Electronic Supplementary Material (ESI) for Nanoscale.
This journal is © The Royal Society of Chemistry 2019

SUPPORTING INFORMATION

Shear-force exfoliation of indium and gallium chalcogenides for selective gas sensing applications

Petr Marvan,[a] Vlastimil Mazánek,[a] Zdeněk Sofer [a]*

[a] Department of Inorganic Chemistry, University of Chemistry and Technology Prague, Technická 5, 166 28 Prague 6, Czech Republic

**E-mail: zdenek.sofer@vscht.cz*

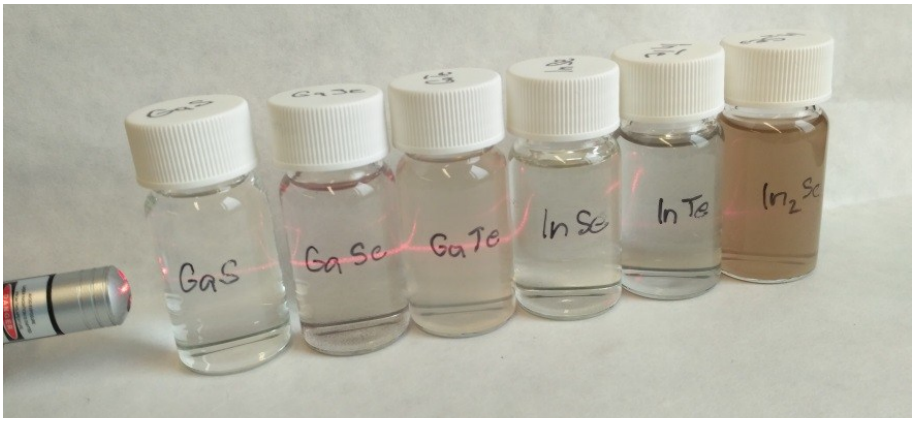

Figure S1. Stored suspensions of nano samples.

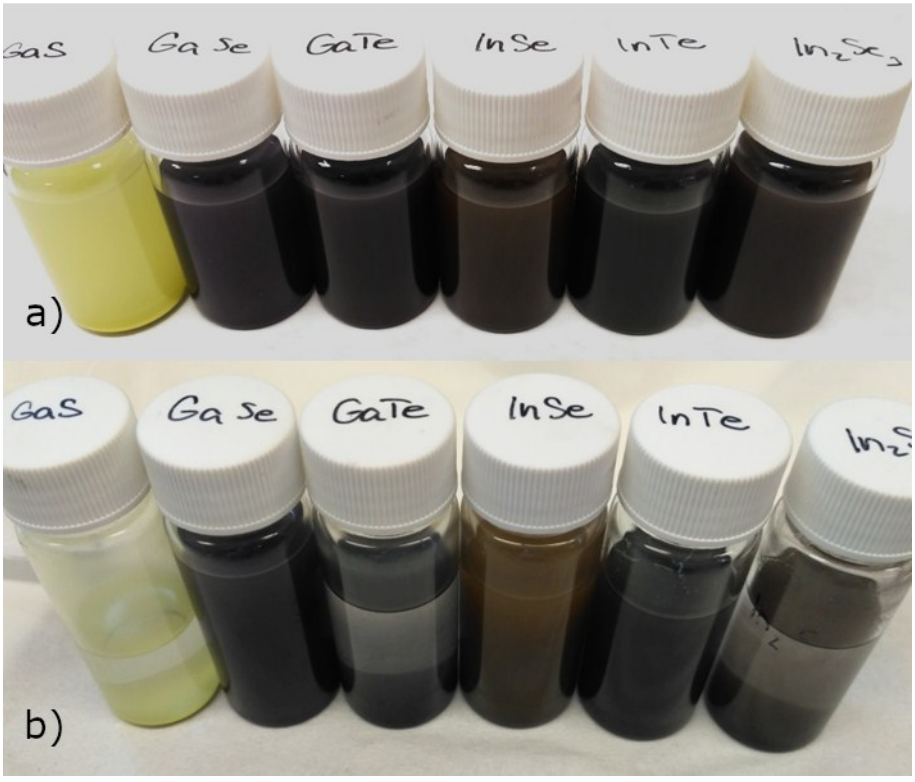

Figure S2. Suspension stability of stored samples of exfoliated chalcogenides: a) 1 day after exfoliation; b) 1 week after exfoliation

Table S1. Reference cards from PDF2 database for exfoliated samples.

Sample	Reference card ID
GaS	04-002-0621
GaSe	04-004-7903
Se	04-004-4240
GaTe	01-074-8974
In_2Se_3	04-007-1688
InSe	04-004-6176
InTe	04-005-6349

