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

Electronic Supplementary Information

Layered double hydroxide/boron nitride nanocomposite membranes for efficient separation and photodegradation of water-soluble dyes

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Section S.1: Zeta potential measurements

			Mean (mV)	Area (%)	St Dev (mV)
Zeta Potential (mV):	-30.7	**Peak 1:**	-30.7	100.0	7.12
Zeta Deviation (mV):	7.12	**Peak 2:**	0.00	0.0	0.00
Conductivity (mS/cm):	0.00398	**Peak 3:**	0.00	0.0	0.00
Result quality	Good				

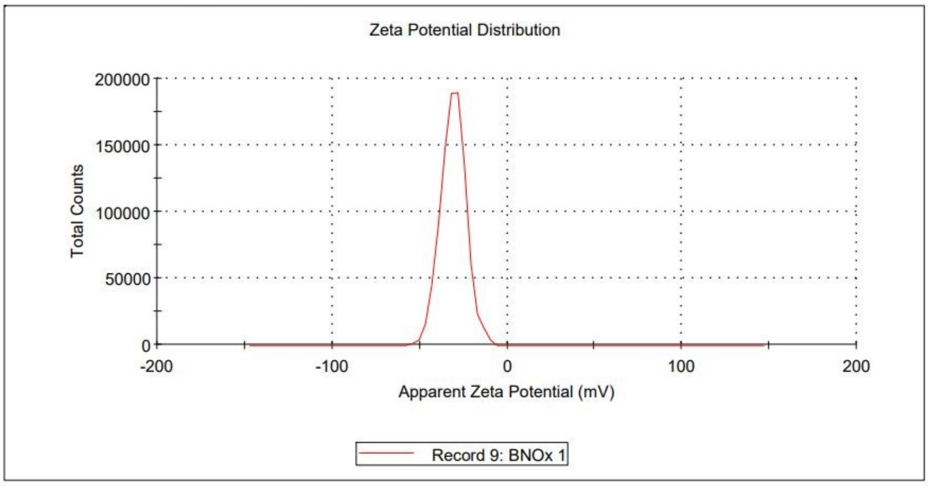

Figure S.1: Zeta potential measurement of exfoliated BNOx in water.

			Mean (mV)	Area (%)	St Dev (mV)
Zeta Potential (mV):	33.6	**Peak 1:**	33.6	100.0	6.13
Zeta Deviation (mV):	6.13	**Peak 2:**	0.00	0.0	0.00
Conductivity (mS/cm):	0.00380	**Peak 3:**	0.00	0.0	0.00
Result quality	Good				

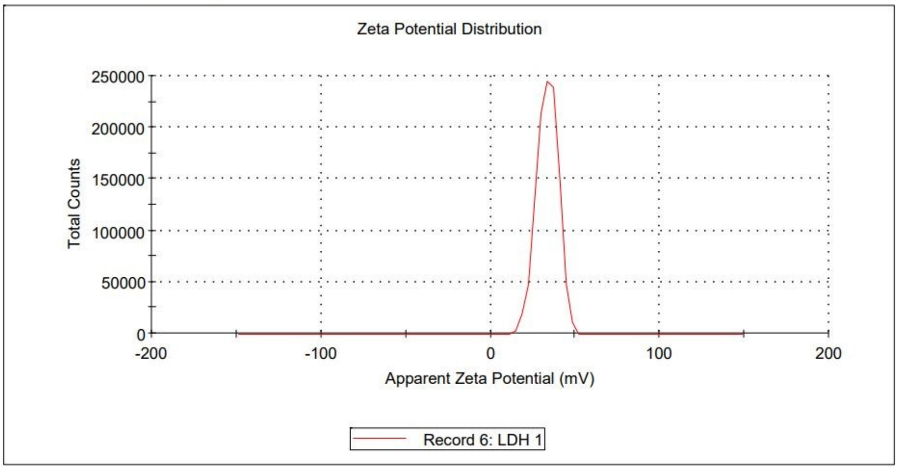

Figure S.2: Zeta potential measurement of CuAl-CO_3 nanosheets in water.

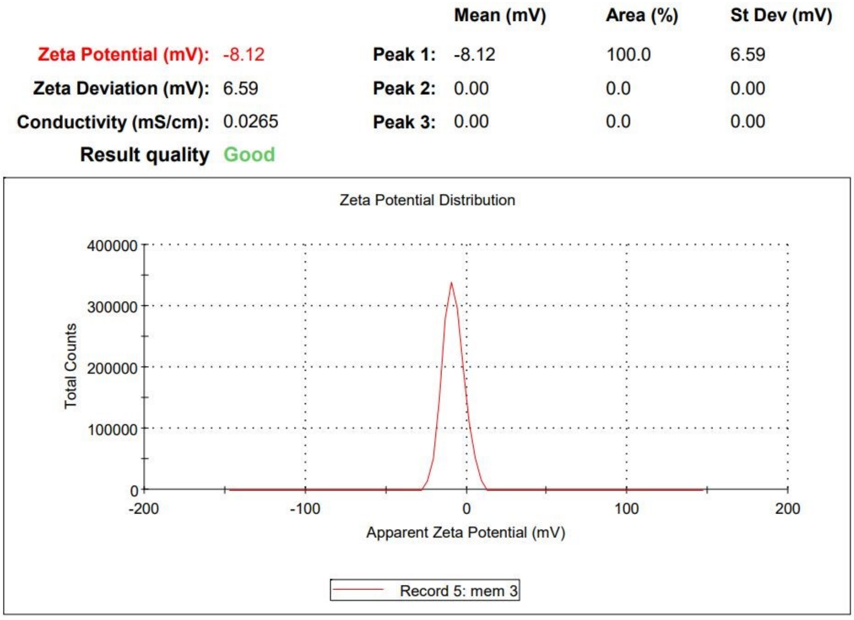

Figure S.3: Zeta potential measurement of LDH/BNOx nanocomposite in water.

