Supporting Information

A simple and economical method using graphene oxide for the fabrication of water/oil separation papers

Hongyi Qin [a, #], Tao Gong [a, #], Yujin Cho [b], Cheolmin Shin [b], Changgu Lee [a,b,*], Taesung Kim [a,b,*]

[a] SKKU Advanced Institute of Nano Technology (SAINT), Sungkyunkwan University, Suwon 440-746, South Korea

[b] School of Mechanical Engineering, Sungkyunkwan University, Suwon 440-746, South Korea

[#] These authors contribute equally to this work.

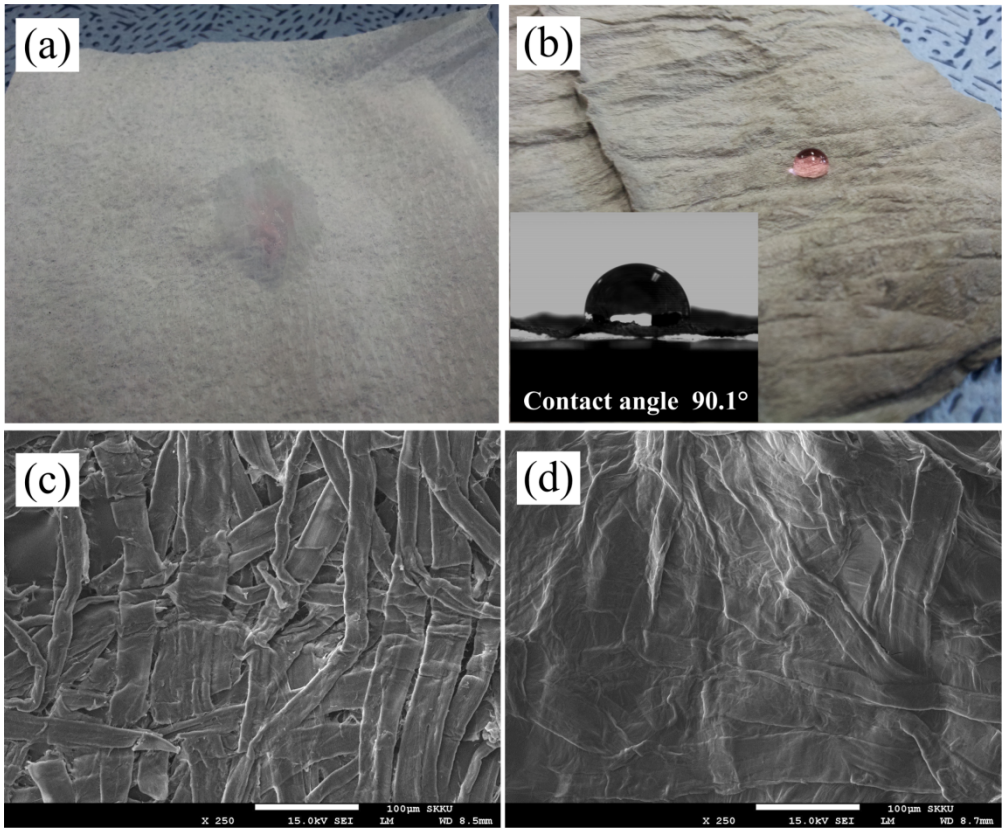

Fig. S1 Photographs of a paper with a water droplet. (a) A pure KIMTECH tissue paper is wet by water. (b) A separation paper based on KIMTECH tissue paper, where the contact angle is 90.1° shown in the insert image. (c) SEM image of pure KIMTECH tissue paper. (d) SEM image of separation paper using KIMTECH tissue paper. The separation papers are treated by a GO aqueous solution at 180 °C for 3 hours. The red colour of the water is due to azorubine dye.

