Supporting information

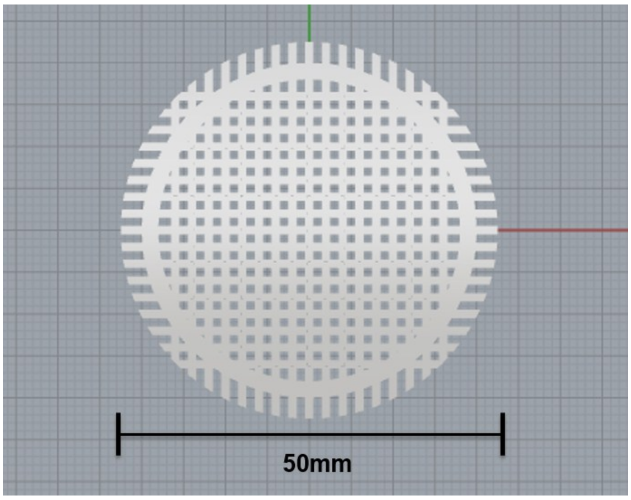

Figure S1. Computer aided design (CAD) image for photocatalyst backbone

Fig. S1 shows the CAD image of the 3D-printed backbone structure for photocatalyst. The overall diameter is 50mm and the spacing between the interstitial grids is 1mm. Additionally, the thickness is 2mm. The overal size for the backbone was deteremined because of the size of the chalet used in the experiment. The holes between the grids was made for the water circulation which is necessary for the efficient photocatalytic reaction.

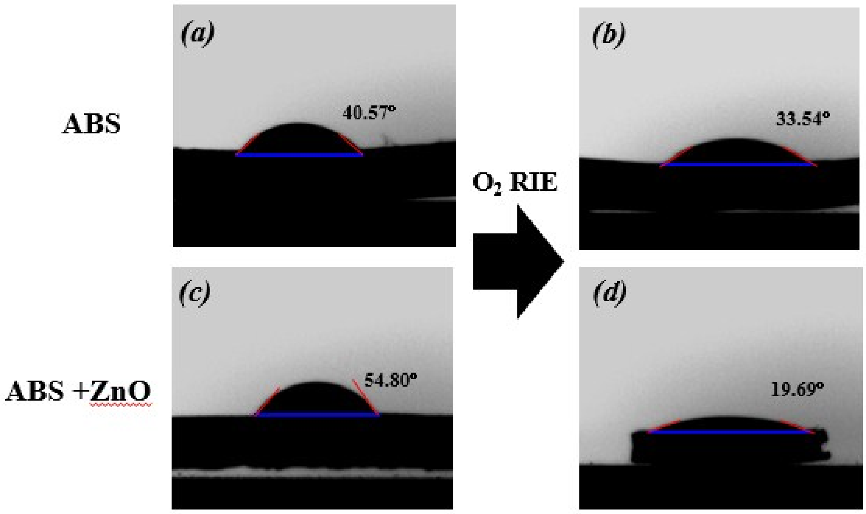

Figure S2. Contact angles of the 3D-backbones
The contact angle of 3D-backbones made of (a) ABS and (c) ABS+ZnO before O_2 treatment, and (c) ABS and (d) ABS+ZnO after O_2 treatment

It is possible to make 3D printer filaments using ABS resin and ABS + ZnO resin. The 3D-backbone was fabricated in the same shape using two filaments, and the contact angles with water droplet were measured. According to the results, it can be seen that the contact angle (c) of ABS + ZnO is higher than the contact angle of only ABS (a). However, when the properties of the surface are modified by O_2 treatment, it can be confirmed that the contact angle (b) and ABS + ZnO contact angle (d) are changed to be more hydrophilic, which can be supported by the Wenzel model. Therefore, O_2 treated ABS + ZnO resin was used as the material in this photocatalytic performance, and it can be suggested that it is advantageous to wet the water as a photocatalyst.