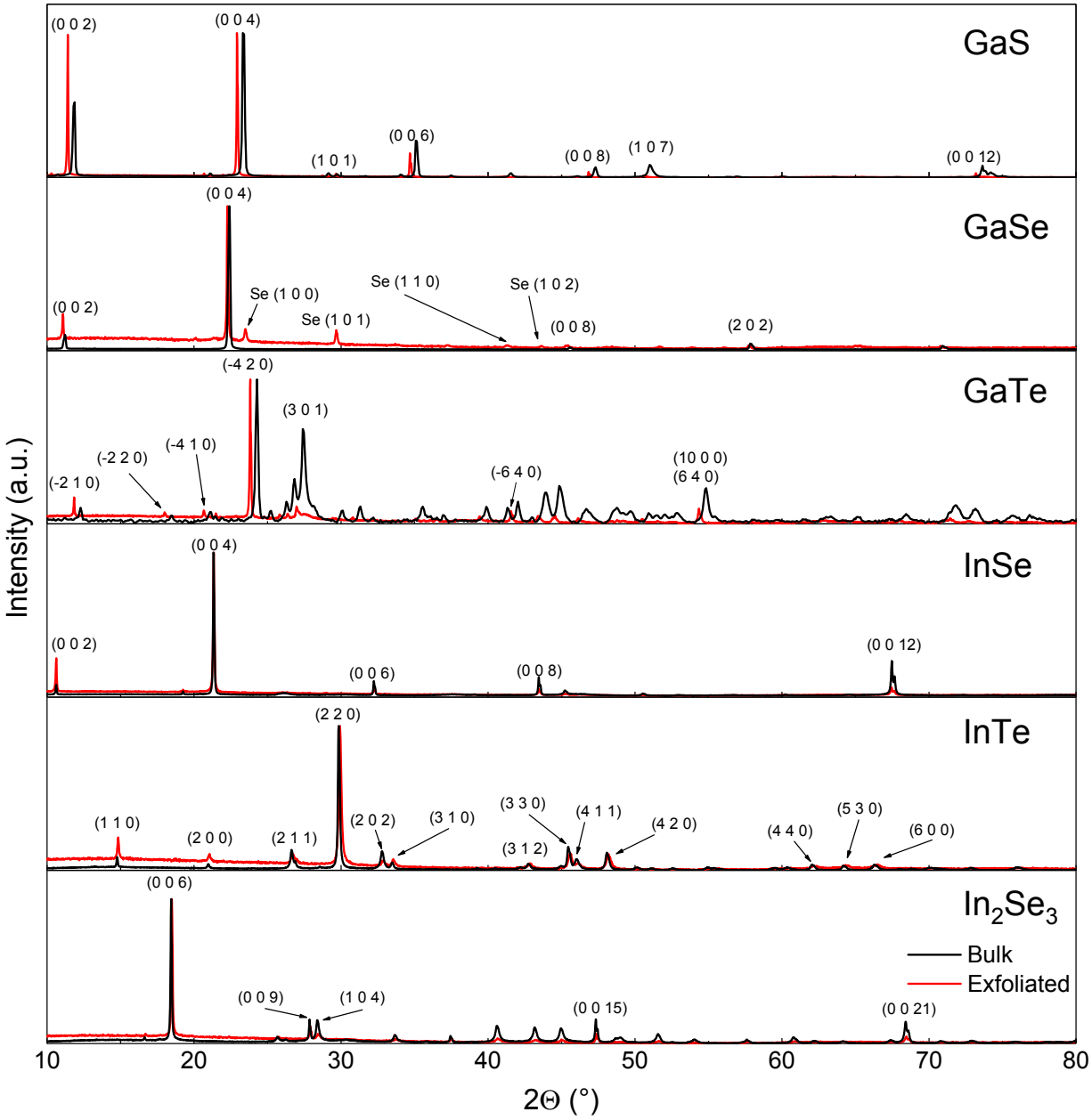

Figure S3. Diffractograms of bulk and exfoliated materials.

Table S2. Chemical composition and binding ratios determined by XPS immediately after the exfoliation.

Sample	Composition	M-M (at. %)	M-X (at. %)	M-O (at. %)
GaS	$Ga_1S_{0.988}$	50.63	49.37	0
GaSe	$Ga_1Se_{0.910}$	49.79	41.99	8.22
GaTe	$Ga_1Te_{0.990}$	49.90	46.56	3.54
InSe	$In_1Se_{1.014}$	50.45	49.75	0
InTe	$In_1Te_{0.990}$	49.71*	50.29*	0*
In_2Se_3	$In_2Se_{2.989}$	0	100	0

Table S3. Chemical composition and binding ratios determined by XPS after 5 months.

Sample	M-M (at. %)	M-X (at. %)	M-O (at. %)
GaS	49.22	43.46	7.32
GaSe	47.32	34.20	18.48
GaTe	48.64	41.39	9.97
InSe	49.82	50.19	0
InTe	49.16*	45.02*	5.82*
In_2Se_3	0	100	0

