Electronic Supplementary Material (ESI) for Materials Advances.

Electronic supplementary information

$^{n}Bu_2Sn(S^{n}Bu)_2$ and $^{n}Bu_3SnE^{n}Bu$ (E = S or Se) - effective single source precursors for the CVD of SnS and SnSe thermoelectric thin films

Fred Robinson[a], Peter J. Curran[b], C. H. (Kees) de Groot[c], Duncan Hardie,[b] Andrew L. Hector[a], Katherine Holloway[a], Ruomeng Huang[c], Daniel W. Newbrook,[c] and Gillian Reid[a]*

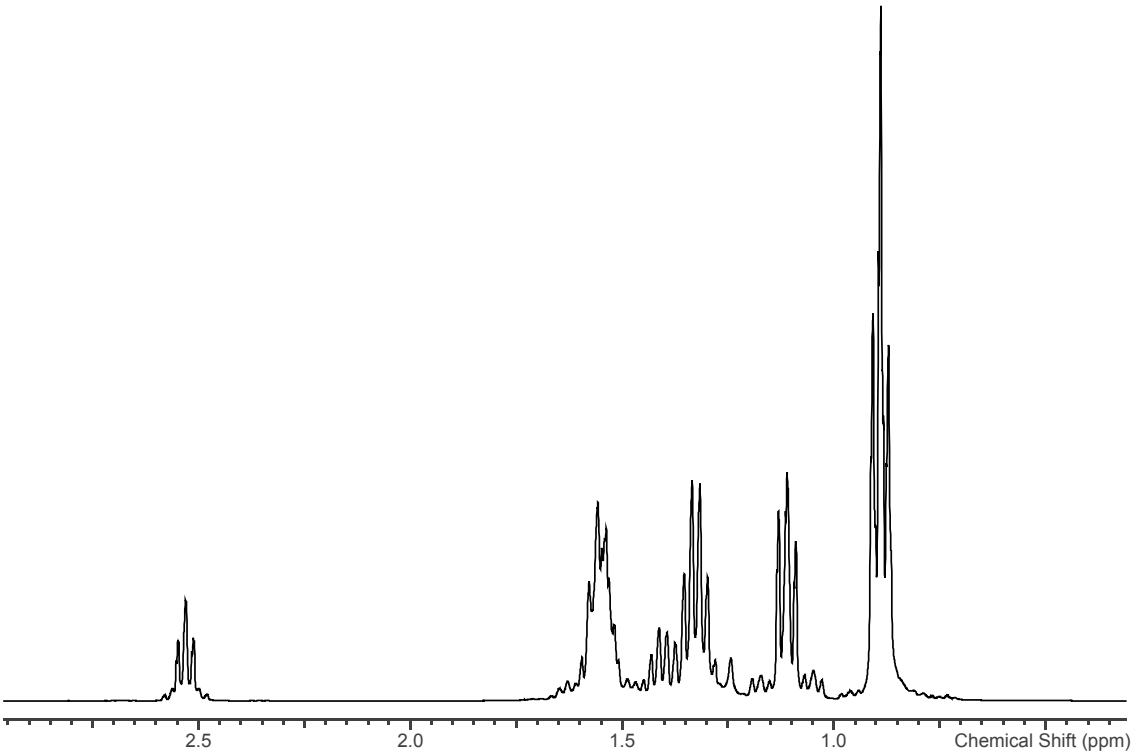

Figure S1- ^{1}H NMR spectrum of $[Sn^{n}Bu_3(S^{n}Bu)]$ ($CDCl_3$)

