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Supporting Information

for

Nickel nanoparticle-decorated reduced graphene oxide/WO_3 nanocomposite – a promising candidate for gas sensing

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Comparison with other gas sensors as well as the sensor response figures for CO and acetone

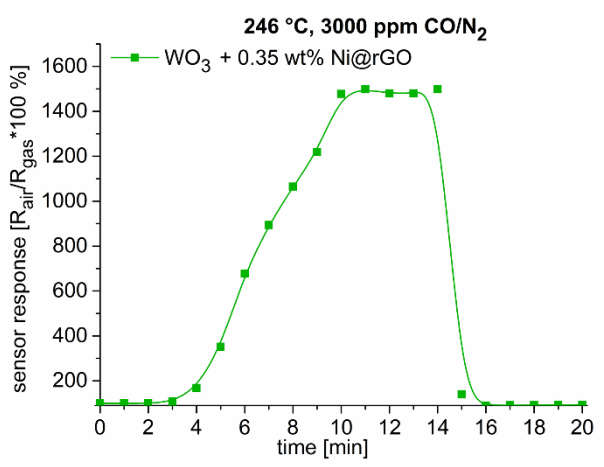

Figure S1: Time dependence of the sensor response of the 0.35 wt % Ni@rGO/WO_3 (green) samples under exposure to a CO vapor in nitrogen gas mixture at 3000 ppm. Response time: 0.35 wt % Ni@rGO/WO_3 (ca. 7 min.) Recovery time: 0.35 wt % Ni@rGO/WO_3 (ca. 2 min.)

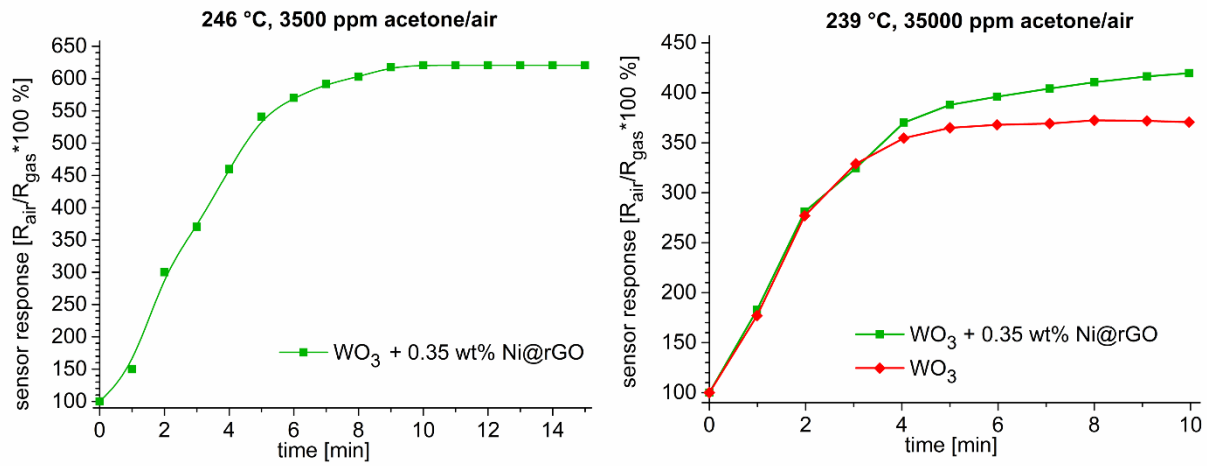

Figure S2: Left: time dependence of the sensor resistance values of the 0.35 wt % Ni@rGO/WO_3 samples (green) under exposure to an acetone vapor in air mixture at 3500 ppm. Right: time dependence of the sensor resistance values of the 0.35 wt % Ni@rGO/WO_3 (green) and WO_3 (red) samples under exposure to an acetone vapor in air mixture at 35000 ppm.

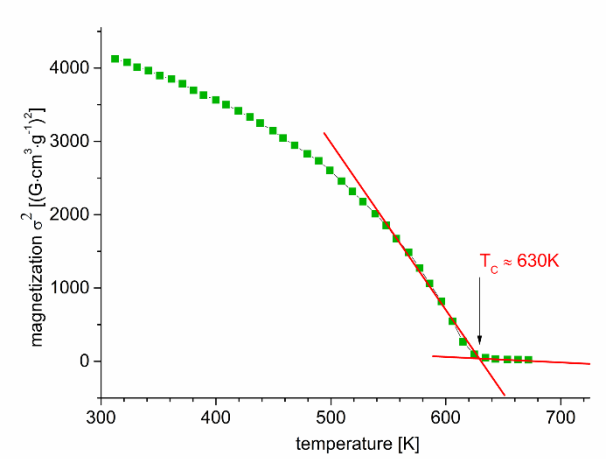

Figure S3: Square of the magnetization as a function of temperature for the reference sample of ferromagnetic nickel powder. Curie temperature T_c = 630 K.

