

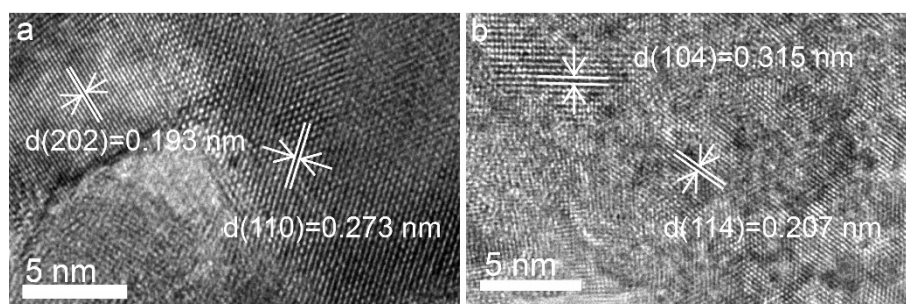
## Electronic Supplementary Information

### Synergistic Effect between La-Ni Bimetallic Oxides for the Efficient Decomposition of Hydrogen Peroxide

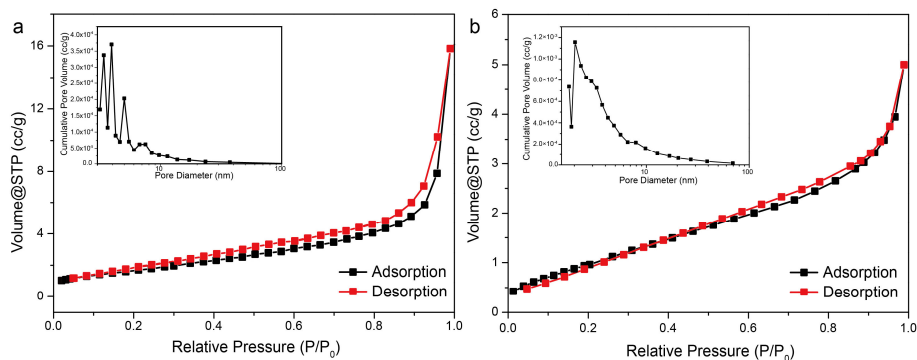
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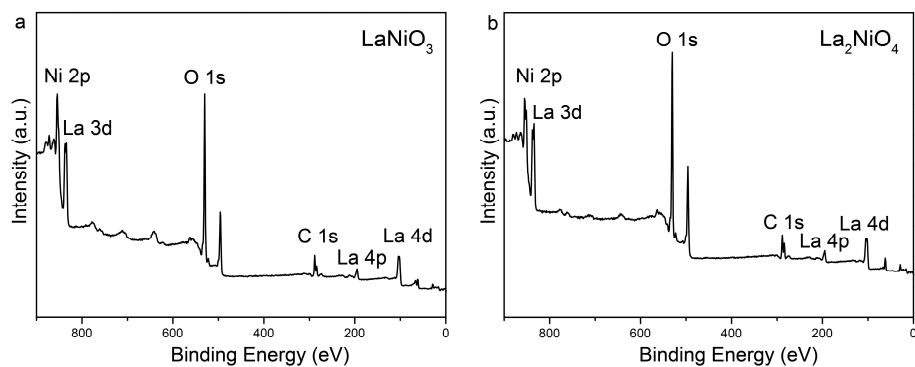
E-mail: linxijie@mailbox.gxnu.edu.cn



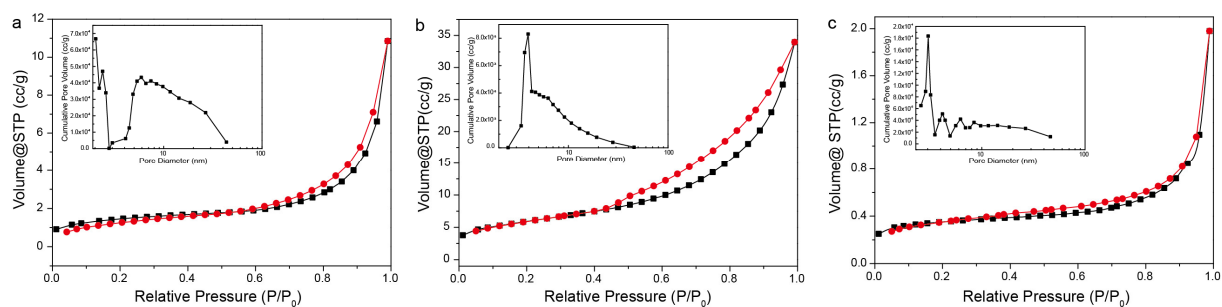
**Fig. S1** HR-TEM images of as-prepared LaNiO<sub>3</sub> (a) and La<sub>2</sub>NiO<sub>4</sub> (b).



**Fig. S2** N<sub>2</sub> sorption isotherms of as-prepared LaNiO<sub>3</sub> (a) and La<sub>2</sub>NiO<sub>4</sub> (b), respectively. Inset was the corresponding pore-size distribution plot.



