Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supplementary data

A robust, sustainable and multifunctional nanofiber with smart switch ability for water-in-oil and oil-in-water emulsions separation and liquid marble preparation

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Figure, Table and Movie captions

Table S1. The used equations for characterization of the NBF.

Table S2. The amount of available elements of the NBF and grape seed obtained by SEM-EDX. Most of the elements related to the impurities, pectin, lipid, lignin and contaminants were removed in NBF.

Fig. S1. ATR-FTIR spectra recorded from grape seed and NBF. Most of the peaks related to the phenolic, polysaccharide, pectin, lignin and lipid compounds were removed from the pristine grape seed by treatment with NaOH solution.

Fig. S2. A) TGA, DTGA thermograms, and B) DSC curves of grape seed and NBF

Fig. S3. SEM image of the pristine grape seed.

Fig. S 4. A) TEM images of NBFs after exposure to acidic (pH= 2), and B) basic (pH=13) solution for one month. The NBFs retain their nanofiber structure even in harsh environment for a long time.

Fig. S5. The optical microscope images and digital images of the water-in-oil emulsions before and after separation and their corresponding droplet size distributions obtained via DLS.

Fig. S6. A water droplet encapsulated on the bed of NBFs.

Fig. S7. The effect of treated soil with NBF on the growth of lentil seeds (*Lens culinaris*) in arid environment were studied (left image); (T1) 100% soil (control), (T2) 60% NBF (top layer) and 40% soil (bottom layer), (T3) 50 % NBF (top layer) and 50% soil (bottom layer) and (T4) mixing the 50% NBF and 50% soil. Lentil seed planted in T4 growth faster (the length of root and lentil plant in T4 were longer) than the other treated soils (right image).

Movie S1. The process of a water droplet infiltrates into the NBF membrane in air.

Movie S2. The process of an oil droplet infiltrates into the NBF membrane in air.

Movie S3. The process of an underoil water droplet infiltrates into the NBF membrane.

Movie S4. The process of an oil-in-water emulsion droplet stabilized with span 80 infiltrates into the NBF membrane in air.

Movie S5. The process of a water-in-oil emulsion droplet stabilized with span 80 infiltrates into the NBF membrane in air.

Video S6. The separation processes of hexane-in-water emulsion stabilized with span 80 driven by gravity on the NBF membrane.

Video S7. The separation processes of water-in-oil emulsion stabilized with span 80 driven by gravity on the NBF membrane.

Video S8. The separation processes of oil/dyed-water mixture (MB as dye) driven by gravity on the NBF membrane.

Video S9. Fully-coated and encapsulated a water droplet by NBF powder and making a liquid marble.

Video S10. NBF-based liquid marbles adsorbed dye from the encapsulated methylene blue solution.

Video S11. Dispensing aqueous solution using a pipette and rolling the droplets on a NBF bed made the liquid marbles.

Video S12. Dropping the water droplet on the powder of NBF to make a liquid marble with water volume of 120 μL.

Table S1. The used equations for characterization of the NBF.