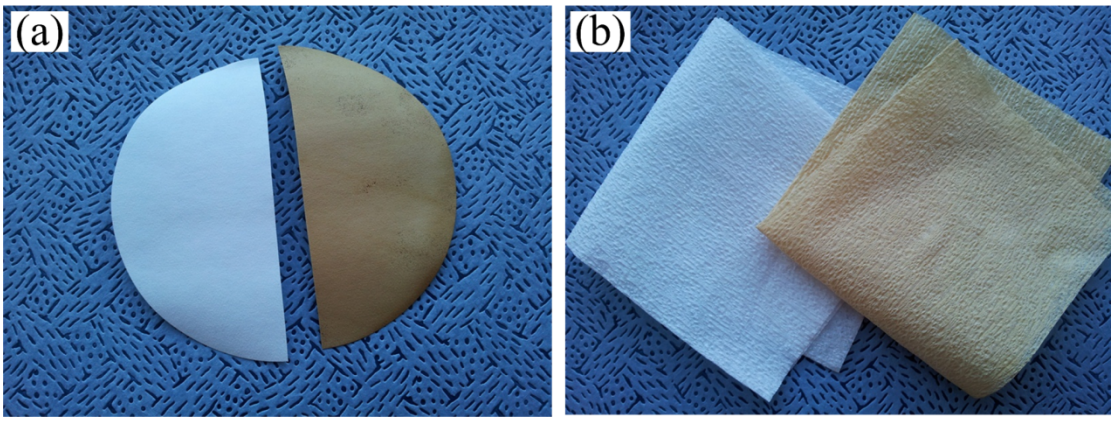

Fig. S2 Photographs of the pure paper before and after 200 °C thermal treatment for 3 hours. (a) filter paper (b) KIMTECH tissue paper. The papers are oxidized to become brown.

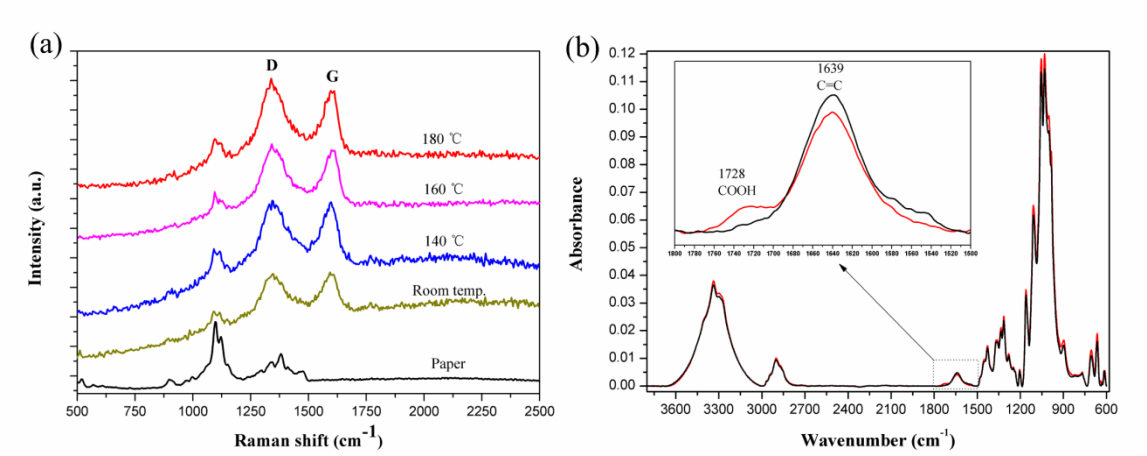

Fig. S3 (a) Raman spectra of the filter paper and separation papers treated by GO aqueous solution at different temperatures and for 3 hours. (b) ATR-FTIR spectra of pure paper (black) and separation paper (red) treated by GO aqueous solution at 180 °C for 3 hours. The insert image is enlarged image from 1800 to 1500 cm^{-1}.