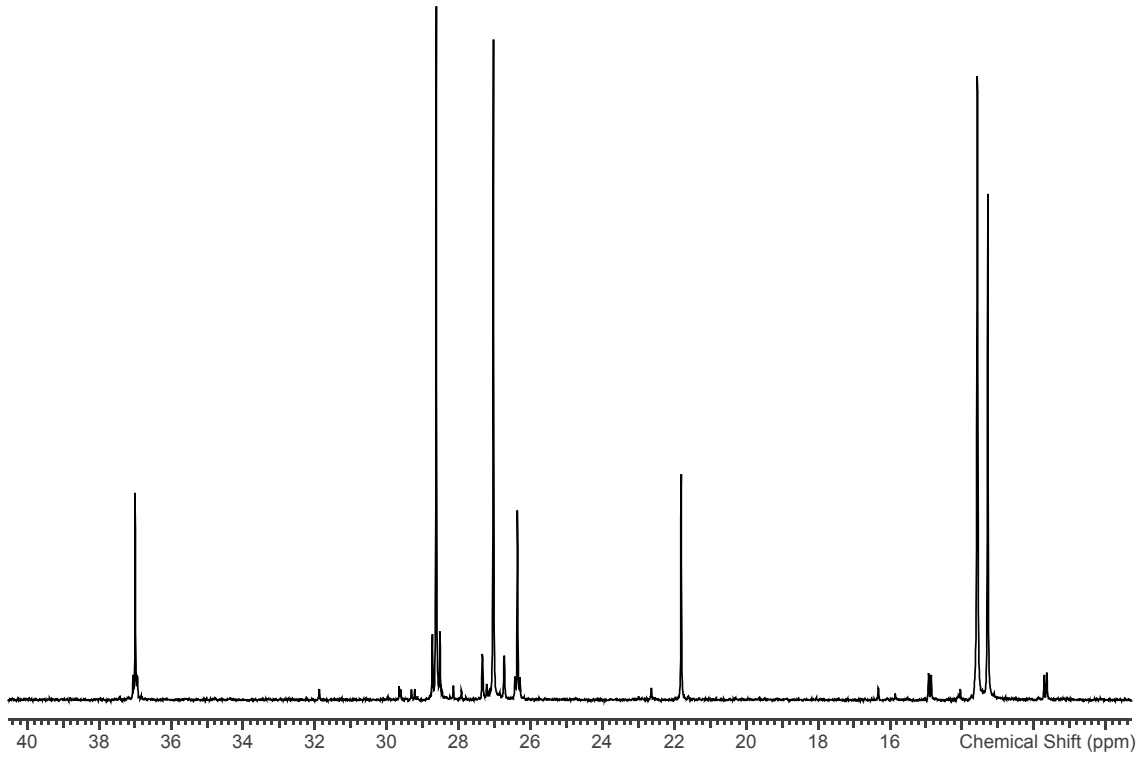

Figure S2- $^{13}C\{^{1}H\}$ NMR spectrum of $[Sn^{n}Bu_3(S^{n}Bu)]$ ($CDCl_3$)

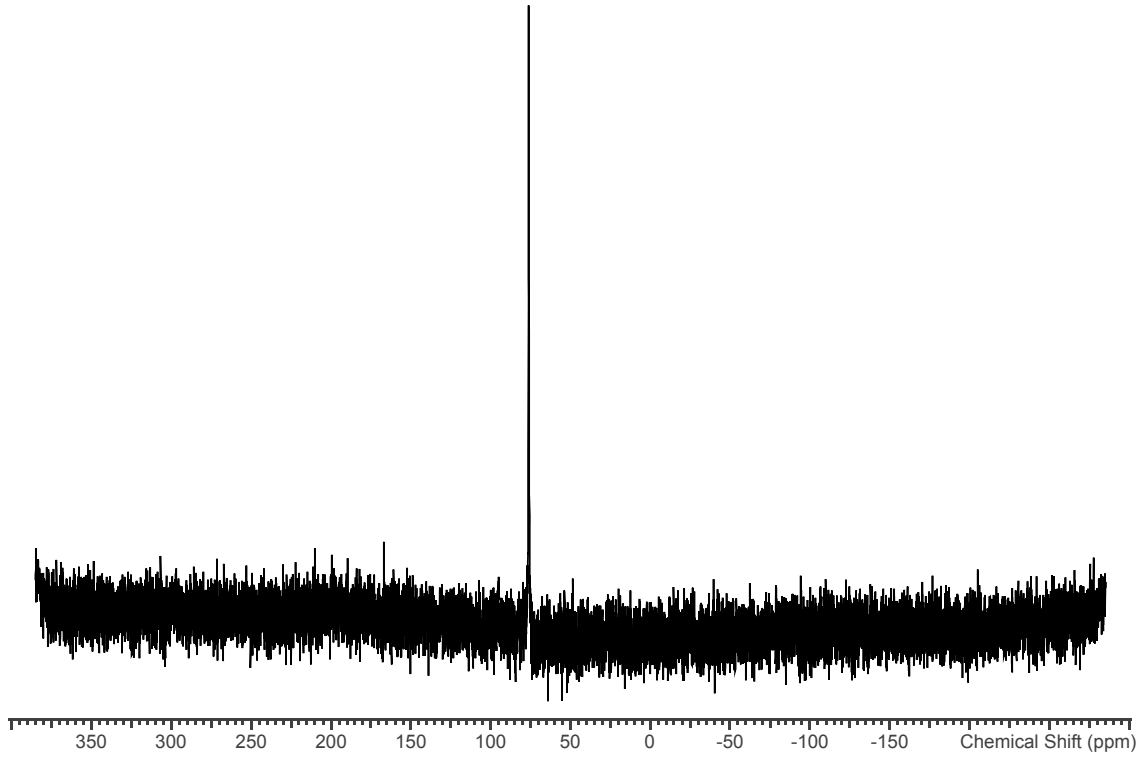

Figure S3- $^{119}Sn\{^{1}H\}$ NMR spectrum of $[Sn^{n}Bu_3(S^{n}Bu)]$ ($CDCl_3$)

