(3)#1	75.520(8)
C(1)-O(1)-Sn(1)	135.59(18)
C(1)-O(2)-Sn(2)	131.19(18)
Sn(1)-O(3)-Sn(2)	128.58(9)
Sn(1)-O(3)-Sn(3)	127.19(9)
Sn(2)-O(3)-Sn(3)	100.83(8)
Sn(2)-O(4)-Sn(3)	102.93(8)
Sn(2)-O(4)-Sn(3)#1	148.92(10)
Sn(3)-O(4)-Sn(3)#1	104.99(8)
C(2)-O(5)-Sn(3)	125.33(18)
C(2)-O(6)-Sn(1)	136.26(19)
C(4)-O(7)-Sn(2)	137.48(19)
C(4)-O(8)-Sn(1)	130.71(19)
C(6)-O(9)-Sn(2)	127.89(18)
C(6)-O(10)-Sn(3)	131.27(18)
O(1)-C(1)-O(2)	125.2(3)
O(1)-C(1)-C(3)	117.8(3)
O(2)-C(1)-C(3)	117.1(3)
O(5)-C(2)-O(6)	125.4(3)

O(5)-C(2)-C(16)	117.6(3)
O(6)-C(2)-C(16)	117.0(3)
C(1)-C(3)-H(1)	109.5
C(1)-C(3)-H(2)	109.5
H(1)-C(3)-H(2)	109.5
C(1)-C(3)-H(3)	109.5
H(1)-C(3)-H(3)	109.5
H(2)-C(3)-H(3)	109.5
O(7)-C(4)-O(8)	125.4(3)
O(7)-C(4)-C(5)	117.8(3)
O(8)-C(4)-C(5)	116.8(3)
C(4)-C(5)-H(5)	109.5
C(4)-C(5)-H(6)	109.5
H(5)-C(5)-H(6)	109.5
C(4)-C(5)-H(4)	109.5
H(5)-C(5)-H(4)	109.5
H(6)-C(5)-H(4)	109.5
O(10)-C(6)-O(9)	126.0(3)
O(10)-C(6)-C(7)	117.3(2)
O(9)-C(6)-C(7)	116.8(3)
C(6)-C(7)-H(8)	109.5
C(6)-C(7)-H(7)	109.5
H(8)-C(7)-H(7)	109.5
C(6)-C(7)-H(9)	109.5
H(8)-C(7)-H(9)	109.5
H(7)-C(7)-H(9)	109.5
C(9)-C(8)-Sn(2)	113.9(2)
C(9)-C(8)-H(8A)	108.8
Sn(2)-C(8)-H(8A)	108.8
C(9)-C(8)-H(8B)	108.8
Sn(2)-C(8)-H(8B)	108.8
H(8A)-C(8)-H(8B)	107.7
C(10)-C(9)-C(8)	113.7(3)
C(10)-C(9)-H(10)	108.8
C(8)-C(9)-H(10)	108.8
C(10)-C(9)-H(16)	108.8
C(8)-C(9)-H(16)	108.8
H(10)-C(9)-H(16)	107.7

C(9)-C(10)-C(11)	112.1(4)
C(9)-C(10)-H(15)	109.2
C(11)-C(10)-H(15)	109.2
C(9)-C(10)-H(11)	109.2
C(11)-C(10)-H(11)	109.2
H(15)-C(10)-H(11)	107.9
C(10)-C(11)-H(12)	109.5
C(10)-C(11)-H(13)	109.5
H(12)-C(11)-H(13)	109.5
C(10)-C(11)-H(14)	109.5
H(12)-C(11)-H(14)	109.5
H(13)-C(11)-H(14)	109.5
C(13)-C(12)-Sn(1)	119.1(2)
C(13)-C(12)-H(12A)	107.5
Sn(1)-C(12)-H(12A)	107.5
C(13)-C(12)-H(12B)	107.5
Sn(1)-C(12)-H(12B)	107.5
H(12A)-C(12)-H(12B)	107.0
C(14)-C(13)-C(12)	117.2(3)
C(14)-C(13)-H(17)	108.0
C(12)-C(13)-H(17)	108.0
C(14)-C(13)-H(23)	108.0
C(12)-C(13)-H(23)	108.0
H(17)-C(13)-H(23)	107.2
C(13)-C(14)-C(15)	116.6(4)
C(13)-C(14)-H(18)	108.1
C(15)-C(14)-H(18)	108.1
C(13)-C(14)-H(19)	108.1
C(15)-C(14)-H(19)	108.1
H(18)-C(14)-H(19)	107.3
C(14)-C(15)-H(21)	109.5
C(14)-C(15)-H(20)	109.5
H(21)-C(15)-H(20)	109.5
C(14)-C(15)-H(22)	109.5
H(21)-C(15)-H(22)	109.5
H(20)-C(15)-H(22)	109.5
C(2)-C(16)-H(24)	109.5
C(2)-C(16)-H(26)	109.5

