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Near-UV Light Emitting Diode with On-Chip Photocatalysts for Purification Applications

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Comparison of the surface-to-volume ratio of the zero-dimensional nanodisk vs. two-dimensional film structures

For a thin film with a thickness *t*, which is attached to the substrate on its one side, the surface-to-volume ratio is 1/*t*.

For a nanodisk with a thickness *t* and a radius R, which is attached to the substrate on its one side, the surface-to-volume ratio is

$$\frac{\pi R^2 + 2\pi Rt}{\pi R^2 t} = \frac{1}{t} + \frac{2}{R}$$

Therefore, for the case when the thickness is 1/4 of the diameter (*R*=2*t*), the surface-to-volume ratio is 2/*t*, which is two times larger than that of the film.

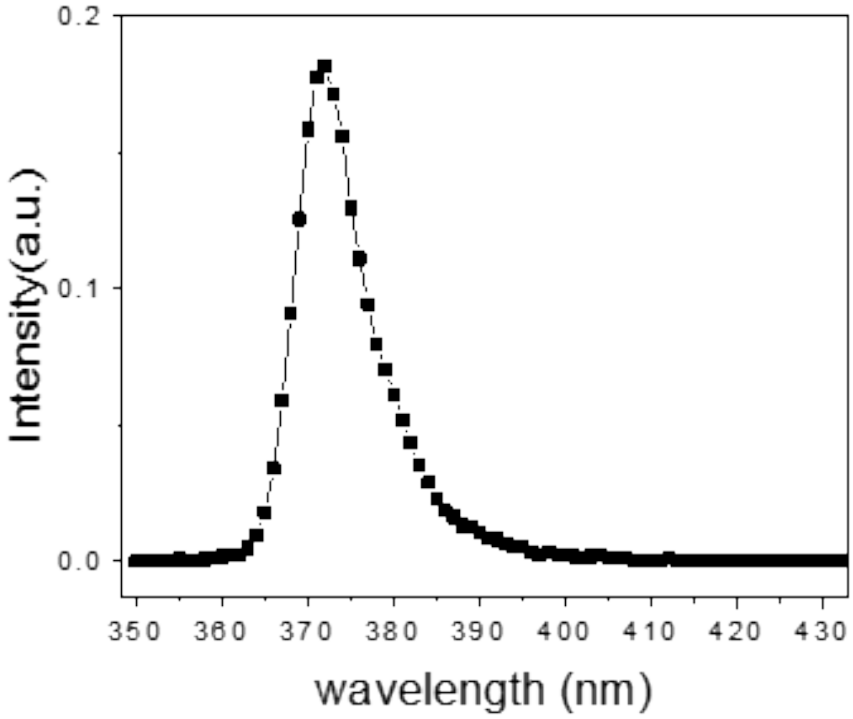

Figure S1. Spectrum of near-UV InGaN-based LED