Sensing materials – examples form literature

Table S1: A summary of graphene-based gas sensor characteristics for NO_2 gas.

Sensing Material	T_{res} **(s)**	**Detection Limit**	T_{rec} **(s)**	**Ref.**
GR	3000	4 / 100 ppb	3000	[1]
Ozone-treated GR	900	1.3 ppb	1800	[2]
rGO/hydrasine + WO_3	25	5 ppm (250 °C)	200	[3]
Multilayred GR	1800	6 / 1 ppm	–	[4]
rGO + NiO	125	200% / 1 ppm (200 °C)	250	[5]
FGO/$FeCl_3$+α-Fe_2O_3	80	180 ppb	44	[6]
rGO/hydrasine + ZnO	165	25.6 / 5 ppm (RT)	499	[7]
rGO+SnO_2 aerogel	190	50 ppm	224	[8]
SnO_2/S-rGO	40	26.3 / 20 ppm (RT)	357	[8]
rGO/$NaBH_4$	420	11.5% / 5 ppm	1680	[9]
rGO+SnO_2	75	3.3 / 5 ppm (50 °C)	300	[10]
rGO/WO_3	540	769% / 5 ppm (RT)	1080	[11]
rGO/In_2O_3	240	8.2 / 30 ppm	1440	[12]
WO_3/GR	–	202% / 20 ppm (300 °C)	–	[13]
MWCNTs/WO_3	10.5	77 / 5 ppm (RT)	20	[14]
WO_3/S-rGO	6	149% / 20 ppm (RT)	56	[15]
WO_3/rGO	250	40.8 / 56 ppm (RT)	–	[16]
WO_3/GR	0.42–3.3	96 / 1 ppm	0.42–3.3	[3]
NiO/SnO_2/rGO	220	62.27 / 60 ppm (RT)	835	[17]
(InOx/SnO_2)+rGO	400	22 / 100 ppm (RT)	–	[18]
FeOx/WO_3/rGO	1500	5.9 / 3 ppm (RT)	7200	[19]
Ag/rGO/SnO_2	49	2.17 / 5 ppm (RT)	339	[20]
0.35 wt % Ni/rGO/WO_3	540	295% / 10 ppm (240 °C)	–	this work
1.00 wt % Ni/rGO/WO_3	540	192% / 10 ppm (240 °C)	–	this work

Table S2: A summary of graphene-based gas sensor characteristics for acetone gas.

Sensing Material	T_{res} **(s)**	**Detection Limit**	T_{rec} **(s)**	**Ref.**
rGO/SnO_2 NFs	<198	100 ppb (350 °C)	<114	[21]
rGO/$ZnFe_2O_4$	4	10 ppm (275 °C)	18	[22]
Co_3O_4 NFs + Ir NPs + GO	–	1.18 / 120 ppb (300 °C)	–	[23]
SnO_2/rGO	198	1000 / 5 ppm	114	[21]
SnO_2/GO		200% / 200 ppm		[24]
CuO/ZnO/rGO		9.4 / 10 ppm		[25]
WO_3/Pt/rGO	14.1	12.2 / 10 ppm (200 °C)	16.8	[26]
NiO/SnO_2/GR	5.4	2.17 /200 ppm (150-350 °C)	150	[27]
0.35 wt % Ni/rGO/WO_3	660	620% / 3500 ppm (246 °C)	–	this work
0.35 wt % Ni/rGO/WO_3	660	420% / 35000 ppm (239 °C)	–	this work

Table S3: A summary of graphene-based gas sensor characteristics for CO gas.

Sensing Material	T_{res} **(s)**	**Detection Limit**	T_{rec} **(s)**	**Ref.**
CuO+rGO	70	2.56% / 1 ppm	160	[28]
0.35 wt % Ni/rGO/WO_3	420	1480% / 3000 ppm (in N_2)	120	this work

rGO – reduced graphene oxide, GO – Graphene oxide, GR – graphene; NPs – nanoparticles, NFs – nanofibers, DL – detection limit or response value at minimum measured concentration; T_{res} – period of time from gas sensor contact with gas to be detected to variation of resistance reach to 90% of R_a/R_g; T_{rec} – period of time from gas sensor away from gas to be detected to variation of resistance reach to 90% of R_a/R_g; RT = room temperature

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