Table 3-1 Specimen designation of the as-deposited nanostructures and their deposition conditions (for different deposition times)

Specimen designation[1,2]	Catalyst	H_2/CH_4 (sccm/sccm)	deposition time (min)	Substrate temperature (℃)	Working pressure (Torr)	Remarks (The as-deposited morphology of the nanostructures)
A1	Co	100/1	1	285	9	Fig. 4-1 (a)
A2	Co	100/1	3	446	9	Fig. 4-1 (b)
A3	Co	100/1	5	537	9	Fig. 4-1 (c)
A4	Co	100/1	10	603	9	Fig. 4-1 (d)
A5	Co	100/1	20	617	9	Fig. 4-1 (e)
A6	Co	100/1	40	604	9	Fig. 4-1 (f)
B1	Ni	100/1	1	285	9	Fig. 4-2 (a)
B2	Ni	100/1	3	446	9	Fig. 4-2 (b)
B3	Ni	100/1	5	537	9	Fig. 4-2 (c)
B4	Ni	100/1	10	603	9	Fig. 4-2 (d)
B5	Ni	100/1	20	617	9	Fig. 4-2 (e)
B6	Ni	100/1	40	604	9	Fig. 4-2 (f)
C1	Fe	100/1	1	285	9	Fig. 4-3 (a)
C2	Fe	100/1	3	446	9	Fig. 4-3 (b)
C3	Fe	100/1	5	537	9	Fig. 4-3 (c)
C4	Fe	100/1	10	603	9	Fig. 4-3 (d)
C5	Fe	100/1	20	617	9	Fig. 4-3 (e)
C6	Fe	100/1	40	604	9	Fig. 4-3 (f)
D1	×	100/1	1	285	9	Fig. 4-4 (a)
D2	×	100/1	3	446	9	Fig. 4-4 (b)
D3	×	100/1	5	537	9	Fig. 4-4 (c)
D4	×	100/1	10	603	9	Fig. 4-4 (d)
D5	×	100/1	20	617	9	Fig. 4-4 (e)
D6	×	100/1	40	604	9	Fig. 4-4 (f)

NOTE：

[1]H-plasma pretreatment conditions: substrates = 10 nm thickness Co-, Ni- and Fe-coated Si [(100) p-type] wafers, H_2 = 100 sccm, microwave power = 400 W, working pressure = 14 Torr, substrate bias = 0 V, substrate temperature = ~ 428^{o}C and 10 min pretreatment time.

[2]Other deposition conditions: microwave power = 800 W, substrate bias = -320 V.

×: bare Si [(100) p-type] wafers.

Table 3-2 Specimen designation of the as-deposited carbon nanostructures and their deposition conditions (for different working pressures)

Specimen designation[1,2]	**Catalyst**	**H_2/CH_4 (sccm/sccm)**	**deposition time (min)**	**Substrate temperature (℃)**	**Working pressure (Torr)**	**Remarks (The as-deposited morphology of the carbon nanostructures)**
A7	Co	100/1	20	621	16	Fig. 4-10 (a)、(b)
A8	Co	100/1	20	641	23	Fig. 4-10 (c)、(d)
A9	Co	100/1	20	643	30	Fig. 4-10 (e)、(f)
B7	Ni	100/1	20	621	16	Fig. 4-11 (a)、(b)
B8	Ni	100/1	20	641	23	Fig. 4-11 (c)、(d)
B9	Ni	100/1	20	643	30	Fig. 4-11 (e)、(f)
C7	Fe	100/1	20	621	16	Fig. 4-12 (a)、(b)
C8	Fe	100/1	20	641	23	Fig. 4-12 (c)、(d)
C9	Fe	100/1	20	643	30	Fig. 4-12 (e)、(f)

NOTE：

[1]H-plasma pretreatment conditions: substrates = 10 nm thickness Co-, Ni- and Fe-coated Si [(100) p-type] wafers, H_2 =100 sccm, microwave power = 400 W, working pressure = 14 Torr, substrate bias = 0 V, substrate temperature = ~ 428^{o}C and 10 min pretreatment time.

[2]Other deposition conditions: microwave power = 800 W, substrate bias = -320 V.