H(24)-C(16)-H(26)	109.5
C(2)-C(16)-H(25)	109.5
H(24)-C(16)-H(25)	109.5
H(26)-C(16)-H(25)	109.5
C(18)-C(17)-Sn(3)	118.30(19)
C(18)-C(17)-H(17A)	107.7
Sn(3)-C(17)-H(17A)	107.7
C(18)-C(17)-H(17B)	107.7
Sn(3)-C(17)-H(17B)	107.7
H(17A)-C(17)-H(17B)	107.1
C(17)-C(18)-C(19)	112.1(3)
C(17)-C(18)-H(33)	109.2
C(19)-C(18)-H(33)	109.2
C(17)-C(18)-H(27)	109.2
C(19)-C(18)-H(27)	109.2
H(33)-C(18)-H(27)	107.9
C(20)-C(19)-C(18)	112.6(3)
C(20)-C(19)-H(31)	109.1
C(18)-C(19)-H(31)	109.1
C(20)-C(19)-H(32)	109.1
C(18)-C(19)-H(32)	109.1
H(31)-C(19)-H(32)	107.8
C(19)-C(20)-H(28)	109.5
C(19)-C(20)-H(30)	109.5
H(28)-C(20)-H(30)	109.5
C(19)-C(20)-H(29)	109.5
H(28)-C(20)-H(29)	109.5
H(30)-C(20)-H(29)	109.5

Symmetry transformations used to generate equivalent atoms:

#1 -x+1,-y+1,-z+2

Table 4. Anisotropic displacement parameters ($Å^2 x 10^3$) for 190807LT_0M. The anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2 a^{*2} U^{11} + ... + 2 h k a^* b^* U^{12}]$

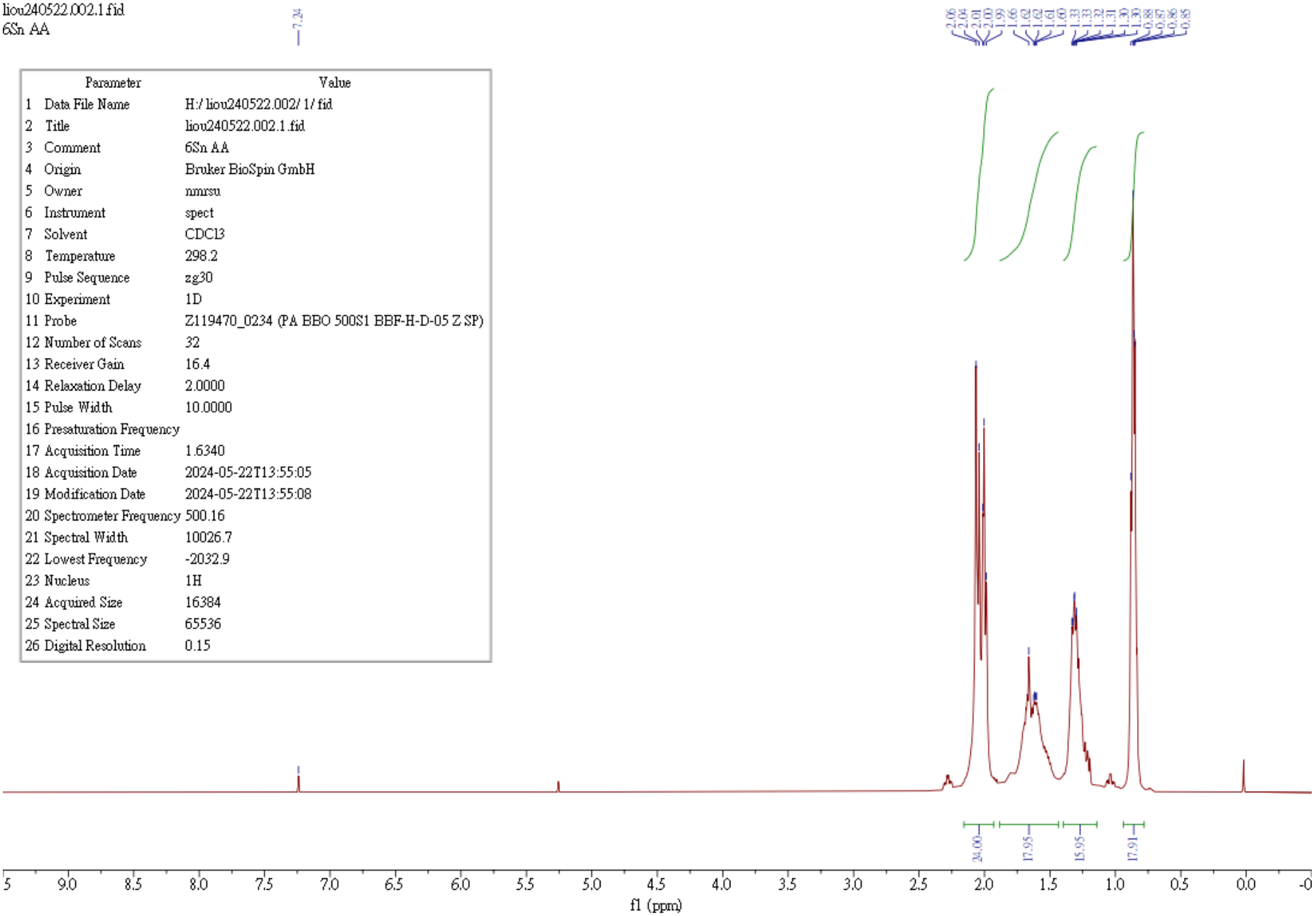
	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
Sn(1)	14(1)	14(1)	9(1)	-2(1)	-2(1)	-1(1)

