

Supplementary Material: Diffraction-Limited Imaging with a Graphene Metalens*

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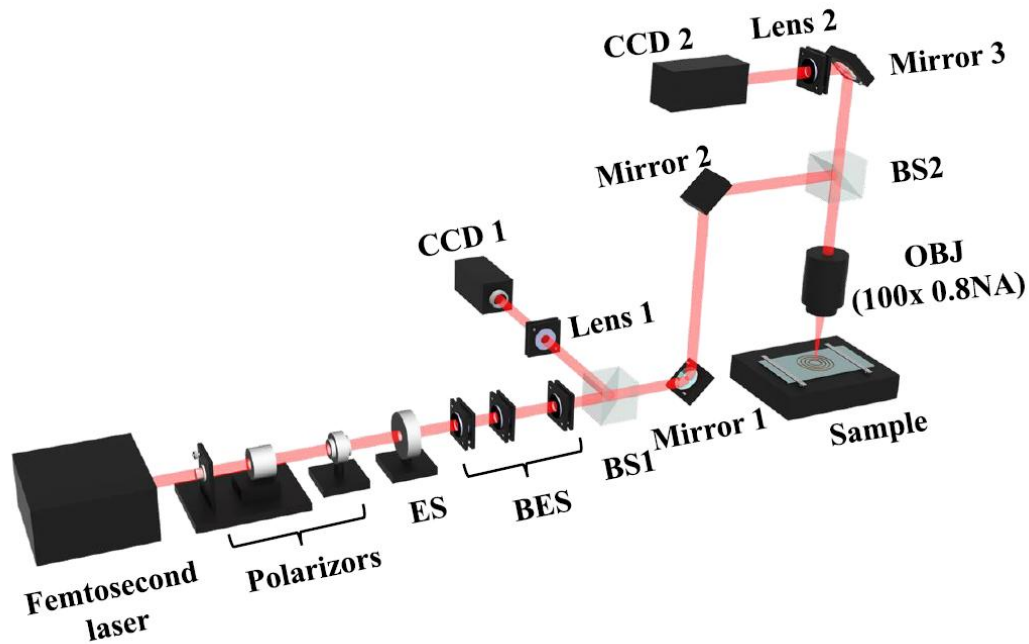


Fig. S1: Experimental setup of the direct laser writing fabrication system. ES: electronic shutter; BES: beam expanding system; BS1 and BS2: beam splitter; Sample: Graphene film; OBJ: objective; CCD1 and CCD2: charge coupled device. The graphene lens is directly fabricated by a homemade DLW system on the graphene film of controllable thickness. The sample is mounted on a 3D nanometric piezo stage. A computer-controlled system can control the repetition rate, femtosecond pulsed and laser beam (100 fs pulse, 10 kHz, 800 nm, Coherent Libra) to reduce the graphene oxide film.

