Harnessing Solar Energy for Electrocatalytic Biorefinery Using Lignin-derived Photothermal Materials

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**Figure S1.** Phenolic hydroxyl content of lignin and D-Lig.

**Figure S2.** ESR spectra of D-Lig and D-Lig-Fe.
Figure S3. Raman spectra of D-Lig and D-Lig-Fe.

Figure S4. The decay curves of D-Lig-Fe at 520 nm (ESA) after 365 nm excitation.
Figure S5. Efficiency of photothermal conversion of carbon nanotubes upon mimetic solar irradiation.

Figure S6. The photothermal stability measurement of D-lig-Fe powder (8 cycles).
**Figure S7.** TGA curves of D-Lig-Fe.

**Figure S8.** Time-dependent temperature change of D-Lig-Fe upon mimetic solar irradiation (100 mW cm\(^{-2}\)) after treating at 80 °C, 100 °C or 150 °C for 1 h.
Figure S9. Six times cycling of voltage output by the on-off simulated solar irradiation.

Figure S10. XRD of NiCoB.
**Figure S11.** Tafel slope of OER and HMFOR on the NiCoB.

**Figure S12.** Electrochemical impedance spectroscopy of OER and HMFOR.
**Figure S13.** HMF conversion and FDCA yield at different potentials.

![Graph showing HMF conversion and FDCA yield at different potentials.](image)

**Figure S14.** FDCA yield of our research and the previously reported research.\(^1\text{-}^7\)

![Bar chart comparing FDCA yield.](image)
**Figure S15.** HPLC of the product from our system and standard samples (DFF, HMF HMFCA FFCA FDCA). 2,5-Diformylfuran (DFF), 5-Formylfuran-2-carboxylic acid (FFCA), 5-Hydroxymethyl-2-furancarboxylic acid (HMFCA)
Table S1. The retention time for standard compounds

<table>
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<tr>
<th>Intermediates</th>
<th>Chemical formula</th>
<th>Molecular weight</th>
<th>HPLC retention time/min</th>
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<td>HMF</td>
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<td>16.7</td>
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<tr>
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<td>C₆H₄O₅</td>
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Figure S16. Real-time monitoring of the solar power and environmental temperature during the outdoor experiment, the outdoor experiment started at 9:50 on Sep 20, 2022, in Harbin.

Figure S17. Photothermal efficiency of D-Lig-Fe upon irradiation concentrated by Fresnel lens.
**Video S1:** A motion of engine triggered by generated electricity.

**Video S2:** A bulb lighted by generated electricity.

**References**