Electronic Supplementary Material (ESI) for Green Chemistry.


# Green fabrication of fabric by ethanol/water solvent mediated self-assembly of homogeneous lignin for oil-water separation

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## Methods

*Surface energy*

The surface energy (SE) of cotton fabrics was calculated according to WORK method. The contact angle values of water and ethylene glycol determined by OCA-50 with four replicates were conducted. The surface tension (SFT) of the water and ethylene glycol with disperse ($\gamma_{LD}$) and polar ($\gamma_{LP}$) fractions was got by the software of OCA-50 (Table S1). The contact angles of the water and ethylene glycol of cotton fabric were used to calculate the polar and disperse force according to Eq. (1).

$$\frac{1}{2}(1+cos\theta)\frac{\gamma_{LV}}{\sqrt{\gamma_L^d}}=\sqrt{\gamma_S^P}\sqrt{\frac{\gamma_L^P}{\gamma_L^d}}+\sqrt{\gamma_S^d} \qquad (1)$$

Where, $\theta$ (°) refers to directly measured contact angle ; $\gamma_{LV}$ refers to surface tension of a liquid ; $\gamma_L{}^d$ refers to disperse fraction of $\gamma_{LV}$; $\gamma_S{}^P$ refers to polar fraction of $\gamma_s$; $\gamma_L{}^P$ refers to polar fraction of $\gamma_{LV}$; $\gamma_S{}^d$ refers to disperse fraction of the $\gamma_{LV}$.

*Loading amount and percentage*

The amount of FLP/Fe particle loaded on cotton fabrics was calculated according to Eq. (2) and (3):

$$\text{Loading amount (g/m}^2\text{)} = (W_2 - W_1)/S \qquad (2)$$

$$\text{Loading percentage (\%)} = (W_2 - W_1)/\ W_1 \qquad (3)$$

where, $W_1$ (g) and $W_2$ (g) refer to the weight of pure fabric and FLP/Fe@cotton fabric, respectively. S ($m^2$) refers to the area of fabric.

