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Variable Parameters

Power = 215 - 415 W
MIPSCP = 2.0 - 3.3 g/min
O₂ = 25 - 125 sccm

Fixed Parameters

Temp = 400 °C
Spacing = 380 mils
He Carrier = 1500 sccm
Pressure = 7.5 Torr

DOE Run #	Power (Watts)	O ₂ (sccm)	MIPSCP (mg/min)	Deposition Rate (nm/min)	RI (632 nm)	AD NU (%)	Elastic Modulus (GPa)	Hardness (GPa)	XPS Carbon (%)	Si(CH ₃) ₂ /SiO _x *E2	Si(CH ₃) ₂ /SiO _x *E3	Si(CH ₃) ₂ /SiO _x *E4	Si(CH ₃) ₂ /SiO _x *E5	Si(CH ₃) ₂ /SiO _x *E6	Si(CH ₃) ₂ /SiO _x *E7
1	315	75	2650	49	1.407	1.7	2.90	12	1.7	18	2.9	23.5	3.6	13%	6
2	315	75	2650	49	1.407	1.6	2.90	12	1.7	18	2.9	23.5	3.6	13%	6
3	315	75	2650	48	1.407	1.6	2.91	12	1.7	18	2.9	23.6	3.6	13%	6
4	415	125	3300	73	1.398	1.7	2.88	11	1.5	17	3.1	25.0	3.6	12%	5
5	415	125	2000	101	1.419	2.2	2.99	15	2.1	17	2.4	20.0	2.9	13%	6
6	415	25	3300	59	1.458	1.7	2.91	13	1.8	29	2.9	16.5	10.5	39%	17
7	415	25	2000	80	1.488	2.7	3.05	17	2.3	31	2.6	13.9	10.7	44%	19
8	215	125	3300	24	1.374	3.3	3.13	11	1.5	12	2.7	24.2	1.1	4.4%	1
9	215	125	2000	36	1.381	1.9	3.20	13	1.8	12	2.5	22.7	1.0	4.3%	3
10	215	25	3300	17	1.410	2.3	2.87	11	1.6	20	2.9	23.3	4.3	16%	9
11	215	25	2000	28	1.427	2.3	2.92	13	1.8	21	2.7	20.5	4.7	19%	12
12	415	75	2650	83	1.425	2.1	2.92	13	1.8	22	2.8	20.8	5.1	20%	10
13	215	75	2650	25	1.390	1.4	2.91	11	1.6	14	2.9	25.3	2.1	7.7%	5
14	315	125	2650	52	1.392	1.4	2.93	12	1.6	15	2.9	25.0	2.2	8.0%	6
15	315	25	2650	41	1.443	2.1	2.92	14	1.7	25	2.8	18.8	7.3	28%	17
16	315	75	3300	40	1.400	1.4	2.82	11	1.6	17	3.0	24.8	3.5	12%	6
17	315	75	2000	62	1.420	2.2	2.95	14	2.0	18	2.6	21.4	3.3	13%	7

FIG. 1

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Fixed Parameters
Temp = 400 °C
Spacing = 380 mils
 He Carrier = 1500 sccm
 Pressure = 7.5 Torr

Variable Parameters
 Power = 215 - 415 W
 MESCP = 2.0 - 3.3 g/min
 O₂ = 25 - 125 sccm