**Fig. S3** XPS survey spectrum of as-prepared  $\text{LaNiO}_3$  (a) and  $\text{La}_2\text{NiO}_4$  (b).



**Fig. S4**  $\text{N}_2$  sorption isotherms of  $\text{La}_2\text{O}_3$  (a),  $\text{Ni}_2\text{O}_3$  (b), and  $\text{NiO}$  (c), respectively.

Inset was the corresponding pore-size distribution plot.

## Kinetics study of H<sub>2</sub>O<sub>2</sub> decomposition

For the H<sub>2</sub>O<sub>2</sub> decomposition, the kinetic equation can be described as Eq. (1).

$$r = -\frac{dc_{H_2O_2}}{dt} = kc_{H_2O_2}^n \quad (1)$$

After logarithm, Eq. (2) can be obtained:

$$\ln r = \ln k + n \ln c_{H_2O_2} \quad (2)$$

Here,  $r$ : rate of H<sub>2</sub>O<sub>2</sub> decomposition, mol/(L·min)

$t$ : time, min

$c_{H_2O_2}$ : concentration of H<sub>2</sub>O<sub>2</sub>, mol/L

$k$ : rate constant

$n$ : reaction order

If the reaction follows first order kinetics ( $n=1$ ), Eq. (3) can be obtained through integration of Eq.(1). The concentration of H<sub>2</sub>O<sub>2</sub> on a log scale is plotted as a function of the reaction time.

$$\ln[c_{H_2O_2}]_t = -kt + \ln[c_{H_2O_2}]_0 \quad (3)$$

Here,  $[c_{H_2O_2}]_t$ : concentration of H<sub>2</sub>O<sub>2</sub> at time  $t$ , mol/L

$[c_{H_2O_2}]_0$ : initial concentration of H<sub>2</sub>O<sub>2</sub>, mol/L

From the fitting data of Eq.(3), rate constant  $k$  can be obtained.

If rate constant  $k$  conforms to Arrhenius equation(Eq.(4)),

$$k = Ae^{-\frac{E_a}{RT}} \quad (4)$$

After logarithm we obtain Eq. (5):

$$\ln k = \ln A - \frac{E_a}{RT} \quad (5)$$

The activation energy can be calculated by Arrhenius equation by fitting data at different temperature( $T$ ).

Here,

$k$ : rate constant

$A$ : pre-exponential constant, mol/(m<sup>2</sup>·s)

$E_a$ : activation energy, kJ/mol

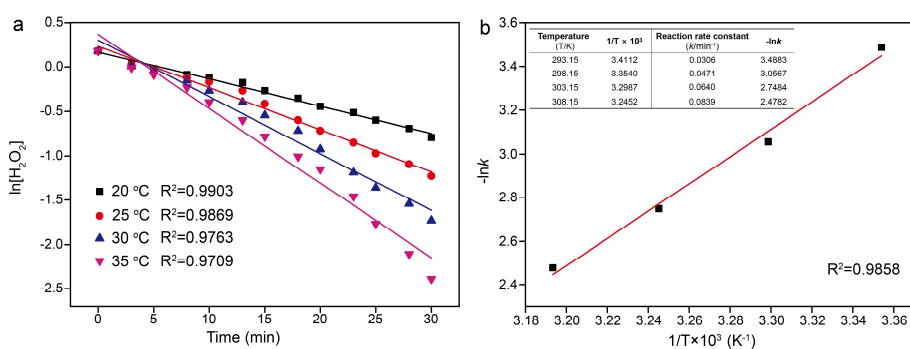
$R$ : gas constant, 8.314 J/(mol·K)

$T$ : temperature, K

Assuming the reaction order  $n$  of  $\text{H}_2\text{O}_2$  decomposition catalyzed by  $\text{LaNiO}_3$  and  $\text{La}_2\text{NiO}_4$  is 1, the experimental data of concentration of  $\text{H}_2\text{O}_2$  at different time  $t$  (Table S1 and Table S2) are fitted according to Eq.(3). As shown in Fig.S5a and Fig.S6a, the straight lines ( $\ln c_{\text{H}_2\text{O}_2}$  versus  $t$ ) with higher correlation coefficient ( $R^2 > 0.96$ ) indicate that the assumption is correct. The rate constant  $k$  is obtained from the slope of the fitted straight lines. Then, the data of  $k$  at different temperatures  $T$  are fitted according to Eq.(5). Again, the straight lines with higher correlation coefficient ( $R^2 > 0.98$ ) are obtained, as shown in Fig.S5b and Fig.S6b. The activation energy is calculated from the slope of the fitted line, which is 52.84 kJ/mol and 61.43 kJ/mol for  $\text{LaNiO}_3$  and  $\text{La}_2\text{NiO}_4$ , respectively.

**Table S1** The concentration of H<sub>2</sub>O<sub>2</sub> collected from different reaction conditions (used prepared LaNiO<sub>3</sub> as the catalyst).