Section S.2: Optimisation studies of composition of LDH/BNOx nanocomposite membranes

Membranes were prepared from a variety of compositions of LDHs. Their retentions were tested for Evans Blue and it was observed that high retentions were observed for all samples, as shown in Table S1. The UV-Vis spectra of the feed and filtrates are shown in Figure S.4.

Table S.1: Retention values of LDH/BNOx nanocomposite membranes with various compositions.

LDH/BNOx composition by mass	Average retention (%)	No. of samples
20:80	99	3
30:70	100	1
40:60	100	1
50:50	100	2

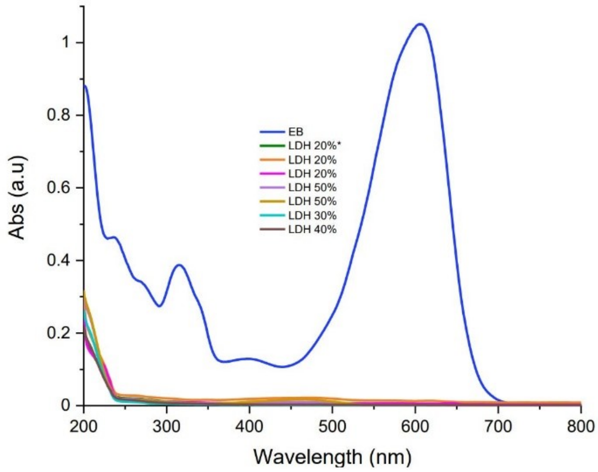

Figure S.4: UV-Vis spectra of the retention of 20 mL of Evans Blue by the LDH/BNOx nanocomposite membranes with various compositions.

However, for LDH loading above 20%, two problems were encountered. The first was that the mechanical stability of the membranes suffered, due to significant shrinking of LDHs after drying, as a large amount of water can be incorporated into their interlayer. This resulted in mechanical failure of membranes prepared with a CuAl-CO_3 LDH mass loading of 30% or above, as shown in Figure S.5.

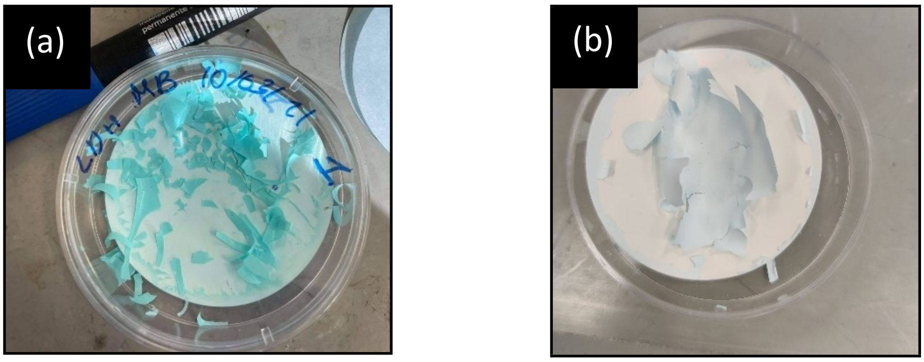

Figure S.5: (a) Pure CuAl-CO_3 LDH membrane and (b) 30:70 LDH/BNOx membrane, showing mechanical failure.

The second issue encountered was the formation of unwanted side products. At 50% mass loading of LDH, the formation of copper (II) oxide was observed by a colour change from light blue to brown, and was confirmed by pXRD, as shown in Figure S.6. Therefore, it was decided to proceed with the 20:80 LDH/BNOx membranes, as they did not impact the mechanical stability of existing LDH side products, and were reliable and reproducible, not resulting in the formation of side products.

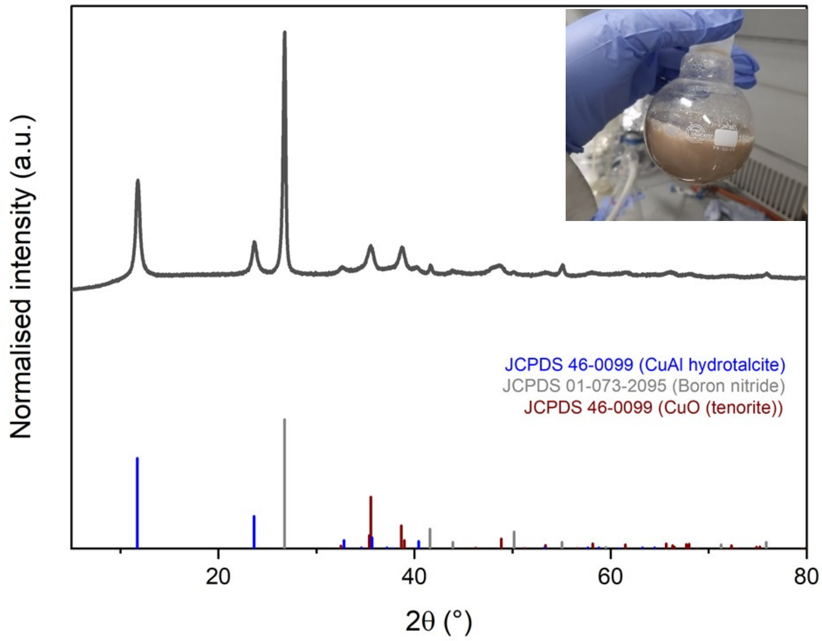

Figure S 6: pXRD pattern of 50:50 LDH/BNOx nanocomposite membranes. Brown colour change is shown in inset.

