

Supporting Information

Development of Resonant Cavity Film for 575 nm All-solid-state Laser System

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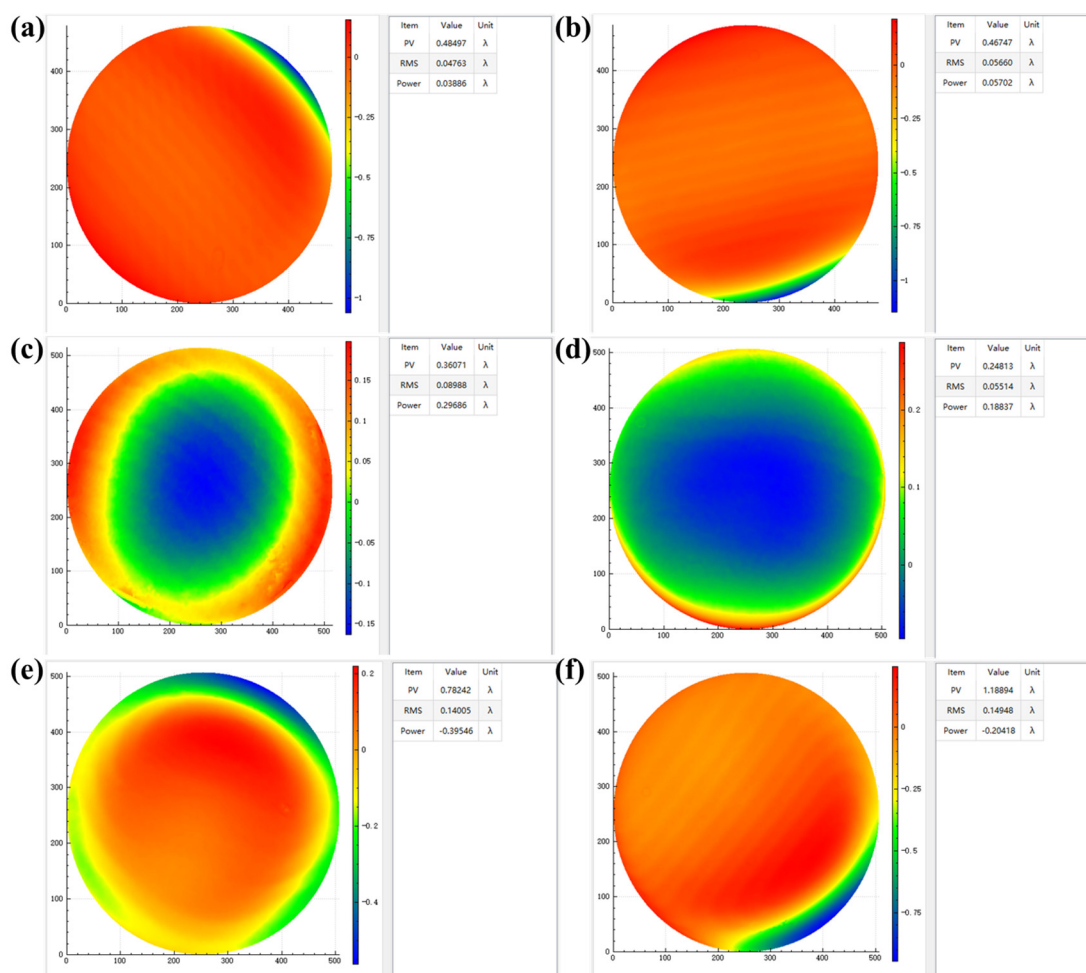


Figure S1. Surface shape test of coated BK7 substrate at different temperatures and uncoated BK7 substrate (a) BK7; (b) 120 °C; (c) 150 °C; (d) 180 °C; (e) 210 °C; (f) 240 °C.