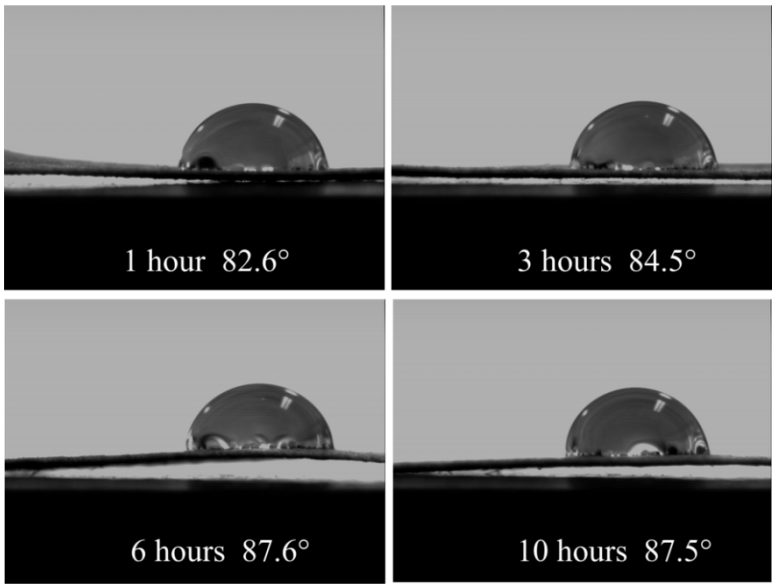

Fig. S4 Contact angle measurements for separation papers with different time treatment. 1 hour, the contact angle is 82.6°. 3 hours, the contact angle is 84.5°. 6 hours, the contact angle is 87.6°. 10 hours, the contact angle is 87.5°. All the samples were based on filter paper treated by GO aqueous solution at 180 °C.

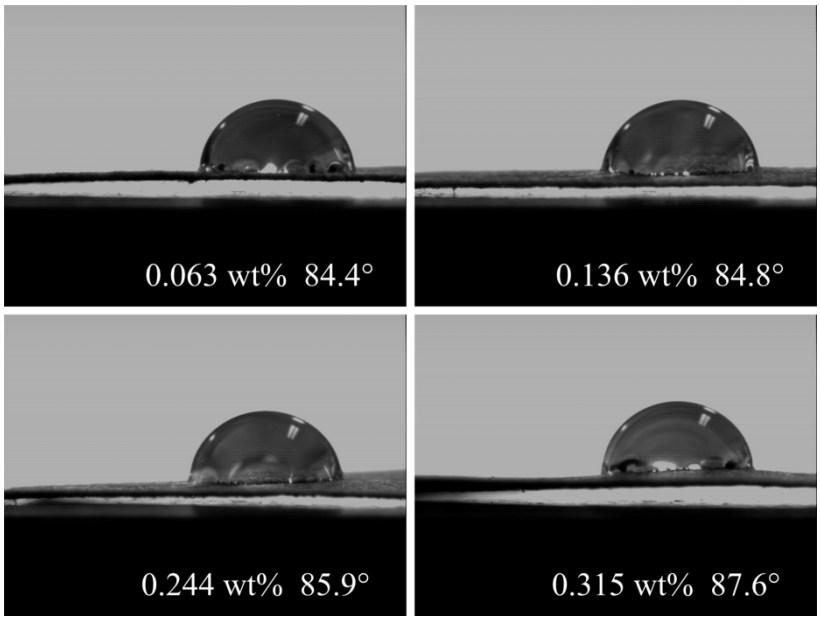

Fig. S5 Contact angle measurements for separation papers with different weight percentage (*wt%*) of RGO. 0.063 *wt%*, the contact angle is 84.4°. 0.136 *wt%*, the contact angle is 84.8°. 0.244 *wt%*, the contact angle is 85.9°, and 0.315 *wt%*, the contact angle is 87.6°. All the samples were based on filter papers treated at 180 °C for 3 hours. The weight percentage of RGO is calculated following the equation wt%=(W-W_0)/W×100%, where W is the weight of separation paper and W_0 is the weight of original pure paper. The different weight percentage samples were obtained by immersing paper in GO solution with different concentration.

