Supporting information

**Sr$_{1.7}$Zn$_{0.3}$CeO$_4$F$_{0.2}$:Eu$^{3+}$: Novel Dual-emission Temperature Sensors for Remote, Noncontact Thermometric Application**

Haifeng Li,$^a$ Ran Pang,*$^a$ Wenzhi Sun,$^{a,b}$ Huimin Li,$^{a,b}$ Tengfei Ma,$^c$ Yonglei Jia,$^a$ Da Li,$^a$
Lihong Jiang,$^a$ Su Zhang,$^a$ Chengyu Li*,$^a$

$^a$ State key Laboratory of Rare Earth Resource Utilization, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun 130022, P. R. China.

$^b$ University of Chinese Academy of Sciences, Beijing 100049, P. R. China.

$^c$ Shandong Industrial Ceramics Research & Design Institute Co., Ltd, Zibo 255000, P. R. China

* Corresponding author: E-mail address: pangran@ciac.ac.cn; cyli@ciac.ac.cn.
**Fig. S1** PL spectrum of SZCF excited at 356 nm.

**Table S1** CIE chromaticity coordinates of SZOF:Eu$^{3+}$ with the temperature

<table>
<thead>
<tr>
<th>Temperature (K)</th>
<th>x coordinate</th>
<th>y coordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>291</td>
<td>0.309</td>
<td>0.424</td>
</tr>
<tr>
<td>311</td>
<td>0.329</td>
<td>0.431</td>
</tr>
<tr>
<td>331</td>
<td>0.349</td>
<td>0.438</td>
</tr>
<tr>
<td>351</td>
<td>0.368</td>
<td>0.443</td>
</tr>
<tr>
<td>371</td>
<td>0.389</td>
<td>0.449</td>
</tr>
<tr>
<td>391</td>
<td>0.408</td>
<td>0.454</td>
</tr>
</tbody>
</table>
Fig. S2 Relationship of the integrated intensity of PL spectra of \( \text{Sr}_{1.7}\text{Zn}_{0.3}\text{CeO}_4\text{F}_{0.2}0.01\text{Eu}^{3+} \) with the temperature

Apparently, the relation of the integrated intensity with the temperature is linear within the range between 291 K and 391 K. The linear function can be fitted using the following equation:

\[
I = -9.82 \times 10^3 T + 4.41 \times 10^6
\]  

(1)

With the correlation coefficient of 0.993, where I denotes the integrated intensity of the spectrum, T represents the temperature of the detected object, and the slope of the line stands for the resolution of the intensity method.
Conspicuously, it shows that the relation of the ratio with the temperature is linear. The linear relation remains perfect in the temperature range between 291 K and 391 K, obeying the below function:

$$ R = -0.0097T + 4.27 \quad (2) $$

With the residual sum of squares (RSS) of 0.00283, along with the correlation coefficient of 0.994, where $R$ stands for the ratio: $I_b/I_a$, $T$ is the temperature of the object. Based on the definition of the temperature sensitivity ($S$), the value of $S$ for this composition of $\text{Sr}_{1.7}\text{Zn}_{0.3}\text{CeO}_4\text{F}_{0.2}:0.01\text{Eu}^{3+}$ is 0.009, which demonstrates the alternation of the temperature sensitivity with the composition of the sensor. Unfortunately, a comprehensive conclusion cannot be reached due to the limited knowledge.
FTIR analysis was performed to study the vibration property of the sample, as shown in Fig. S4. The wavenumber from 400 to 900 cm$^{-1}$ derives from stretching and bending vibration of metal-oxygen (M–O) group. Remarkably, the strong peak at 835.4 cm$^{-1}$, along with the shoulder peak at 880 cm$^{-1}$, are attributed to the stretching vibration of Ce–O group in the octahedral CeO$_6$. Based on this, the cutoff frequency of the phonon was calculated to be $2.64 \times 10^{13}$ Hz which is similar as that from Arrhenius equation in terms of the order of the magnitude. The large values of the frequency implies the high thermal stability of the sample, indicating the high potential in the practical application.