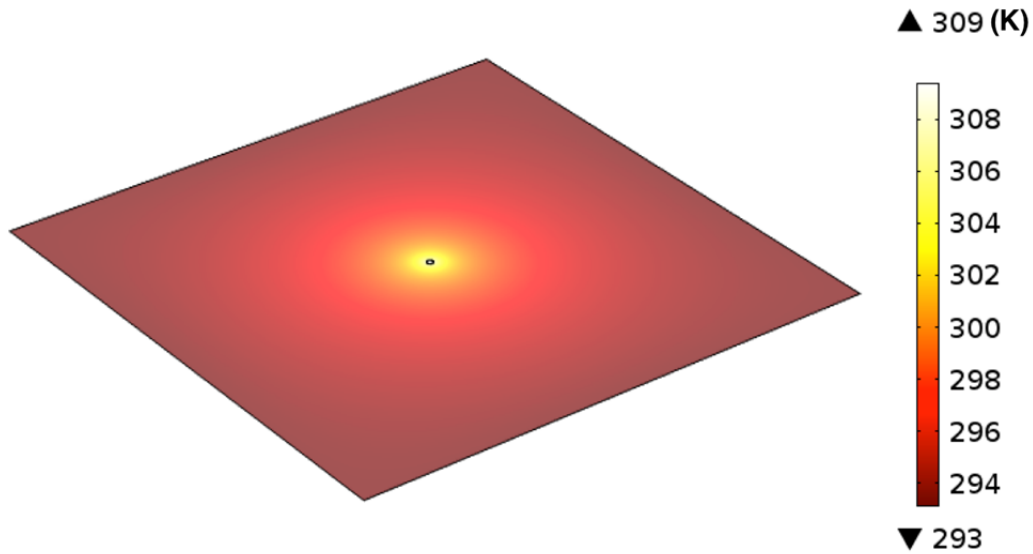


# 1 Supplementary Information



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3 **Supplementary Figure 1. COMSOL simulation of the steady-state temperature rise**  
4 **of the silicon membrane under illumination of 15 mW of 780-nm excitation beam**  
5 **with 60-μm beam diameter.** The size of the membrane is 5 mm by 5 mm, and the  
6 thickness is 1.7 μm. The membrane is supported by a 500-μm-thick silicon frame, which  
7 is set at room temperature (293 K) in the simulation. The upper and lower surfaces of the  
8 membrane are set as adiabatic in the simulation. Since there is natural convection and  
9 radiation from the surfaces in the real experiment, the actual temperature rise should be  
10 lower than the simulation.

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12

400 nm Pump Power (mW)	6	9	12	15
Intrinsic Lifetime (ps)	238.3±57.9	224.9±26.1	234.3±23.5	248.2±3.5

13

14 **Supplementary Table 1. The measured phonon lifetime without the 780-nm**  
15 **excitation beam with different power of the 390-nm pump pulses, at the same**  
16 **location on the membrane.** There is no systematic reduction of the intrinsic phonon  
17 lifetime with increasing pump power observed. The large uncertainty at lower pump  
18 power is due to the reduced signal amplitude and thus the signal-noise ratio.

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