Sn(2)	12(1)	12(1)	9(1)	0(1)	-2(1)	-1(1)
Sn(3)	10(1)	12(1)	9(1)	-1(1)	-2(1)	-1(1)
Cl(1)	20(1)	29(1)	21(1)	-2(1)	-3(1)	2(1)
O(1)	19(1)	22(1)	17(1)	-7(1)	-7(1)	4(1)
O(2)	13(1)	22(1)	16(1)	-5(1)	-5(1)	0(1)
O(3)	14(1)	13(1)	9(1)	-1(1)	-3(1)	-1(1)
O(4)	15(1)	12(1)	8(1)	-1(1)	-2(1)	0(1)
O(5)	14(1)	16(1)	15(1)	-3(1)	-1(1)	-4(1)
O(6)	24(1)	18(1)	16(1)	-3(1)	-1(1)	-6(1)
O(7)	22(1)	20(1)	11(1)	-1(1)	0(1)	0(1)
O(8)	23(1)	22(1)	14(1)	-2(1)	0(1)	-3(1)
O(9)	17(1)	17(1)	16(1)	2(1)	-6(1)	-3(1)
O(10)	14(1)	15(1)	16(1)	0(1)	-3(1)	-2(1)
C(1)	16(2)	20(2)	12(1)	4(1)	-3(1)	-3(1)
C(2)	17(2)	17(2)	18(2)	1(1)	-5(1)	-5(1)
C(3)	17(2)	30(2)	22(2)	-7(1)	-6(1)	2(1)
C(4)	18(2)	19(2)	13(1)	2(1)	-5(1)	-3(1)
C(5)	33(2)	24(2)	23(2)	0(1)	8(1)	-5(2)
C(6)	13(1)	17(2)	11(1)	-4(1)	1(1)	-1(1)
C(7)	15(2)	22(2)	20(2)	1(1)	-4(1)	-6(1)
C(8)	24(2)	15(2)	17(2)	-2(1)	-1(1)	0(1)
C(9)	31(2)	22(2)	43(2)	2(2)	-11(2)	6(2)
C(10)	47(2)	29(2)	43(2)	6(2)	-4(2)	10(2)
C(11)	66(3)	54(3)	71(3)	5(2)	-22(3)	32(3)
C(12)	31(2)	20(2)	16(2)	-6(1)	-7(1)	0(1)
C(13)	58(3)	37(2)	28(2)	-9(2)	-10(2)	-11(2)
C(14)	70(3)	26(2)	44(2)	-8(2)	-19(2)	0(2)
C(15)	110(5)	26(2)	65(3)	1(2)	-12(3)	-10(3)
C(16)	30(2)	61(3)	36(2)	-19(2)	2(2)	-26(2)
C(17)	14(1)	15(2)	14(1)	0(1)	-3(1)	-1(1)
C(18)	19(2)	17(2)	19(2)	-2(1)	-5(1)	0(1)
C(19)	31(2)	18(2)	38(2)	-1(1)	-6(2)	4(1)
C(20)	60(3)	16(2)	94(4)	-6(2)	-12(3)	0(2)

Table 5. Hydrogen coordinates (x 10^4) and isotropic displacement parameters (Å ^{2}x 10 ^{3}) for 190807LT_0M.

