## **Supporting information**

## Transforming Lignin into Porous Graphene via Direct Laser Writing for Solid-State Supercapacitors

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**Fig. S1** (a) SEM image of porous LIG-80 embedded on a lignin/PEO film, scale bar is 2  $\mu$ m. (b) A higher magnification of SEM image of the white square region in (a), showing a beehive-like porous structure, scale bar is 500 nm.



**Fig. S2** SEM images of LIG obtained at the power levels of 50% and 70%. (a-c) LIG-50 obtained at 50% power level. (d-f) LIG-70 obtained at 70% power level. The scale bars: (a, d) 50  $\mu$ m, (b, e) 10  $\mu$ m, and (c, f) 2  $\mu$ m.



**Fig. S3** TEM images of LIG obtained at the power levels of 50% and 70%. (a-c) LIG-50 obtained at 50% power level. (d-f) LIG-70 obtained at 70% power level. The scale bars: (a, d) 0.5  $\mu$ m, (b, e) 100 nm, and (c, f) 20 nm.



**Fig. S4** XRD analysis of LIG-80. Survey scans were conducted at  $2\theta$  of 0-50° with a scan rate of 0.6s/0.02°. Detailed analysis of LIG-80 (shown in the inset and XRD pattern in red) was conducted at  $2\theta$  of 17-26° with a scan rate of 12s/0.02°. LIG-80 embedded on the lignin/PEO film was used for analysis, and the pristine lignin/PEO film (non-irradiated) used as a control. The presence of the characteristic peaks of PEO in the XRD pattern for LIG-80 suggests that the lignin/PEO film below embedded LIG could interfere with the analysis.



**Fig. S5** XPS survey spectra of the lignin/PEO film and LIG-80. LIG embedded on the lignin/PEO film was used for XPS spectroscopy, and the pristine lignin/PEO film used as a control.



**Fig. S6** Electrochemical analysis of LIG-50-SC and LIG-70-SC. (a) CV curves of LIG-50-SC at different scan rates. (b) CV curves of LIG-70-SC at different scan rates. (c) Specific areal capacitance ( $C_A$ ) as a function of scan rate. (d) CD curves of LIG-50-SC at different discharge current densities. (e) CD curves of LIG-70-SC at different discharge current densities. (f) Specific areal capacitance ( $C_A$ ) as a function of discharge current density.



Fig. S7 (a, b) Specific volumetric ( $C_V$ ) capacitances calculated from LIG-80-SC as a function of scan rate and current density, respectively. (c, d) Ragone plots of LIG-80-SC.