* In InTe M-M corresponds to In^{1+}-Te, M-X to In^{3+}-Te and M-O to In^{3+}-O

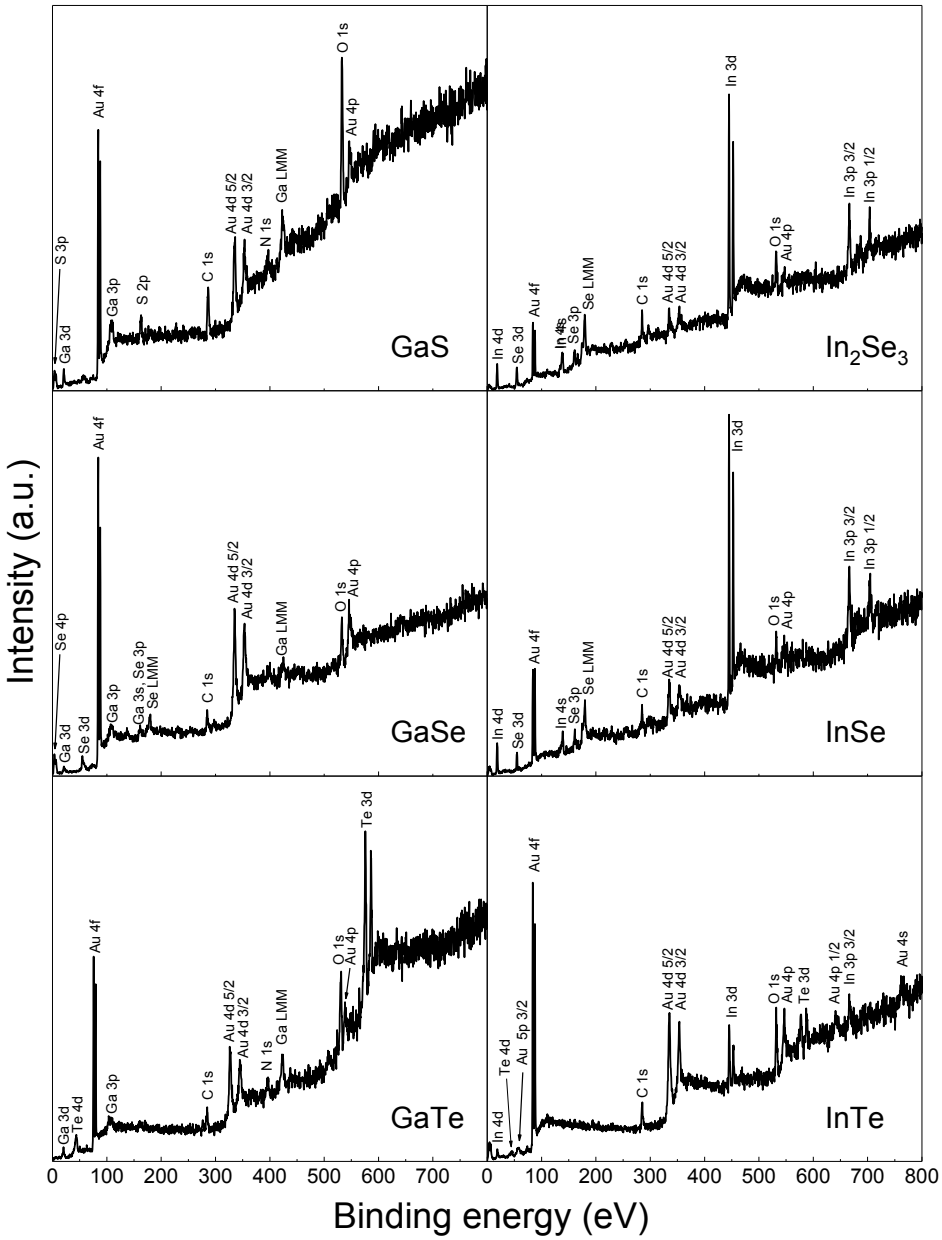

Figure S4. XPS survey spectra of exfoliated chalcogenides.

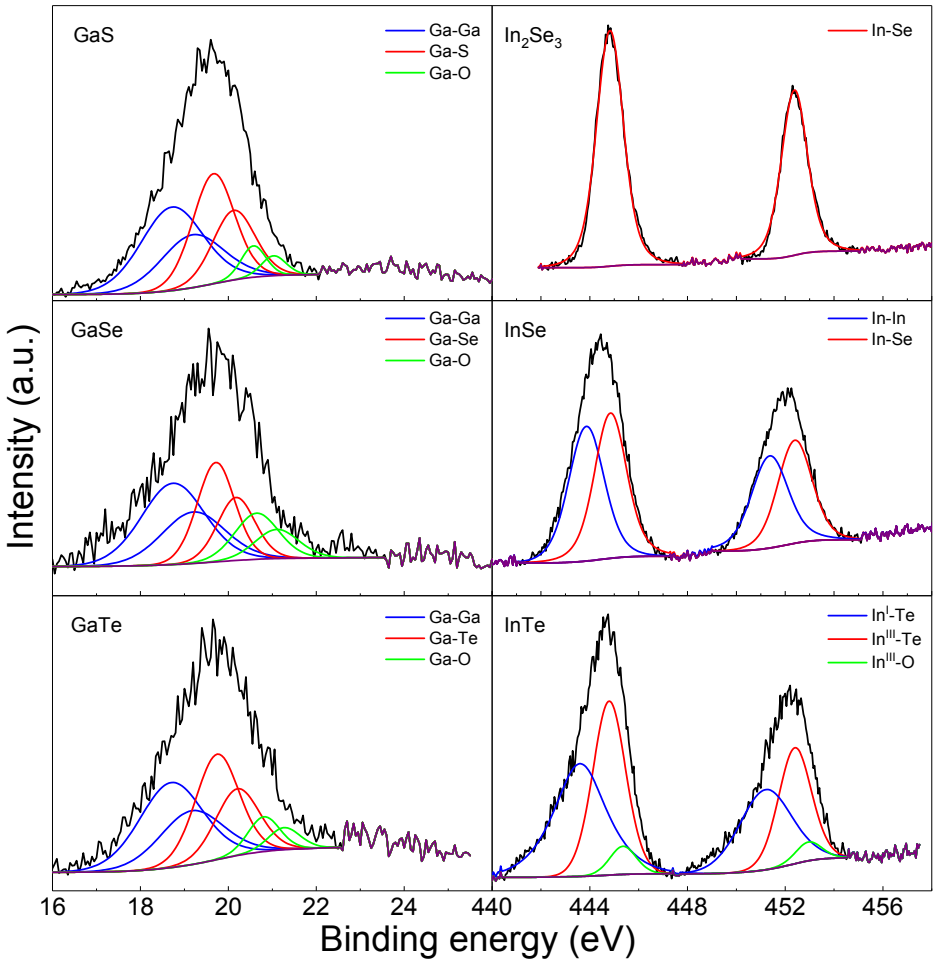

Figure S5. Fitted HR-XPS measurement data after 5 months.