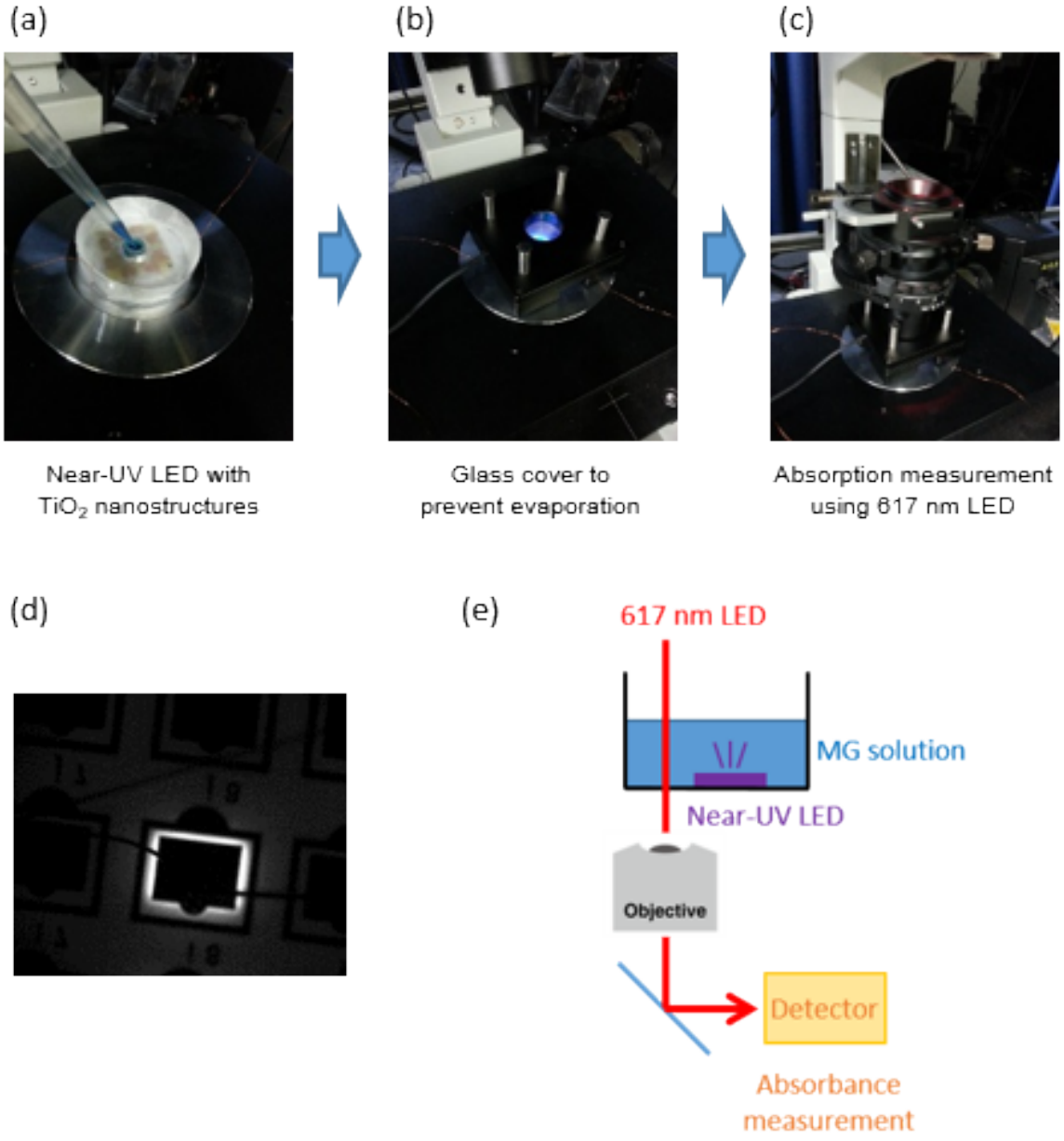

Figure S2. An experimental setup and sequential measurement process to measure photocatalytic degradation rates of MG by the near-UV LED with TiO_2 nanostructures: (a) A cylindrical cell attached on the surface of the near-UV LED with TiO_2 nanostructures was filled with MG aqueous solution with a concentration of 0.1 g/L. (b) A cylindrical cell filled with MG solution was covered by the glass to prevent the evaporation of the solution. Then, the near-UV LED was turned-on to induce photocatalytic degradation of MG after 1 h of equilibration for MG adsorption on the TiO_2 structures in the dark. (c) The MG concentration

was measured at every 30 min based on the absorbance of the light from 617 nm visible LED, which is installed in the illumination pillar of the microscope. (d) Microscopic image of the near-UV LED. (e) Measurement scheme.