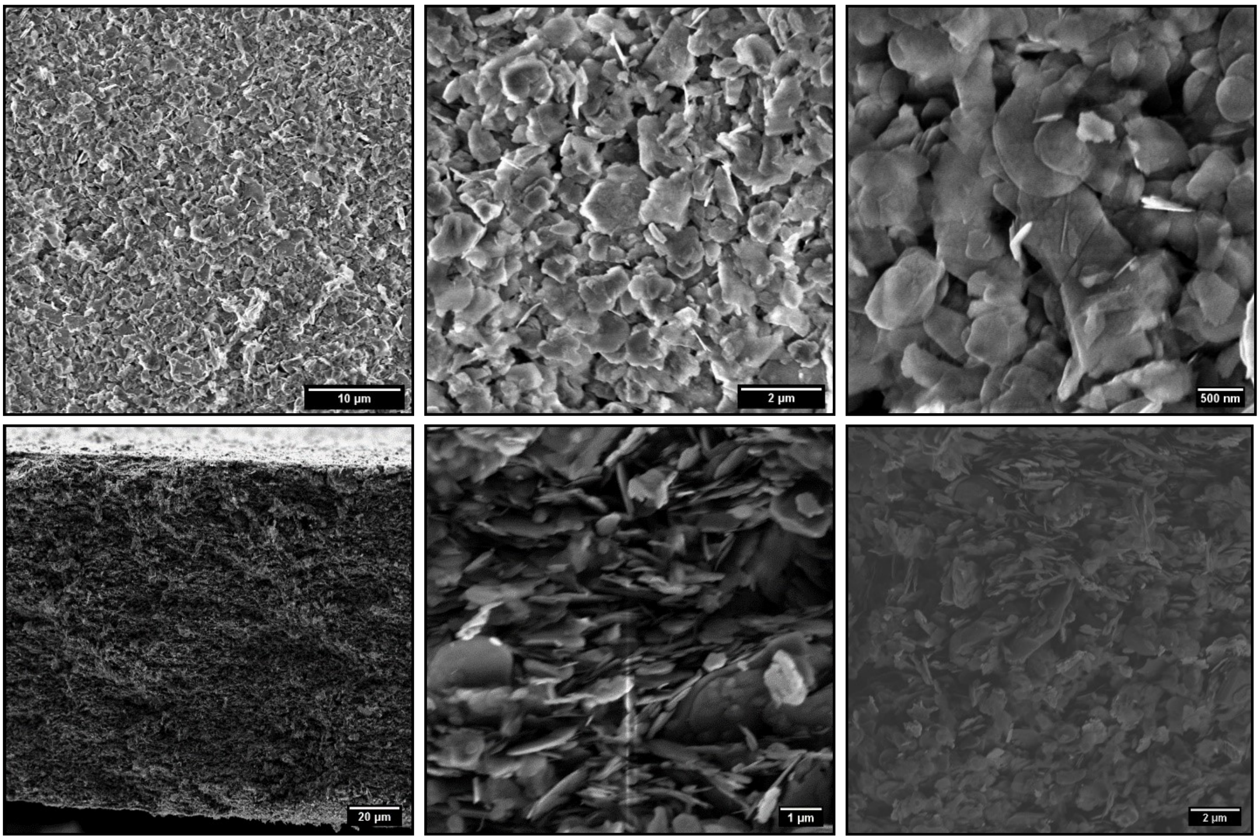

Figure S.7: Additional top-view and (a,b,c) and cross-sectional (d,e,f) SEM images of LDH/BNOx membranes.

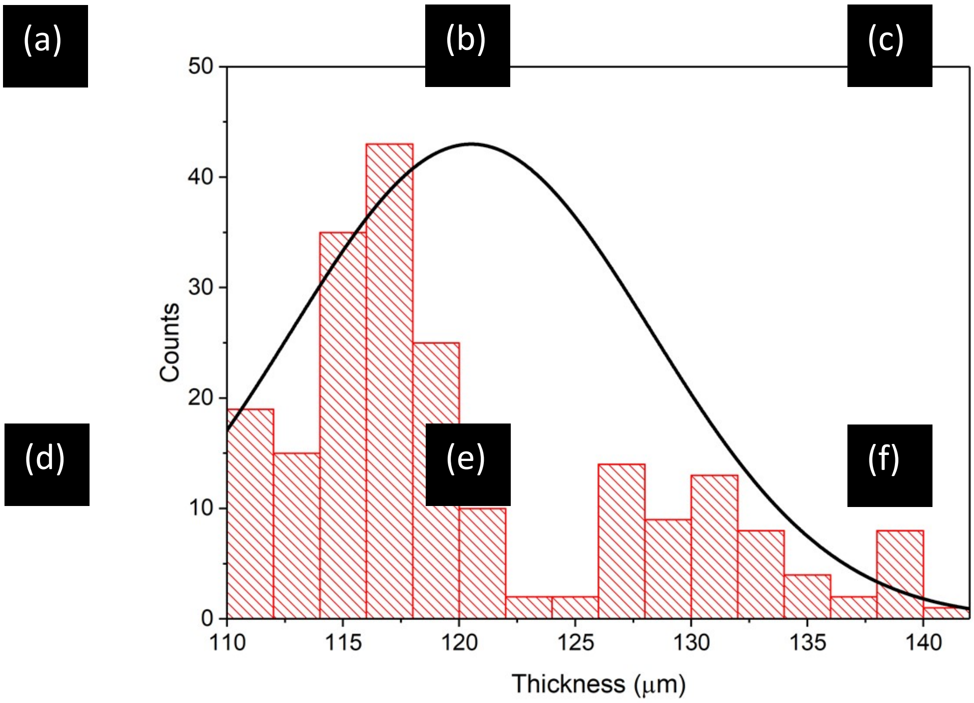

Figure S.8: Distribution of LDH/BNOx membrane thickness across membrane samples, as evaluated from SEM images.