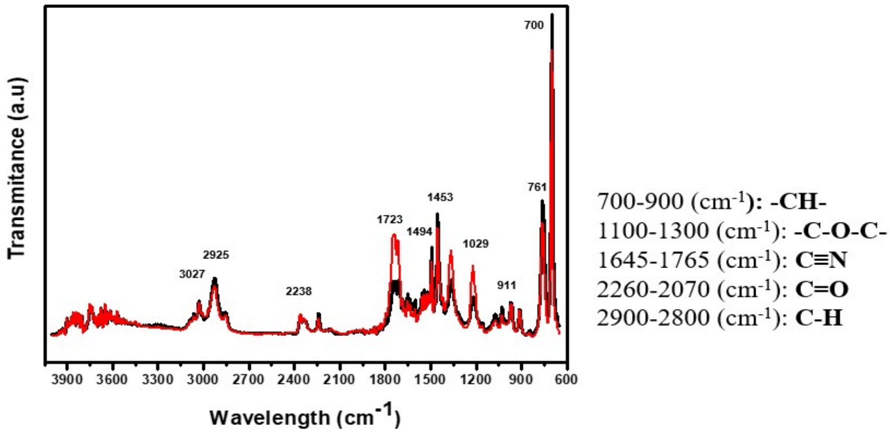

Fig. S3. Changes of ABS+ZnO transmittance by Fourier transform infrared spectroscopy (FT-IR). Before (black) and after (red) O_2 treatment on ABS+ZnO 3D-backbone

Fig. S3 shows the FT-IR transmittance of ABS+ZnO resin before and after O_2 treatment, used for 3D-printer filament. Acrylonitrile butadiene styrene (ABS) is a terpolymer composited of styrene and acrylonitrile in the presence of polybutadiene. According to the data, it can be seen that three changes of chemical bonds greatly changed after O_2 treatment. The increase in the chemical chain of -CH- in the ranges of 700-900 cm^{-1} and the decrease in the C≡N (Nitrile) in the ranges of 16450-1765 cm^{-1} and -C-O-C- bonds in the range of 1100-1300 cm^{-1} are most noticeable. The chemical bond of -CH- provides hydrophilicity whereas the other two provide hydrophobic properties. O_2 treatment can be made to make the water more easily wetted by variations in the surface chemistry chain.

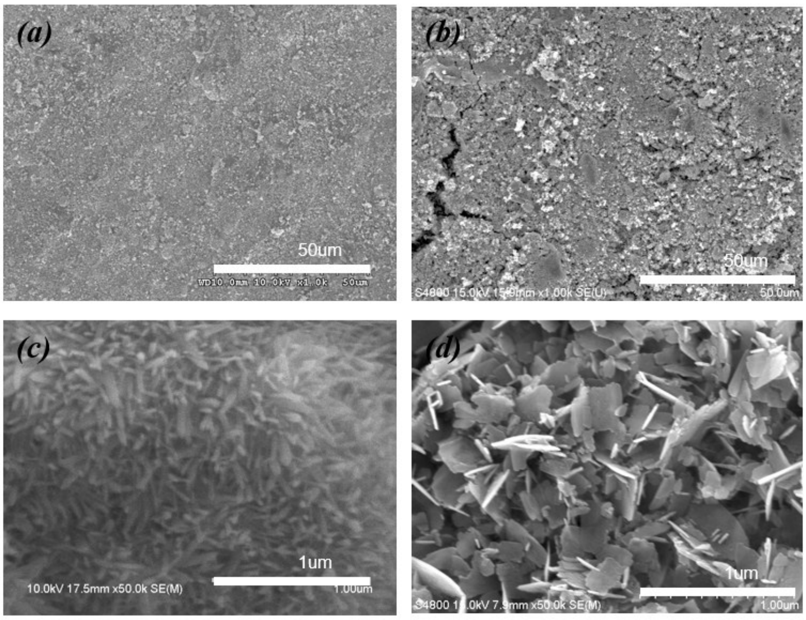

Figure S4. SEM images of the ZnO-based NRs (a), (c) and NFs (b), (d) structures on the 3D-backbones