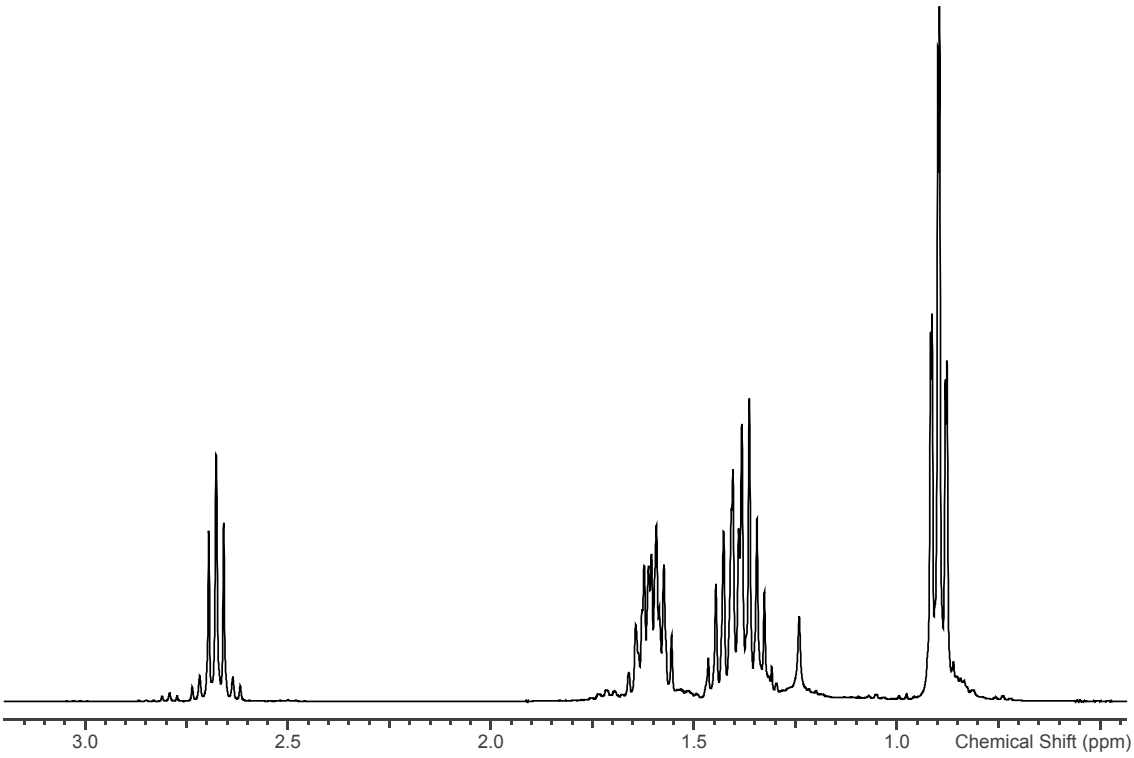

Figure S4- ^{1}H NMR spectrum of $[Sn^{n}Bu_2(S^{n}Bu)_2]$ ($CDCl_3$)