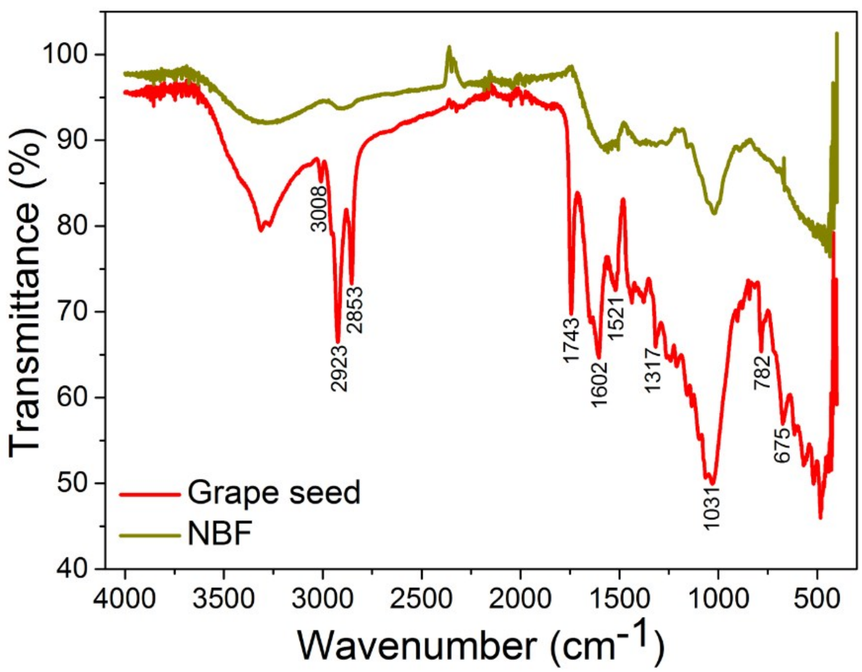
Name	Equation*
Separation capability	$R = (1 - C_f) / C_o \times 100$
Density of NBF	$\rho_{layer} = m_{layer} / V_{layer}$
The porosity of the NBF	$\varepsilon_{layer} = (m_{layer} / \rho_{layer}) / V_{layer} \times 100$
Theoretical value of separation capacity	$V_g = [(m_{saturated} - m_{wetted}) / \rho_{water} \times 50] / m_{raw}$
The flux of NBF	$Flux = V/At$
Hagen–Poiseuille	$J = \varepsilon \pi r_p^2 \Delta p / 8 \mu L$
Intruding pressure	$p = \rho g h_{max}$

* m_0 is the quality of raw NBF, m_w is the quality of NBF after it is wetted by oil, $m_{saturated}$ *is the* quality *of saturated NBF after water adsorption in oil-rich environment, V* is the volume of the filtrated phase that passes through the membrane, A is the valid area of the NBF (cm^2), and t is the filtration time (2 min). The separation process was performed under gravity and the height of feed emulsion was fixed at 20 cm. J is the theoretical flux, ε is the surface porosity, r_p is the pore radius, Δp is the pressure drop, μ is the oil viscosity, and L is the thickness of the NBF, ρ_{water} is the density of water, ρ is the density of the liquid, g stands for the acceleration of gravity, the number 50 is the volume ratio between oil and water in the emulsions

Table S2. The amount of available elements of the NBF and grape seed obtained by SEM-EDX. Most of the elements related to the impurities, pectin, lipid, lignin and contaminants were removed in NBF sample.

	Element	Wt%
NBF	C	73.38
	O	23.86
	S	0.37
	Na*	2.39
	Total	100
Grape seed	C	73.37
	O	24.63
	S	0.36
	Na	0.65
	P	0.35
	K	0.26
	Si	0.13
	Mg	0.25
	Total	100

