Supplementary Materials

Recyclable, Recoverable, and Reformable Hydrogel-Based Smart Photocatalyst

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S1. Investigation on the adsorption kinetics of dyes on the hybrid gel

The diffusion of MB molecules from the bulk solution into the hydrogel was dominant at the initial stage, leading to the decrease in MB concentration (Fig. S1a). As time elapsed, the MB concentration gradient between bulk and hydrogel decreased gradually (Figure S1b), and there was no further drop in MB concentration in the bulk via the diffusion process when the system reached an equilibrium state (Figure S1c). Consequently, it was important to determine the timescale in which the system reached the equilibrium state. As shown in Figure S1d, the absorbance of the MB solution measured every hour from the bulk under dark conditions. Without photodegradation, the MB concentration did not change after 1 h, suggesting that 1 h in the dark is sufficient to reach an equilibrium state. Therefore, for all of the subsequent experiments, we held the samples for approximately 1 h in the dark before irradiating with UV light. The removal of MB from the adsorption was ~ 4% which is trivial compared to that from the photodegradation.

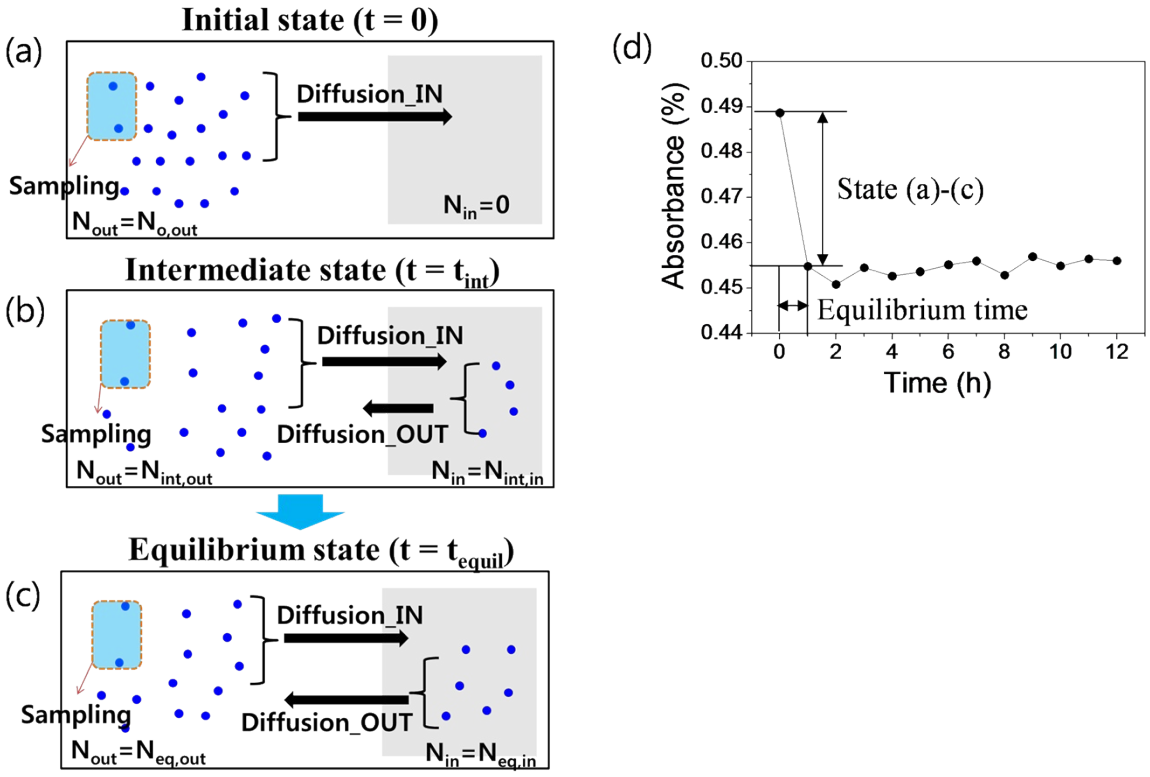

Fig. S1. Illustration of equilibrium kinetics for dye molecule diffusion into the TiO_2/agarose hybrid gel photocatalyst at dark state: (a) At initial stage (t = 0), the diffusion from the bulk solution to the hydrogel (Diffusion_IN) is dominant due to the high concentration gradient ($N_{o,out} >> N_{in}$), (b) at intermediate state ($t = t_{int}$), the difference in diffusion rate between bulk and hydrogel (Diffusion_IN – Diffusion_OUT) becomes alleviated due to the reduced concentration gradient ($N_{int,out} > N_{int,in}$), (c) at equilibrium state, the difference in diffusion rate between bulk and hydrogel (Diffusion_IN – Diffusion_OUT) becomes almost zero due to no

concentration gradient (($N_{int,out} \sim N_{int,in}$), and (d) Absorbance of the MB solution taken at every 1 h from the bulk at dark condition.