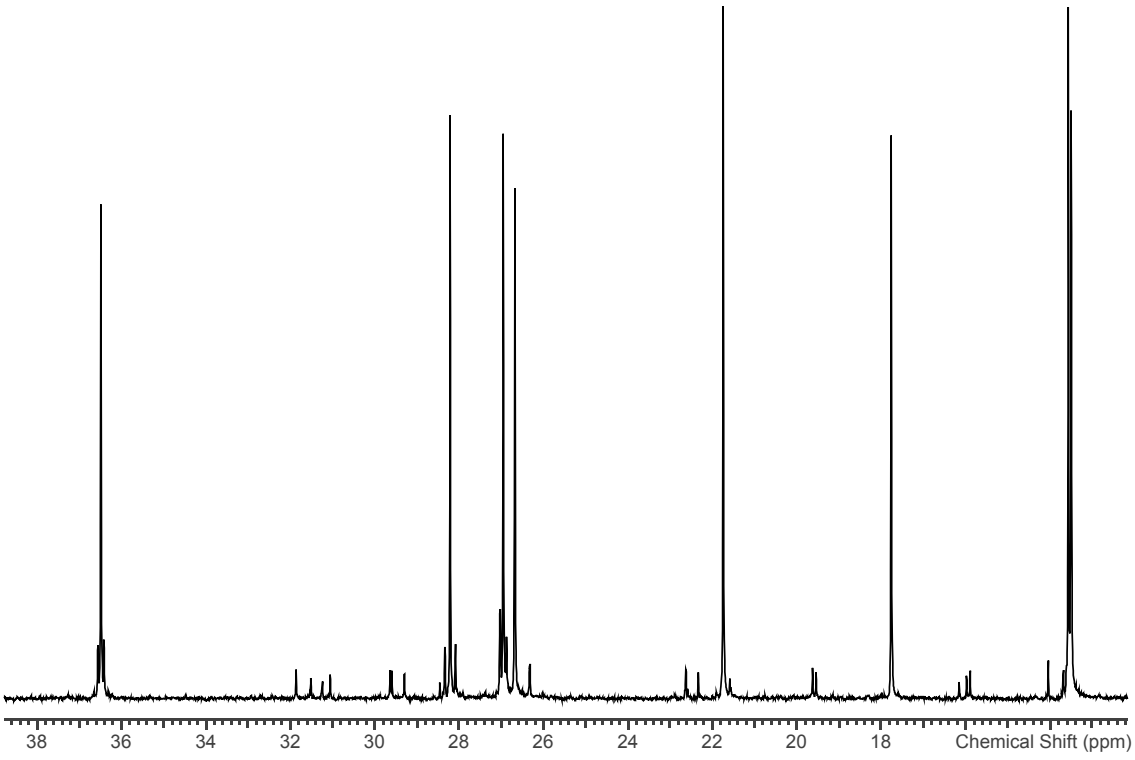

Figure S5- $^{3}C\{^{1}H\}$ NMR spectrum of $[Sn^{n}Bu_2(S^{n}Bu)_2]$ ($CDCl_3$)

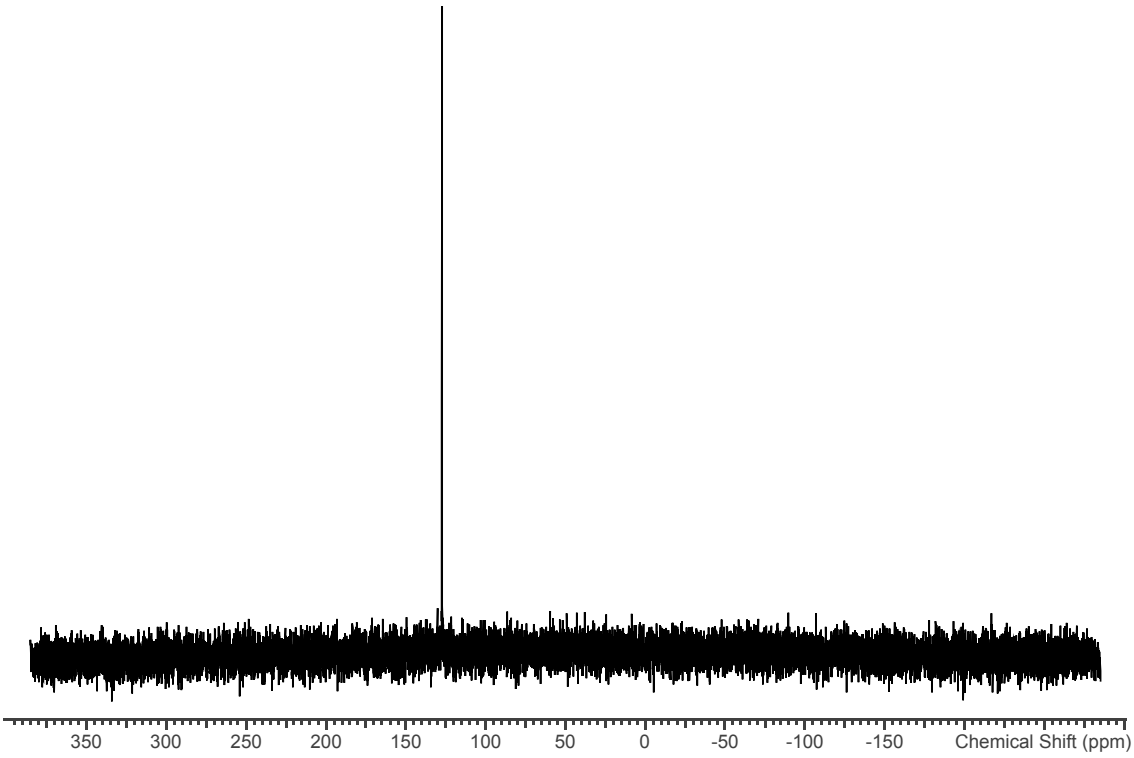

Figure S6- $^{119}Sn\{^{1}H\}$ NMR spectrum of $[Sn^{n}Bu_2(S^{n}Bu)_2]$ ($CDCl_3$)

