Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information for

A bottom-up strategy toward the flexible vanadium dioxide/silicon nitride composite film with infrared sensing performance

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1. Optical image of the VO_2 grown on the quartz substrate

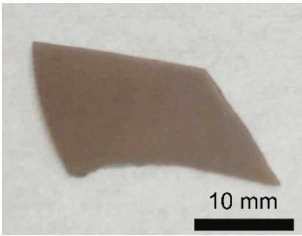

Figure S1. Optical image of the VO_2 grown on the quartz substrate

2. Preparation process of the Infrared sensor based on the vanadium dioxide (VO_2)/silicon nitride (VO_2/SN) composite film

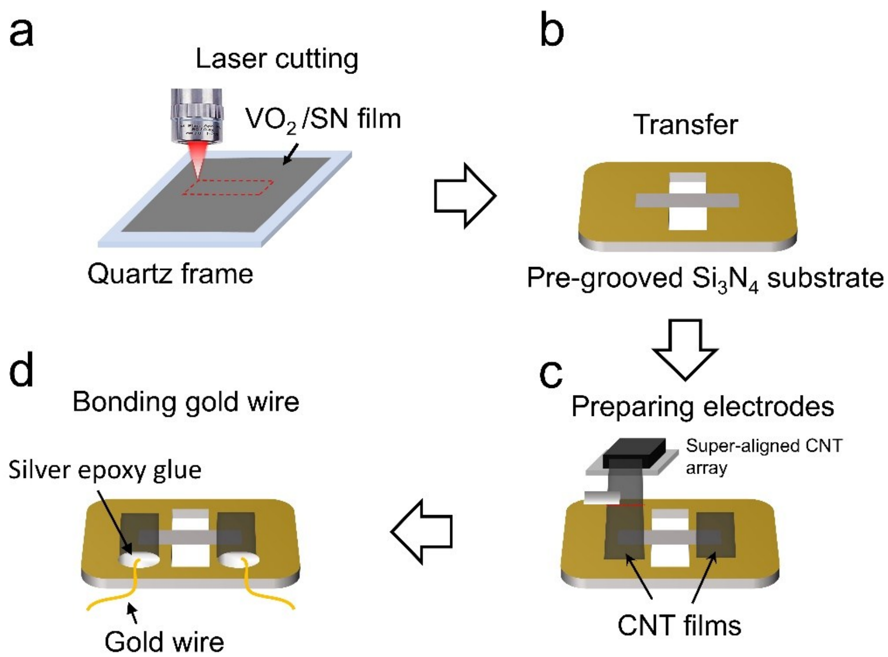

Figure S2. (a) Cutting a small sheet from a suspending VO_2/SN film by laser. (b) Transferring the VO_2/SN film to a pre-grooved Si_3N_4 substrate by a tweezer. (c) Few-layer CNT films drawn from a super-aligned CNT array to fix both ends of the VO_2/SN sheet. (d) Bonding Gold wires on CNT films by silver epoxy glue to serve as conductive wires.

3. Infrared response of the VO_2/SN film in the air

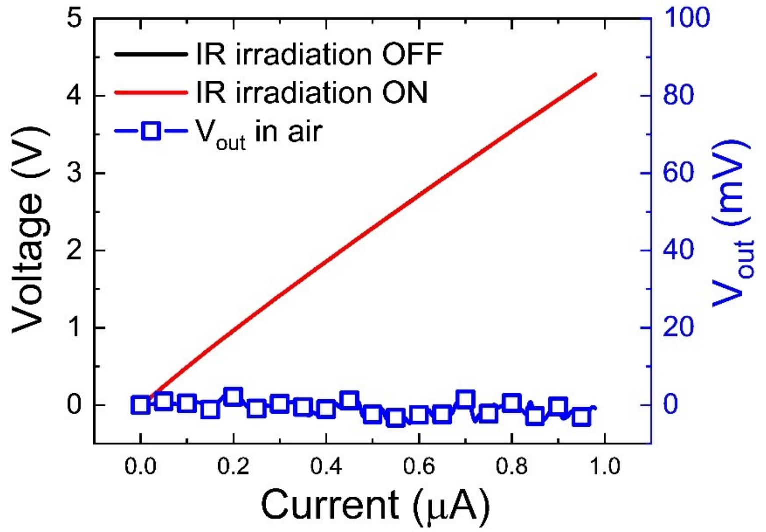

Figure S3. I-V curves of the VO_2/SN film in the air under IR irradiation ON and OFF and the change of V_{out} with the current.