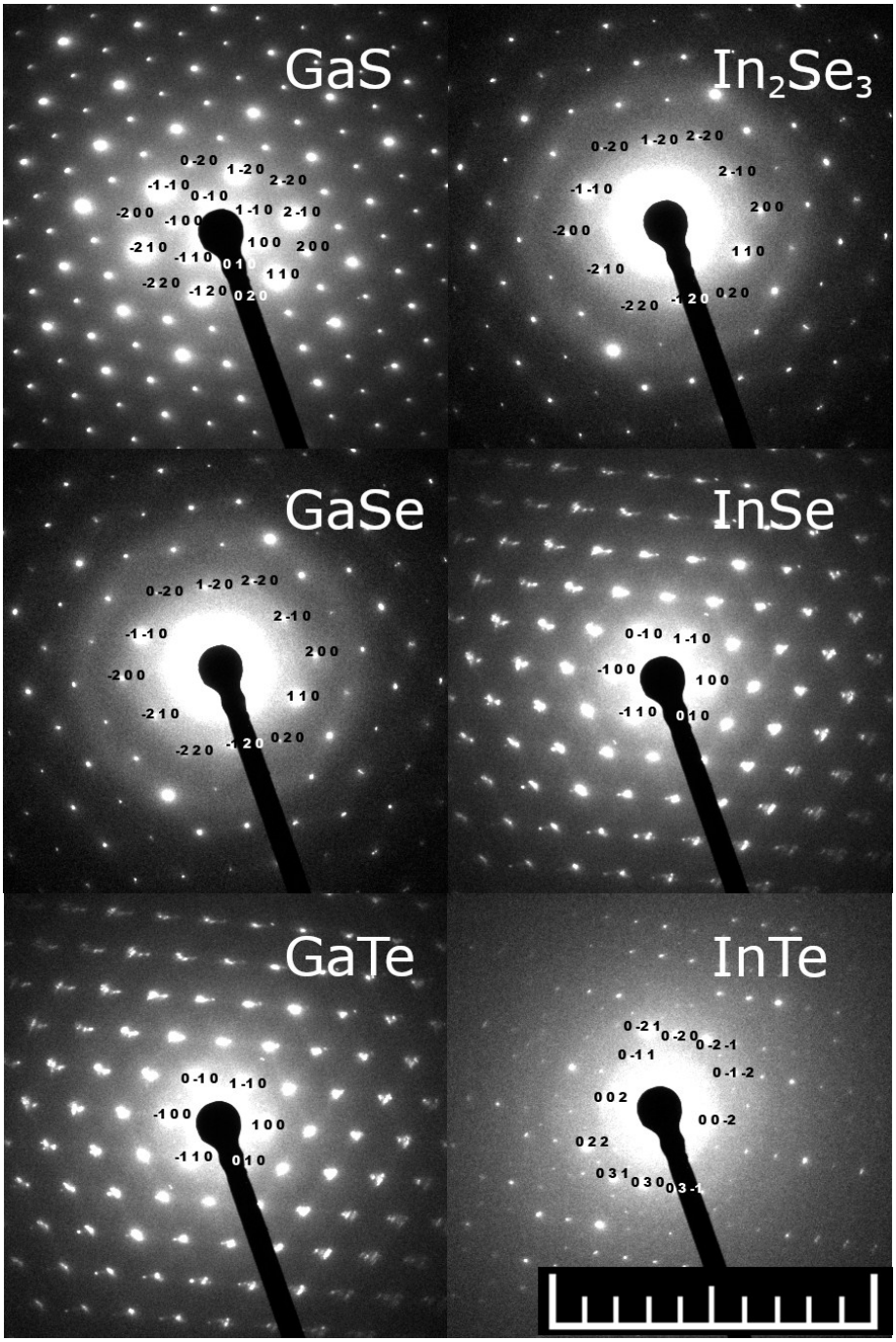

Figure S6. Diffraction pattern of exfoliated nano samples, scale bar 1/(0.04 nm).

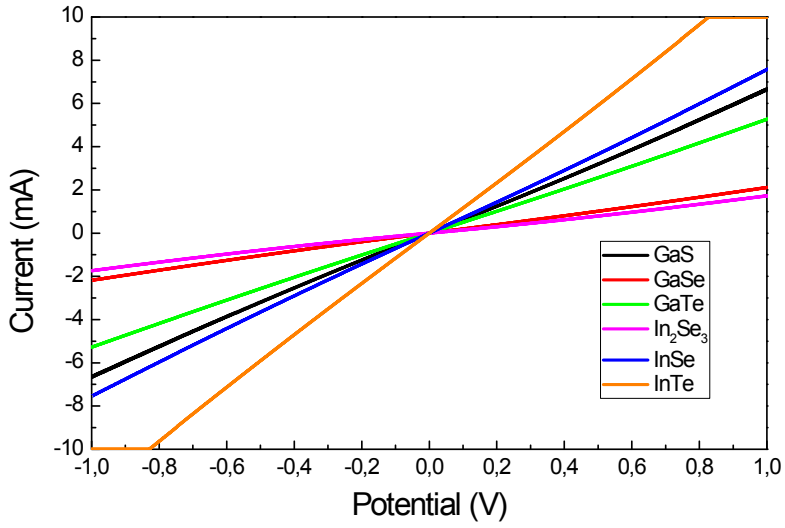

Figure S7. Volt-ampere characterisation of sensors prepared after exfoliation.

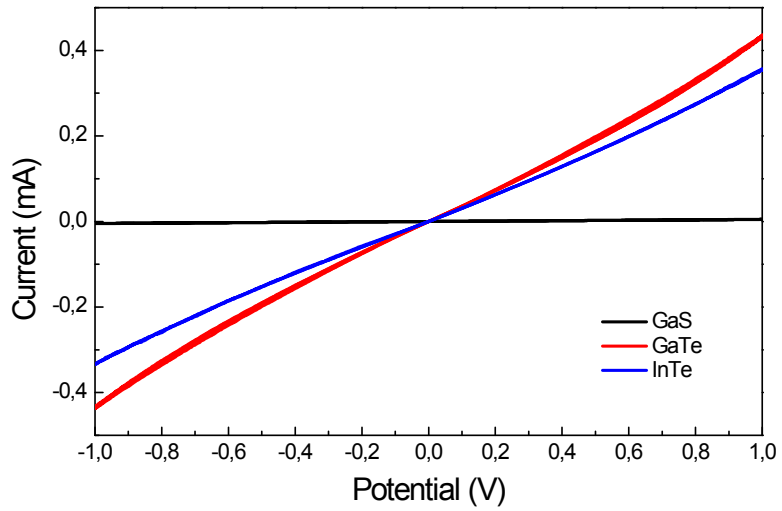

Figure S8. Volt-ampere characteristic of ohmic contacts after 5 months.

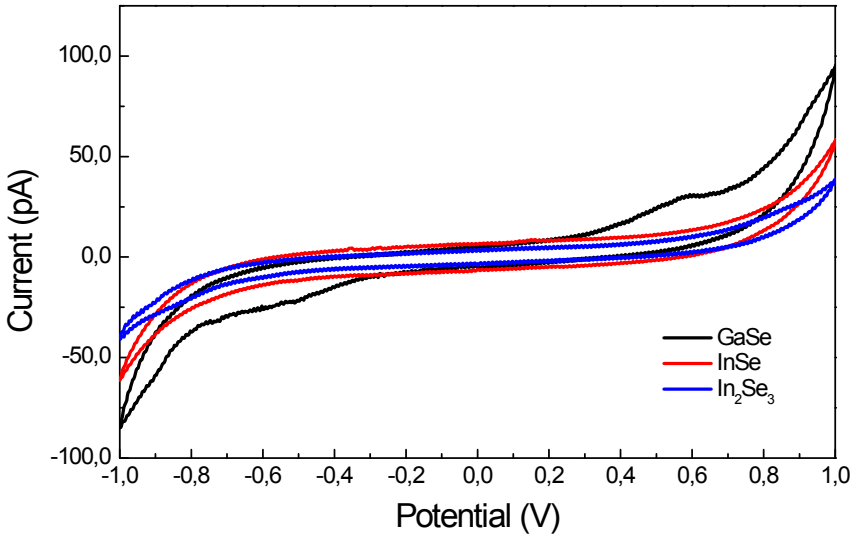

Figure S9. Volt-ampere characteristic of Schottky contacts after 5 months.