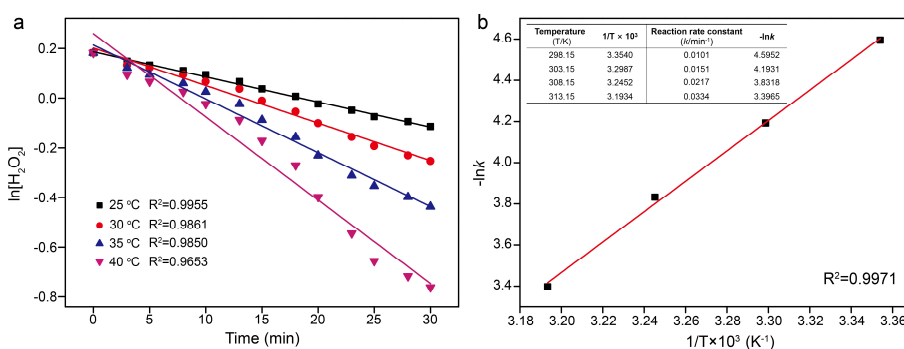
| Temperature (°C) | Reaction Time (min) | H <sub>2</sub> O <sub>2</sub> Concentration (mol/L) | Temperature (°C) | Reaction Time (min) | H <sub>2</sub> O <sub>2</sub> Concentration (mol/L) |
|------------------|---------------------|---|------------------|---------------------|---|
| 20               | 0                   | 1.2000  | 30               | 0                   | 1.2000  |
|                  | 5                   | 0.9800  |                  | 5                   | 0.9463  |
|                  | 10                  | 0.8852  |                  | 10                  | 0.7631  |
|                  | 15                  | 0.7631  |                  | 15                  | 0.5800  |
|                  | 20                  | 0.6410  |                  | 20                  | 0.3968  |
|                  | 25                  | 0.5495  |                  | 25                  | 0.2564  |
|                  | 30                  | 0.4526  |                  | 30                  | 0.1774  |
| 25               | 0                   | 1.2000  | 35               | 0                   | 1.2000  |
|                  | 5                   | 0.9768  |                  | 5                   | 0.9158  |
|                  | 10                  | 0.8425  |                  | 10                  | 0.6716  |
|                  | 15                  | 0.6593  |                  | 15                  | 0.4579  |
|                  | 20                  | 0.4884  |                  | 20                  | 0.3175  |
|                  | 25                  | 0.3785  |                  | 25                  | 0.1709  |
|                  | 30                  | 0.2930  |                  | 30                  | 0.0916  |



**Fig. S5** (a) Kinetics of H<sub>2</sub>O<sub>2</sub> decomposition (1.2 mol/L) catalyzed by LaNiO<sub>3</sub> (0.1 g) at different reaction temperatures; (b) Arrhenius plots of  $\ln k$  as a function of inverse temperature ( $1/T$ ) for LaNiO<sub>3</sub>.

**Table S2** The concentration of H<sub>2</sub>O<sub>2</sub> collected from different reaction conditions (used prepared La<sub>2</sub>NiO<sub>4</sub> as the catalyst).

| Temperature (°C) | Reaction Time (min) | H <sub>2</sub> O <sub>2</sub> Concentration (mol/L) | Temperature (°C) | Reaction Time (min) | H <sub>2</sub> O <sub>2</sub> Concentration (mol/L) |
|------------------|---------------------|---|------------------|---------------------|---|
| 25               | 0                   | 1.2000  | 35               | 0                   | 1.2000  |
|                  | 5                   | 1.1416  |                  | 5                   | 1.0989  |
|                  | 10                  | 1.0989  |                  | 10                  | 1.0256  |
|                  | 15                  | 1.0379  |                  | 15                  | 0.9158  |
|                  | 20                  | 0.9768  |                  | 20                  | 0.7937  |
|                  | 25                  | 0.9280  |                  | 25                  | 0.7021  |
|                  | 30                  | 0.8919  |                  | 30                  | 0.6460  |
| 30               | 0                   | 1.2000  | 40               | 0                   | 1.2000  |
|                  | 5                   | 1.1294  |                  | 5                   | 1.0684  |
|                  | 10                  | 1.0684  |                  | 10                  | 0.9768  |
|                  | 15                  | 0.9890  |                  | 15                  | 0.8425  |
|                  | 20                  | 0.9035  |                  | 20                  | 0.6716  |
|                  | 25                  | 0.8242  |                  | 25                  | 0.5189  |
|                  | 30                  | 0.7362  |                  | 30                  | 0.4669  |



**Fig. S6** (a) Kinetics of H<sub>2</sub>O<sub>2</sub> decomposition (1.2 mol/L) catalyzed by La<sub>2</sub>NiO<sub>4</sub> (0.1 g) at different reaction temperatures. (b) Arrhenius plots of lnk as a function of inverse temperature (1/T) for La<sub>2</sub>NiO<sub>4</sub>.