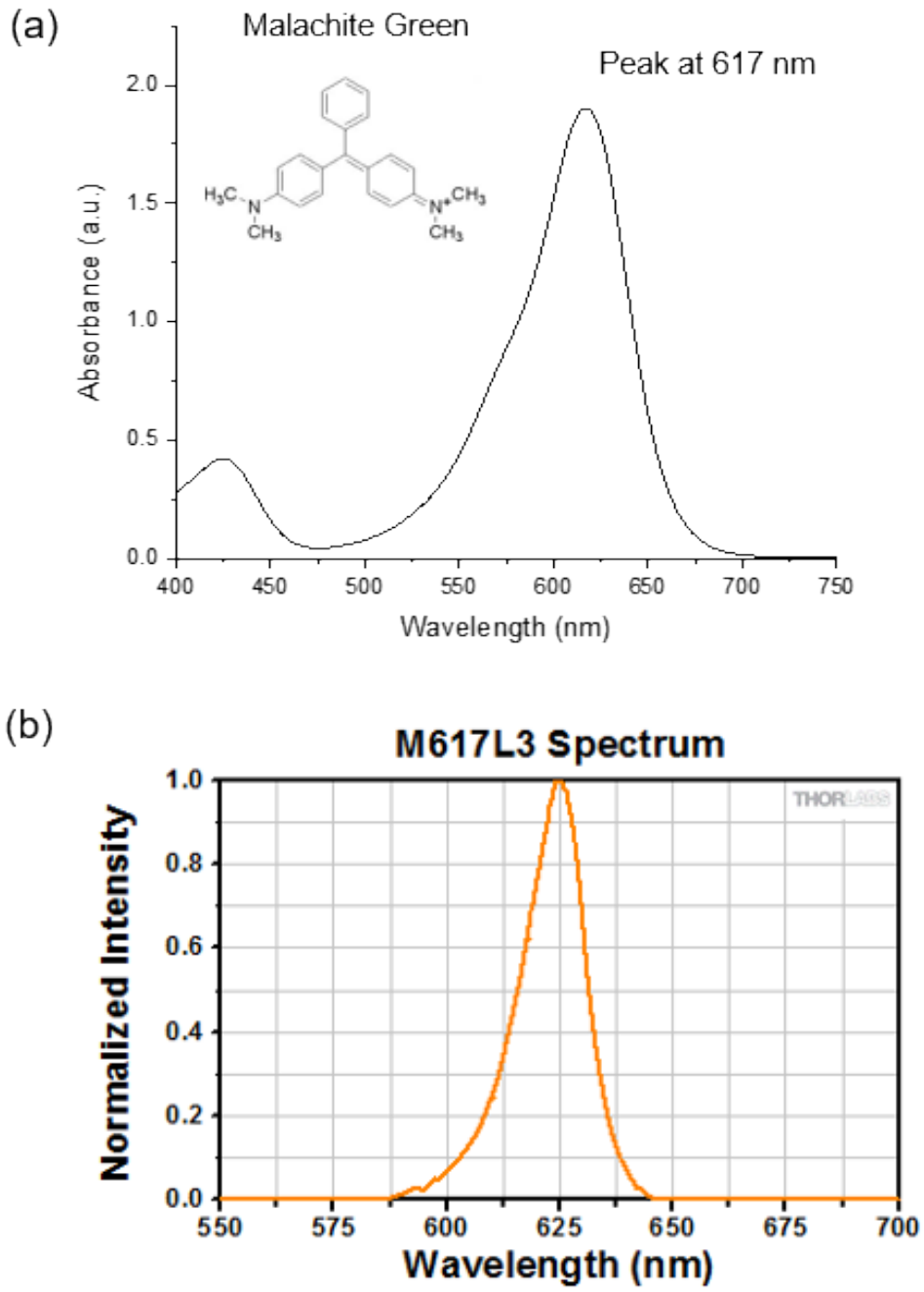

Figure S3. (a) Chemical structure and absorption spectrum of Malachite Green (MG) in water. (b) A spectrum of the visible LED with a nominal wavelength of 617 nm (THORLABS, M617L3) used to monitor the change of MG concentration in the photocatalytic degradation measurement. The spectrum was obtained from the THORLABS website.

