Supplementary Information

Optically anisotropic ZnO nanorings fabricated by near-field photoelectrochemistry

Yuki Oba, Seung Hyuk Lee and Tetsu Tatsuma*

Institute of Industrial Science, The University of Tokyo, Tokyo 153-8505, Japan. E-mail: tatsuma@iis.u-tokyo.ac.jp



Fig. S1 (a) AFM and cross-sectional AFM images of the ZnO nanoplates on a glass substrate. Histograms of the (b) size and (c) thickness of the ZnO nanoplates.



Fig. S2 Distribution of optical near field calculated for 100, 400 and 1000 nm ZnO nanoplates on a glass substrate.



Fig. S3 Zn 2p, In 3d and O 1s XPS spectra for the ZnO nanoplates on a glass substrate before and after the UV-induced nanohole formation.



Fig. S4 Extinction spectra of the ZnO nanoplates on a glass plate after irradiation with vertically polarized UV light (0–90 min) in a 1 mM benzoquinone solution.

Statistical analysis of nanohole geometry: methods

Parameters of nanoholes were evaluated as follows.

1. SEM images of the samples were taken so that the longitudinal direction was in the direction of polarization of the vertically polarized light (in the case of polarized light irradiation).

2. 100 nanoplates (75 nanoplates in the case of nonpolarized light irradiation) were randomly picked up from the nanoplates with one nanohole and parallel to the substrate surface.

3. The center of each plate, indicated by the green cross, and the center of the nanohole, indicated by the red cross, were determined (Fig. S3).

4. The length of the line segment connecting those centers, d, was evaluated (Fig. S3).

5. The angle between the connecting line and the vertical green line, θ , was evaluated (Fig. S3).

6. The lengths of the red horizontal and vertical lines overlapping the nanohole, *a* and *b*, were evaluated (Fig. S3).



Fig. S5 Definitions of the parameters for nanohole geometry.



Fig. S6 SEM images of ZnO nanoplates after irradiation with vertically polarized UV light (30 min) in a 1 mM benzoquinone solution used for statistical analysis.



Fig. S7 SEM images of ZnO nanoplates after irradiation with nonpolarized UV light (30 min) in a 1 mM benzoquinone solution used for statistical analysis.



Fig. S8 (a) Polar histogram for the angle of nanohole position θ on ZnO nanoplates for the samples prepared by nonpolarized UV light and polar diagram for the intensity of optical near field around a ZnO nanoplate under vertically + horizontally polarized UV light. (b) Histograms of nanohole geometry parameters *a* and *b* and (c) histogram of the nanohole area (0.25 πab) for the samples prepared by vertically polarized UV light.



Fig. S9 (a) Calculation model for ZnO nanoplate with a rhombus nanohole. (b) LD spectra calculated for the nanoplate model with a rhombus nanohole (Panel a) and the model with an elliptic nanohole (Fig. 4a).



Fig. S10 Distribution of optical near field calculated for (a, b, d, e) hexagonal and (c) circular ZnO nanoplates of different orientations with a (a–c) circular, (d) vertically elliptic or (e) horizontally elliptic nanohole.