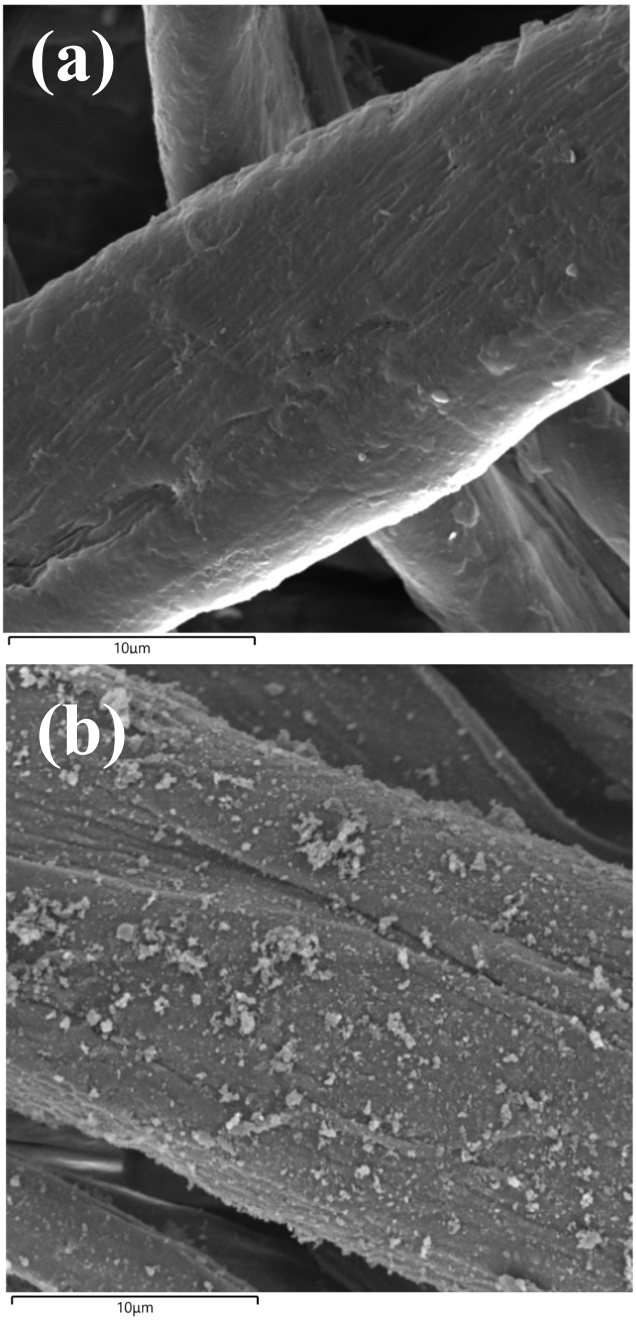


**Fig.S1** The SEM of EDX bright field images of pristine cotton fabric (a) and FLP-50/Fe@cotton fabric (b)

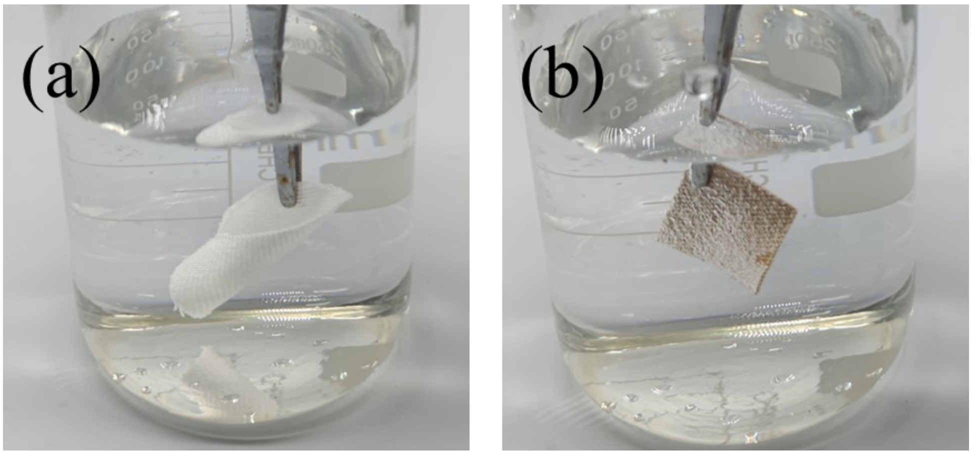


**Fig.S2** The water wettability images of (a) pristine