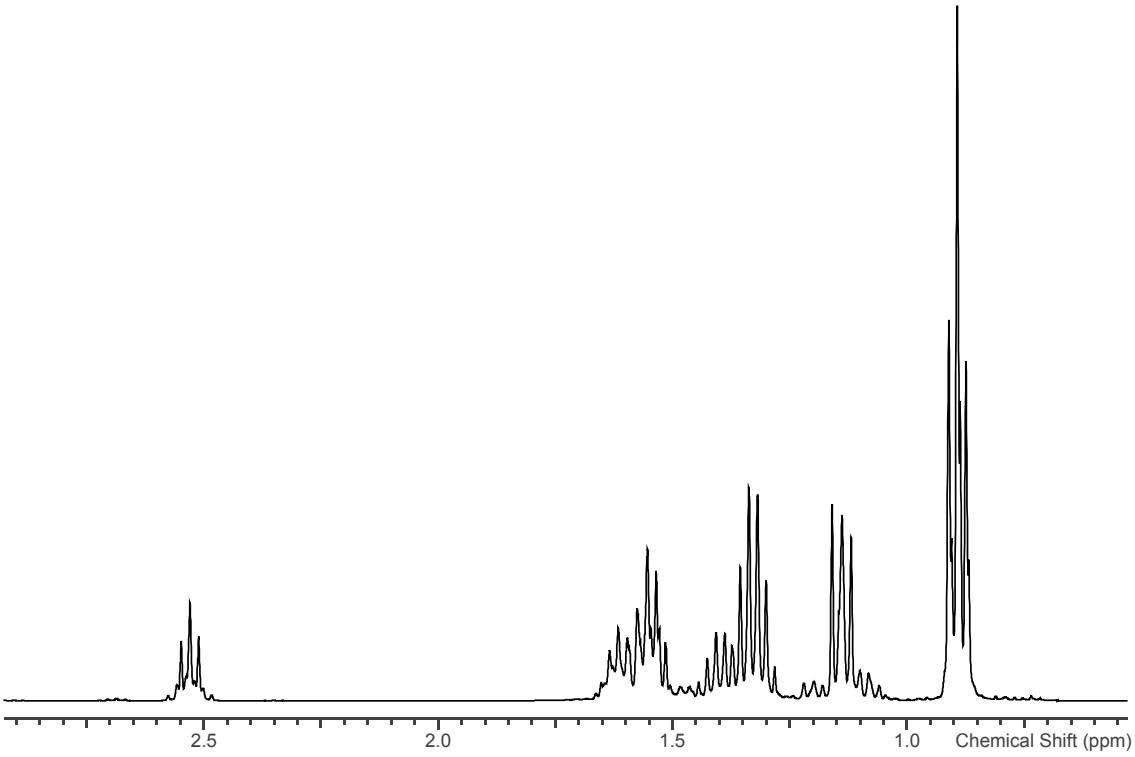

Figure S7- ^{1}H NMR spectrum of $[Sn^{n}Bu_3(Se^{n}Bu)]$ ($CDCl_3$)