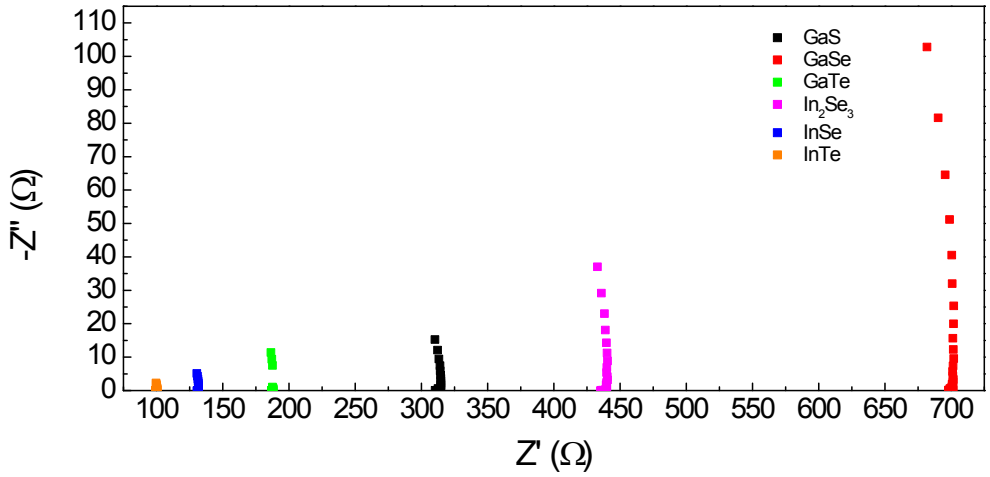

Figure S10. Nyquist diagram for the reference measurement.

Table S4. Parameters of equivalent circuit of Randles cell for reference measurement.

Sample	Rs (Ω)	R_{CT} (Ω)	R_{total} (Ω)	CPE	CPE n
GaS	263	52	315	3,06 pF	1,00
GaSe	322	378	700	11,1 pF	1,07
GaTe	135	53	188	7,53 pF	1,06
In_2Se_3	290	150	440	2,64 pF	1,00
InSe	114	18	132	22,7 pF	1,00
InTe	95	5	100	332 mF	1,00

Table S5. Frequency of peak maximum determined from Bode diagram.

	Frequency of peak maximum (Hz)			
Sample	Methanol	Ethanol	Isopropyl alcohol	Acetone
GaS	4000	1600	100, 32000	200
GaSe	72000	5800	360	-
GaTe	10000	2500	200	-
InSe	63000	-	-	-
InTe	-	-	-	-
In_2Se_3	12500	2500	-	-

Table S6. Phase of peak maximum determined from Bode diagram.

	- Phase of peak maximum (°)			
Sample	Methanol	Ethanol	Isopropyl alcohol	Acetone
GaS	40	11.4	1.2; 2.7	0.35
GaSe	31.5	0.6	1.4	-
GaTe	18.05	0.83	0.2	-
InSe	11.1	-	-	-
InTe	-	-	-	-
In_2Se_3	36.3	2.3	-	-

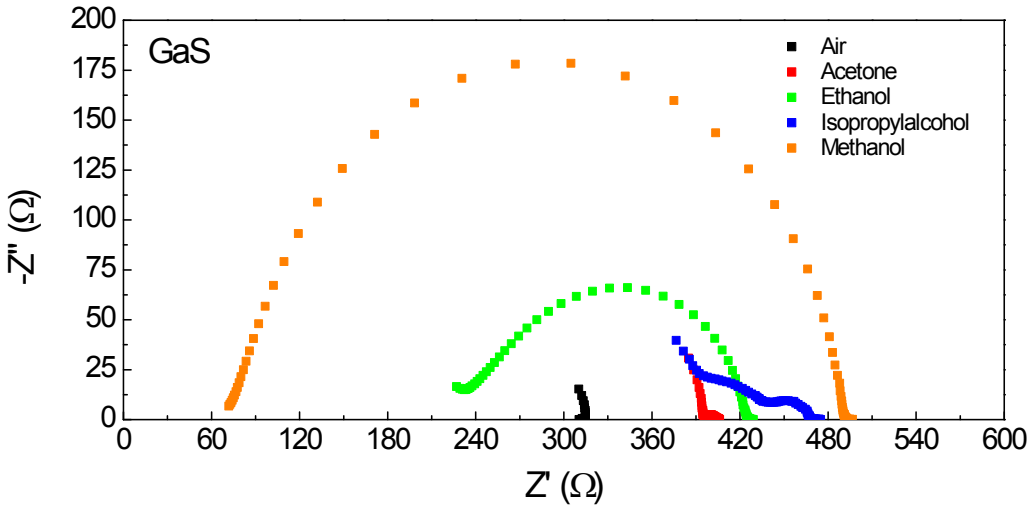

Figure S11. Nyquist diagrams for GaS sensor.

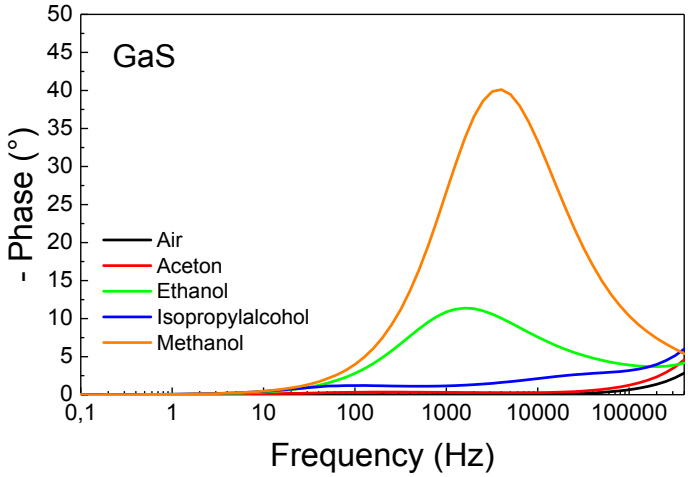

Figure S12. Bode diagrams for GaSe sensor.