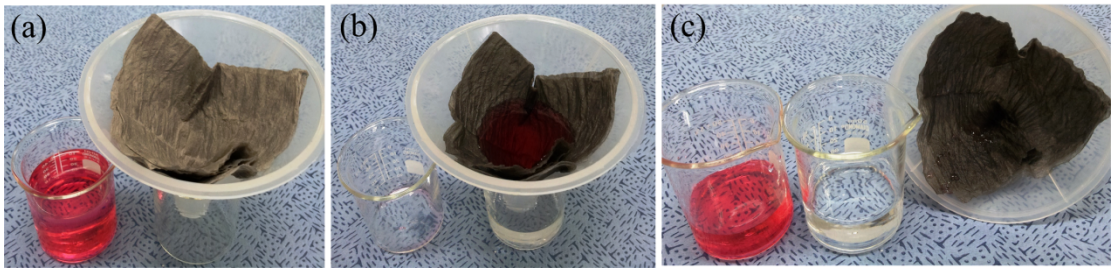

Fig. S6 Experimental photographs of water/oil separation based on a KIMTECH tissue paper. (a) The top transparent liquid is hexane and the bottom red color liquid is water with dye. (b) After separation, only hexane selectively passed through the separation paper. (c) The mixture solution can be completely separated. The tissue paper is treated by GO aqueous solution at 180 °C for 3 hours.

