Supporting Information to

Silicon-based Spectrally Selective Emitters with Excellent High-Temperature Stability on Stepped Metasurface

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Section 1 *SEM characterizations of the hybrid silicon-based structures and absorption spectra of Si stepped NPs*

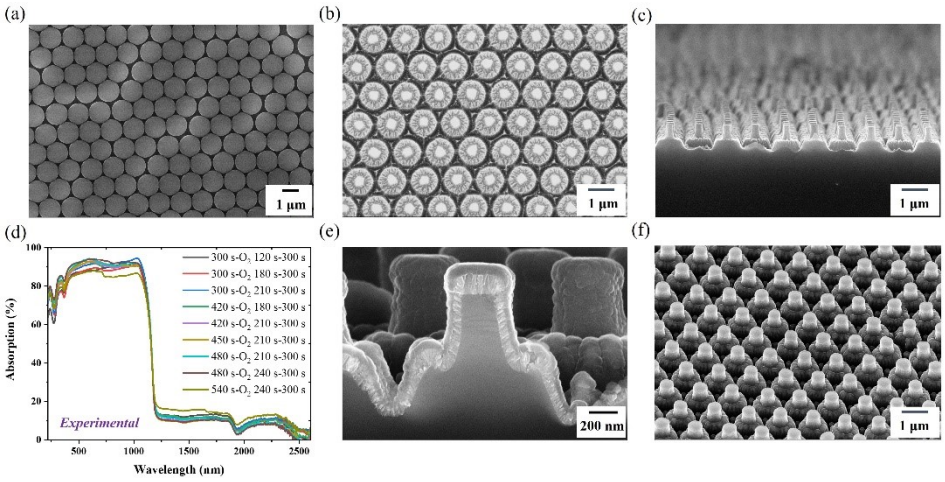

Figure S1 (a) SEM image of a Si wafer coated with a monolayer of close-packed PS nanospheres. (b-c) Top-view and side-view SEM characterizations of the Si stepped NPs (ICP etching parameters: 300 s-O_2 210 s-300 s). (d) Absorption spectra of Si stepped NPs with different ICP etching parameters. (e) Sectional-view SEM image of the hybrid Si stepped NP/Mo/SiN_x structure. (f) SEM image at a 45° tilted view of the hybrid Si stepped NP/Mo/SiN_x structure.

Section 2 *Absorption spectra of the hybrid silicon-based structures*

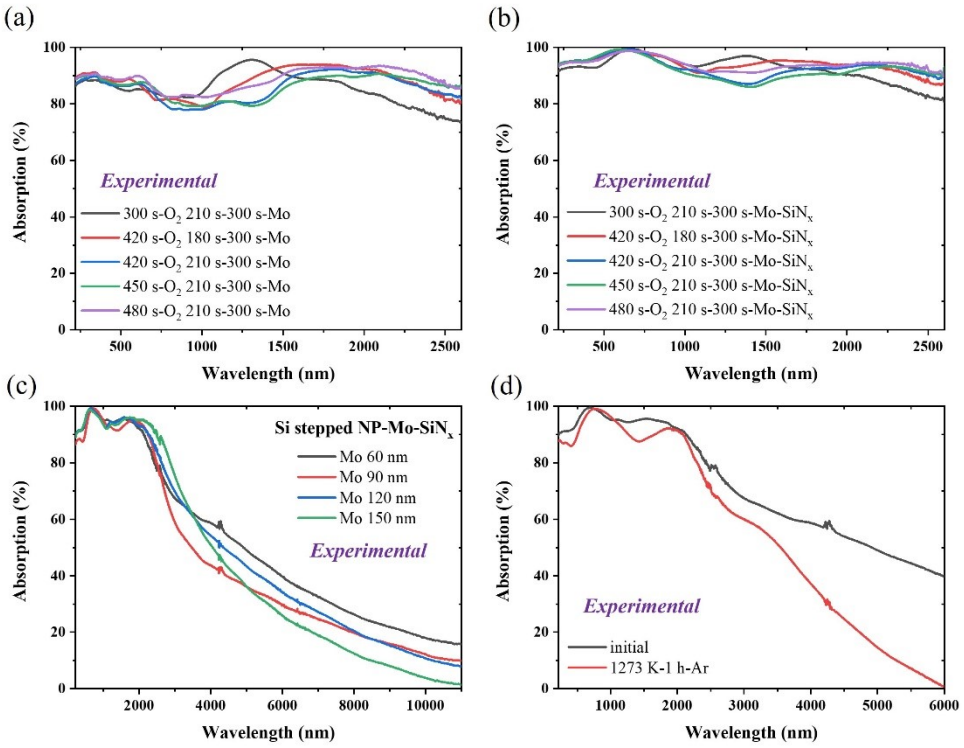

Figure S2 (a) Absorption spectra of the Si stepped NPs with different ICP etching parameters coated with 30 nm Mo. (b) Absorption spectra of the Si stepped NPs with different ICP etching parameters coated with 30 nm Mo and

36 nm thick SiN_x. (c) Absorption spectra of the hybrid silicon-based metasurface emitter from 220 nm to 11000 nm with 60, 90, 120, 150 nm thick Mo. (d) Absorption spectra of the metasurface emitter taken at room temperature in the wavelength range of 220 nm- 6000 nm, before and after annealing at 1273 K in Ar atmosphere for 1 h.