cotton fabric and (b) FLP-50/Fe@cotton fabric

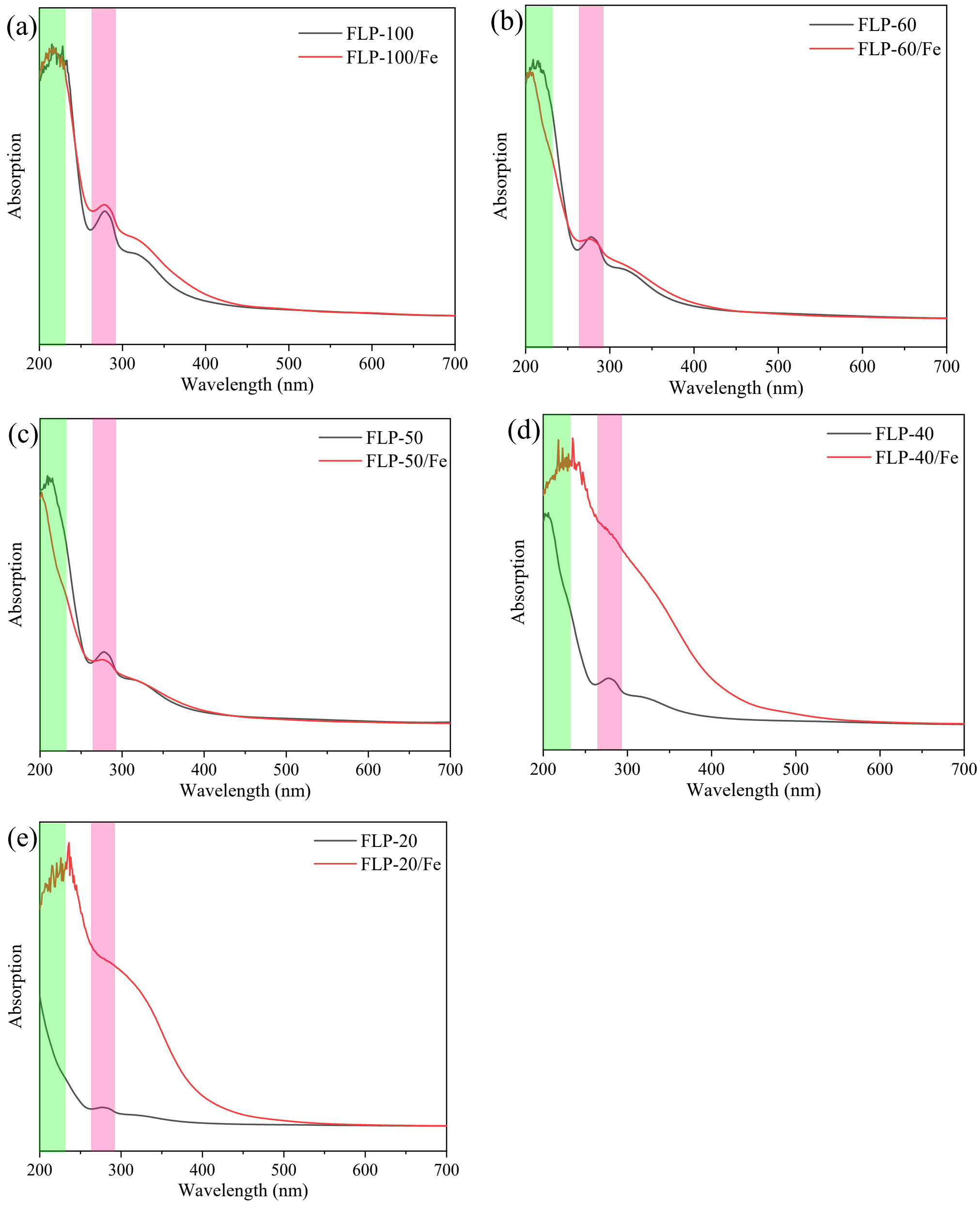


**Fig.S3** UV–vis spectra of (a) FLP-100, FLP-100/Fe, (b) FLP-60, FLP-60/Fe, (c) FLP-50, FLP-50/Fe, (d) FLP-40, FLP-40/Fe and (e) FLP-20, FLP-20/Fe

