Supplementary Information

A real-time naked-eye recognizable temperature monitoring based on Ho³⁺, (or Tm³⁺)-activated NaYF₄ upconversion nanowires *via* visual multicolor alteration

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Materials Characterization

The morphology of upconversion nanowires was recorded on a FEI Talos F200x high resolution transmission electron microscopy and a Hitachi S-4800 scanning electron microscope. A temperature-controlled heating system was used for temperature-dependent UCL spectra measurements. The solid powder samples were put into a copper sample cell, which is 10 mm in diameter and 2 mm in depth. The temperature was monitored by a thermocouple embedded on the copper surface near the sample cell. In the measurements of the UCL spectra, a continuous 975 nm diode laser was used as the excitation source. The UCL signals were collected and analyzed by a portable spectrometer (Maya 2000, Ocean Optics Co.). The photographic images were taken by a digital camera (Canon 600D, Japan).



Figure S1 (a) Temperature-dependent UCL spectra of NaYF₄:20%Yb³⁺, 0.3%Ho³⁺, 0.7%Tm³⁺ upconversion nanowires (synthesis temperature: 180°C). (b) The corresponding integrated UCL intensities at different wavelengths as a function of temperatures. Integrated intensities at various temperatures were normalized to that at 40°C.



Figure S2 (a) Temperature-dependent UCL spectra of NaYF₄:20%Yb³⁺, 0.5%Ho³⁺, 0.5%Tm³⁺ upconversion nanowires (synthesis temperature: 180°C). (b) The corresponding integrated UCL intensities at different wavelengths as a function of temperature. Integrated intensities at various temperatures were normalized to that at 40°C.



Figure S3 (a) Chromaticity coordinate shifts of NaYF₄:20%Yb³⁺, 0.3%Ho³⁺, 0.7%Tm³⁺ upconversion nanowires (synthesis temperature: 180°C) with increasing temperatures. The corresponding color change of upconversion nanowires at (b) 40°C, (c) 200°C and (d) 300°C.



Figure S4 (a) Chromaticity coordinate shifts of NaYF₄:20%Yb³⁺, 0.5%Ho³⁺, 0.5%Tm³⁺ upconversion nanowires (synthesis temperature: 180°C) with increasing temperatures. The corresponding color change of upconversion nanowires at (b) 40°C, (c) 200°C and (d) 300°C.