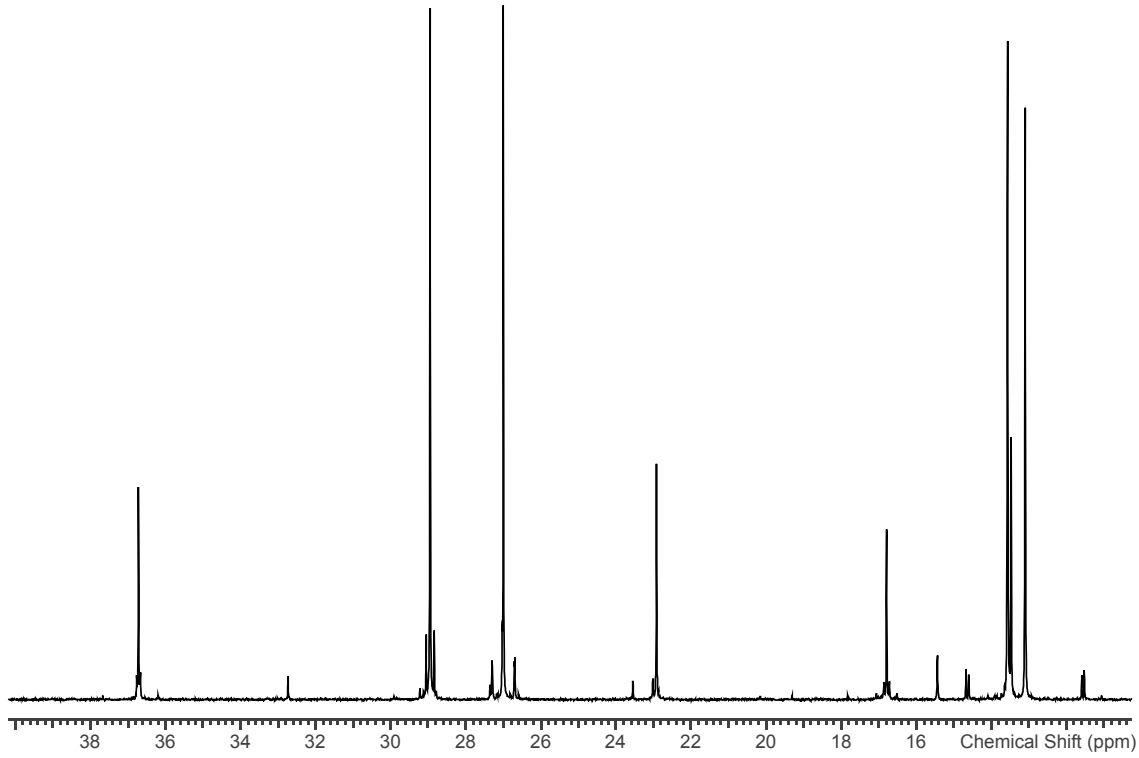

Figure S8- $^{13}C\{^{1}H\}$ NMR spectrum of $[Sn^{n}Bu_3(Se^{n}Bu)]$ ($CDCl_3$)

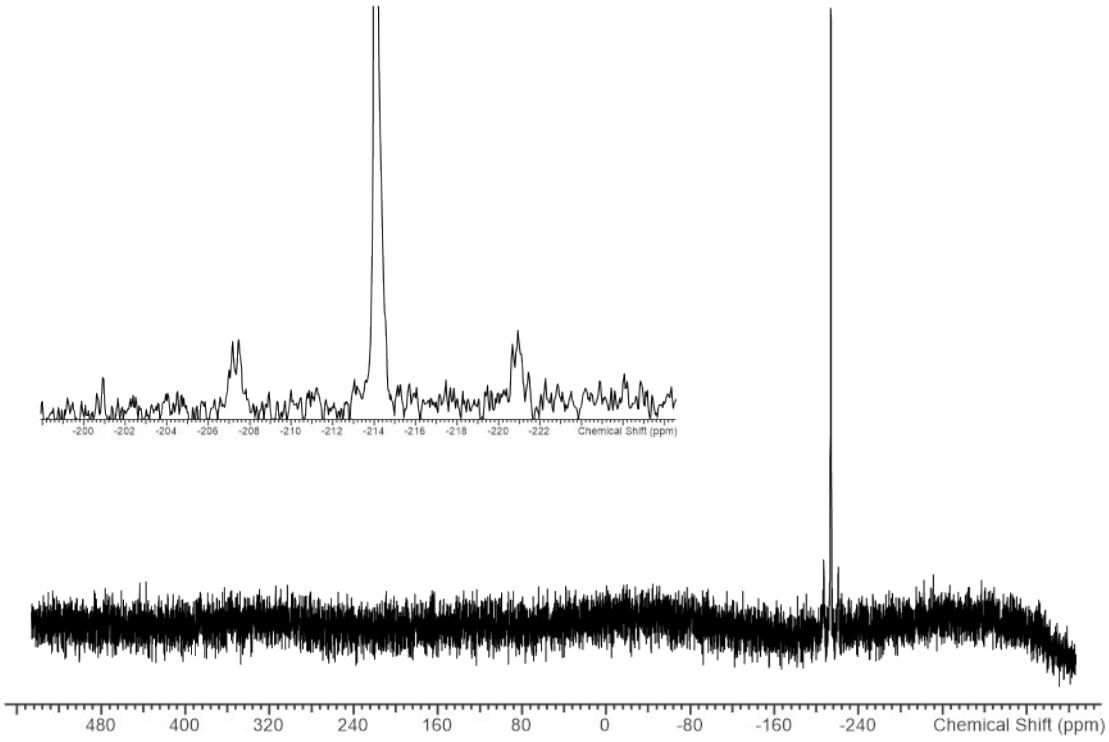

Figure S9- $^{77}Se\{^{1}H\}$ NMR spectrum of $[Sn^{n}Bu_3(Se^{n}Bu)]$ ($CDCl_3$) (insert shows an expanded view with the $^{117/119}Sn$ satellites clearly visible).