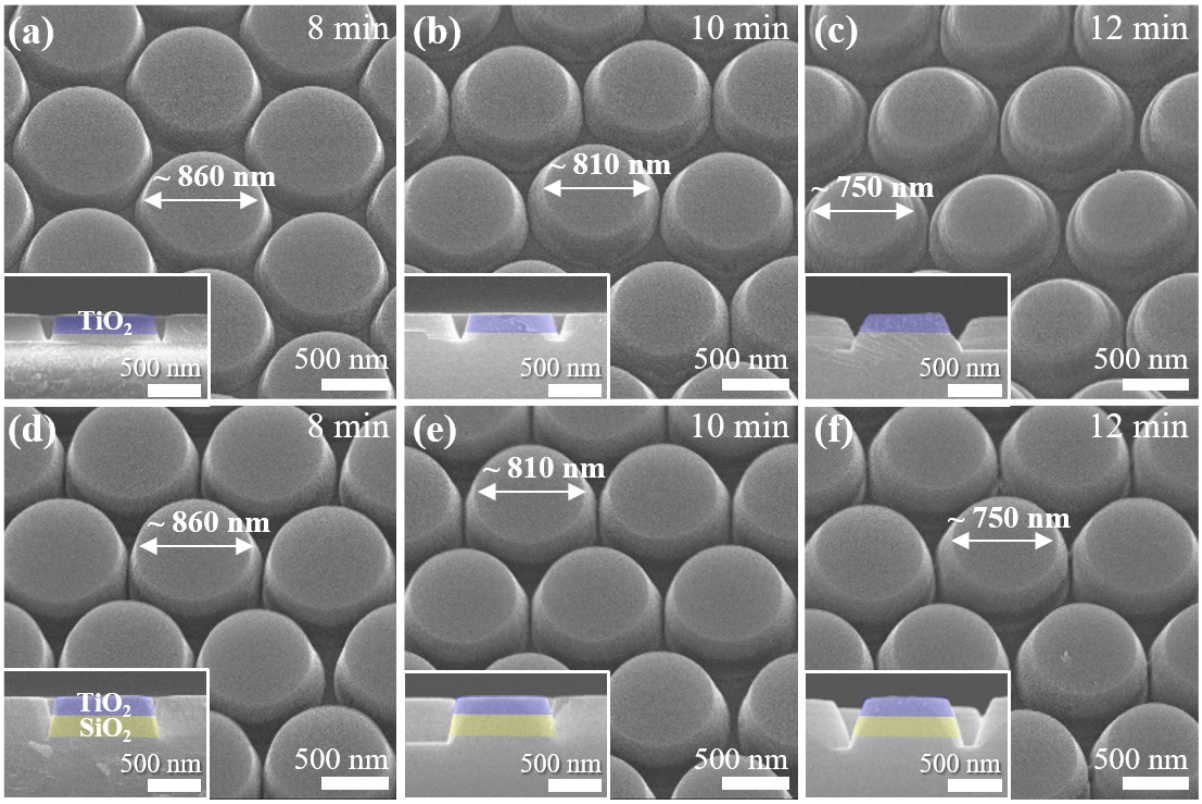

Figure S4. The bird's-eye view SEM images of (a-c) pristine TiO_2 nanodisk array and (d-f) TiO_2/SiO_2 nanodisk/pedestal array as a function of the ICP etching time. Insets are the corresponding cross-sectional SEM images of nanodisks. As the ICP etching time increased, the diameter of the TiO_2 nanodisks gradually decreased.