DOE Run #	Power (W)	O ₂ (sccm)	MESCP (mg/min)	Deposition Rate (nm/min)	RI (632 nm)	AD NU (%)	k	Elastic Modulus (GPa)	Hardness (GPa)	XPS Carbon (%)	Si(CH ₃) ₃ /SiO _x *100	Si(CH ₃) ₃ /SiO _x *IE3	Si(CH ₃) ₃ /Si(CH ₃)CH ₂ Si/SiO _x *IE3	Si(CH ₃)CH ₂ Si in the Si(CH ₃) ₃ IR Band	SiCH ₂ Si/SiO _x *IE4	CH ₄ /SiO _x *IE2
1	315	75	2650	55	1.411	1.6	2.96	12	1.8	19	3.0	23.6	4.2	15%	7	1.9
2	315	75	2650	55	1.410	1.7		12	1.8	19	3.0	23.7	4.2	15%	7	1.9
3	315	75	2650	54	1.410	1.6	2.95	11	1.7	19	3.0	23.7	4.2	15%	8	1.9
4	415	125	3300	82	1.401	1.6	2.94	10	1.5	18	3.1	25.1	4.2	14%	6	1.9
5	415	25	3300	52	1.466	1.6	3.05	14	2.0	29	2.8	16.1	10.5	39%	23	3.4
6	415	125	2000	108	1.420	2.1	3.06	14	2.1	18	2.5	20.3	3.3	14%	7	1.7
7	415	25	2000	74	1.498	2.4	3.17	18	2.6	33	2.6	13.5	11.3	46%	29	3.7
8	215	125	3300	27	1.373	2.5	3.04	11	1.5	12	3.0	26.0	1.5	5.6%	3	1.1
9	215	25	3300	18	1.414	1.9	2.93	11	1.6	20	2.9	22.6	4.8	18%	10	2.0
10	215	125	2000	40	1.381	1.7	3.13	12	1.7	12	2.8	24.4	1.5	6%	3	1.0
11	215	25	2000	28	1.432	2.2	2.98	14	1.9	22	2.7	20.1	5.1	20%	12	2.0
12	415	75	2650	89	1.434	2.0	2.96	13	1.9	23	2.8	20.5	5.7	22%	11	2.6
13	215	75	2650	30	1.392	1.4	2.92	11	1.6	14	3.1	26.1	2.8	9.8%	5	1.5
14	315	75	3300	46	1.405	1.4	2.89	11	1.6	19	3.1	24.6	4.3	15%	7	1.9
15	315	75	2000	69	1.424	2.1	2.98	14	2.2	19	2.7	21.6	4.0	16%	9	1.8
16	315	125	2650	61	1.393	1.4	2.94	11	1.7	15	3.0	25.4	2.8	10%	6	1.5
17	315	25	2650	40	1.453	2.2	3.01	14	2.0	26	2.8	18.4	7.4	29%	19	2.8

FIG. 2

COMPARISON OF k = 2.9 MIPSCP AND MESCP BASED LOW K FILMS

	k = 2.9 MIPSCP Based Film	k = 2.9 MESCP Based Film
k	2.92	2.93
Elastic Modulus (GPa)	14	11
Hardness (GPa)	1.7	1.6
RI (632 nm)	1.443	1.414
%C (XPS)	25	20
CH _x /SiO _x *1E2 IR Ratio	2.8	2.0
Si(CH ₃) _x /SiO _x *1E2 IR Ratio	2.8	2.9
% Si(CH ₃)CH ₂ Si in Si(CH ₃) _x IR Band	28	18
SiCH ₂ Si/SiO _x *1E4 IR Ratio	17	9.5
Power (Watts)	315	215
Liquid Flow Rate (mg/min)	2650	3300
O ₂ (sccm)	25	25
Deposition Rate (nm/min)	41	18
AD % NU	2.1	1.9

FIG. 3

COMPARISON OF k = 3.0 MIPSCP AND MESCP BASED LOW K FILMS

	k = 3.0 MIPSCP Based Film	k = 3.0 MESCP Based Film
k	3.05	3.05
Elastic Modulus (GPa)	17	14
Hardness (GPa)	2.3	2.0
RI (632 nm)	1.488	1.466
%C (XPS)	31	29
CH _x /SiO _x *1E2 IR Ratio	3.7	3.4
Si(CH ₃) _x /SiO _x *1E2 IR Ratio	2.6	2.8
% Si(CH ₃)CH ₂ Si in Si(CH ₃) _x IR Band	44	40
SiCH ₂ Si/SiO _x *1E4 IR Ratio	19	23
Power (Watts)	415	415
Liquid Flow Rate (mg/min)	2000	3300
O ₂ (sccm)	25	25
Deposition Rate (nm/min)	80	52
AD % NU	2.7	1.6

FIG. 4

