Electronic Supplementary Information (ESI) for

Acceleration of NO_2 gas sensitivity in two-dimensional $SnSe_2$ by Br doping

Myung Sik Choi,[1†] Geukchan Bang,[2†] Jeongmin Lee,[2] Inseo Kim,[2] Joonho Bang,[3] Seung Yong Lee,[4,5] Kimoon Lee,[*2] and Kyu Hyoung Lee[*4]

[1]School of Nano & Materials Science and Engineering, Kyungpook National University, Sangju 37224, Republic of Korea.

[2]Department of Physics, Kunsan National University, Gunsan 54150, Republic of Korea.

[3]School of Materials Science & Engineering, Gyeongsang National University, Jinju 52828, Republic of Korea.

[4]Department of Materials Science and Engineering, Yonsei University, Seoul 03722, Republic of Korea.

[5]KIURI Institute, Yonsei University, Seoul 03722, Republic of Korea.

[†]These authors contributed equally to this work.

*e-mail : kimoon.lee@kunsan.ac.kr and khlee2018@yonsei.ac.kr

S1. Operational stability test under a humid condition

Figure S1 shows the NO_2 gas sensing characteristics results for 20 ppm under a humid condition (60 RH%). The responsivity to 20 ppm NO_2 gas under 60 RH% is 1.0229, supporting the stability of gas sensing properties.

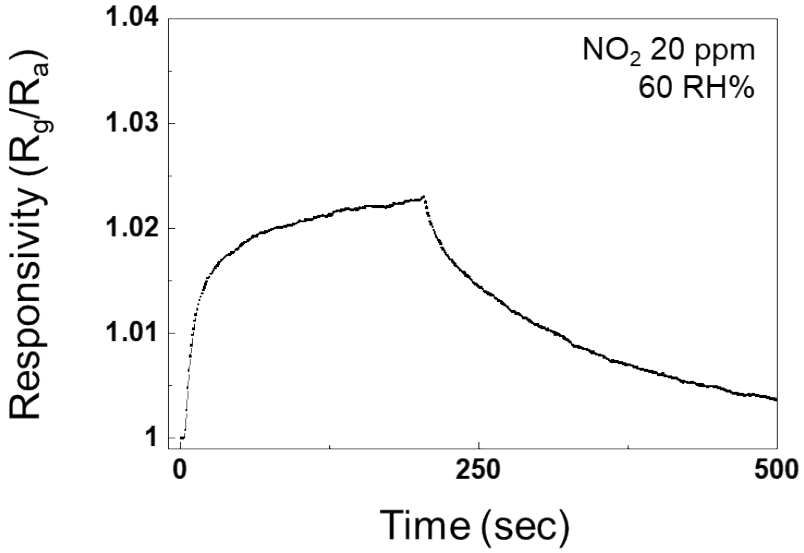

Figure S1. Dynamic responsivity curves of Br-doped $SnSe_2$ (x = 0.004) at 20 ppm NO_2 gas under humidity condition (60 RH%)

S2. Operational stability test under a repeated gas on and off condition

To evaluate the stability of Br-doped $SnSe_2$ gas sensor, we performed the cyclic measurement under a repeated gas on and off condition. As shown in Figure S2, the initial resistance and its gas responsivity values are relatively well retained over five sequential cycles to 1 ppm NO_2 gas at room temperature.

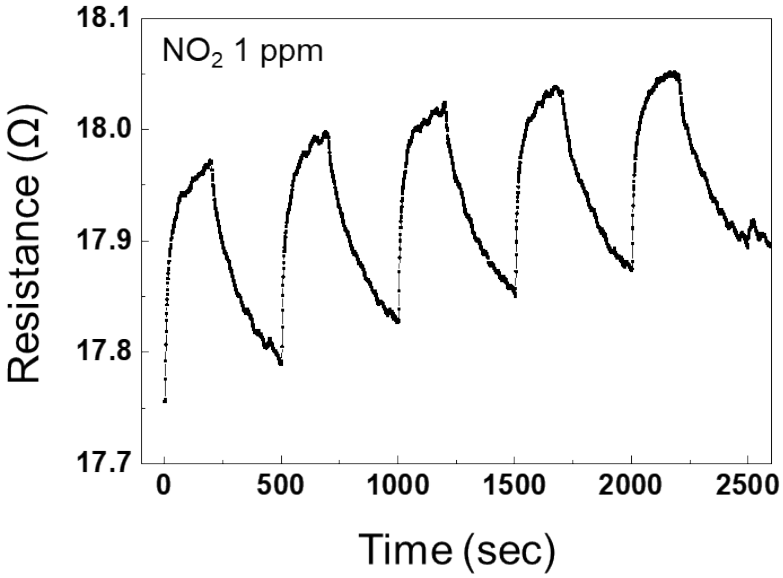

Figure S2. Repeatability of Br-doped $SnSe_2$ (x = 0.004) over five sequential cycles to 1 ppm NO_2 gas at room temperature.