	x	y	z	U(eq)
H(1)	1372	5453	5928	35
H(2)	677	6150	6852	35
H(3)	772	4853	6912	35
H(5)	7574	6783	4547	42
H(6)	9234	6355	4921	42
H(4)	8166	7454	5316	42
H(8)	9872	7081	8841	28
H(7)	10786	5865	8908	28
H(9)	9700	6408	9830	28
H(8A)	4007	8172	8751	23
H(8B)	5292	8419	7849	23
H(10)	3401	8173	6834	39
H(16)	2112	7985	7752	39
H(15)	3376	9983	7280	50
H(11)	2083	9795	8198	50
H(12)	1506	9793	6277	100
H(13)	716	10708	7025	100
H(14)	223	9510	7169	100
H(12A)	5574	3374	5062	27
H(12B)	7427	2916	5030	27
H(17)	4892	1820	5939	48
H(23)	5854	1560	4904	48
H(18)	7056	1126	6633	55
H(19)	8206	1038	5633	55
H(21)	5824	-304	6278	101
H(20)	7724	-672	6156	101
H(22)	6869	-365	5240	101
H(24)	2370	2097	7759	61
H(26)	1414	3018	8461	61
H(25)	2256	1902	8884	61
H(17A)	8657	2687	8947	18
H(17B)	7894	2586	10037	18
H(33)	6878	1604	8524	22
H(27)	6009	1544	9603	22
H(31)	9284	647	8976	36

H(32)	8410	584	10053	36
H(28)	7560	-472	8521	86
H(30)	6630	-511	9587	86
H(29)	8456	-1075	9346	86



Parameter		Value
1	Data File Name	H:/ liou240522.002/ 1/ fid
2	Title	liou240522.002.1.fid
3	Comment	6Sn AA
4	Origin	Bruker BioSpin GmbH
5	Owner	nmrsu
6	Instrument	spect
7	Solvent	CDCl3
8	Temperature	298.2
9	Pulse Sequence	zg30
10	Experiment	1D
11	Probe	Z119470_0234 (PA BBO 500S1 BBF-H-D-05 Z SP)
12	Number of Scans	32
13	Receiver Gain	16.4
14	Relaxation Delay	2.0000
15	Pulse Width	10.0000
16	Presaturation Frequency	
17	Acquisition Time	1.6340
18	Acquisition Date	2024-05-22T13:55:05
19	Modification Date	2024-05-22T13:55:08
20	Spectrometer Frequency	500.16
21	Spectral Width	10026.7
22	Lowest Frequency	-2032.9
23	Nucleus	1H
24	Acquired Size	16384
25	Spectral Size	65536
26	Digital Resolution	0.15