Section S.3: Supplementary SEM and TEM images

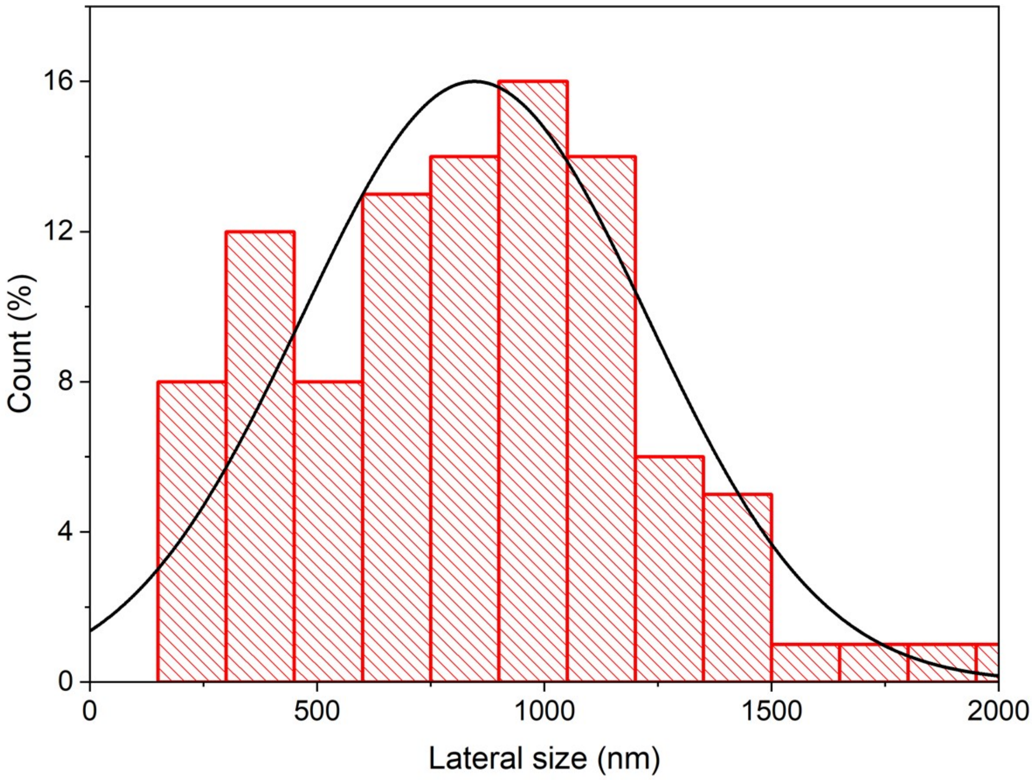

Figure S.9: Distribution of LDH/BNOx flake sizes within membranes, as evaluated from SEM images.