Table 3-3 Specimen designation of the as-deposited carbon nanostructures and their deposition conditions (for different H_2/CH_4 flow ratios)

Specimen designation[1,3]	**Catalyst**	**H_2/CH_4 (sccm/sccm)**	**Substrate temperature (℃)**	**Remarks (The as-deposited morphology of the carbon nanostructures)**
E1	Co	100/5	540	Fig. 4-13 (a)
E2	Co	100/10	575	Fig. 4-13 (b)
E3	Co	100/20	630	Fig. 4-13 (c)
E4	Co	100/30	635	Fig. 4-13 (d)
E5	Co	100/50	658	Fig. 4-13 (e)
E6	Co	100/70	599	Fig. 4-13 (f)
E7	Co	100/85	591	Fig. 4-13 (g)
E8	Co	100/100	583	Fig. 4-13 (h)
F1	Ni	100/5	540	Fig. 4-14 (a)
F2	Ni	100/10	575	Fig. 4-14 (b)
F3	Ni	100/20	630	Fig. 4-14 (c)
F4	Ni	100/30	635	Fig. 4-14 (d)
F5	Ni	100/50	658	Fig. 4-14 (e)
F6	Ni	100/70	599	Fig. 4-14 (f)
F7	Ni	100/85	591	Fig. 4-14 (g)
F8	Ni	100/100	583	Fig. 4-14 (h)
G1	Fe	100/5	540	Fig. 4-15 (a)
G2	Fe	100/10	575	Fig. 4-15 (b)
G3	Fe	100/20	630	Fig. 4-15 (c)
G4	Fe	100/30	635	Fig. 4-15 (d)
G5	Fe	100/50	658	Fig. 4-15 (e)
G6	Fe	100/70	599	Fig. 4-15 (f)
G7	Fe	100/85	591	Fig. 4-15 (g)
G8	Fe	100/100	583	Fig. 4-15 (h)

NOTE：

[1]H-plasma pretreatment conditions: substrates = 10 nm thickness Co-, Ni- and Fe-coated Si [(100) p-type] wafers, H_2 =100 sccm, microwave power = 400 W, working pressure = 14 Torr, substrate bias = 0 V, substrate temperature = ~ 428^{o}C and 10 min pretreatment time.

[3]Other deposition conditions: microwave power = 800 W, working pressure = 9 Torr, substrate bias = -320 V and 10 min deposition time.

Table 3-4 Specimen designation of the as-deposited carbon nanostructures and their deposition conditions (for H_2/CH_4 =0/1 (sccm/sccm))

Specimen designation[1,2]	Catalyst	H_2/CH_4 (sccm/sccm)	Deposition time (min)	Substrate temperature (℃)	Working pressure (Torr)	Remarks (The as-deposited morphology of the carbon nanostructures)
H1	Co	0/1	1	271	9	Fig. 4-16 (a)
H2	Co	0/1	2	389	9	Fig. 4-16 (b)
H3	Co	0/1	3	447	9	Fig. 4-16 (c)
H4	Co	0/1	4	481	9	Fig. 4-16 (d)
H5	Co	0/1	5	578	9	Fig. 4-16 (e)
H6	Co	0/1	10	596	9	Fig. 4-16 (f)
H7	Co	0/1	20	603	9	Fig. 4-16 (g)
I1	Ni	0/1	1	271	9	Fig. 4-17 (a)
I2	Ni	0/1	2	389	9	Fig. 4-17 (b)
I3	Ni	0/1	3	447	9	Fig. 4-17 (c)
I4	Ni	0/1	4	481	9	Fig. 4-17 (d)
I5	Ni	0/1	5	578	9	Fig. 4-17 (e)
I6	Ni	0/1	10	596	16	Fig. 4-17 (f)
I7	Ni	0/1	20	603	23	Fig. 4-17 (g)
J1	Fe	0/1	1	271	9	Fig. 4-18 (a)
J2	Fe	0/1	2	389	9	Fig. 4-18 (b)
J3	Fe	0/1	3	447	9	Fig. 4-18 (c)
J4	Fe	0/1	4	481	9	Fig. 4-18 (d)
J5	Fe	0/1	5	578	9	Fig. 4-18 (e)
J6	Fe	0/1	10	596	9	Fig. 4-18 (f)
J7	Fe	0/1	20	603	9	Fig. 4-18 (g)

NOTE：

[1]H-plasma pretreatment conditions: substrates = 10 nm thickness Co-, Ni- and Fe-coated Si [(100) p-type] wafers, H_2 = 100 sccm, microwave power = 400 W, working pressure = 14 Torr, substrate bias = 0 V, substrate temperature = ~ 428^{o}C and 10 min pretreatment time.