Figure S5. ^{1}H NMR of cluster 1

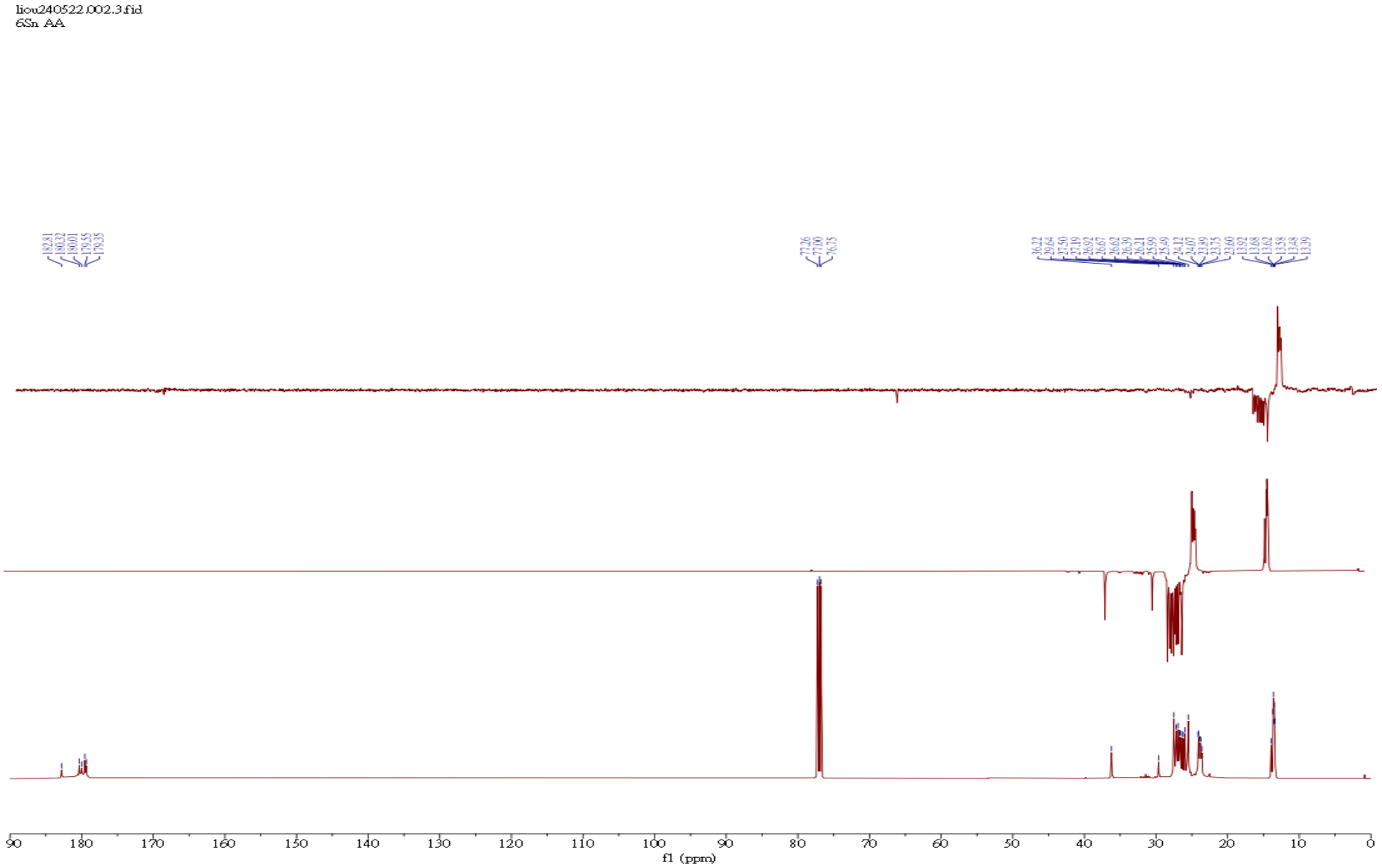


Figure S6. ^{13}C NMR of cluster 1

liou240522.002.5.fid
6Sn AA

	Parameter	Value
1	Data File Name	H:/ liou240522.002/ 5/ fid
2	Title	liou240522.002.5.fid
3	Comment	6Sn AA
4	Origin	Bruker BioSpin GmbH
5	Owner	nmrsu
6	Instrument	spect
7	Solvent	CDCl3
8	Temperature	298.9
9	Pulse Sequence	zgpg
10	Experiment	1D
11	Probe	Z119470_0234 (PA BBO 500S1 BBF-H-D-05 Z SP)
12	Number of Scans	2048
13	Receiver Gain	191.0
14	Relaxation Delay	2.0000
15	Pulse Width	15.0000
16	Presaturation Frequency	
17	Acquisition Time	0.0437
18	Acquisition Date	2024-05-23T06:57:37
19	Modification Date	2024-05-23T06:57:38
20	Spectrometer Frequency	186.51
21	Spectral Width	750000.0
22	Lowest Frequency	-374978.9
23	Nucleus	119Sn
24	Acquired Size	32768
25	Spectral Size	65536
26	Digital Resolution	11.44