* The increase in Na percentage could be due to the washing procedure with NaOH



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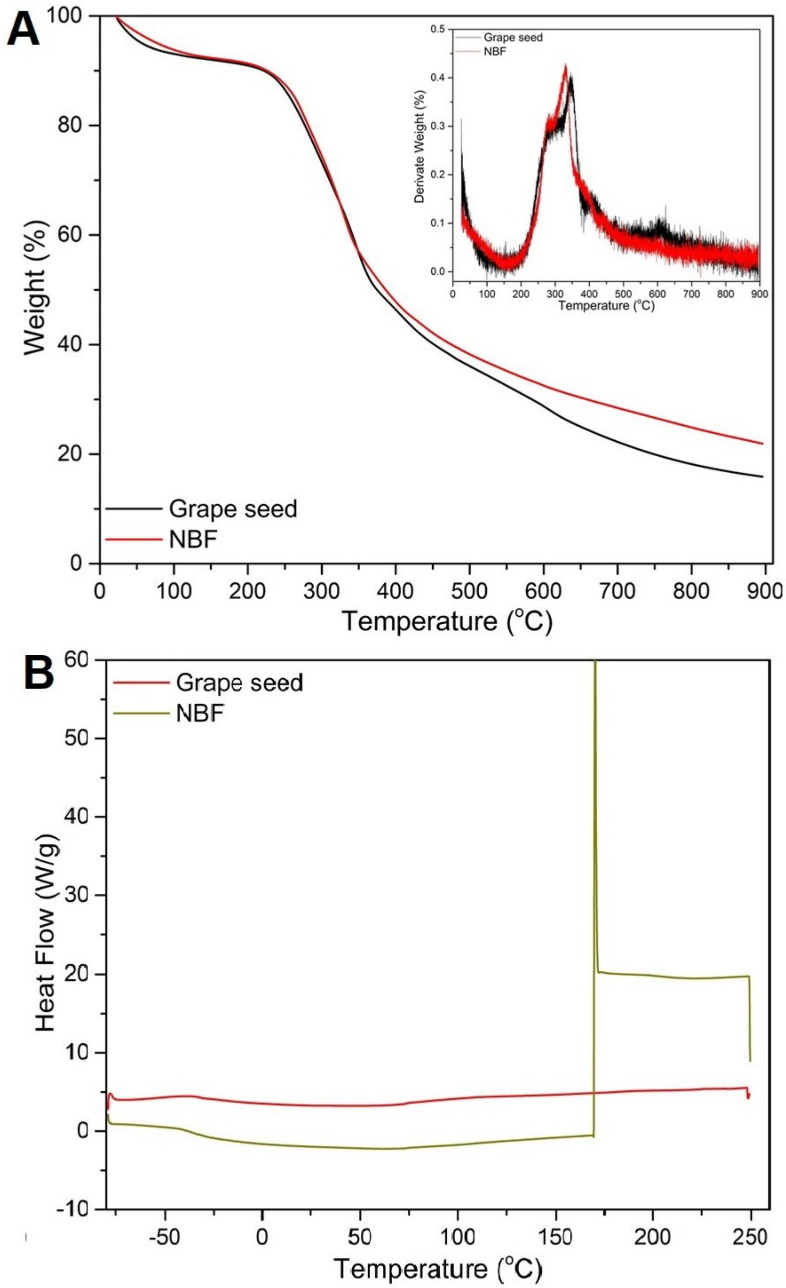

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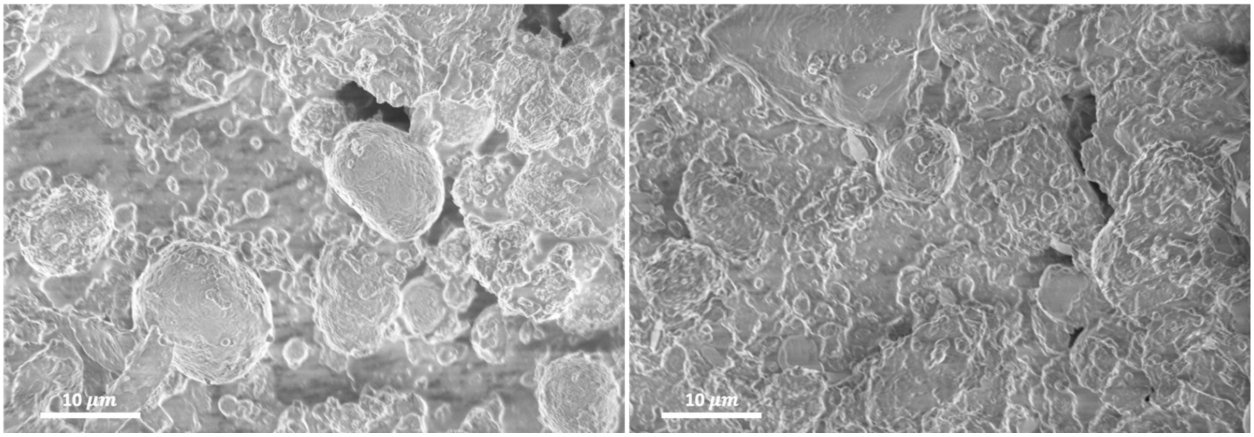
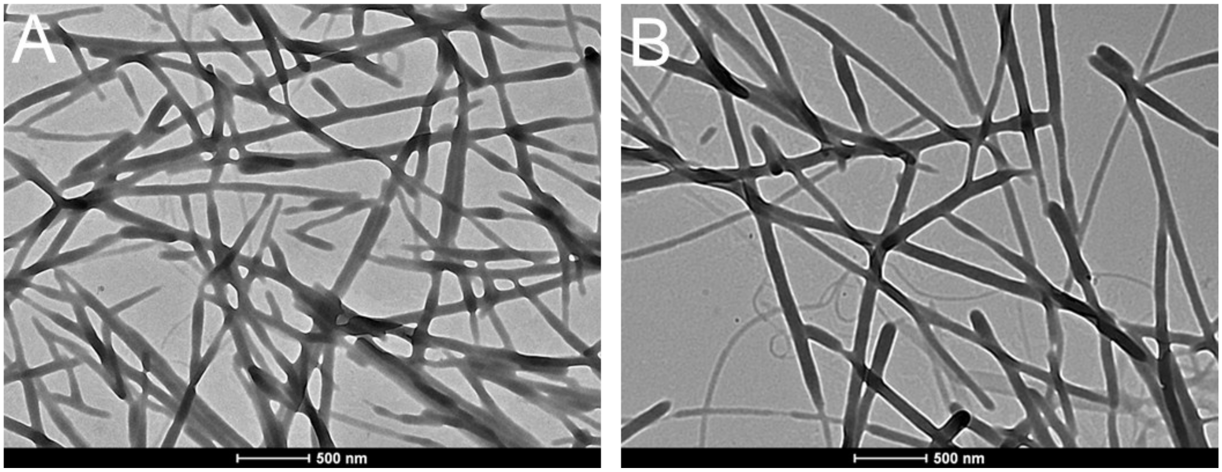