Fig. S2.

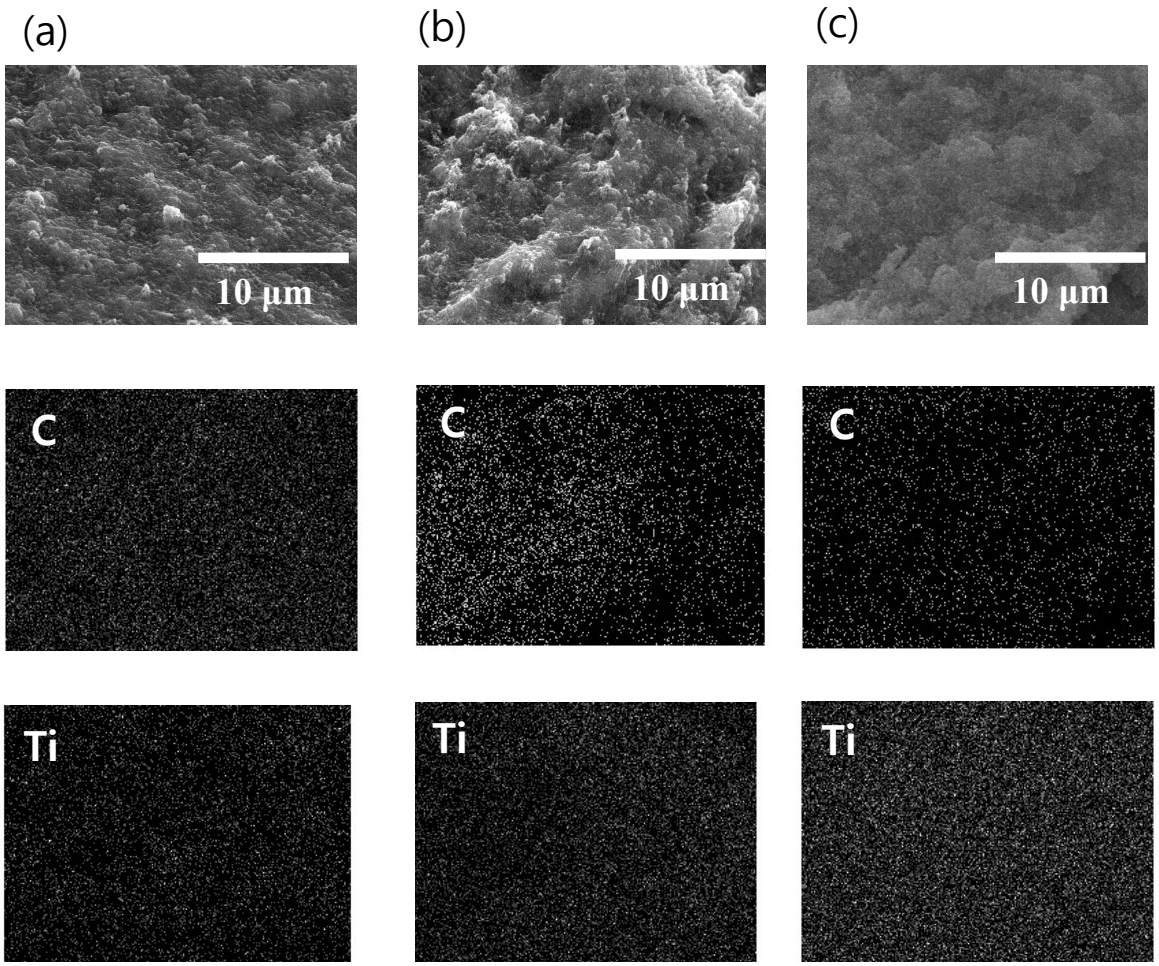

Fig. S2. SEM image and corresponding EDX mapping images based on C and Ti atoms for different TiO_2 content: (a) 1.8, (b) 3.6, and (c) 7.2 wt% in a hybrid gel.

Fig. S3.