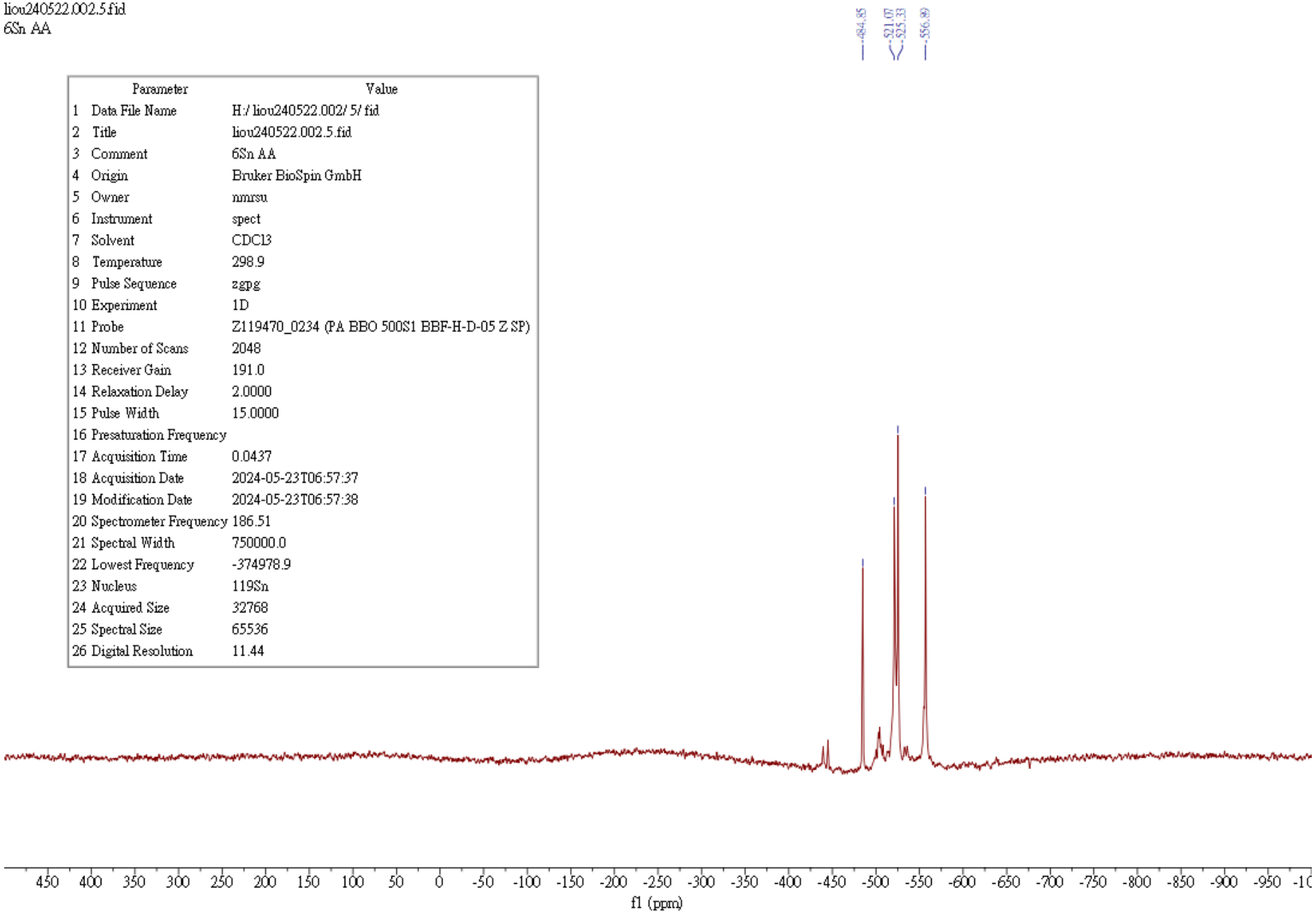


Figure S7. ^{119}Sn NMR of cluster 1

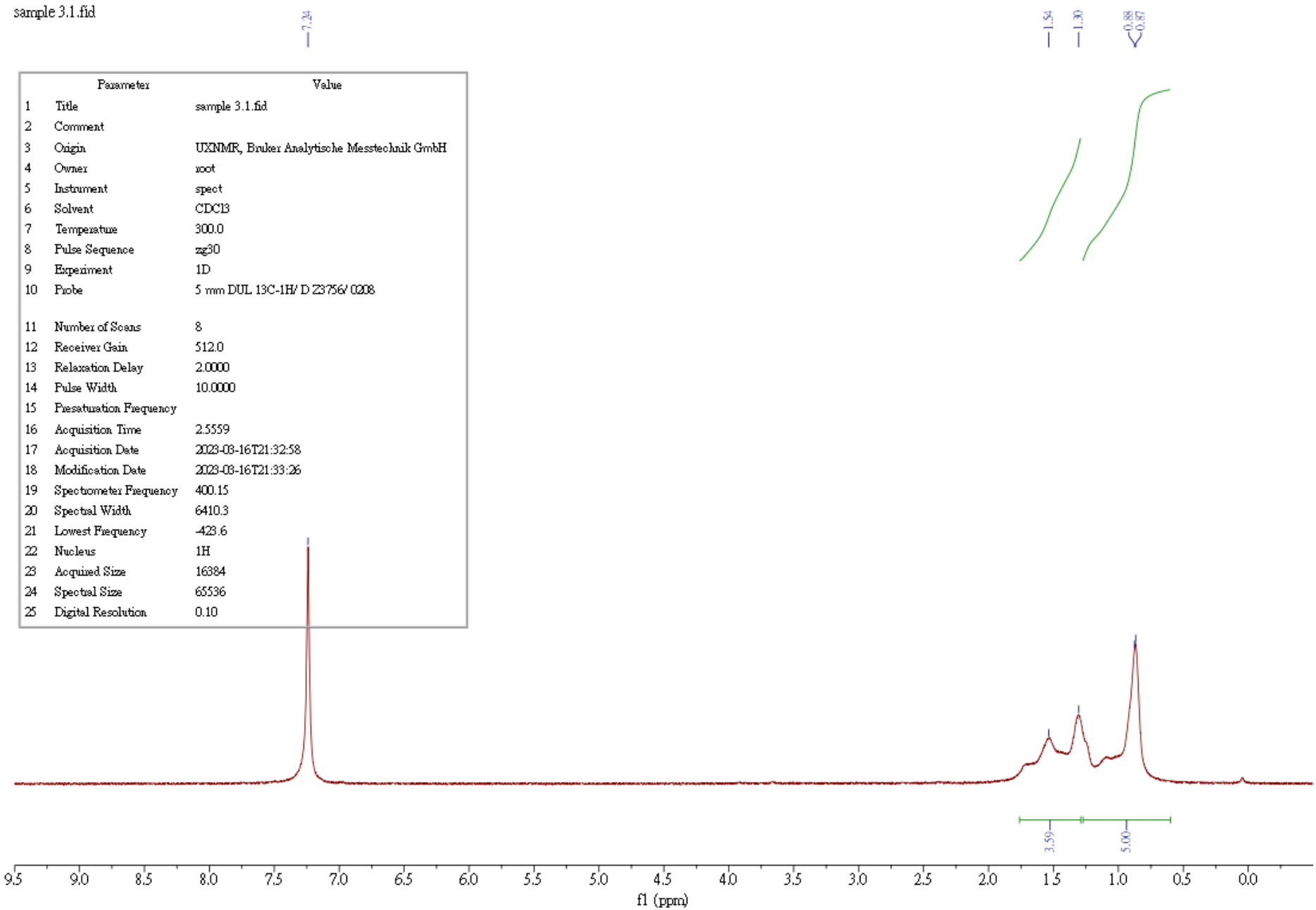


Figure S8. ^{1}H NMR of cluster 2

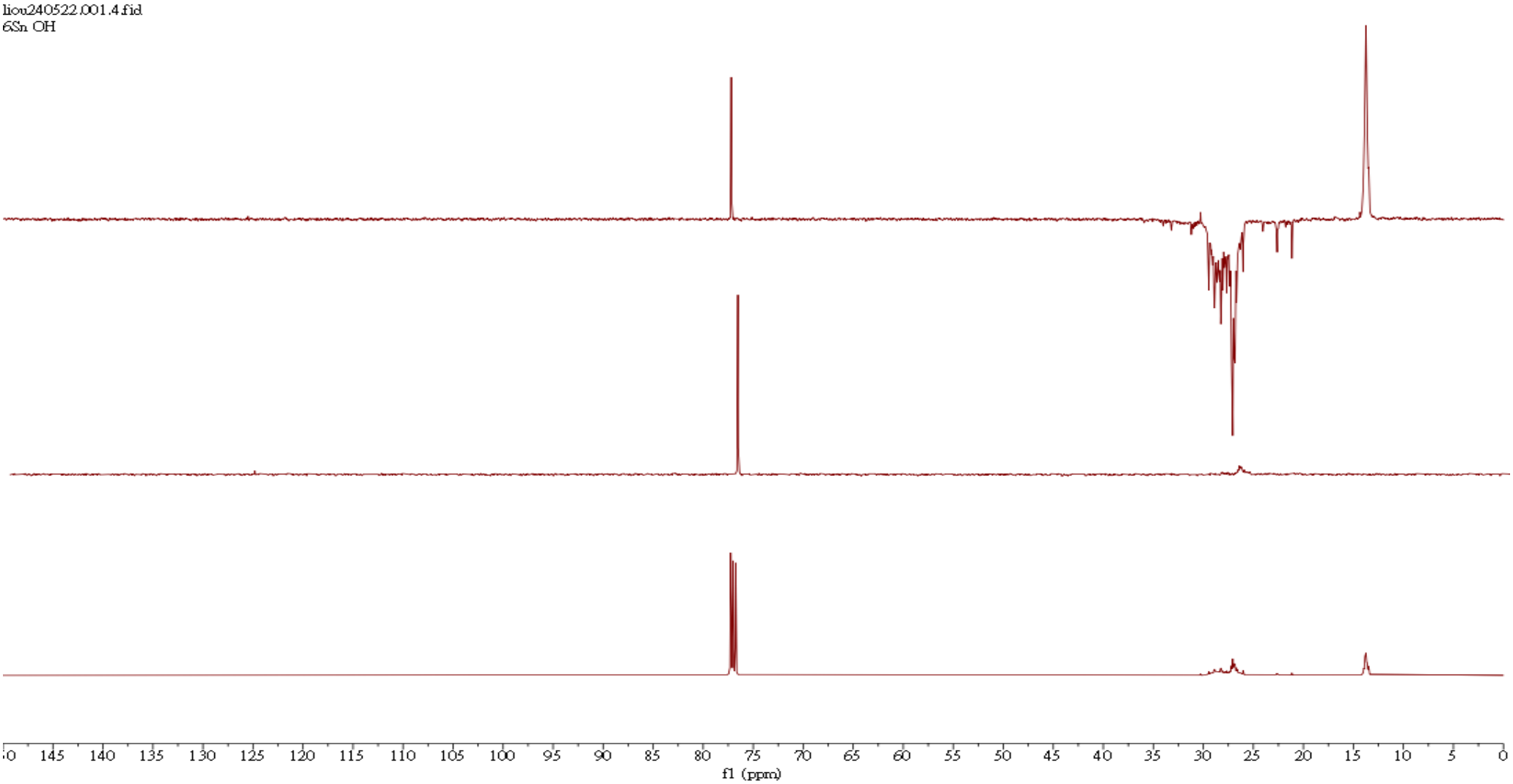


Figure S9. ^{13}C NMR of cluster 2

liou230921.001.2.fid
Jeff-06

451.10
465.08
469.89
485.57

	Parameter	Value
1	Title	liou230921.001.2.fid
