Supporting Information:

Remote Sensing of High Temperatures with Refractory, Direct-Contact Optical Metacavity

Krishnakali Chaudhuri[*1], Urcan Guler[*2], Shaimaa I. Azzam[*1], Harsha Reddy[1], Soham Saha[1], Ernesto E. Marinero [1,3], Alexander V. Kildishev[1], Vladimir M. Shalaev[1], and Alexandra Boltasseva[1ǂ]

[1]*School of Electrical & Computer Engineering and Birck Nanotechnology Center, Purdue University, West Lafayette, IN*

[2]*United Technologies Research Center, East Hartford, CT*

[3]*School of Materials Engineering, Purdue University, West Lafayette, IN*

ǂaeb@purdue.edu

1) High-temperature optical measurements

The sample under inspection was mounted onto a heating cell (commercially available from Linkam instruments, TS1500). The cell is equipped with a ceramic heating cup with embedded electrical heating coil and is externally controlled through a temperature controller assembly. The cell was then mounted on the sample loading stage of a commercial variable angle spectroscopic ellipsometry set up (from J. A. Wollam). The assembly is shown in Figure 1S. The heating cell is then connected to a vacuum pump and the sample was heated under vacuum. An external water line cools the quartz window in front to minimize thermal expansion effect, especially at high temperatures. The temperature was increased with a step of 100^{o}C and we waited 10 minutes after the desired temperature was reached for stabilization of temperature. At temperatures above 800^{o}C, the ceramic heating element glows with bright red radiation which introduces additional noise as well as saturates the Si photodetector on the VASE. To work around this problem, an additional external pinhole aperture was placed in front of the detector arm of the VASE set up as shown in Figure 1S.

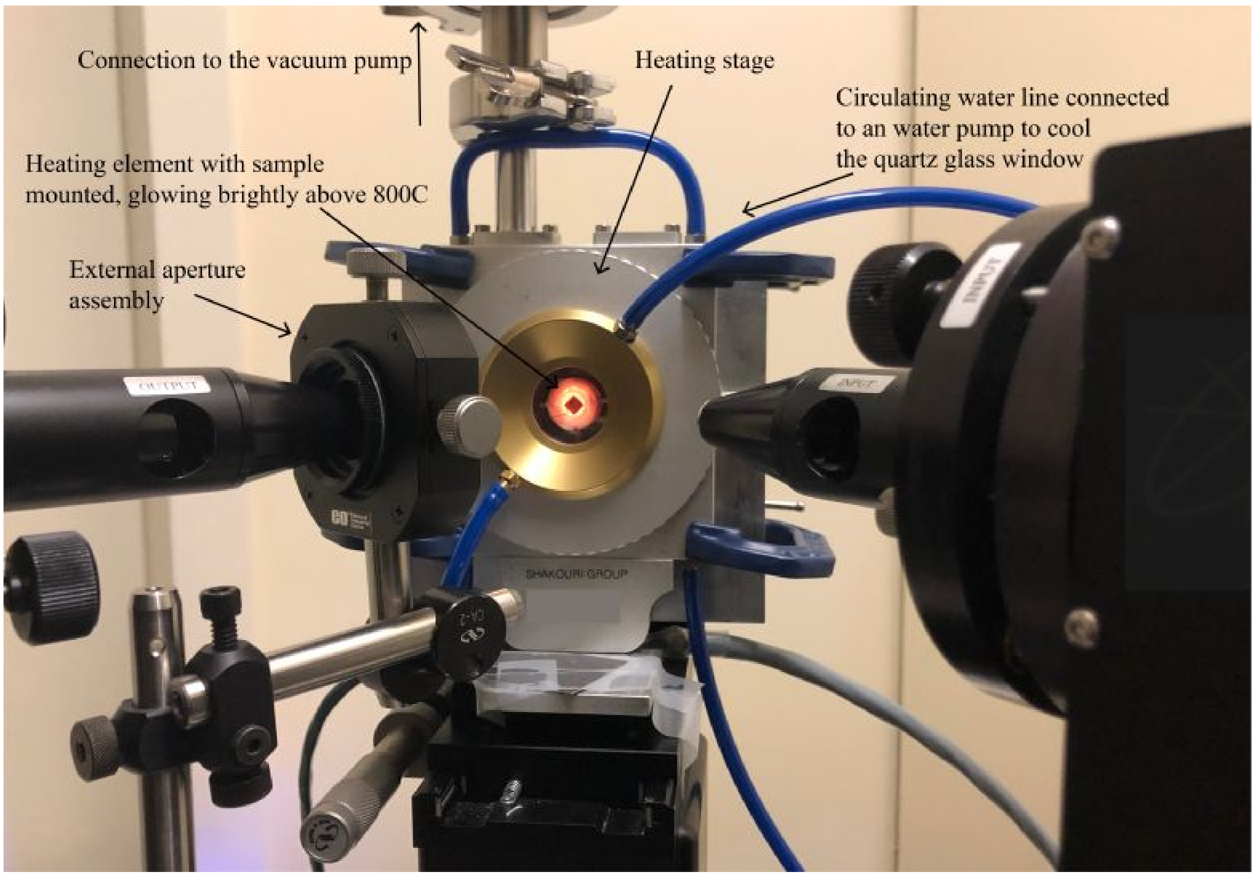


Figure 1S) Photo of the real-life optical measurement set-up integrated with the heating stage

2) Temperature dependent optical properties of Si_3N_4

Table S1 Variation of the ellipsometry C-L Oscillator model parameters with increasing temperature for Si_3N_4