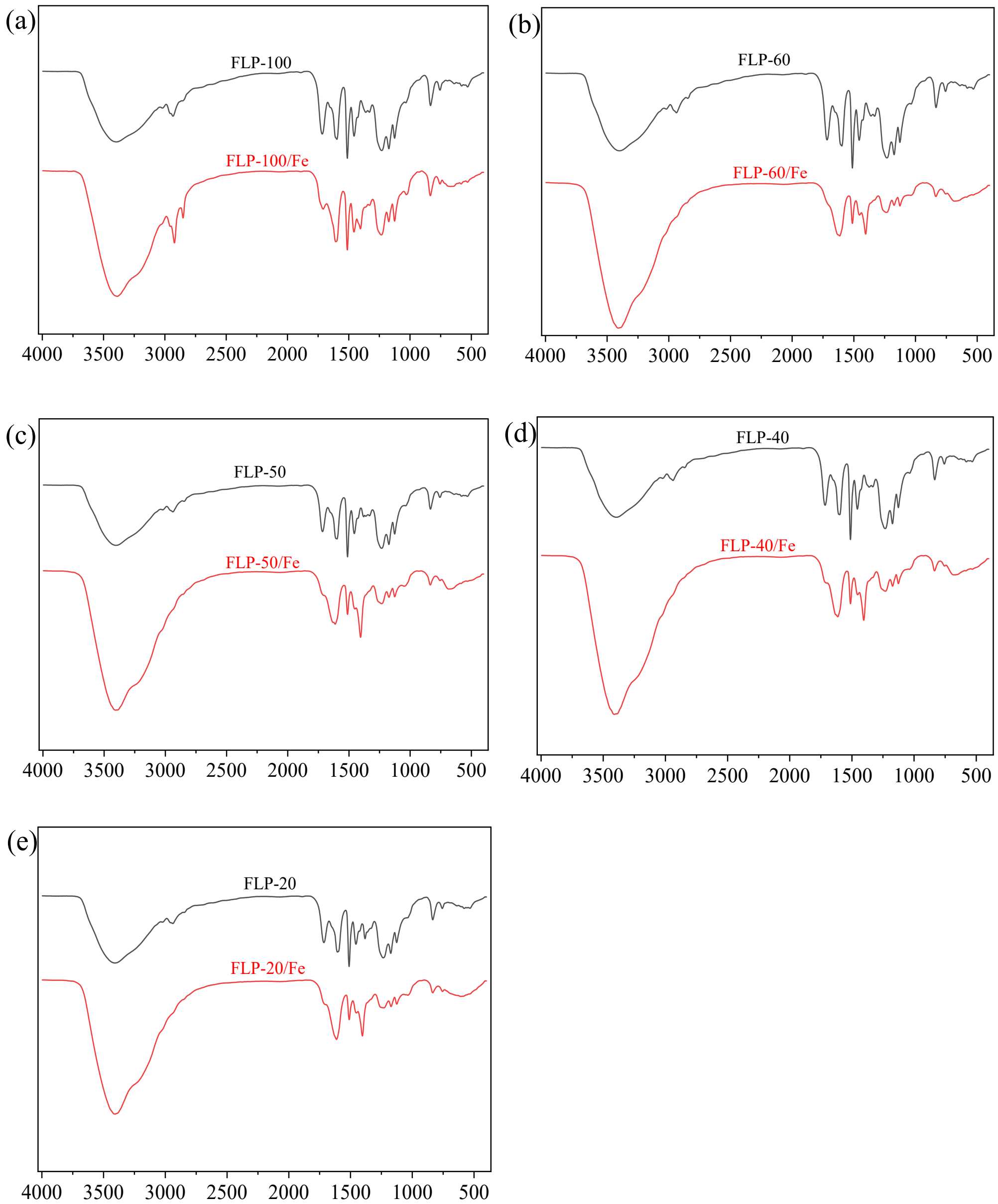


**Fig.S4** FTIR spectra of (a) FLP-100, FLP-100/Fe, (b) FLP-60, FLP-60/Fe, (c) FLP-50, FLP-50/Fe, (d) FLP-40, FLP-40/Fe and (e) FLP-20, FLP-20/Fe