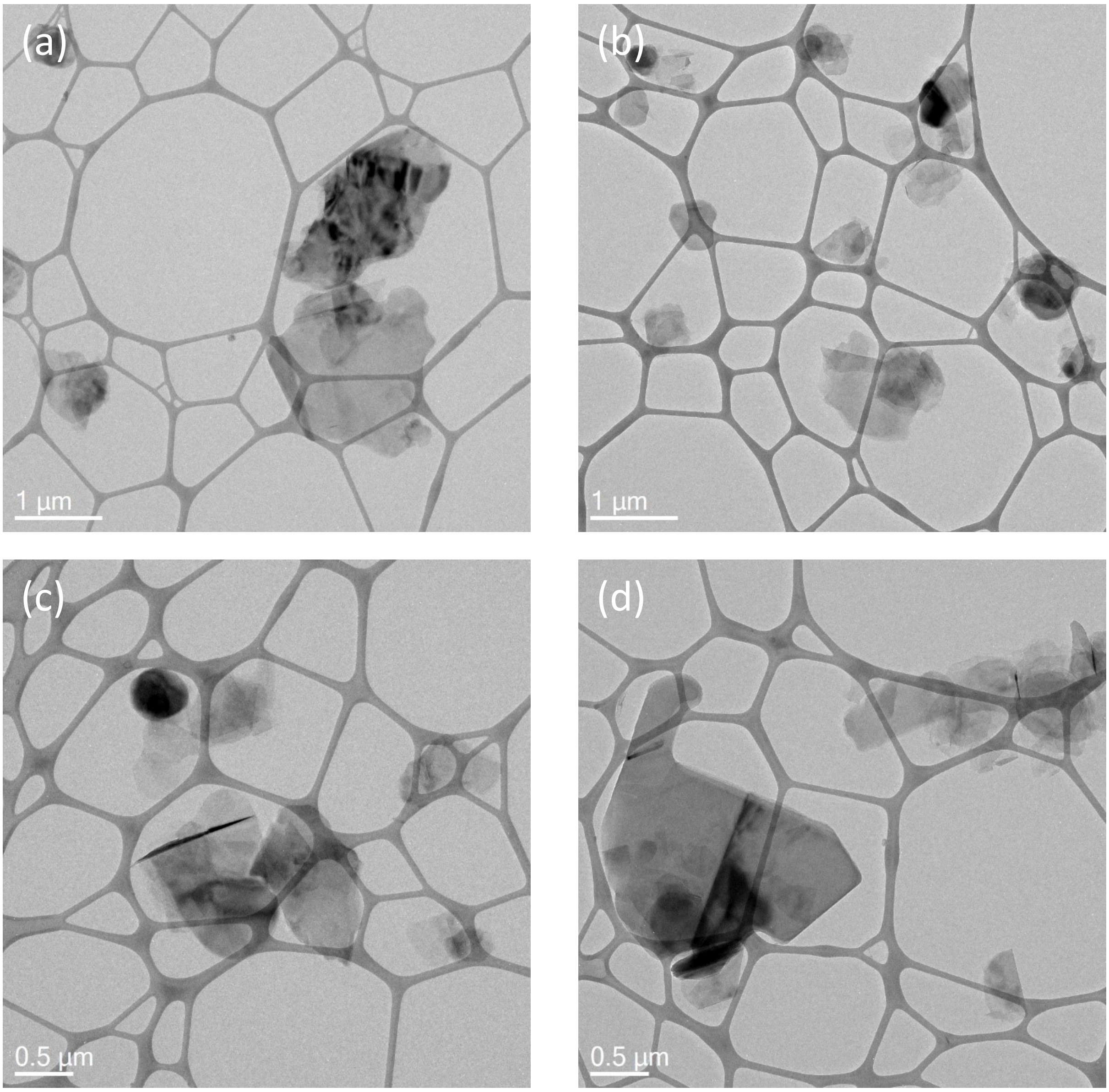

Figure S. 10: TEM images of exfoliated BNOx nanosheets.

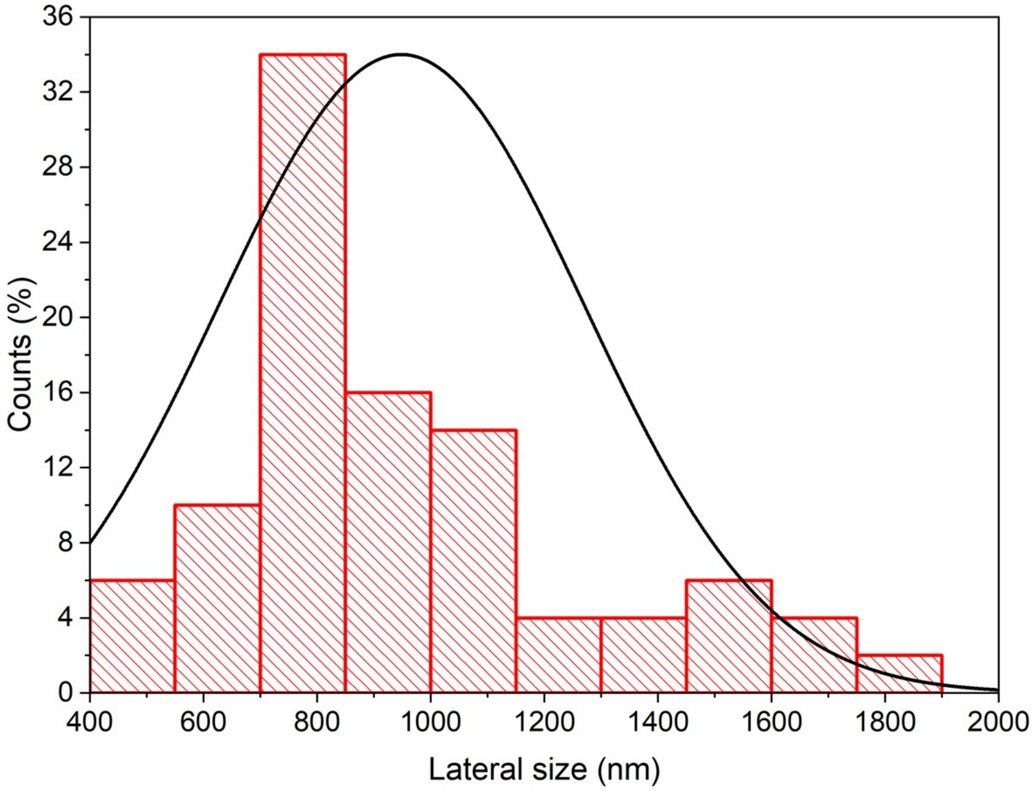

Figure S. 11: Particle size distribution of exfoliated BNOx nanosheets, measured from TEM images.

