Supplementary Information

Modulation of starch nanoparticles surface characteristics for facile construction of recycling Pickering interfacial enzymatic catalysis

Liang Qi¹, Zhigang Luo¹,²,³*, Xuanxuan Lu⁴

1. School of Food Science and Engineering, South China University of Technology, Guangzhou, 510640, China.
2. South China Institute of Collaborative Innovation, Dongguan, 523808, China.
3. Overseas Expertise Introduction Center for Discipline Innovation of Food Nutrition and Human Health (111 Center), Guangzhou 510640, China.
4. Department of Food Science, Rutgers, The State University of New Jersey, 65 Dudley Rd, New Brunswick, New Jersey 08901, USA.

*Corresponding author:
Zhigang Luo, Tel: +86-20-87113845, Fax: +86-20-87113848. E-mail address: zhgluo@scut.edu.cn
Figure S1 XRD diffraction spectrum of samples.

Figure S2 Size distribution of MS, MS-AP (2) and MS-AP (3) calculated by dynamic light scattering.

Figure S3 CD spectra of native CALB (red curve) and CALB released from Pickering emulsion droplets (black curve).

Figure S4 Nitrogen sorption isotherms for microcapsules formed by (A) MS-AP (2) and (B) MS-AP (3).

Figure S5 Molecular model of the substrates used and products formed in the transesterification.

Figure S6 Lineweaver-Burk plot of the reciprocal of initial rate (1/ν) versus the reciprocal of the substrate concentration (1/[S]) for the determination of kinetic parameters $K_m$ and $v_{max}$ of CALB loaded pure Pickering emulsion.

Figure S7 Temperature effects on the kinetics of transesterification in the o/w and w/o Pickering interfacial catalytic system. (A) Kinetics plots for the o/w Pickering interfacial catalytic system at different temperatures. (B) Kinetics plots for the w/o Pickering interfacial catalytic system at different temperatures. (C) $\ln k$ versus $1/T$ for transesterification in the o/w and w/o Pickering interfacial catalytic system.

Figure S8 Microscopy images of the w/o Pickering emulsion in consecutive reaction cycles (1st, 2nd, 5th and 10th cycle). Scale bar: 25μm.

Figure S9 CD spectra of native CALB in Tris-HCl buffer at 25 °C (red curve) and 45°C (black curve).

Figure S10 Microscopy images of the o/w Pickering emulsion in consecutive reaction cycles (1st, 2nd, 5th and 10th cycle). Scale bar: 50μm.

Table S1 Zeta potential of samples at pH 7.2

Table S2 Relationship of stirring input power and stirring rate.
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Figure S2 Size distribution of MS, MS-AP (2) and MS-AP (3) calculated by dynamic light scattering.
Table S1 Zeta potential of samples at pH 7.2

<table>
<thead>
<tr>
<th>Samples</th>
<th>MS</th>
<th>MS-A</th>
<th>MS-AP (3)</th>
<th>MS-AP (2)</th>
<th>MS-AP (1)</th>
<th>MS-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zeta potential (mV)</td>
<td>-7.19±0.83</td>
<td>-5.23±0.45</td>
<td>-14.86±1.16</td>
<td>-18.4±0.89</td>
<td>-22.53±0.83</td>
<td>-26.93±1.07</td>
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</tbody>
</table>
Figure S3 CD spectra of native CALB (red curve) and CALB released from Pickering emulsion droplets (black curve).
Table. S2 Relationship of stirring input power and stirring rate [a].

<table>
<thead>
<tr>
<th>Stirring input power (W)</th>
<th>5</th>
<th>10</th>
<th>12.5</th>
<th>15</th>
<th>17.5</th>
<th>20</th>
<th>22.5</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stirring rate (rpm)</td>
<td>200</td>
<td>400</td>
<td>600</td>
<td>800</td>
<td>1000</td>
<td>1200</td>
<td>1400</td>
<td>1600</td>
</tr>
</tbody>
</table>

[a] The stirring speed is measured using water as medium.
Figure S4 Nitrogen sorption isotherms for microcapsules formed by (A) MS-AP (2) and (B) MS-AP (3).
Figure. S5 Molecular model of the substrates used and products formed in the transesterification.

1-butanol

vinyl acetate

butyl acetate
Kinetic study of CALB inducing biocatalysis in pure Pickering emulsion:

Typically, substrates 1-butanol and vinyl acetate at different concentrations (50 mM, 100 mM, 150 mM, 200 mM, 250 mM) were added into the CALB loaded o/w and w/o pure Pickering emulsions to start the reaction. The initial reaction rates (mM·min⁻¹) were evaluated by linear regression of the experimental data from a plot of the product butyl acetate concentration versus time. The slope of the curve during the first 10 min was defined as the initial reaction rate. The apparent kinetic parameters Michaelis constant-$K_m$ and the maximum reaction rate-$v_{\text{max}}$ were calculated according to the Lineweaver-Burk equation (Eqn. 1):

$$\frac{1}{v} = \frac{K_m}{v_{\text{max}} [S]} + \frac{1}{v_{\text{max}}}$$

Where $v$ is the initial velocity, $v_{\text{max}}$ is the maximal reaction velocity and $[S]$ is the concentration of substrate. Fig.S6 showed the plot of the reciprocal of the reaction rate, $v$ (mM·min⁻¹), versus the reciprocal of the substrate concentration, $[S]$ (mM).

Accordingly, the $1/v$ and $1/[S]$ were related to the Eqn.2 and 3:

$$\frac{1}{v} = 26.49 \cdot \frac{1}{[S]} + 0.057$$

(2)

$$\frac{1}{v} = 60.45 \cdot \frac{1}{[S]} + 0.114$$

(3)

we found that the CALB in o/w emulsion showed a $K_m$ value of 464 mM and a $v_{\text{max}}$ value of 17.54 mM·min⁻¹, whereas the $K_m$ and $v_{\text{max}}$ of CALB in w/o emulsion
was 547 mM and 8.77 mM·min\(^{-1}\), respectively.

**Figure S6** Lineweaver-Burk plot of the reciprocal of initial rate (1/\(\nu\)) versus the reciprocal of the substrate concentration (1/[S]) for the determination of kinetic parameters \(K_m\) and \(v_{\text{max}}\) of CALB loaded pure Pickering emulsion.
Figure S7 Temperature effects on the kinetics of transesterification in the o/w and w/o Pickering interfacial catalytic system. (A) Kinetics plots for the o/w Pickering interfacial catalytic system at different temperatures. (B) Kinetics plots for the w/o Pickering interfacial catalytic system at
different temperatures. (C) ln k versus 1/T for transesterification in the o/w and w/o Pickering
interfacial catalytic system.
Figure S8 Microscopy images of the w/o Pickering emulsion in consecutive reaction cycles (1st, 2nd, 5th and 10th cycle). Scale bar: 25μm.
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