Fig. S4 shows the SEM images of the ZnO-based NRs and NFs structures on 3D-backbone with a low and high magnification. The ZnO-based NRs and NFs were well grown on the entire the 3D-backbones by hydrothermal reactions even though the surface of the 3D-backbone is rough because of the resolution of the 3D-printer. And for the clear images, the ZnO-based hierarchical NRs and NFs structures are provided.

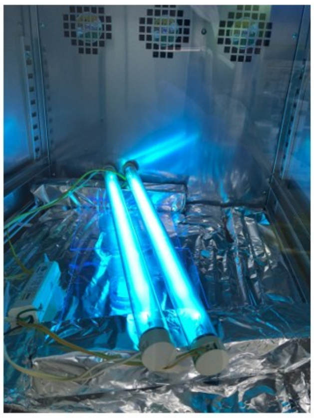

Figure S5. Photoimage of photodegradation experiment

The experiment then progressed to using the ultraviolet light. The light wavelength was in the range of 310-400 nm, where ZnO can reacted because the band gap of ZnO is 3.2 eV. The atmospheric temperature was fixed at 17°C in the refrigerator to prevent the thermal degradation reaction of ZnO by heat generated form the lights. Approximately 30 mL of methylene blue solution was stored in the petri dish of about 2-inch diameter. The intensity density of the light was approximately 0.146 mW(±0.1) per cm^2. And, the distance between the methylene blue dye solution and the UV light is about 5 cm.

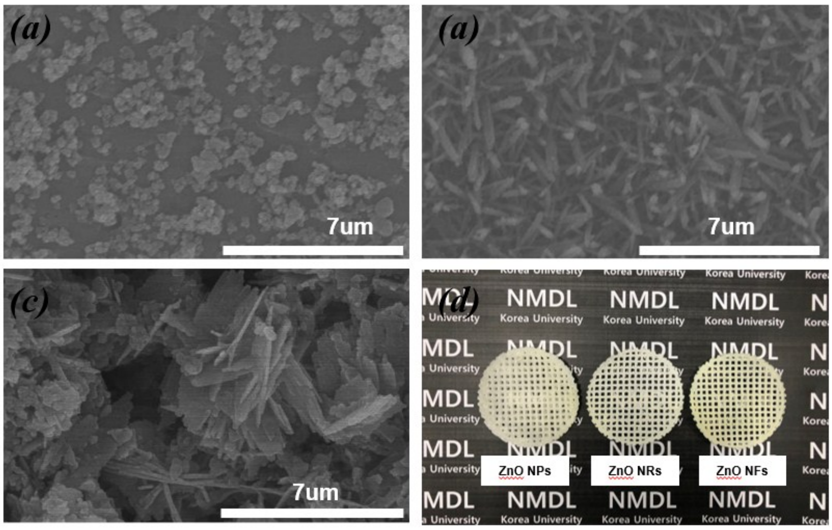

Figure S6. SEM images of ZnO-based hierarchical structures on 3D-backbones after photocatalytic performance; (a) NPs, (b) NRs, (c) NFs, and (d) the real photoimages of ZnO-based hierarchical structures on the 3D-backbone

The SEM images shows the ZnO- (a) NPs, (b) NRs, and (c) NFs on the 3D-backbones after the phtocatlytic reaction for 120 mintues. From the SEM images, it can be seen that the ZnO structures were well held together after the photocatlytic reaction on the backbone. This is because ABS-backbone has high mechanical strength and chemical resistnace and the ZnO structures are chemical stable. And the photoimage in (d) is the actual image of the ZnO-based hierarchical structures formed on the 3D-backbone which was used in the experimen. The 3D-backbone structures are very well maintained after the photocatlytic performance..