Electronic Supplementary Information

A New Kind of Thermocouple Made of $p$-Type and $n$-Type Semi-Conductive Oxides with Giant Thermoelectric Voltage for High Temperature Sensing

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The schematic diagram of screen-printing thermocouple is shown in Fig. S1. Firstly, the powder of material A synthesized by sol-gel method is put into a beaker. Then, the binder is added in the breaker under stirring to form the screen-printing paste. After that, the prepared paste is loaded on the top of the screen with a L-form pattern. Through the movement of wiper, one electrode composed of material A is screen-printed on the surface of Al₂O₃ substrate and then heated on the heating stage at 110 °C for 10 minutes. Secondly, another electrode of thermocouple is fabricated by the same steps with the powder of material B. Finally, the copper wires are attached onto the end of electrodes by silver paste and then heated at 200 °C for 2 hrs in a furnace.

**Fig. S1.** Schematic diagram of screen-printing thermocouple.

**Fig. S2.** Photograph of the test bed used for high-temperature thermoelectric measurement.
Fig. S3. SEM pictures of cross sections of In$_2$O$_3$, ITO and 0.2LSCO. Figures A(1-3) represent the cross sections of In$_2$O$_3$, ITO and 0.2LSCO treated at 1270 °C for 2hrs, respectively. Figures B(1-3) represent the cross sections of In$_2$O$_3$, ITO and 0.2LSCO treated at 1270 °C for 12 hrs, respectively.
Fig. S4. Thermoelectric response of the ITO vs. In$_2$O$_3$ thermocouple. The red curve represents the thermoelectric voltage corresponding to the secondary y-axis. The olive and the blue curves are the hot junction (T hot) and cold junction (T cold) temperatures, respectively, corresponding to the primary y-axis.
Fig. S5. Thermoelectric response of 0.2LSCO vs. ITO thermocouple. The red curve represents the thermoelectric voltage corresponding to the secondary y-axis. The olive and the blue curves are the hot junction (T hot) and cold junction (T cold) temperatures, respectively, corresponding to the primary y-axis.

Fig. S6 shows the output voltage variations of ITO vs. In$_2$O$_3$, 0.2LSCO vs. ITO and 0.2LSCO vs. In$_2$O$_3$ thick-film thermocouples soaked at 1270 ºC for 10 hrs, respectively. The magenta dash lines represent their own mean values in the picture. For 0.2LSCO vs. ITO and 0.2LSCO vs. In$_2$O$_3$, there are very small voltage variation around their mean value when the temperature of the heating furnace reach the dynamic balance at about 1270 ºC compared with standard commercial thermocouple Type-S, indicating they have a very high thermal stability. The mean values of them are derived from calculating the output voltages of 2 hrs to 10 hrs. While for ITO vs. In$_2$O$_3$, the output
voltage reduces continuously to form an obvious deviation from its mean value, indicating it is unstable to suffer from high temperature for a long time.

**Fig. S6.** The output voltage variations of ITO vs. \( \text{In}_2\text{O}_3 \), 0.2LSCO vs. ITO and 0.2LSCO vs. \( \text{In}_2\text{O}_3 \) thick-film thermocouples soaked at 1270 °C for 10 hrs, respectively.
Fig. S7. SEM pictures of the surface of In$_2$O$_3$, ITO and 0.2LSCO. Figures A(1-3) represent the surface of In$_2$O$_3$, ITO and 0.2LSCO treated at 1270 °C for 2 hrs, respectively. Figures B(1-3) represent the surface of In$_2$O$_3$, ITO and 0.2LSCO treated at 1270 °C for 12 hrs, respectively.