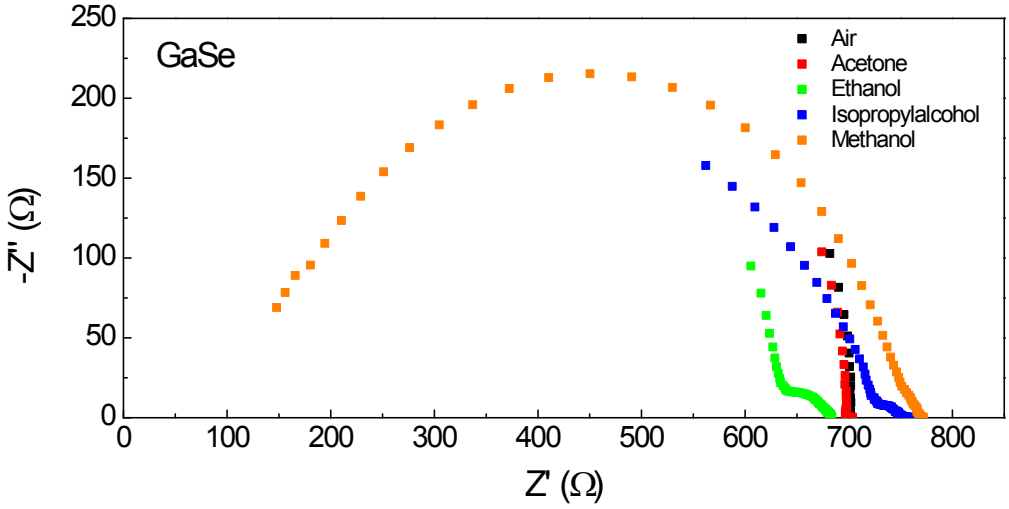

Figure S13. Nyquist diagrams for GaSe sensor.

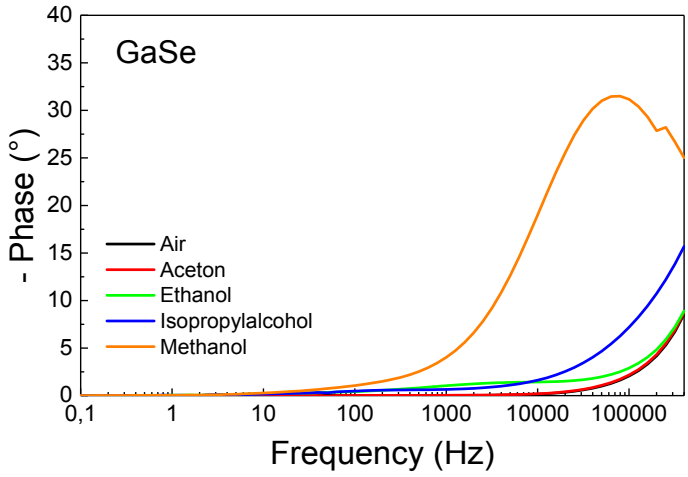

Figure S14. Bode diagrams for GaSe sensor.

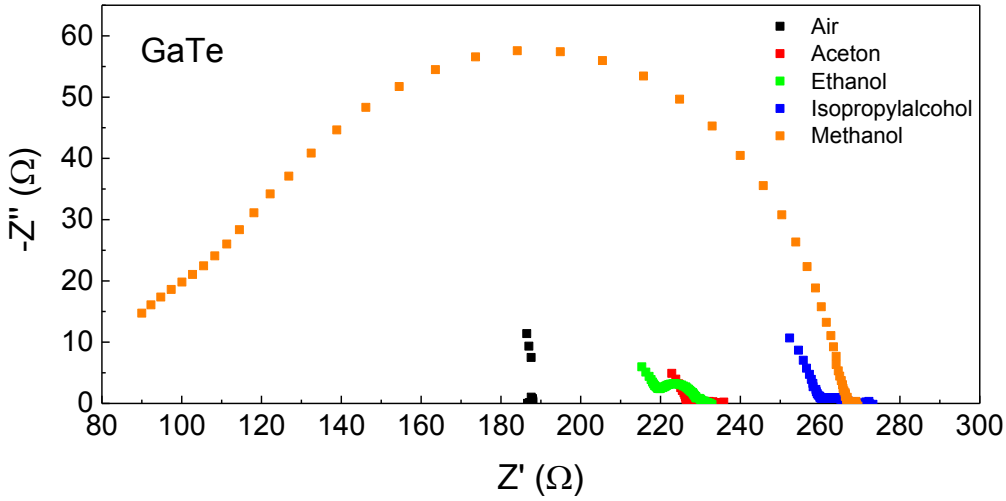

Figure S15. Nyquist diagrams for GaTe sensor.

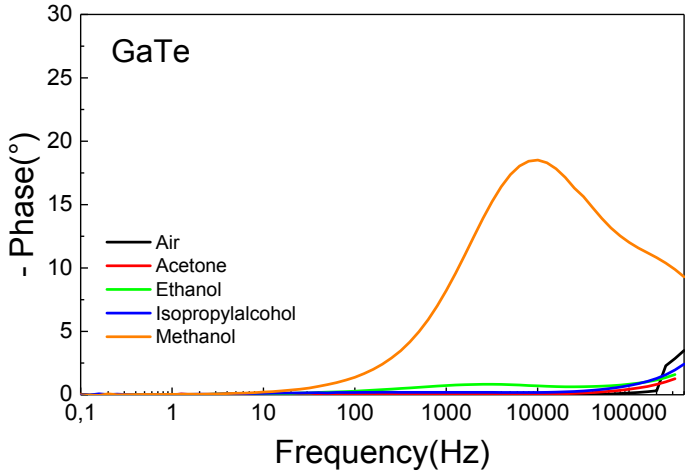

Figure S16. Bode diagrams for GaTe sensor.