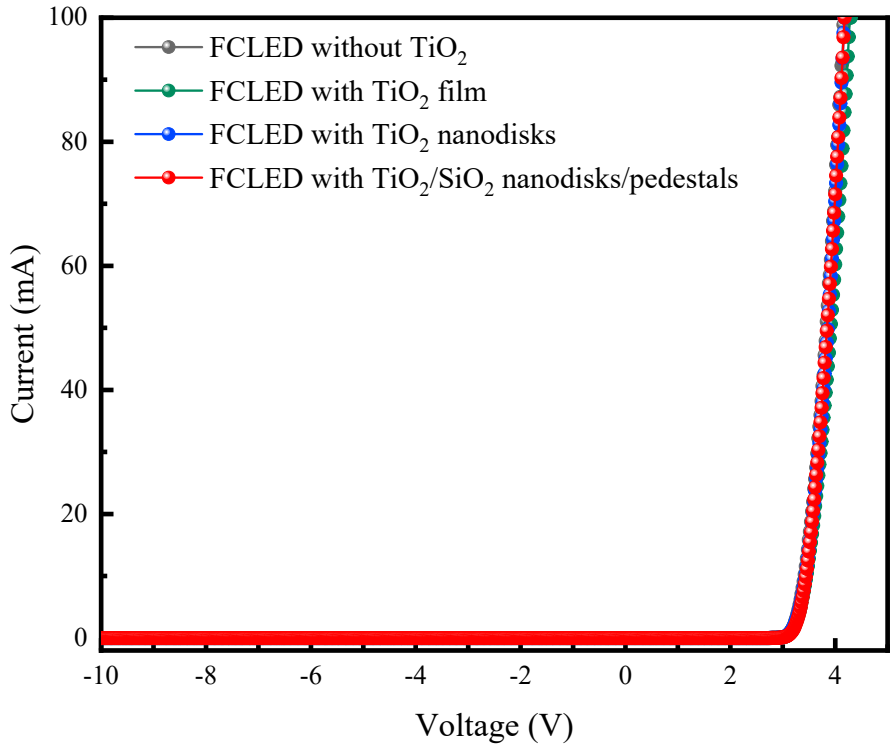

Figure S5. The current–voltage (I–V) characteristics of the near-UV LEDs with different TiO_2 nanostructures.