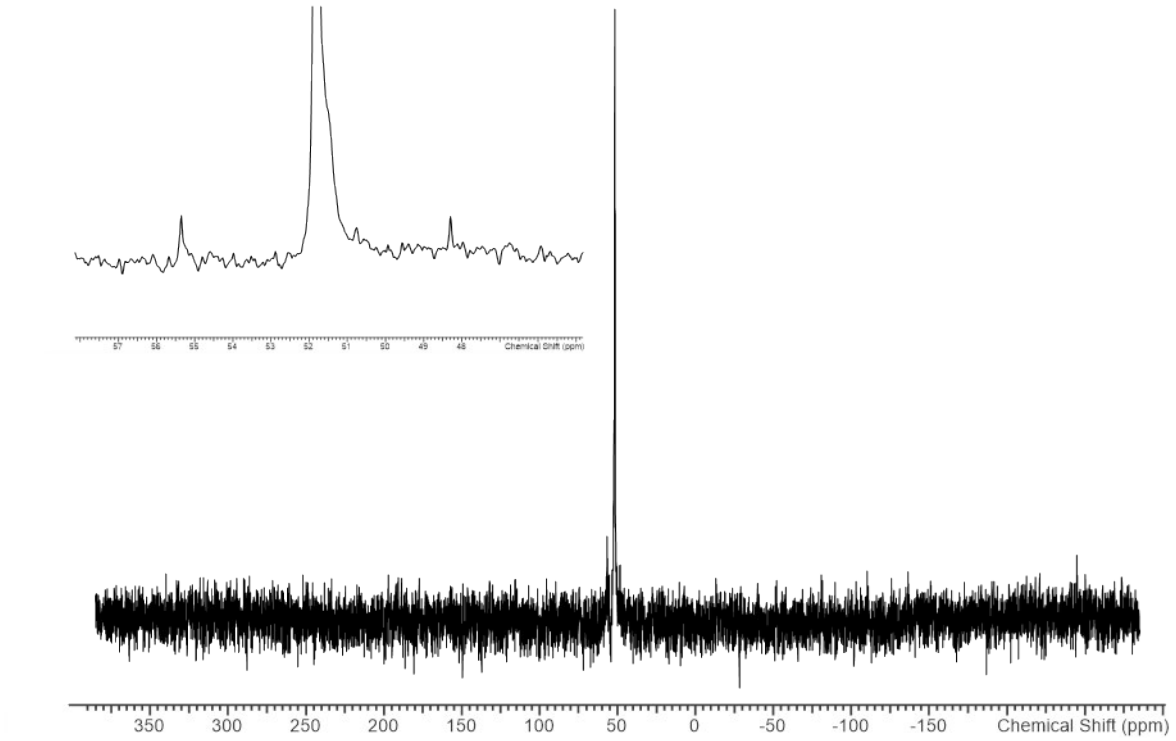

Figure S10- $^{119}Sn\{^{1}H\}$ NMR spectrum of $[Sn^{n}Bu_3(Se^{n}Bu)]$ ($CDCl_3$) (insert shows an expanded view with the ^{77}Se satellites clearly visible)

Sample	Precursor	O%	Si%	S%	Sn%
Dep^{n} 1 tile 1	(**1**)	7.8	1.2	36.4	54.6
Dep^{n} 2 tile 1	(**1**)	-	-	40.2	59.8
Dep^{n} 2 tile 2	(**1**)	-	-	39.9	60.1
Dep^{n} 3 tile 1	(**2**)	6.6	1.3	40.8	51.3
Dep^{n} 4 tile 1	(**2**)	-	0.7	44.2	55.0
Dep^{n} 5 tile 1	(**2**)	13.4	24.1	31.2	31.2
Dep^{n} 5 tile 2	(**2**)	12.3	12.5	37.2	38.1

Table S1: Energy dispersive X-ray analysis results for some SnS films (atom % values); (**1**) = $Sn^{n}Bu_3(S^{n}Bu)$; (**2**) = $Sn^{n}Bu_2(S^{n}Bu)_2$