[2]Other deposition conditions: microwave power = 800 W, substrate bias = -320 V.

Table 3-5 Specimen designation of the as-deposited nanostructures and their deposition conditions (for H_2/CH_4 =100/0 (sccm/sccm))

Specimen designation[1,2]	Catalyst	H_2/CH_4 (sccm/sccm)	Deposition time (min)	Substrate temperature (℃)	Working pressure (Torr)	Remarks (The as-deposited morphology of the nanostructures)
K1	Co	100/0	1	300	9	Fig. 4-19 (a)
K2	Co	100/0	3	415	9	Fig. 4-19 (b)
K3	Co	100/0	5	479	9	Fig. 4-19 (c)
K4	Co	100/0	10	538	9	Fig. 4-19 (d)
K5	Co	100/0	20	551	9	Fig. 4-19 (e)
K6	Co	100/0	40	583	9	Fig. 4-19 (f)
L1	Ni	100/0	1	300	9	Fig. 4-19 (g)
L2	Ni	100/0	3	415	9	Fig. 4-20 (b)
L3	Ni	100/0	5	479	9	Fig. 4-20 (c)
L4	Ni	100/0	10	538	9	Fig. 4-20 (d)
L5	Ni	100/0	20	551	9	Fig. 4-20 (e)
L6	Ni	100/0	40	583	9	Fig. 4-20 (f)
M1	Fe	100/0	1	300	9	Fig. 4-21 (a)
M2	Fe	100/0	3	415	9	Fig. 4-21 (b)
M3	Fe	100/0	5	479	9	Fig. 4-21 (c)
M4	Fe	100/0	10	538	9	Fig. 4-21 (d)
M5	Fe	100/0	20	551	9	Fig. 4-21 (e)
M6	Fe	100/0	40	583	9	Fig. 4-21 (f)

NOTE：

[1]H-plasma pretreatment conditions: substrates = 10 nm thickness Co-, Ni- and Fe-coated Si [(100) p-type] wafers, H_2 = 100 sccm, microwave power = 400 W, working pressure = 14 Torr, substrate bias = 0 V, substrate temperature = ~ 428^{o}C and 10 min pretreatment time.

[2]Other deposition conditions: microwave power = 800 W, substrate bias = -320 V.

Table 3-6 Process conditions of H-plasma post-treatment

Specimen designation[4]	Post-treatment condition[1]	H-plasma etching time (min)	Substrate temperature (℃)	Remarks (The post-treated morphology of the nanostructures)
A5, B5, C5	Post1	1	651	Fig. 4-25, 4-26, 4-27 (a)
A5, B5, C5	Post2	3	630	Fig. 4-25, 4-26, 4-27 (b)
A5, B5, C5	Post3	5	641	Fig. 4-25, 4-26, 4-27 (c)
A5, B5, C5	Post4	7	613	Fig. 4-25, 4-26, 4-27 (d)
A5, B5, C5	Post5	10	665	Fig. 4-25, 4-26, 4-27 (e)
A5, B5, C5	Post6	20	678	Fig. 4-25, 4-26, 4-27 (f)
H4, I4, J4	Post1	1	510	Fig. 4-29, 4-30, 4-31 (a)
H4, I4, J4	Post2	3	581	Fig. 4-29, 4-30, 4-31 (b)
H4, I4, J4	Post3	5	633	Fig. 4-29, 4-30, 4-31 (c)
H4, I4, J4	Post4	7	671	Fig. 4-29, 4-30, 4-31 (d)
H4, I4, J4	Post5	10	660	Fig. 4-29, 4-30, 4-31 (e)
H4, I4, J4	Post6	20	629	Fig. 4-29, 4-30, 4-31 (f)

NOTE：

[4]The other parameters of H-plasma post-treatment：H_2= 100 sccm, microwave power = 800 W, working pressure =9 Torr, substrate bias = -320 V.