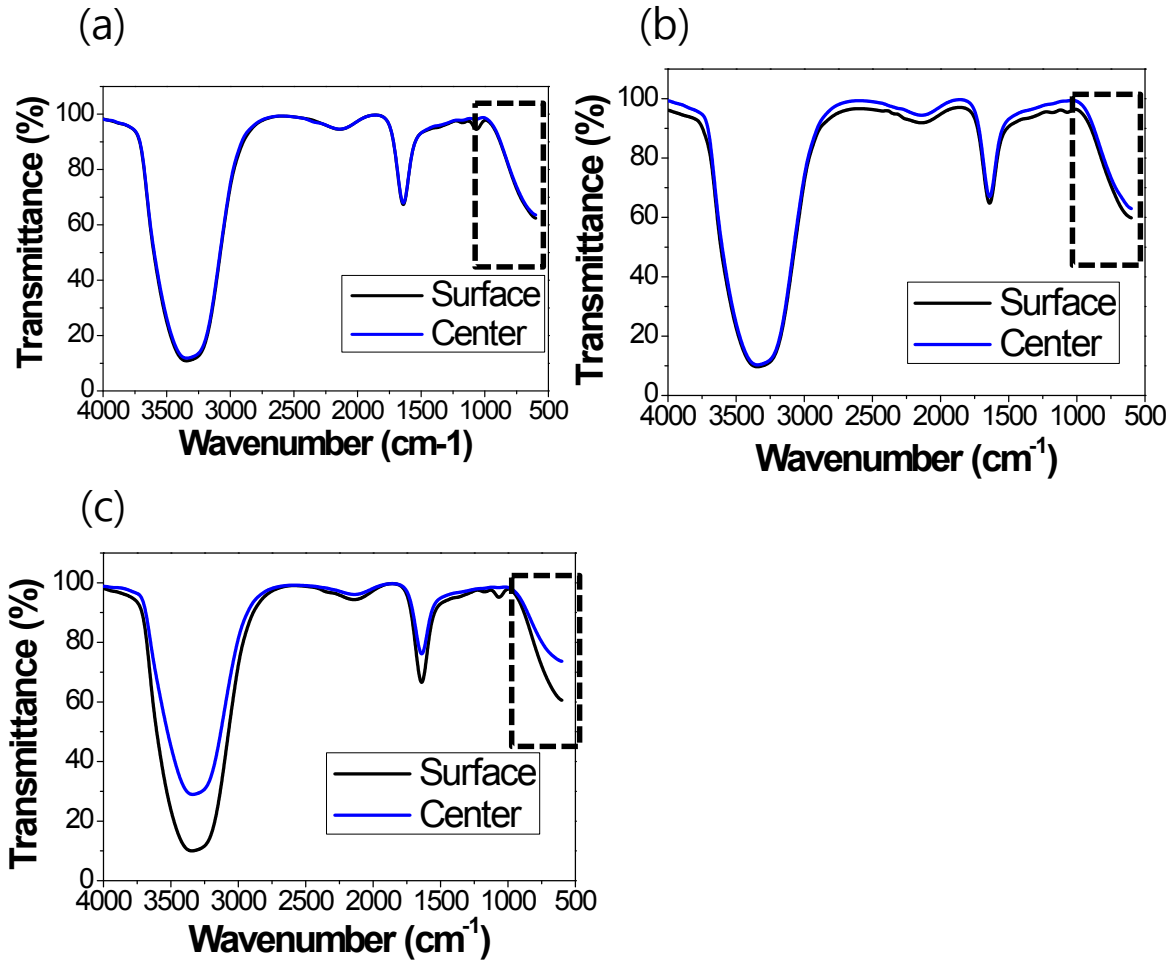

Fig. S3. Comparison of FT-IR data taken at surface and center of the dried a hybrid gel for the different initial TiO_2 loading concentration: (a) 1.8, (b) 3.6, and (c) 7.2 wt% .

Fig. S4.

