**Figure S1.** Schematic setup of the gas-sensing measurement.

**Figure S2.** XRD pattern of Cu$_2$O nanocubes.

**Figure S3.** A) FESEM image of Cu$_2$O nanocubes. Inset: high magnification image of two Cu$_2$O nanocubes. B) TEM image of Cu$_2$O nanocubes. Inset: the SAED of one cubic Cu$_2$O. Scale bar: 400 nm.

**Figure S4.** PL spectra of the obtained Cu$_7$S$_4$ nanoboxes with A) single wall, and B) double walls with exciting wavelength of 370 nm.

**Figure S5.** Room temperature time profiles of PL intensity of sensor based on double-walled Cu$_7$S$_4$ nanoboxes to NH$_3$ for 20 cycles.

**Figure S6.** Time profiles of PL intensity of sensors based on A) single-walled and B) double-walled Cu$_7$S$_4$ nanoboxes to water vapor at room temperature.
Figure S1
Figure S2
Figure S3
Figure S4

![Graph showing PL intensity vs wavelength with peaks at 418 nm, 460 nm, 523 nm]
Figure S5
Figure S6

A)  

H₂O on  H₂O on  H₂O on

H₂O off  H₂O off  H₂O off

B)  

H₂O on  H₂O on  H₂O on

H₂O off  H₂O off  H₂O off

PL Intensity (cps)  

Time (s)