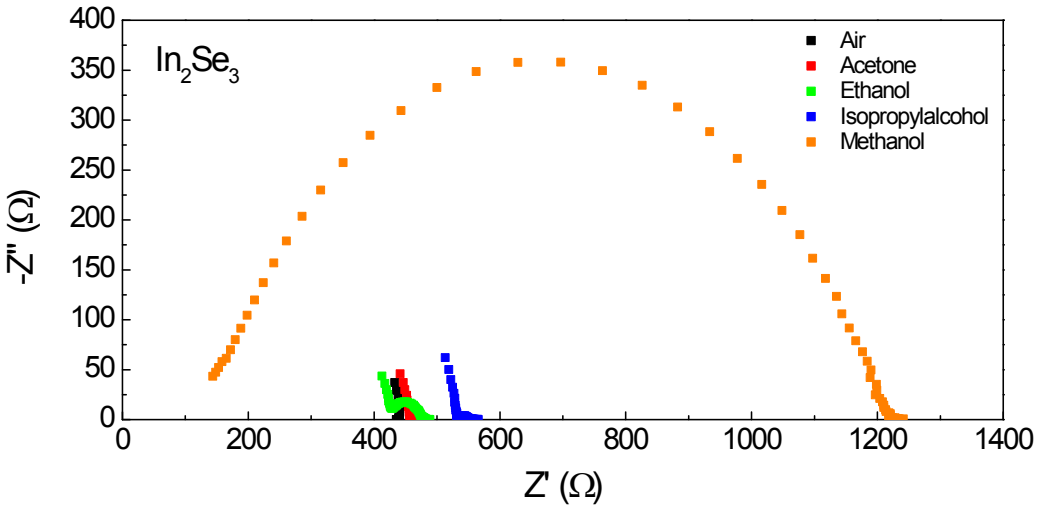

Figure S17. Nyquist diagrams for In_2Se_3 sensor.

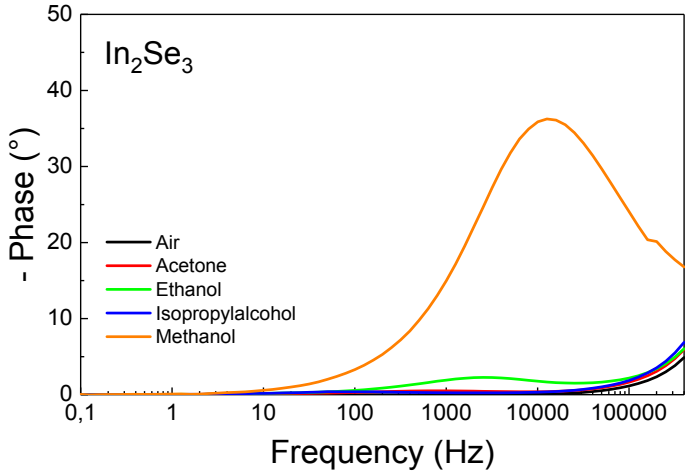

Figure S18. Bode diagrams for In_2Se_3 sensor.

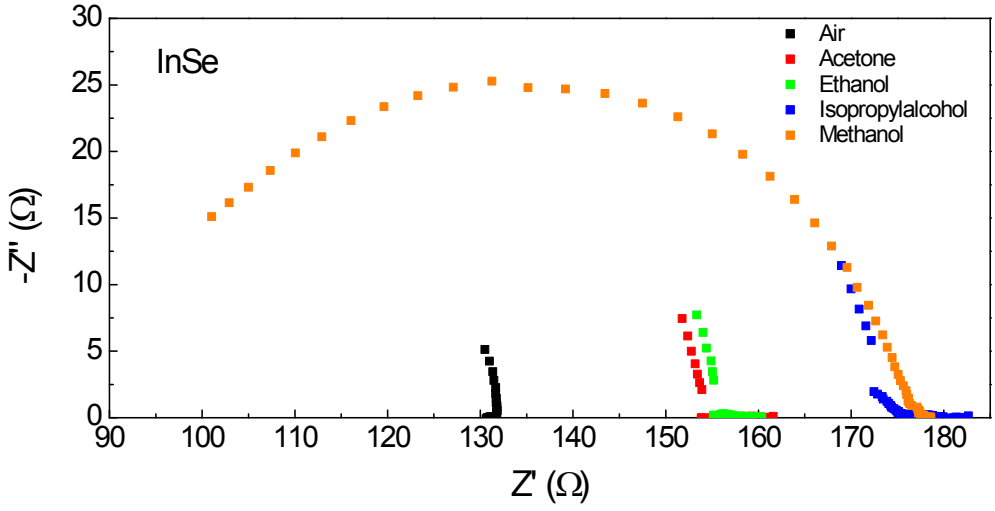

Figure S19. Nyquist diagrams for InSe sensor.

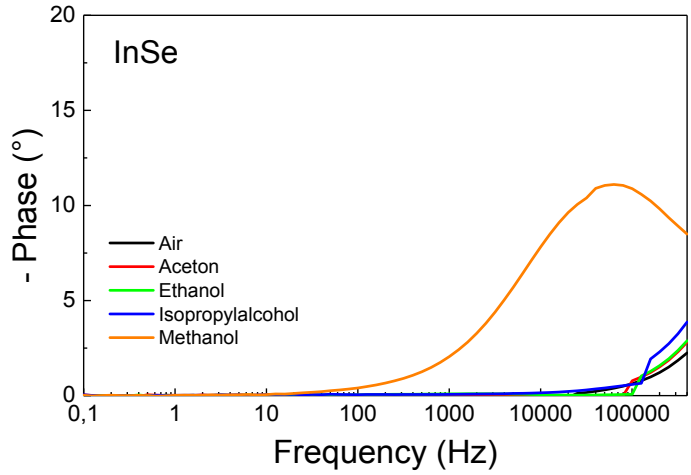

Figure S20. Bode diagrams for InSe sensor.