T	Amp	E_n	B_r	E_g	E_p	E_t	E_u
23	56.64076	7.761036	0.457359	5.562586	2.967356	1.246741	0.587698
300	48.76215	7.709287	0.084777	5.333728	2.967356	1.246741	0.587698
500	47.57953	7.672107	1.00E-06	5.305233	2.967356	1.246741	0.587698
600	47.26444	7.647879	1.00E-06	5.292529	2.967356	1.246741	0.587698
700	46.89055	7.62065	1.00E-06	5.284816	2.967356	1.246741	0.587698
800	46.4615	7.604193	1.00E-06	5.2859	2.967356	1.246741	0.587698
900	46.19414	7.579885	1.00E-06	5.287852	2.967356	1.246741	0.587698

3) Simulated temperature dependent response of the device

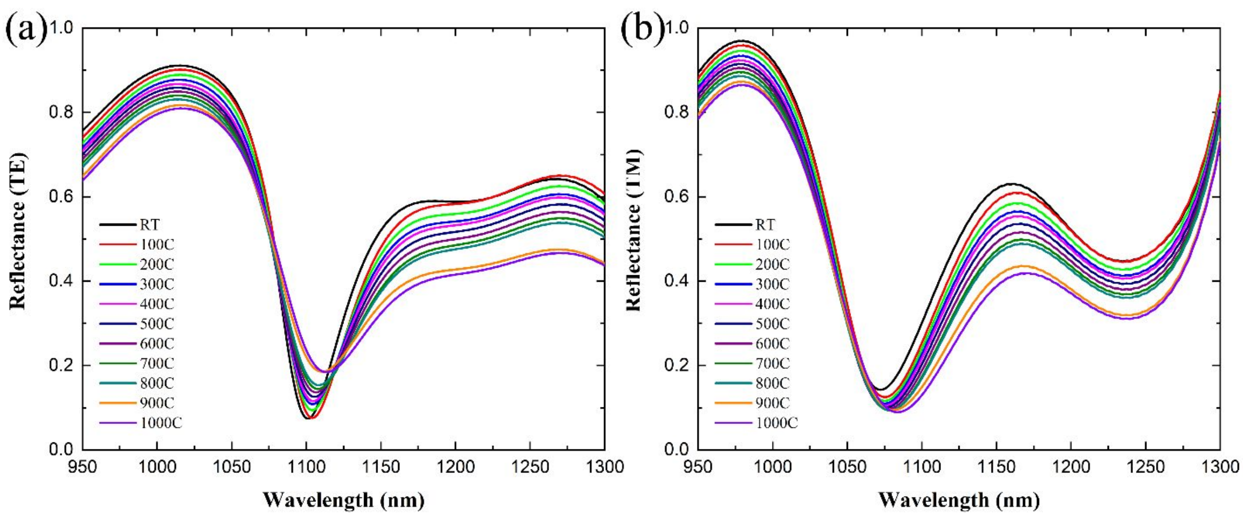
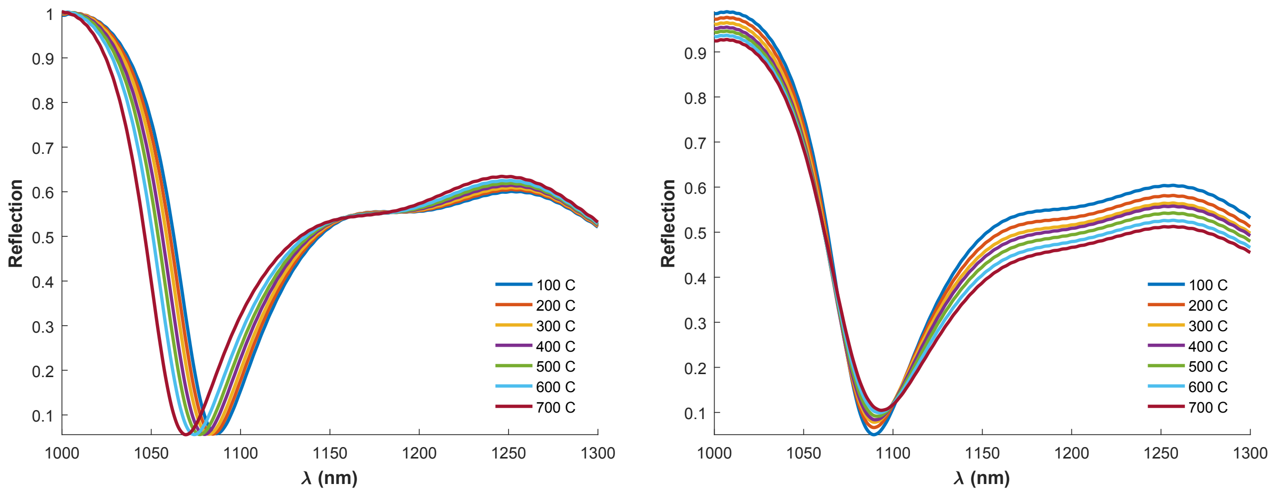


Figure 2S Temperature dependence of the device reflectance response for (a) TE and (b) TM polarized incidence, estimated in FDTD simulation utilizing the measured temperature dependent optical properties of the constituent layers.



(a) (b)

Figure 3S (a) Simulated reflectance of s-polarized light as (a) the refractive index of the Si_3N_4 changes with temperatures while TiN dielectric function is fixed to its the room temperature value (b) the refractive index of Si_3N_4 is kept constant while the dielectric function of TiN is varied.