2	Comment	Jeff-06
3	Origin	Bruker BioSpin GmbH
4	Owner	nmrsu
5	Instrument	spect
6	Solvent	CDCl3
7	Temperature	233.1
8	Pulse Sequence	zgpg
9	Experiment	1D
10	Probe	Z119470_0234 (PA BBO 500S1 BBF-H-D-05 Z SP)
11	Number of Scans	4096
12	Receiver Gain	191.0
13	Relaxation Delay	2.0000
14	Pulse Width	15.0000
15	Presaturation Frequency	
16	Acquisition Time	0.0437
17	Acquisition Date	2023-09-21T11:38:49
18	Modification Date	2023-09-21T11:38:50
19	Spectrometer Frequency	186.51
20	Spectral Width	750000.0
21	Lowest Frequency	-374978.8
22	Nucleus	119Sn
23	Acquired Size	32768
24	Spectral Size	65536
25	Digital Resolution	11.44

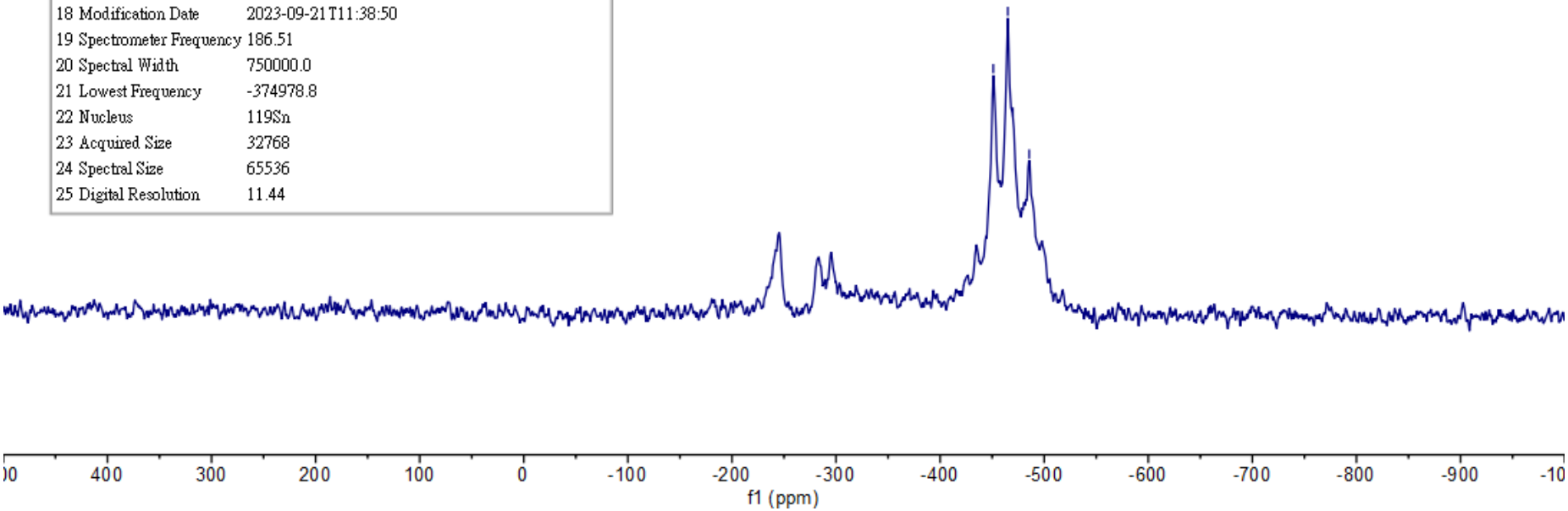


Figure S10. ^{119}Sn NMR of cluster 2