Fig. S3. SEM image of the pristine grape seed.



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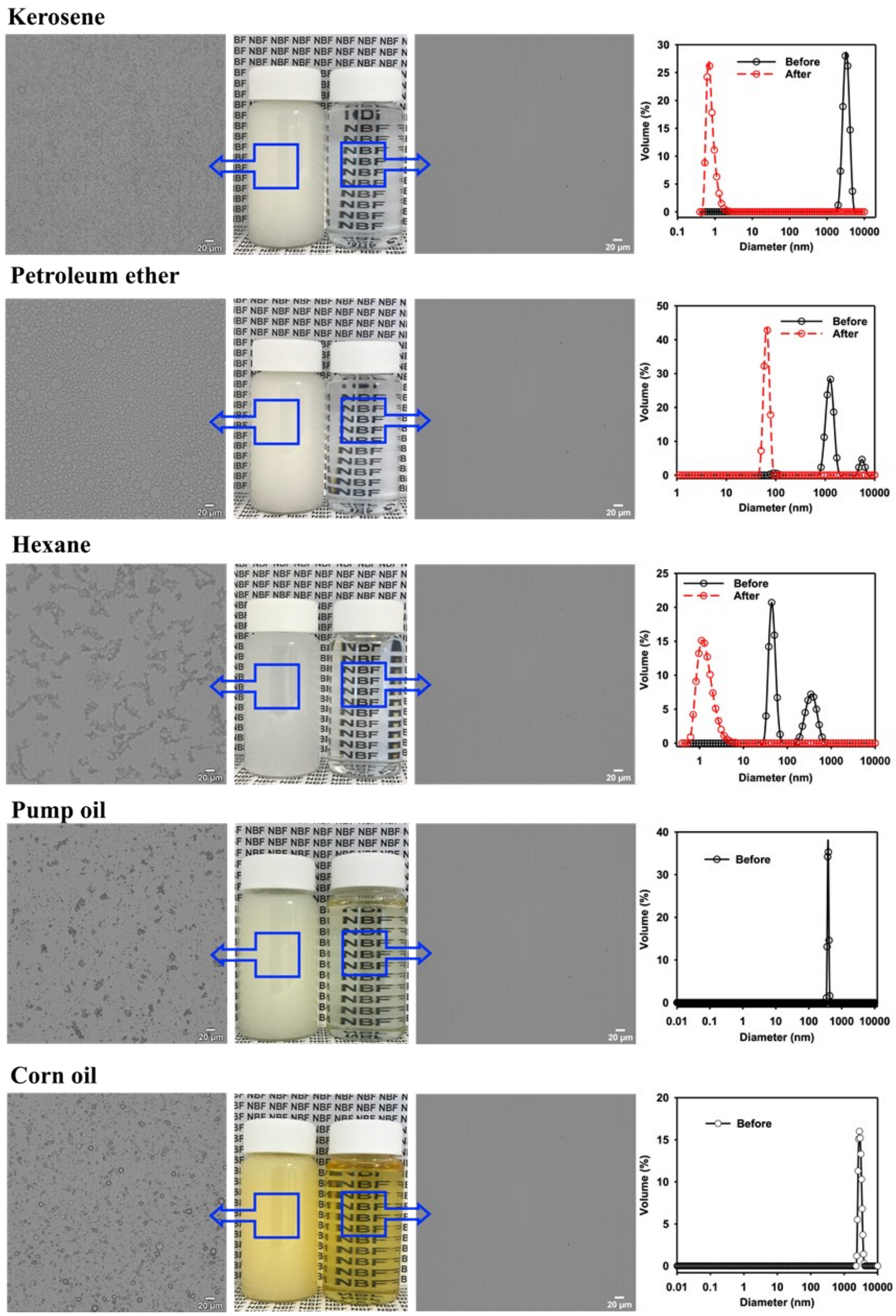