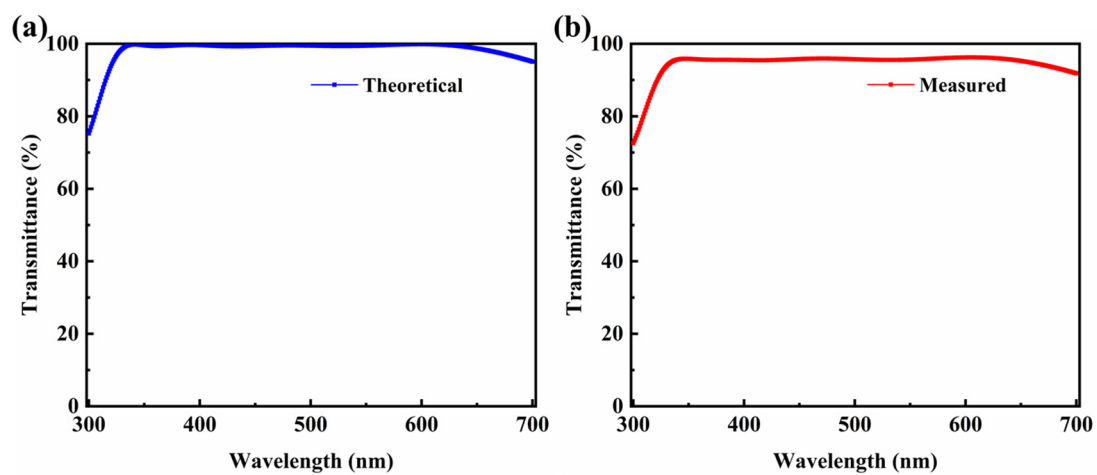


Figure S2. (a) Theoretical and (b) measured transmittance curve of antireflective film (when the second surface was not coated, the substrate/air interface reflectance was 3.7% @550 nm).

Table S1. Output wavelength and output power of each yellow laser band obtained from previous studies and this work.

Laser crystals	Nd:YAG	LiB ₃ O ₅	Nd:YVO ₄	Nd:YVO ₄	Diamond	Nd:YVO ₄	Dy,Tb:LuLiF ₄
Output wavelength (nm)	561	578	579.5	588	572.5	559/588	575
Output power (W)	60.3	0.0375	6.8	13.7	9.2	6.54/5.12	0.106
Year of publication	2012	2016	2020	2020	2021	2021	this work

The variation of the substrate temperature of the ion source affects the denseness of the film, which further leads to the variation of the refractive index of the film. The denseness of a film is expressed in the optical field by the aggregation density. It is reported that the film layers of optical films almost always have a significant columnar structure, which runs across the film and is perpendicular to the interface. The aggregation density is defined as the ratio of the volume of the solid column to the volume of the film, with values typically in the range of 0.75 to 1.0. The refractive index of the film is a function of the aggregation density and the simplest linear approximation is given by the Equation (S1).

$$n_f = pn_s + (1 - p)n_v \quad (S1)$$

Where n_f is the refractive index of the material in solid state, p is the aggregation density, n_s is the refractive index of the material in the solid state, and for HfO₂, n_s = 2.1 at 575 nm, n_v is the refractive index of air, n_v = 1.

It can be seen that the aggregation density of the film at different temperature follows the relationship of Formula (S2).

$$p = \frac{n_f - n_v}{n_s - n_v} \quad (S2)$$

The aggregation density is calculated according to Formula (2), and the results are shown in Table S2.

Table S2. Refractive index and packing density of HfO₂ films under different temperature.

Temperature /°C	Refractive index@575 nm	Packing density
120	2.039	0.945
150	2.049	0.954
180	2.061	0.965
210	2.080	0.982
240	2.078	0.980

Table S3. Each film layer physical thickness of resonant cavity film A.