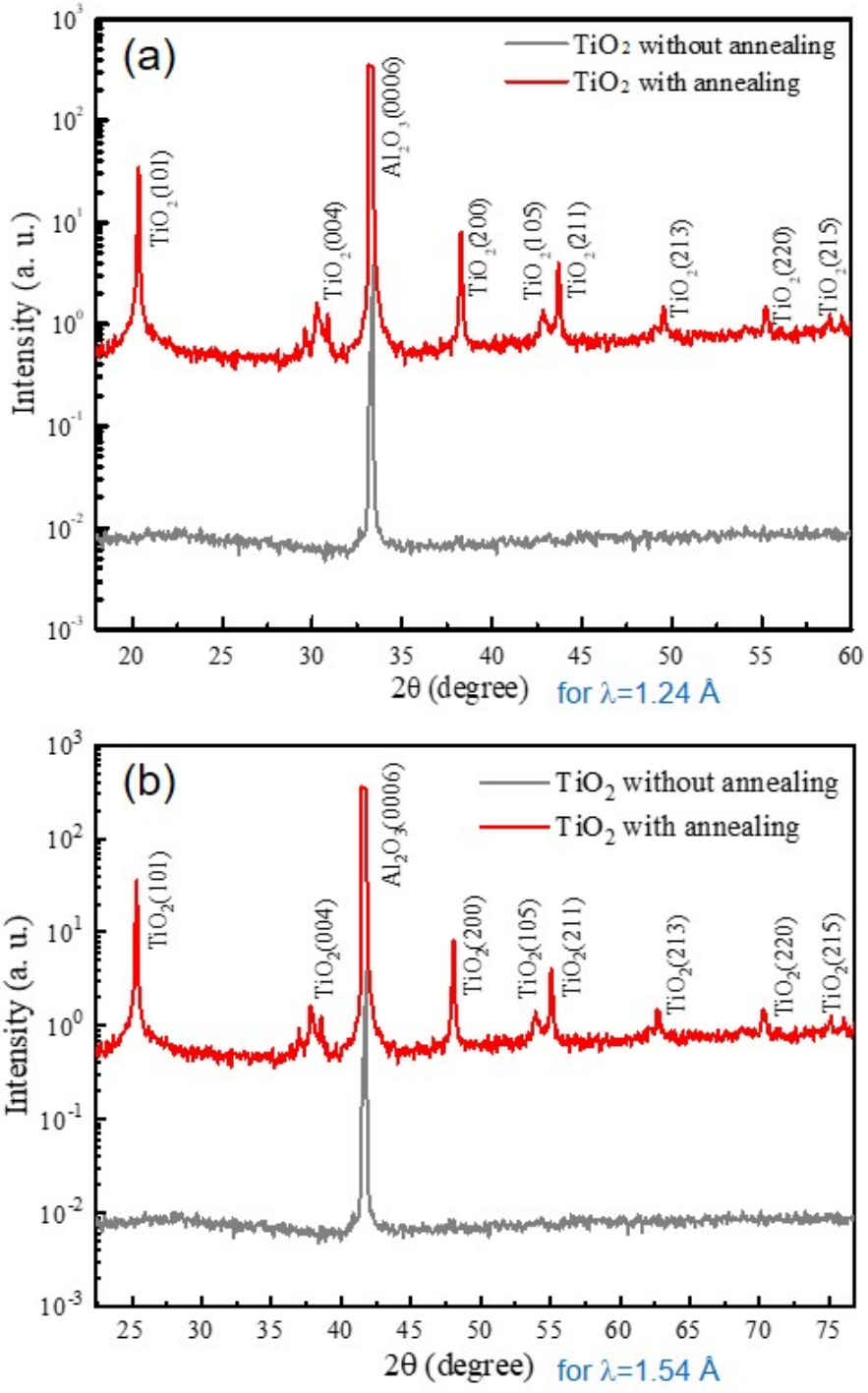

Figure S6. Indexing of XRD peaks. (a) A synchrotron X-ray source (1.24 Å) was used in our experiment. (B) The replotted XRD graph with the 2θ recalculated for the frequently used Cu Kα (1.54 Å) source for more convenient indexing of XRD peaks.

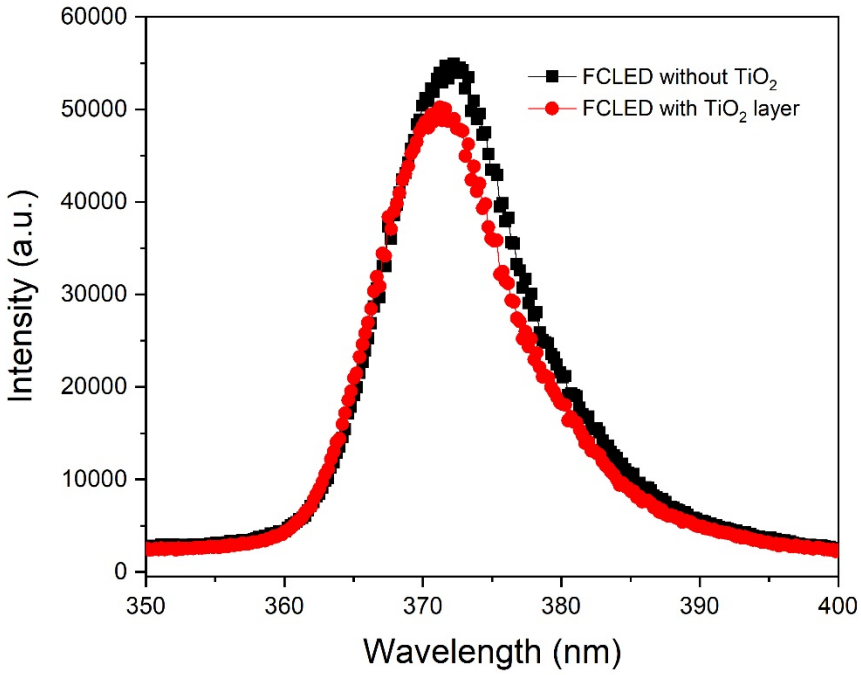

Figure S7. The light intensity measured from FCLEDs at the injection current of 20 mA. After application of TiO_2 layer, the extracted light intensity was decreased about 8.8%, which is probably attributed to the absorption of UV light by TiO_2 layer.