Section S.4: Water flux of LDH/BNOx nanocomposite membranes

Table S.2: Water flux studies of hydrophilic PVDF support

	1st run	**2nd run**	**3rd run**
Time (s)	10.36	10.48	9.76
Flux (L m^{-2} h^{-1})	7239	7156	7684

Table S.3: Water flux studies of LDH/BNOx nanocomposite membranes on PVDF support

	1st run	**2nd run**	**3rd run**
Time (s)	44.87	47.20	46.40
Flux (L m^{-2} h^{-1})	1672	1589	1616

Section S.5: Adsorption of dyes by LDH/BNOx nanocomposite

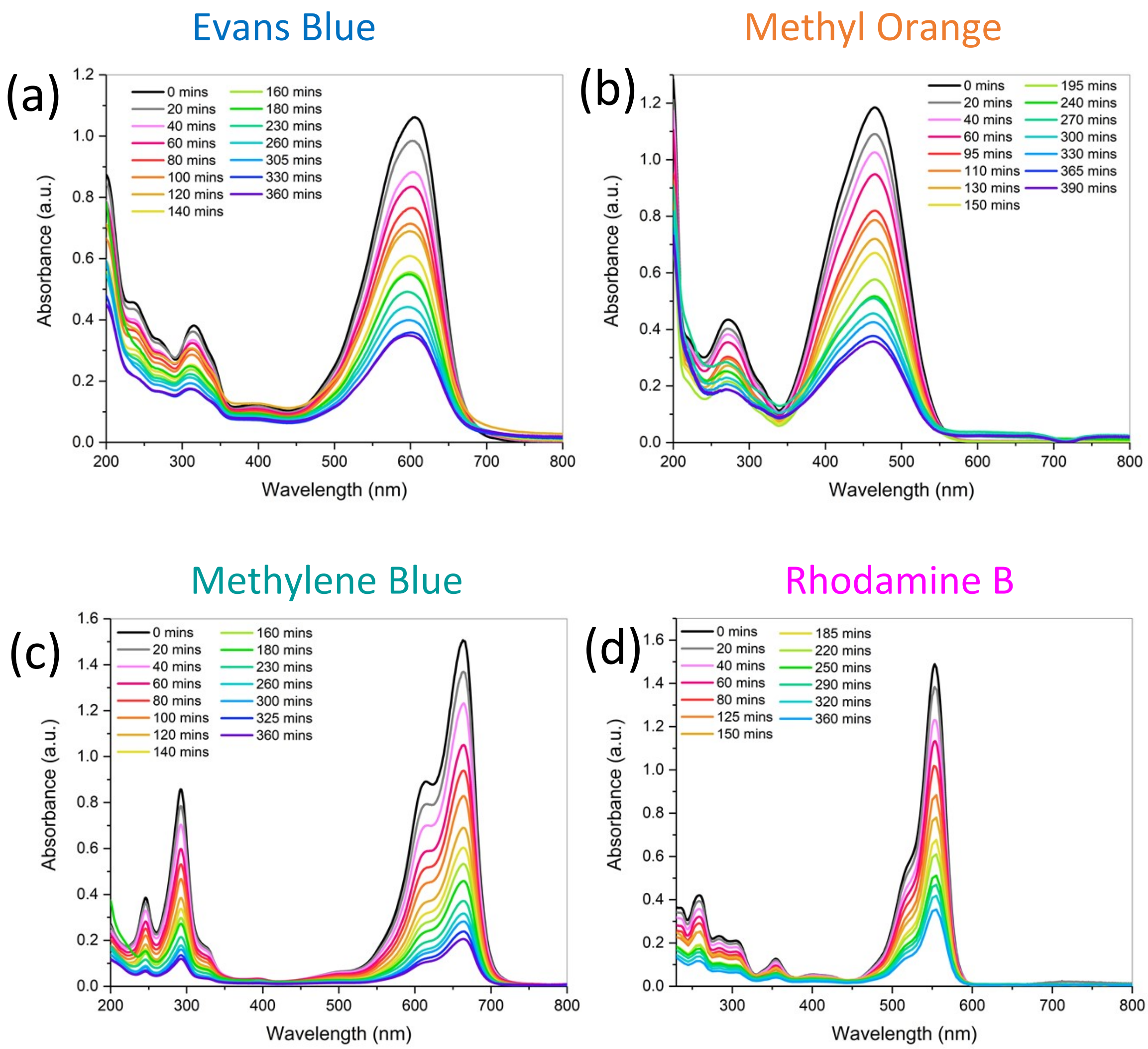

Figure S.12: UV-Vis absorbance spectra showing absorbance of (a) Evans Blue, (b) Methyl Orange, (c) Methylene Blue and (d) Rhodamine B by LDH/BNOx nanocomposite membranes.