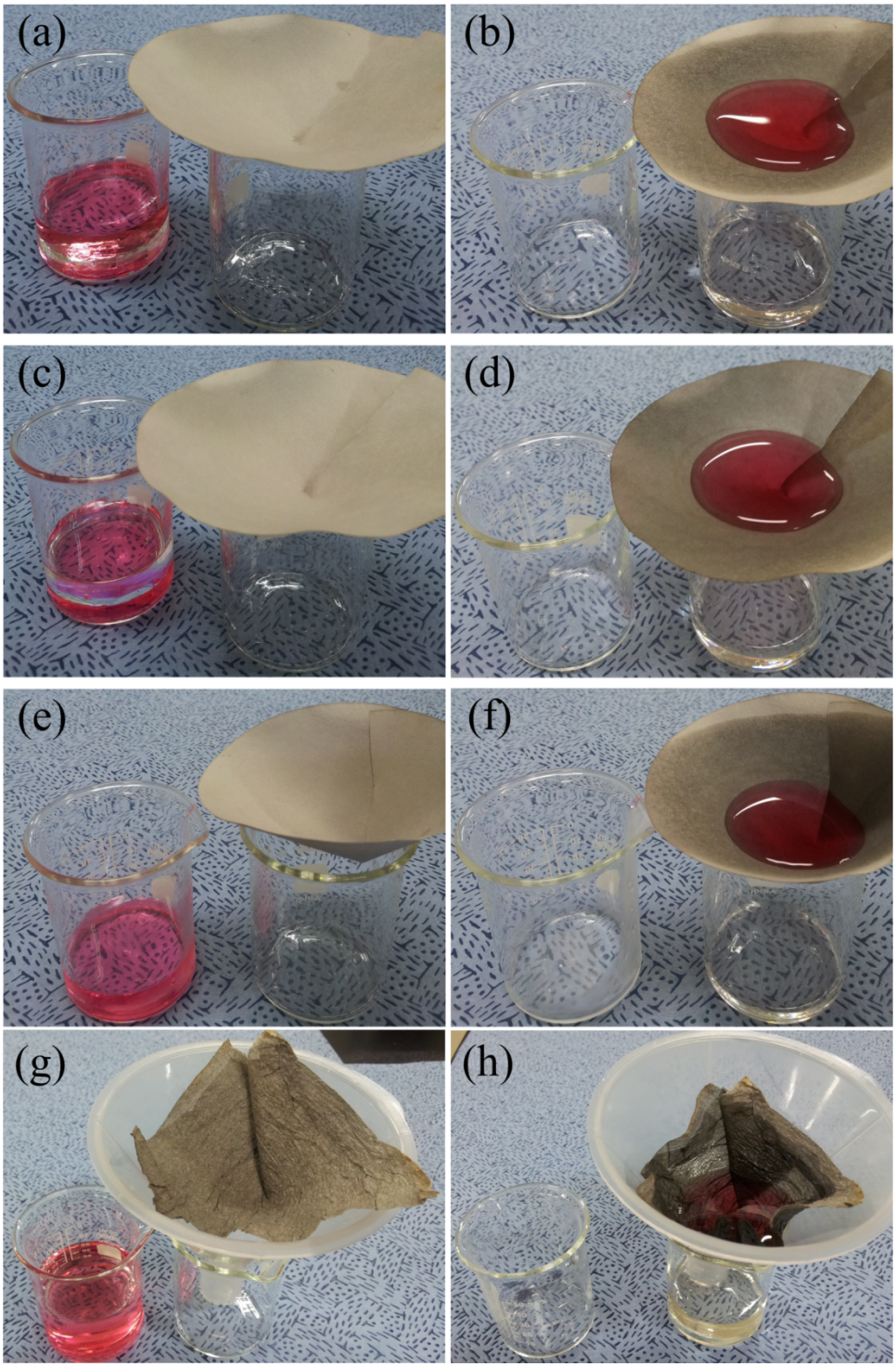

Fig. S7 Experimental photographs of water/oil separation for different organic solvents using the same filter paper: (a, b) chloroform, (c, d) toluene, (e, f) dichloromethane and (g, h) mineral oil. The filter paper and KIMTECH tissue paper were treated by GO aqueous solution at 180 °C for 3 hours.

Table S1 Separation selectivity of water (~10 mL) and loss ratio of organic solvents and oil (~10 mL): W_{s0} is the organic solvents weight before separation, W_s is the organic solvent weight in filtrates after separation and $\Delta R_s = (W_s - W_{s0})/W_{s0} \times 100\%$ is the loss ratio of organic solvent before and after separation process. W_0 is the water weight before separation, W is the water weight after separation and $R = W/W_0 \times 100\%$ is the separation selectivity of water.

Solvents	W_{s0} (g)	W_s (g)	ΔR_s (%)	W_0 (g)	W (g)	R (%)
Hexane/Water	7.3458	6.8546	-6.69	10.7645	10.7171	99.56
Chloroform/Water	14.7592	13.9854	-5.24	10.2687	10.1948	99.28
Toluene/Water	7.8972	7.2848	-8.41	10.1586	10.1179	99.60
Dichloromethane/Water	8.9578	8.3687	-7.04	10.2586	10.2513	99.93
Mineral oil/Water	8.7549	7.3256	-19.51	10.6587	10.6371	99.80

Table S2 Reusable performance (5 times) of separation paper using mixture of chloroform/water:

Stability was measured by atomic ratio of C/O in separation filter papers using elemental analysis (EA) (Elementar Analysensysteme GmbH).

Flux was measured using filter apparatus in figure 5(c). The area of separation paper is ~12.5 cm^2, the volume of filtrated chloroform is 20 mL. The flux can be calculated by the filtration time.

	Paper	Separation Times					
		0 Time	1 Time	2 Times	3 Times	4 Times	5 Times
Stability (EA, C/O)	1.093	1.166	1.165	1.169	1.171	1.167	1.167
Selectivity of water (%)	/	/	99.60	99.32	99.54	99.12	99.68
Flux (L h^{-1} m^{-2})	/	/	344.4	362.6	355.9	349.8	372.4