S3. Gas selectivity test

We examine the selectivity of the Br-doped $SnSe_2$ gas sensor by exposing it to 20 ppm H_2S gas. (Figure S3) The corresponding responsivity values is 1.0094 which is much inferior to 1.0338 with the same concentration of NO_2 one, strongly suggesting an excellent selectivity to NO_2 gas.

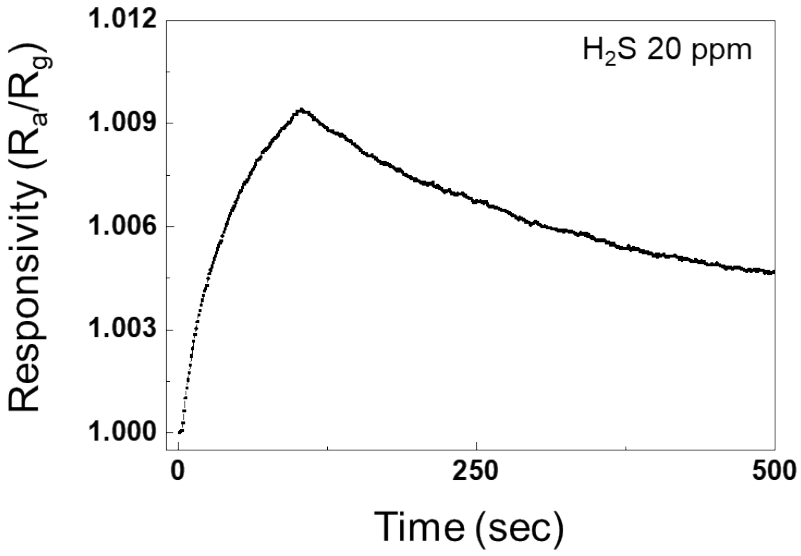

Figure S3. Dynamic responsivity curves of Br-doped $SnSe_2$ (x = 0.004) gas sensor to 20 ppm H_2S gas

S4. Comparison of gas sensing properties

Table S1. Comparison of NO_2 gas sensing properties in various 2D materials including our Br-doped $SnSe_2$

Material	NO_2 responsivity (Concentration)	Operational condition	Ref.
1L Gr	28 % (10 ppm)	100 – 165 °C	*Small*, **10**, 3685 (2014)
RGO	74.3 % (5 ppm)	RT	*J. Mater. Chem. C*, **5**, 6862 (2017)
Gr/MoS_2	7 % (5 ppm)	150 °C	*ACS Appl. Mater. Interf.* **7**, 16775 (2015)
N/Si co-doped Gr nanosheets	26 % (21 ppm)	RT	*J. Mater. Chem. A*, **1**, 6130 (2013)
RGO/porous PEDOT	33 % (10 ppm)	RT	*ACS Appl. Mater. Interf.* **6**, 13807 (2014)
Flexible Ag-S-RGO	45 % (10 ppm)	RT	*ACS Appl. Mater. Interf.* **6**, 7426 (2014)
Holey RGO nanosheets	54 % (12.5 ppm)	RT	*J. Mater. Chem. A*, **2**, 17415 (2014)
Sulfonated RGO	58 % (10 ppm)	RT	*Adv. Mater.* **25**, 766 (2013)
RGO/In-SnO_2 nanohybrids	75 % (10 ppm)	RT	*J. Mater. Chem. A*, **1**, 4462 (2013)
PGNS	75 % (5 ppm)	RT	*ACS Nano*, **12**, 2521 (2018)
MoS_2 atomic layer	15 % (5 ppm)	RT	*Sci. Rep.* **5**, 8252 (2015)
MoS_2 single layer	120 % (1 ppm)	RT	*ACS Appl. Mater. Interf.* **7**, 2952 (2015)

MoS_2 2 layers	2.6 % (1 ppm)	RT	*J. Alloys Compd.* **725**, 253 (2017)
MoS_2 5 layers	30 % (100 ppm)	RT	*ACS Nano*, **7**, 4879 (2013)
WS_2 multilayers	68.4 % (5 ppm)	RT	*Sens. Actuators B*, **259**, 789 (2018)
$SnSe_2$ 10 layers	60 % (1 ppm)	UV light	*ACS Sens.* **4**, 2546 (2019)
$SnSe_2$ bulky single crystal	**3.38 % (20 ppm)**	**RT**	**Our work**