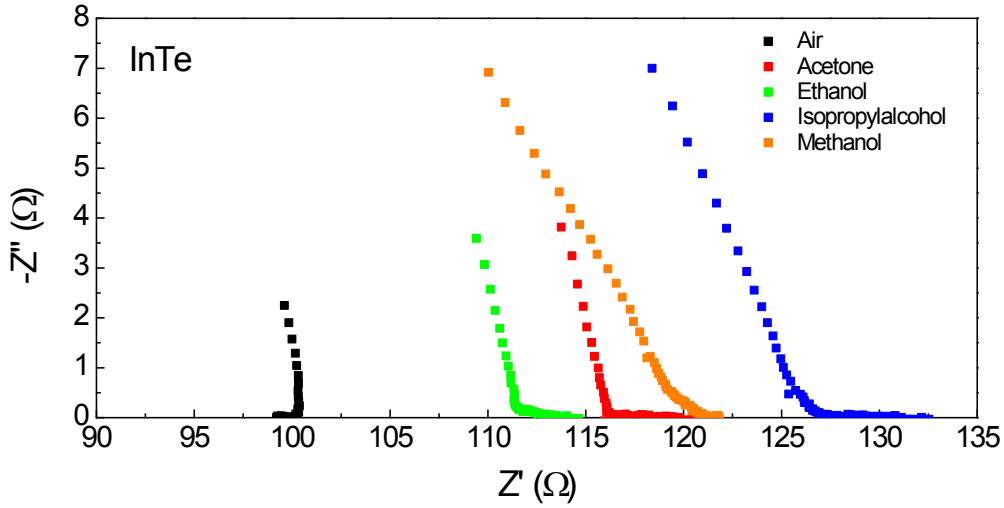

Figure S21. Nyquist diagrams for InTe sensor.

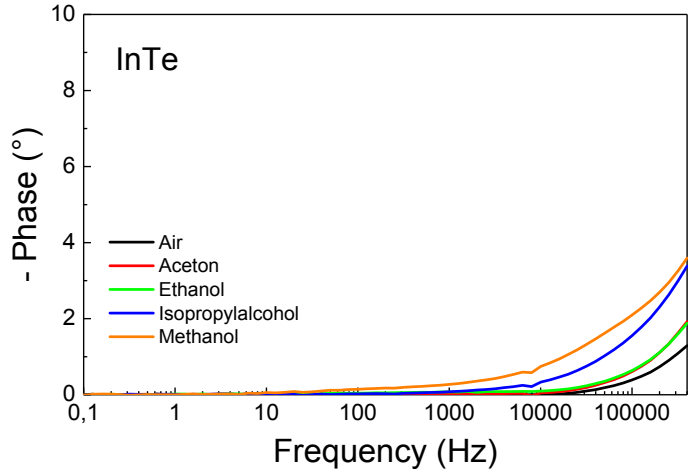

Figure S22. Nyquist diagrams for InTe sensor.

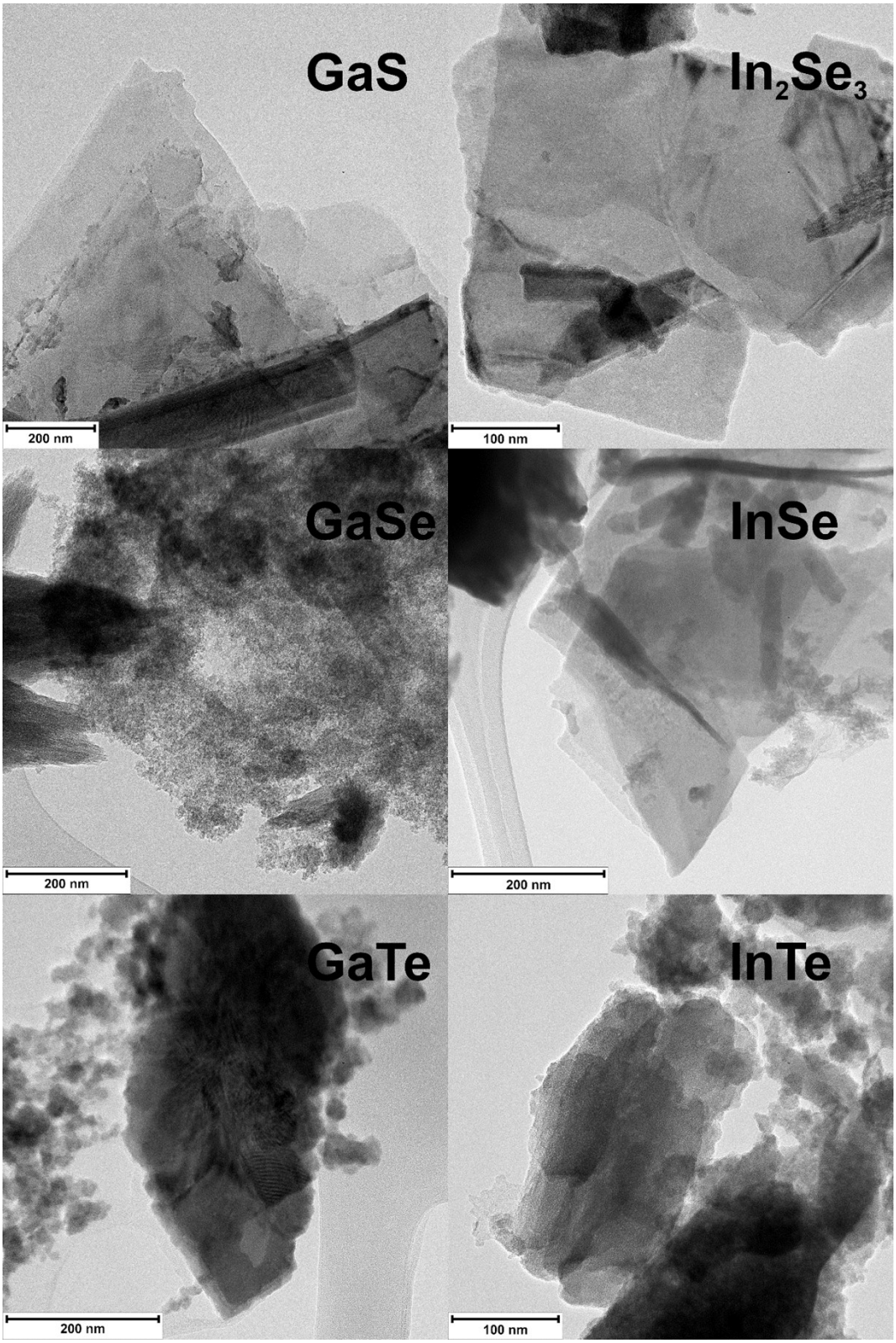

Figure S23. More TEM images of few layered chalcogenides