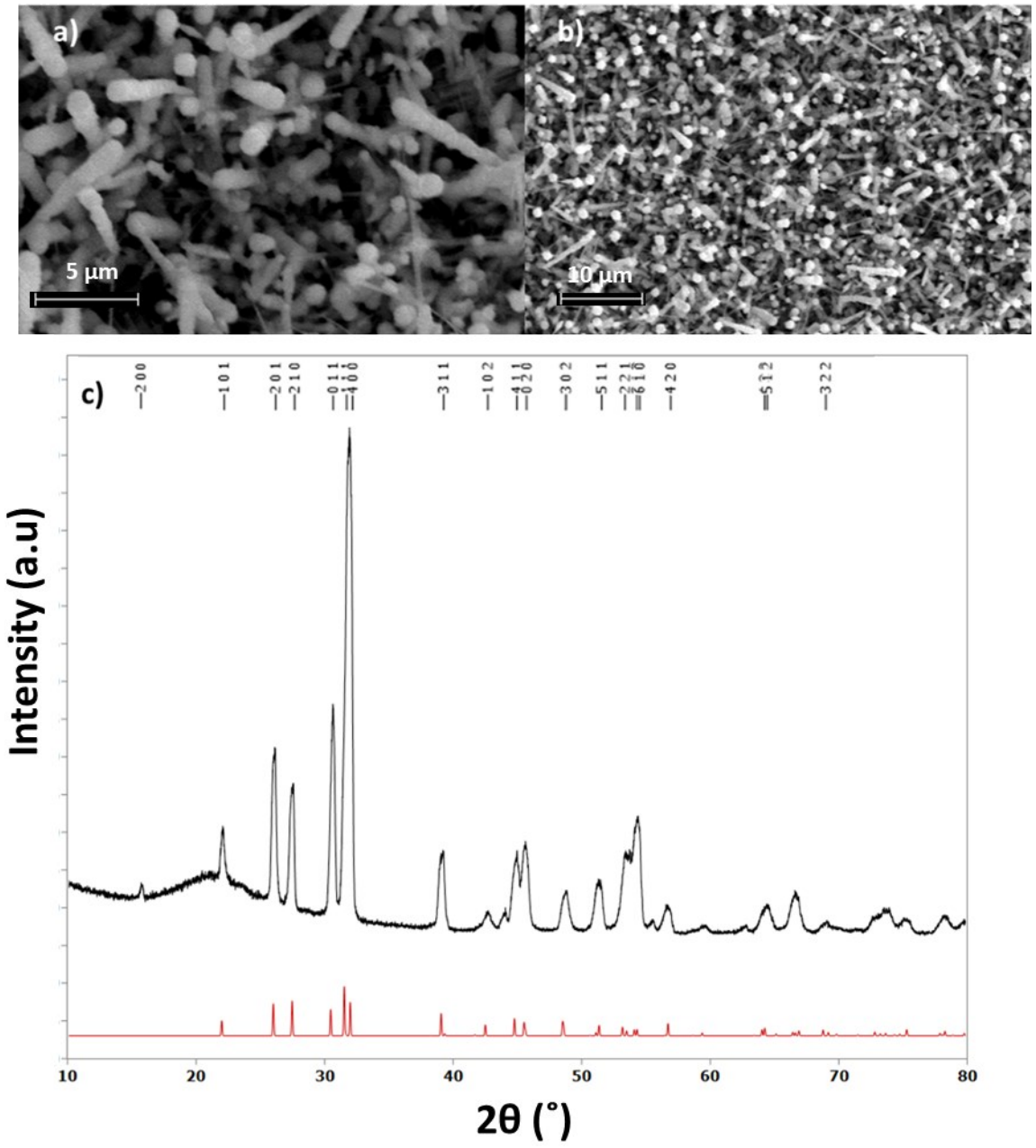

Figure S11: Top down SEM images a) and b) of two thin films of sulfur deficient SnS deposited using (**1**) and c) a GIXRD pattern (black) for the film seen in b) matched to a bulk literature pattern (red).[15]

Sample	%C	%O	% Si	%Se	%Sn
dep^{n} 1	-	11.3	29.4	29.1	30.2
dep^{n} 2 tile 1	17.4	10.1	-	35.4	37.1
dep^{n} 2 tile 2	-	7.54	4.2	44.4	43.9
dep^{n} 3	11.7	7.1	-	38.9	42.3
dep^{n} 4	12.2	8.0	7.1	37.5	35.2

Table S2: Energy dispersive X-ray analysis results for SnSe thin films (atom % values)