4. Transient thermal transfer simulation

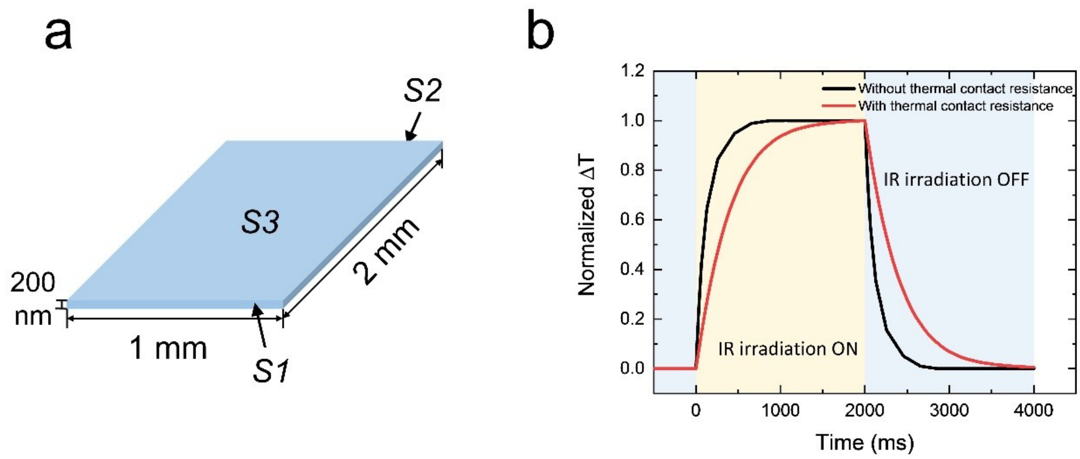

Figure S4. (a) Geometrical model of the VO_2/SN-film IR sensor. (b) Variation of normalized ΔT with time with (red) and without (black) consideration of the thermal contact resistance.

We use COMSOL Multiphysics software to simulate the transient thermal transfer of the VO_2/SN-film IR sensor under the irradiation of the modulated infrared radiation with frequency of 0.25 Hz. Figure S4a shows the geometrical model of the VO_2/SN-film IR sensor. The length, the wide, and the thickness of the VO_2/SN film are 2 mm, 1 mm, and 200 nm, respectively. The 3D transient thermal transfer equation $\rho C_p \frac{\partial T}{\partial t} + \nabla \cdot (-k \nabla T) = Q$ is solved, where ρ is the density, C_p is the specific heat capacity at constant stress, k is the thermal conductivity, and Q is the heat source. These material data can be found in the material database of COMSOL Multiphysics software. The thermal conductivity of the VO_2/SN film is set to be 12.5 W/(m·K), which is the average value of VO_2 (5 W/(m·K)) and Si_3N_4 (20 W/(m·K)). The boundary conditions are as follows. When the thermal contact resistance between the VO_2/SN film and substrate is ignored, the temperature of surfaces S1 and S2 is set to 298 K. When considering the thermal contact resistance, the boundary condition for S1 and S2 is $-n \cdot \nabla(-k \cdot \nabla T) = h_c \cdot (T - T_0)$, where h_c is the thermal contact conductance coefficient and is set to be 10000 W/(m^2·K) and T_0 is the substrate temperature (298 K). The surface S3 is irradiated by the IR light and thus an inward heat (6 W/m^2) is set on this surface. For other surfaces, boundary conditions are $-n \cdot \nabla(-k \cdot \nabla T) = 0$. ΔT is defined as the difference between the maximum temperature of the VO_2/SN film under the IR irradiation and the environmental temperature (298 K). Figure S4b shows transient simulation results of normalized ΔT. The rising time and the falling time calculated from the ΔT-t curve without consideration of the thermal contact resistance are 350 and 349 ms, respectively, which are almost the same. However, when considering the thermal contact resistance, the rising time and the falling time of the IR sensor are 810 and 825 ms, respectively. The rising time is not equal to the falling time. Also, the ΔT-t curve with consideration of the thermal contact resistance is very analogical to the experimental result (Figure 3e). Therefore, we consider that the little difference between the rising time and the falling time in our experiment is possibly caused by the thermal contact resistance between the VO_2/SN film and the substrate.