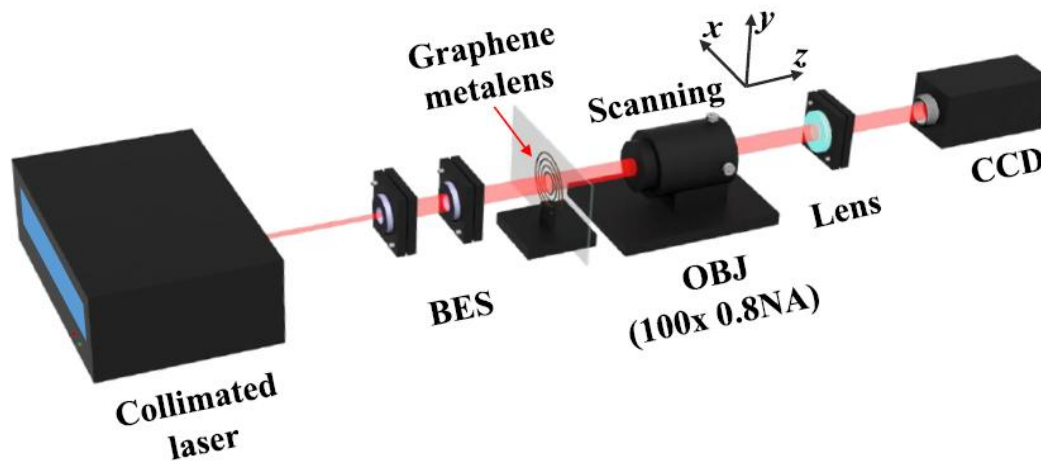


Fig. S2: Experimental setup for characterizing the focus of the graphene metalens. A collimated laser beam is worked at 500 nm as an incident light (a supercontinuum laser (Fianium) operating between wavelengths of 400 and 2,400 nm and used in conjunction with an acousto-optic tunable filter, to select a single wavelength with an approximate bandwidth of 8 nm). BES: beam expansion system; OBJ: microscopic objective lens; CCD: charge coupled device (Watec 902H).

Design of the graphene lens

Design parameter of the graphene lens. The thickness of the prepared GO thin film is 200 nm and the corresponding thickness of graphene is 100 nm. The width of the laser fabricated graphene rings is chosen to be 500 nm. The focal length of the lens is set to be 200 μm , and the diameter is 100 μm . The focusing wavelength of the graphene lens is 500 nm. Transmission and refractive index of graphene and GO are shown in Table S1. The detailed structure parameters are shown Table S2.

Table S1. Design parameters of the graphene lens

Diameter (μm)	Focal Length (μm)	Wavelength (nm)	Width of Rings (nm)
100	200	500	500
Thickness (Graphene) (nm)	Thickness (GO) (nm)	Rings Number	NA
200	100	123	0.82
Transmission Index (GO)	Refractive Index (GO)	Transmission Index (graphene)	Refractive Index (graphene)
0.6067	2.0275	0.2957	2.4605

Table S2. Structural parameters of the graphene lens.

The number of rings	R_n (μm)	The number of rings	R_n (μm)	The number of rings	R_n (μm)
1	2.9055	42	22.33	83	36.8305
2	3.1555	43	22.649	84	37.1215
3	3.4055	44	23.0305	85	37.446
4	3.6555	45	23.561	86	37.863
5	5.0195	46	23.9585	87	38.196
6	5.2695	47	24.341	88	38.4995
7	5.5195	48	24.91	89	38.7495
8	6.4615	49	25.2565	90	39.0325
9	6.7115	50	25.514	91	39.465
10	7.4565	51	25.8655	92	39.7925
11	7.7065	52	26.237	93	40.1095
12	8.248	53	26.7085	94	40.5515
13	8.775	54	27.1	95	40.86
14	9.025	55	27.4325	96	41.11
15	9.5605	56	27.719	97	41.376
16	9.8105	57	28.057	98	41.6855
17	10.0605	58	28.4995	99	42.055
18	10.6925	59	28.898	100	42.4175
19	11.3535	60	29.2495	101	42.7165
20	11.9935	61	29.571	102	42.9665
21	12.2435	62	29.821	103	43.2375
22	12.821	63	30.1085	104	43.578
23	13.3205	64	30.3585	105	43.9675
24	13.775	65	30.6565	106	44.277
25	14.2995	66	31	107	44.5815
26	14.8805	67	31.367	108	45.0205
27	15.5285	68	31.811	109	45.2705
28	16.022	69	32.1295	110	45.5205
29	16.447	70	32.396	111	45.815
30	16.833	71	32.707	112	46.134
31	17.3005	72	33.059	113	46.531
32	17.945	73	33.4925	114	46.83
33	18.401	74	33.8285	115	47.0805
34	18.851	75	34.139	116	47.34
35	19.4765	76	34.389	117	47.6455
36	19.86	77	34.685	118	48.0435
37	20.1865	78	35.159	119	48.3515
38	20.5885	79	35.4875	120	48.6465
39	21.016	80	35.82	121	49.114
40	21.5595	81	36.266	122	49.5645
41	21.97	82	36.5785	123	49.8145