membranes

Section S.6: Photodegradation of dyes by LDH/BNOx nanocomposite membranes

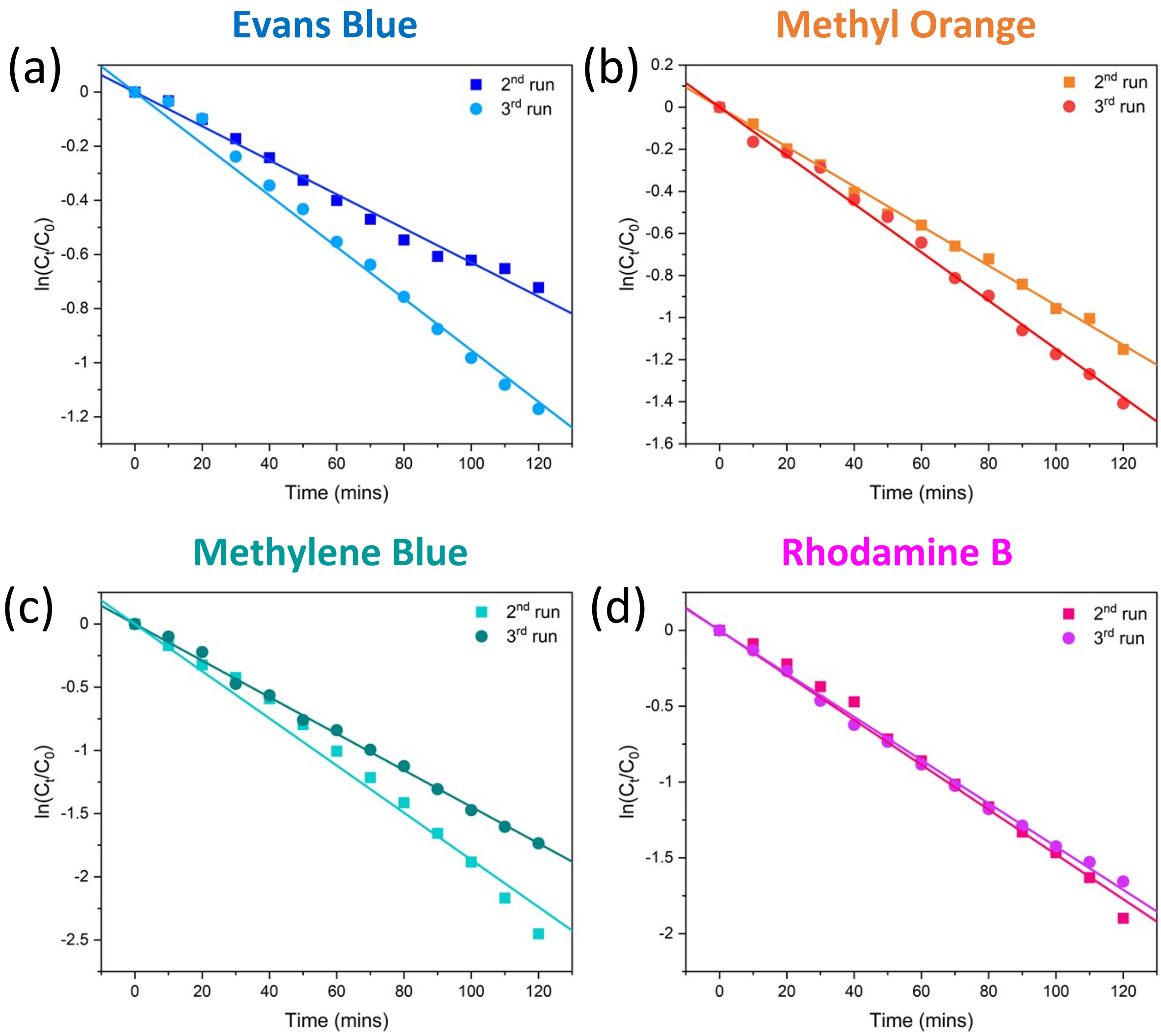

Figure S.13: PFO kinetic modelling of 2nd and 3rd runs of photodegradation of (a) EB, (b) MO, (c) MB and (d) RhB by LDH/BNOx nanocomposite membranes.

Table S.4: PFO analysis of 2^{nd} and 3^{rd} runs of photodegradation experiments

	2^{nd} run		**3^{rd} run**	
Dyes	**k_1 (min^{-1})**	**R_1^2**	**k_1 (min^{-1})**	**R_1^2**
EB	0.0063	0.9962	0.0095	0.9963
MO	0.0094	0.9991	0.0115	0.9984
MB	0.0187	0.9934	0.0145	0.9991
RhB	0.0148	0.9968	0.0143	0.9990