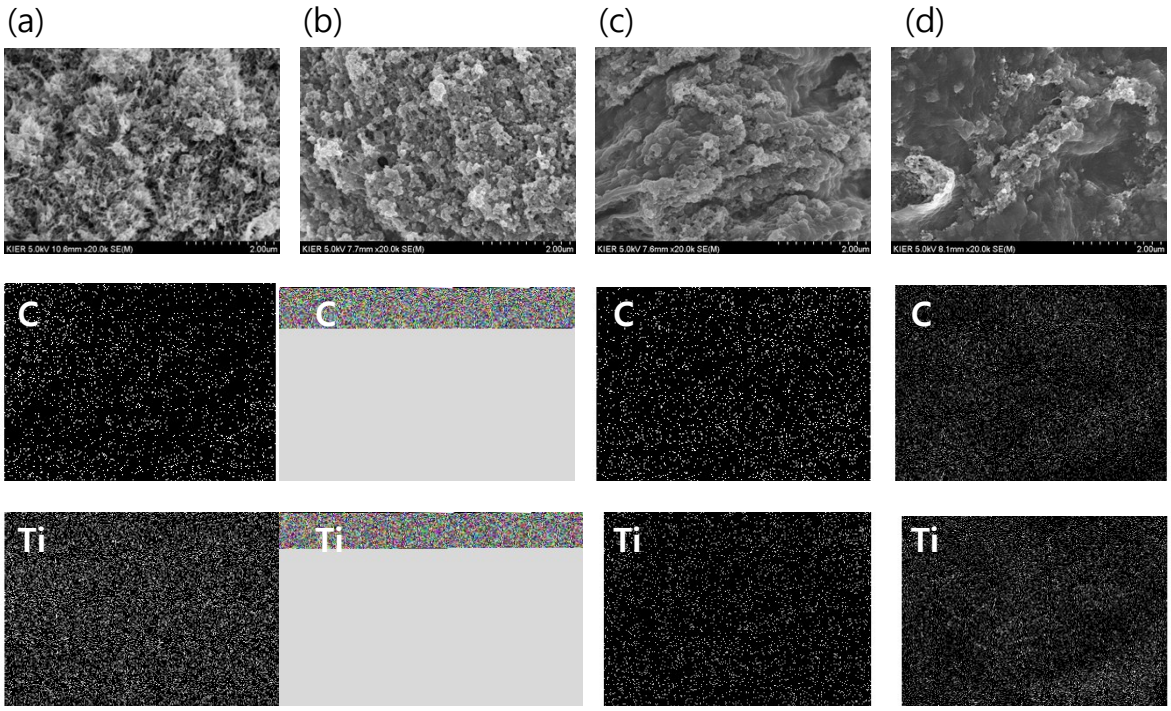

Fig. S4. SEM image and corresponding EDX mapping images based on C and Ti atoms for different agarose content: (a) 2.0, (b) 3.0, (c) 4.0, and (d) 5.0 wt% in TiO_2/agarose hybrid gel.

Fig. S5.

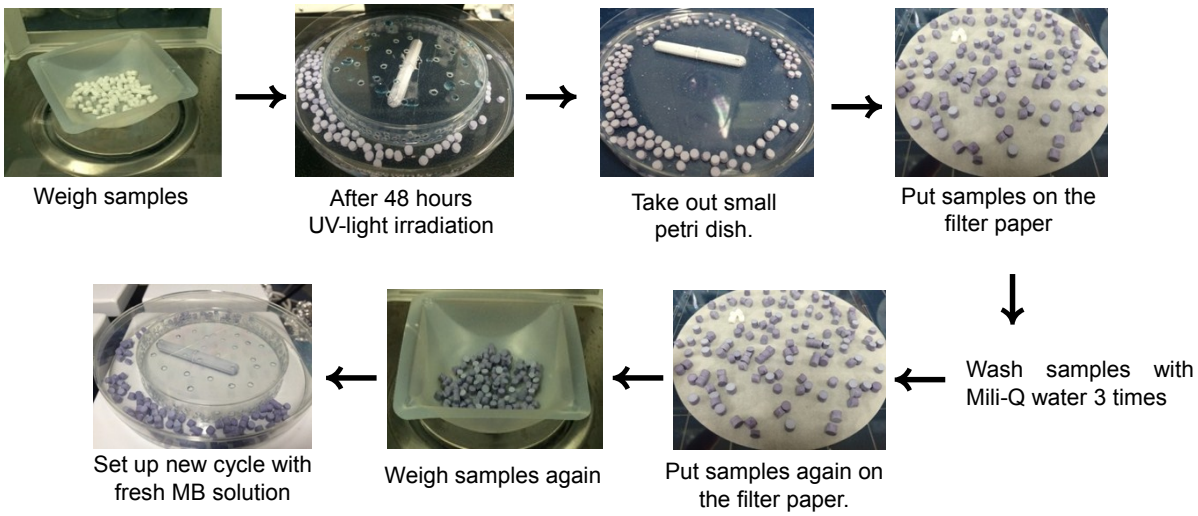

Fig. S5. Photographs showing a detailed recycling process for hybrid gel photocatalysts.

Table S1.

TiO_2 content at melt state	Atomic percentage (%) in dried gel			
	C	O	Ti	Total
1.8 wt%	45.8	51.5	2.7	100.0
3.6 wt%	31.3	57.7	11.0	100.0
7.2 wt%	14.4	69.8	15.8	100.0

Table S1. Atomic percentage (%) in a dried hybrid gel revealed by EDS analysis for the different initial TiO_2 loading (1.8, 3.6, and 7.2 wt%).

Table S2.

Agarose content at melt state	Atomic percentage (%) in dried gel			
	C	O	Ti	Total
2.0 wt%	**23.4**	**57.6**	**19.0**	**100.0**
3.0 wt%	**31.3**	**57.7**	**11.0**	**100.0**
4.0 wt%	**42.7**	**49.3**	**8.0**	**100.0**
5.0 wt%	**44.0**	**49.5**	**6.5**	**100.0**

Table S2. Atomic percentage (%) in a dried hybrid gel revealed by EDS analysis for the different initial agarose loading (2.0, 3.0, 4.0, and 5.0 wt%).