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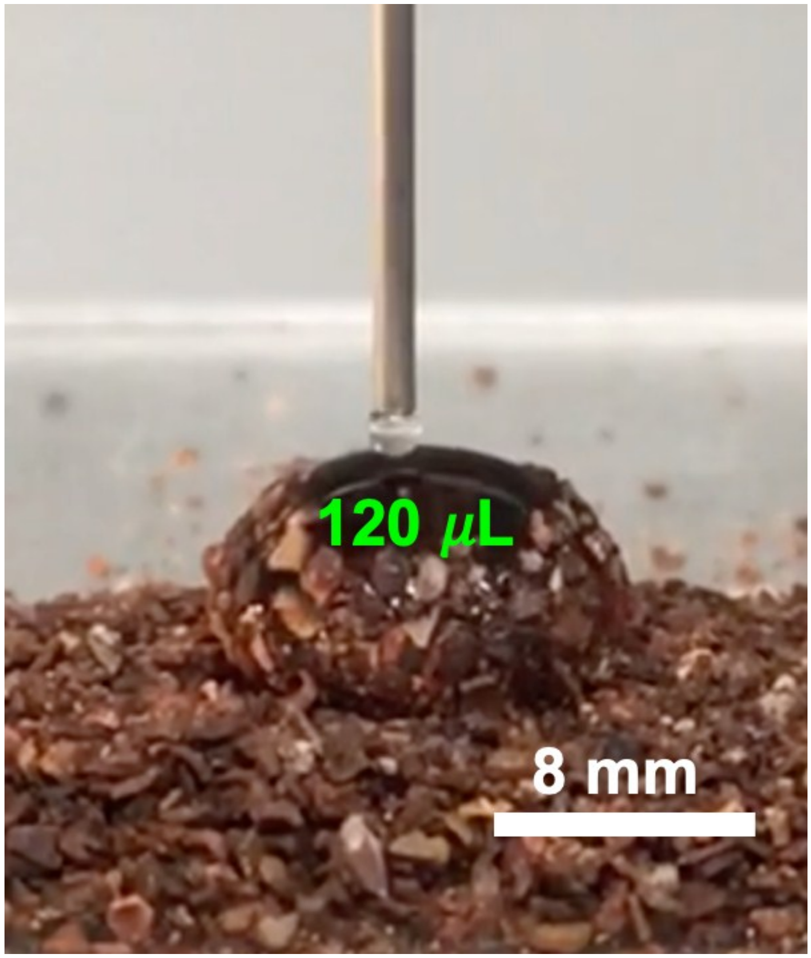

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