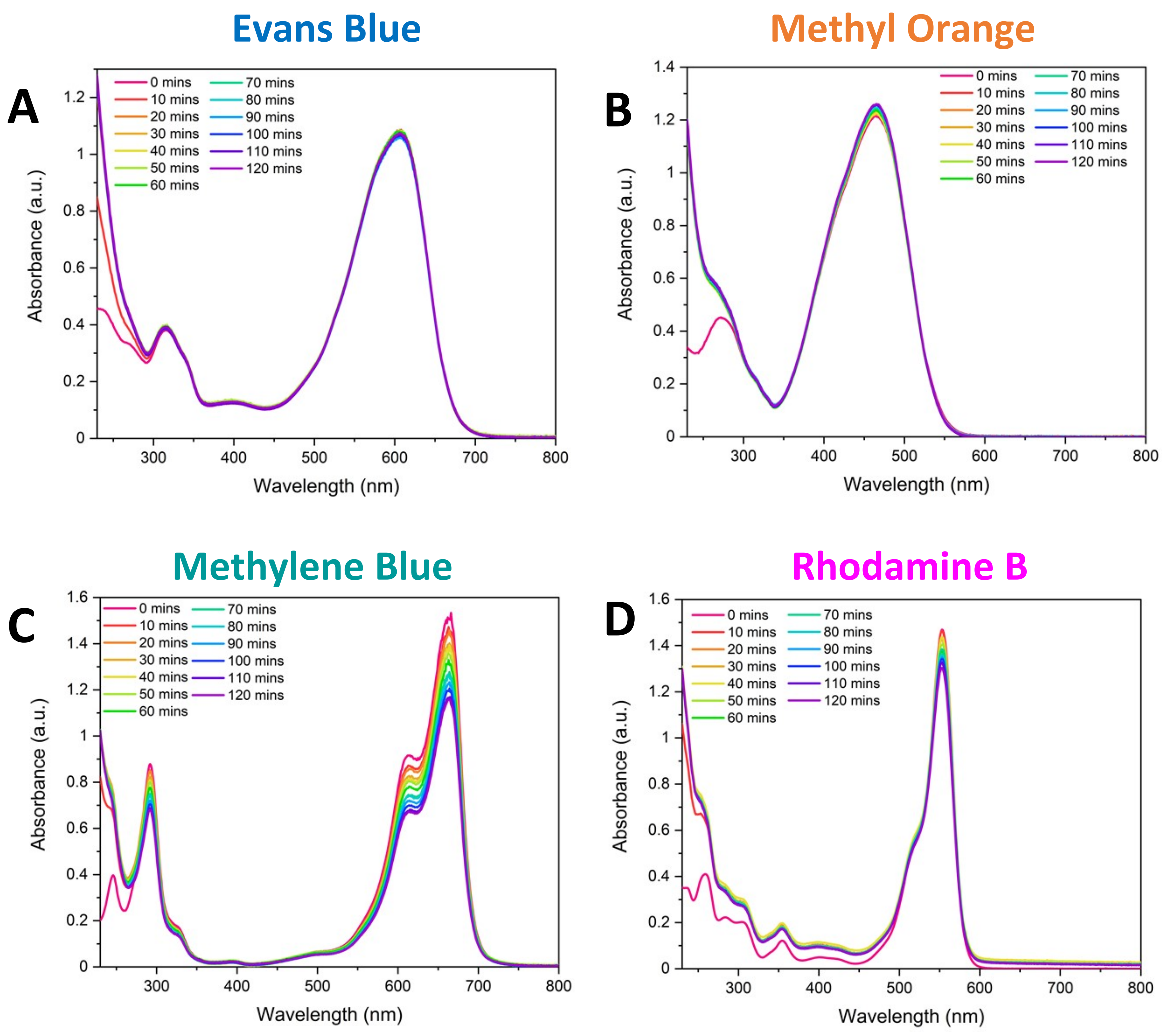

Figure S.14: Photodegradation control experiment of dyes using 10µL H_2O_2 (30% w/w), a 5W COB LED, and no photocatalytic membrane.

Figure S.15: Significant bubbling observed during the photocatalytic degradation of RhB by LDH/BNOx nanocomposite membranes.

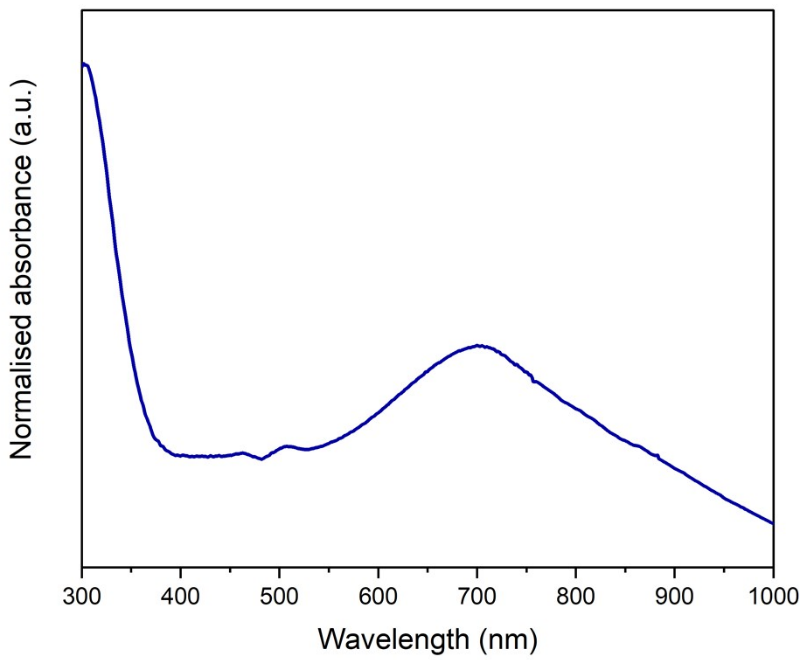

Figure S. 16: DR UV-Vis spectrum of CuAl-CO_3 LDHs.

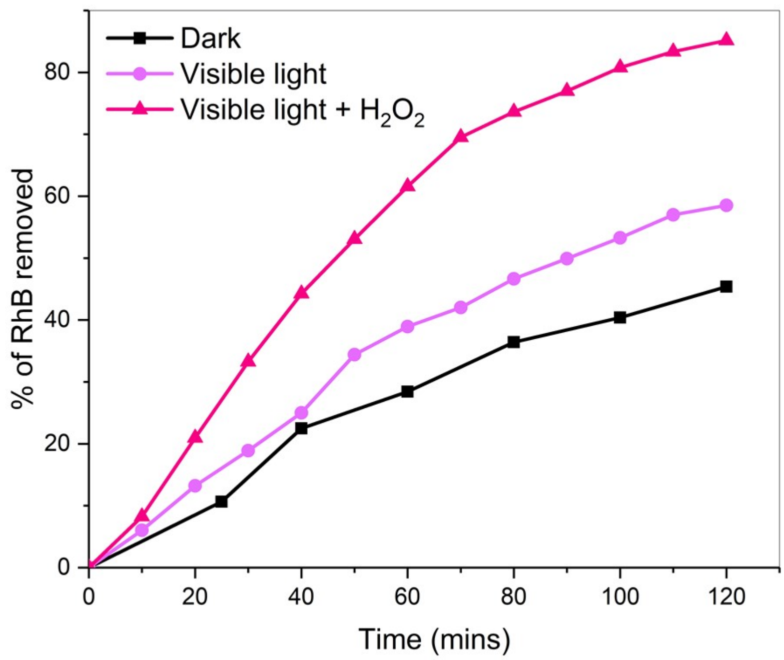

Figure S. 17: Removal of RhB from solution by LDH/BNOx membrane under dark conditions (black), visible light in the absence of H_2O_2 (purple), and light in the presence of H_2O_2 (fuschia).