Section 3 *FDTD simulation of the hybrid silicon-based structures*

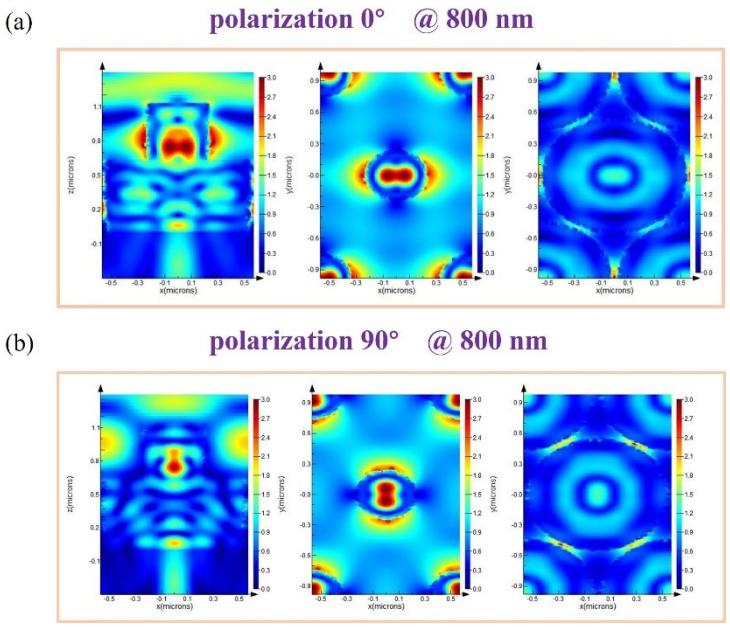

Figure S3 (a, b) Simulated electric field distribution of the hybrid Si stepped NP/Mo/SiN_x structure at 800 nm with polarization angles of 0° and 90°.

Section 4 *Annealing tests of the hybrid silicon-based metasurface emitter*

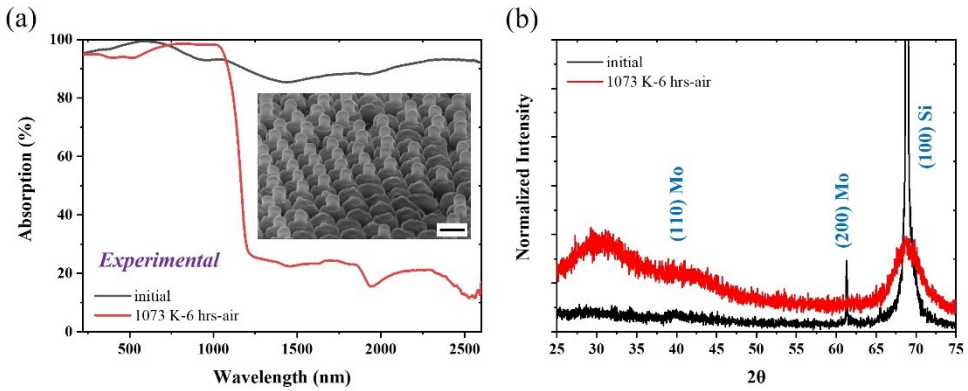

Figure S4 (a) Absorption spectra and SEM images of the hybrid silicon-based metasurface emitter taken at room temperature, before and after annealing at 1073 K in the air for 6hrs. Scale bar: 1 μm. The corresponding XRD patterns are shown in (b).

Section 5 *Comparison of performance and fabrication characteristics*

Sample parameters	Average absorptivity in the visible wavelength range (400nm-780nm)	Average absorptivity from 220nm to 2000nm	Absorptivity corresponding to the interference peak	Wavelength corresponding to the interference peak
Si stepped NP-Mo 120nm-SiN_x 0 nm	86.861%	87.783%	94.019%	1452 nm
Si stepped NP-Mo 120nm-SiN_x 24 nm	95.404%	91.913%	97.667%	506 nm
Si stepped NP-Mo 120nm-SiN_x 36 nm	96.937%	94.923%	99.372%	644 nm
Si stepped NP-Mo 120nm-SiN_x 48 nm	90.235%	92.293%	96.891%	884 nm
Si stepped NP-Mo 120nm-SiN_x 60 nm	90.926%	94.934%	98.327%	1014 nm

Table S1 Comparison of some indicators of the Si stepped NP/Mo structure, coated with 0, 24, 36, 48, 60 nm SiN_x, respectively.

Refs.	19	21	28	32	This work
Material	Si/TiN/HfO_2	SiO_2/TiN/SiN_x	Si/W/Al_2O_3	Si/Mo	Si/Mo/SiN_x
Absorption performance	94% (300-2300 nm)	87% (250-2250 nm)	95% (220-2600 nm)	95% (990-1850 nm)	95% (220-2000 nm)
	-	29% (5-13 μm)	-	10% (5 μm)	19% (5-11 μm)
dielectric layer	30 nm HfO_2	160 nm SiN_x	50 nm Al_2O_3	-	36 nm SiN_x
thermal stability	1473 K in Ar atmosphere	1073 K in vacuum	1273 K in N_2 atmosphere	1473 K in Ar atmosphere	1273 K in Ar atmosphere
	-	-	-	-	1073 K in the air
Fabrication method	hole-mask colloidal lithography	continuously variable spatial frequency photolithography	PS sphere lithography, metal-assisted chemical etching	hole-mask colloidal lithography	PS sphere lithography

Table S2 Comparison of some absorbers/emitters with similar structures.