Number	Materials	Physical thickness(nm)	Number	Materials	Physical thickness(nm)
1	HfO ₂	86.88	26	SiO ₂	100.47
2	SiO ₂	86.58	27	HfO ₂	71.09
3	HfO ₂	83.62	28	SiO ₂	89.19
4	SiO ₂	63.15	29	HfO ₂	77.63
5	HfO ₂	82.77	30	SiO ₂	85.11
6	SiO ₂	80.54	31	HfO ₂	80.43
7	HfO ₂	68.80	32	SiO ₂	88.86
8	SiO ₂	107.04	33	HfO ₂	80.61
9	HfO ₂	45.64	34	SiO ₂	90.71
10	SiO ₂	122.96	35	HfO ₂	79.20
11	HfO ₂	47.52	36	SiO ₂	91.66
12	SiO ₂	135.64	37	HfO ₂	77.82
13	HfO ₂	17.25	38	SiO ₂	102.51
14	SiO ₂	135.65	39	HfO ₂	91.33
15	HfO ₂	16.97	40	SiO ₂	138.91
16	SiO ₂	133.71	41	HfO ₂	78.52
17	HfO ₂	59.02	42	SiO ₂	109.94
18	SiO ₂	118.16	43	HfO ₂	60.29
19	HfO ₂	56.07	44	SiO ₂	117.62
20	SiO ₂	119.74	45	HfO ₂	46.85
21	HfO ₂	60.23	46	SiO ₂	122.53
22	SiO ₂	117.20	47	HfO ₂	52.13
23	HfO ₂	60.75	48	SiO ₂	121.43
24	SiO ₂	110.94	49	HfO ₂	52.24
25	HfO ₂	63.74	50	SiO ₂	60.62

Table S4. Each film layer physical thickness of resonant cavity film B.

Number	Materials	Physical thickness(nm)	Number	Materials	Physical thickness(nm)
1	HfO ₂	40.49	37	HfO ₂	53.33
2	SiO ₂	55.78	38	SiO ₂	66.55
3	HfO ₂	42.41	39	HfO ₂	43.91
4	SiO ₂	65.39	40	SiO ₂	69.90
5	HfO ₂	44.37	41	HfO ₂	58.57
6	SiO ₂	57.09	42	SiO ₂	81.79
7	HfO ₂	36.46	43	HfO ₂	55.02
8	SiO ₂	59.99	44	SiO ₂	80.21
9	HfO ₂	44.12	45	HfO ₂	66.86
10	SiO ₂	60.43	46	SiO ₂	85.28
11	HfO ₂	37.31	47	HfO ₂	53.55
12	SiO ₂	57.01	48	SiO ₂	82.05
13	HfO ₂	43.32	49	HfO ₂	62.67
14	SiO ₂	60.70	50	SiO ₂	79.74
15	HfO ₂	36.04	51	HfO ₂	57.30
16	SiO ₂	54.77	52	SiO ₂	94.48
17	HfO ₂	44.20	53	HfO ₂	68.84
18	SiO ₂	67.06	54	SiO ₂	113.50
19	HfO ₂	45.16	55	HfO ₂	68.47
20	SiO ₂	59.62	56	SiO ₂	90.89
21	HfO ₂	38.34	57	HfO ₂	76.24
22	SiO ₂	59.85	58	SiO ₂	106.55
23	HfO ₂	150.18	59	HfO ₂	71.81
24	SiO ₂	73.50	60	SiO ₂	87.36
25	HfO ₂	47.42	61	HfO ₂	68.41
26	SiO ₂	66.68	62	SiO ₂	97.69
27	HfO ₂	45.81	63	HfO ₂	69.32
28	SiO ₂	67.82	64	SiO ₂	104.74
29	HfO ₂	51.52	65	HfO ₂	63.90
30	SiO ₂	79.94	66	SiO ₂	111.22
31	HfO ₂	53.67	67	HfO ₂	78.98
32	SiO ₂	73.00	68	SiO ₂	124.94
33	HfO ₂	49.52	69	HfO ₂	99.56
34	SiO ₂	71.73	70	SiO ₂	80.31
35	HfO ₂	52.98	71	HfO ₂	79.00
36	SiO ₂	81.14			