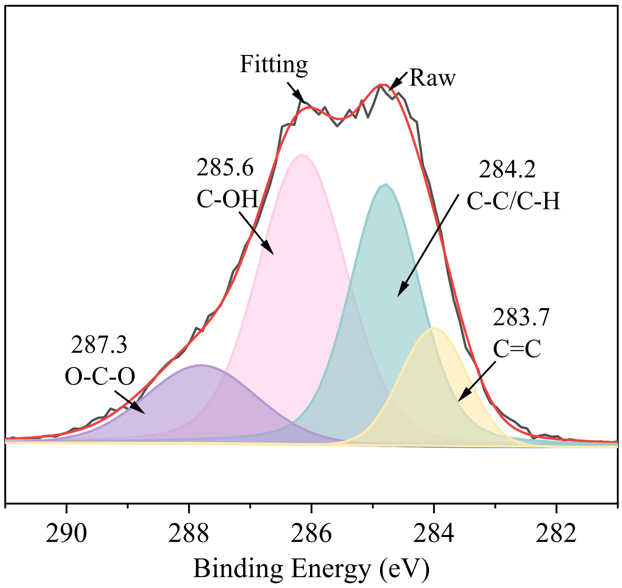


**Fig.S5** High resolution C 1s of pristine fabric

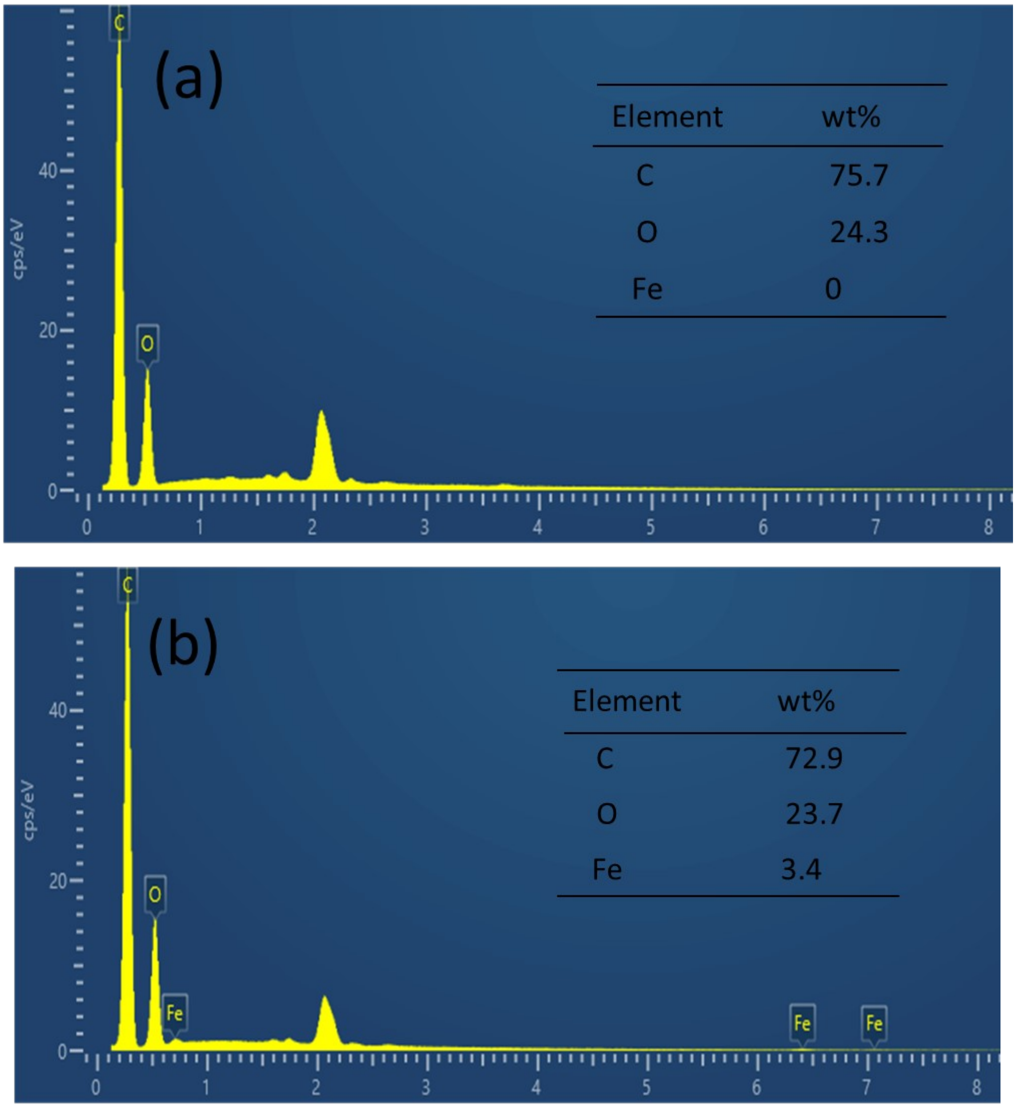


**Fig.S6** EDS of pristine cotton fabric (a) and FLP-50/Fe@cotton fabric (b)

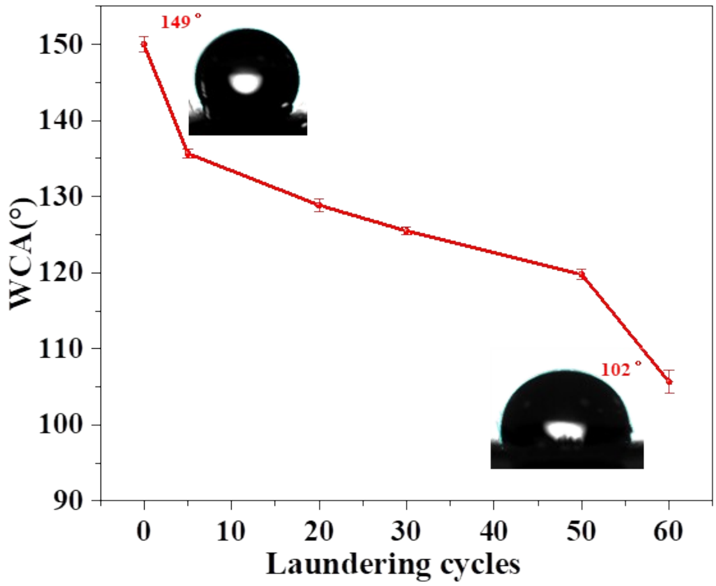


**Fig.S7** The effect of laundering cycles on the water contact angle of FLP-50/Fe@cotton fabric.

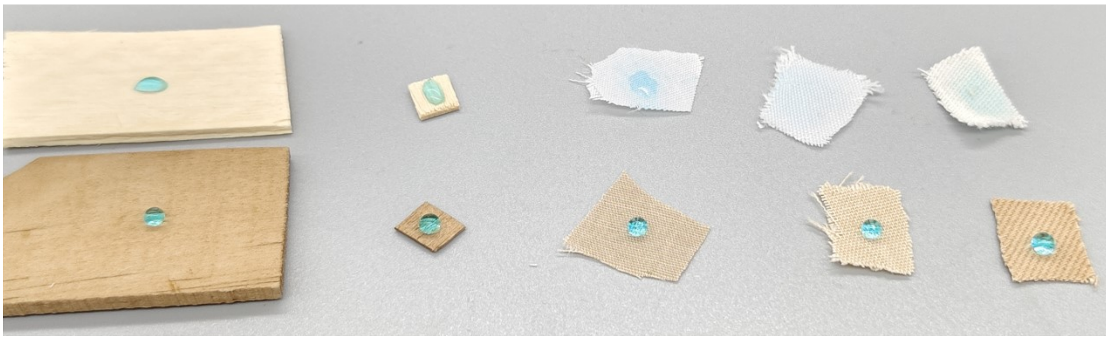

**Fig.S8** The images of water droplet on pristine substrate (First line from left to right: wood, straw and composite fabric (65%polyester-35%cotton, 80%polyester-20%cotton, and 100%cotton)) and corresponding images on modified substrate in second line after the deposition of FLP/Fe.

**Table S1.** The contents of functional groups of FLP based on quantitative $^{31}P$ NMR spectra (mmol/g).

| | syringyl OH | guaiacyl OH | p-hydroxyphenyl OH | total phenolic OH | aliphatic OH | COOH |
|---|---|---|---|---|---|---|
| FLP-100 | 0.22 | 2.94 | 0.05 | 3.21 | 1.29 | 0.28 |
| FLP-60 | 0.26 | 3.44 | 0.10 | 3.80 | 1.20 | 0.38 |
| FLP-50 | 0.25 | 3.42 | 0.12 | 3.79 | 1.24 | 0.38 |
| FLP-40 | 0.13 | 3.36 | 0.09 | 3.58 | 1.41 | 0.31 |
| FLP-20 | 0.28 | 3.31 | 0.34 | 3.93 | 1.43 | 0.34 |

**Table S2.** Characterization results of GPC for Lignin.

| | Mn | Mw | DPI |
|---|---|---|---|
| 100% | 2867 | 5029 | 1.75 |
| 60% | 2705 | 5010 | 1.85 |
| 50% | 2741 | 4762 | 1.74 |
| 40% | 2551 | 4342 | 1.70 |
| 20% | 2500 | 4339 | 1.74 |

**Table S3.** The content of chemical groups of various fabrics determined by C1s of XPS spectra.

| Samples | Contents of chemical groups | | | |
|---|---|---|---|---|
| | O-C-O | C-OH | C=C | C-C/C-H |
| Pristine cotton fabric | 14% | 42% | 32% | 12% |
| FLP-50/Fe@cotton fabric | 15% | 42% | 21% | 22% |

**Table S4.** The content of chemical groups of various fabrics determined by O1s of XPS spectra.

| Samples | Contents of chemical groups | | | |
|---|---|---|---|---|
| | O-H | C-O-C | C-O | Fe-O-C |
| Pristine cotton fabric | 33% | 65% | 2% | 0% |
| FLP-50/Fe@cotton fabric | 42% | 53% | 3% | 2% |

**Table S5** Comparison of oil-water separation efficiency for various materials.

| Raw material | Types of oil | Separation efficiency | WCA(°) | Reference |
|---|---|---|---|---|
| AEL-FP | Chloroform | 98.6 % | 168 | 1 |
| AL/RGO@PDA Composite membrane | Corn cooking oil | 99.7 % | 35 to 67 | 2 |
| Acetylated Lignin/Melamine Formaldehyde(ALMF) Sponge | Trichoromethane | 140.0 g/g | 138.5 | 3 |
| SMA-DMAEMA-KH570 modified lignin-based aerogels | Chloroform | 40.2 g/g | 150 | 4 |
| Lignin-cellulose functionalized graphene (LCG) sponge | DMSO | 102.3 g/g | 110 | 5 |
| lignin-modified graphene aerogel (LGA) | Carbon tetrachloride | 96% | 127 | 6 |
| A lignin-based carbon aerogel enhanced by graphene oxide (LCAGO) | Chloroform | 34.5 g/g | 150 | 7 |
| T-SA/lignin$^{x}$/rGO-MTMS | Chloroform | 13.2 g/g | 161 | 8 |
| FLP-50/Fe@ cotton fabric | Trichloromethane | 99.6% | 149 | This study |
| | Hexane | 99.4% | | |
| | Toluene | 98.7% | | |
| | Dichloromethane | 99.6% | | |

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