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Supporting Information

A curvature-tunable random laser

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Thickness of the R6G/UV glue mixture and covering state of the ZnO nanowires

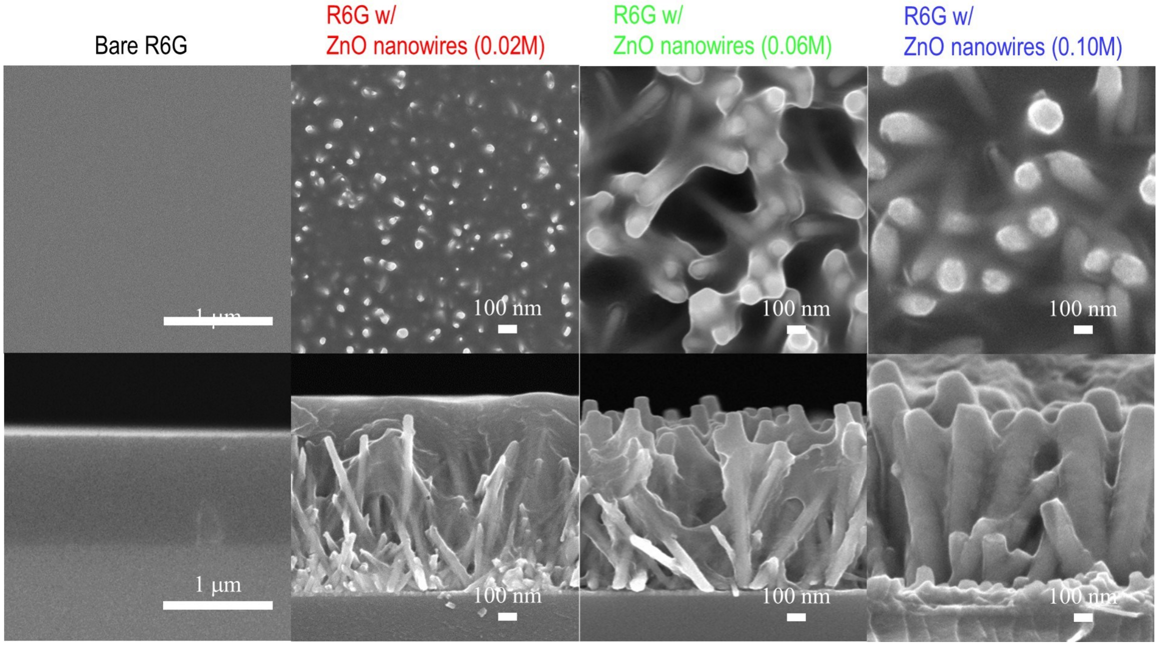

Figure S1. Top-view (top) and cross-sectional (bottom) SEM images of the ZnO nanowires synthesized by using different $Zn(NO_3)_2 \cdot 6H_2O$ concentrations of 0.02 M, 0.06 M, and 0.10 M, and that were covered by the mixture of R6G/UV glue by using two-step spin-coating process (1000 rpm/10s; 3000 rpm/30s). SEM images of bare R6G/UV glue film spin-coated on the PET substrate is also shown the leftmost panel for comparison.

To verify the covering state of the ZnO nanowires and the thickness of gain layer composed by the mixture of R6G/UV glue, we have examined the top-view and cross-sectional SEM images of the fabricated random lasers. **Figure S1** shows top-view (top) and cross-sectional (bottom) SEM images of the ZnO nanowires synthesized by using different $Zn(NO_3)_2 \cdot 6H_2O$ concentrations of 0.02 M, 0.06 M, and 0.10 M, and that were covered by the mixture of R6G/UV glue by two-step spin-coating method (1000 rpm/10s; 3000 rpm/30s). The bare R6G/UV glue film spin-coated on the PET substrate is also shown in the leftmost panel for comparison. Accordingly, the ZnO nanowires are completely covered by the mixture of R6G/UV glue due to the careful control of the two-step spin-coating method. The thickness of the gain layer is hence approximate to that of the ZnO nanowires, which is equivalent to 1 μm for all of the fabricated samples in this study. Consequently, we exclude the influence of the thickness fluctuation in the gain layer on the threshold change of the pump energy.

Homemade tool for exerting bending strain on the PET substrate

Figure S2 shows the homemade tool which is able to deform the PET substrate into a convex shape with a designated curvature. The distance between the two parallel acrylic sheets is controllable by screwing the gears in the center, through that the bending radius of the PET is hence tunable, and that in turn varying the bending strain exerted on it.

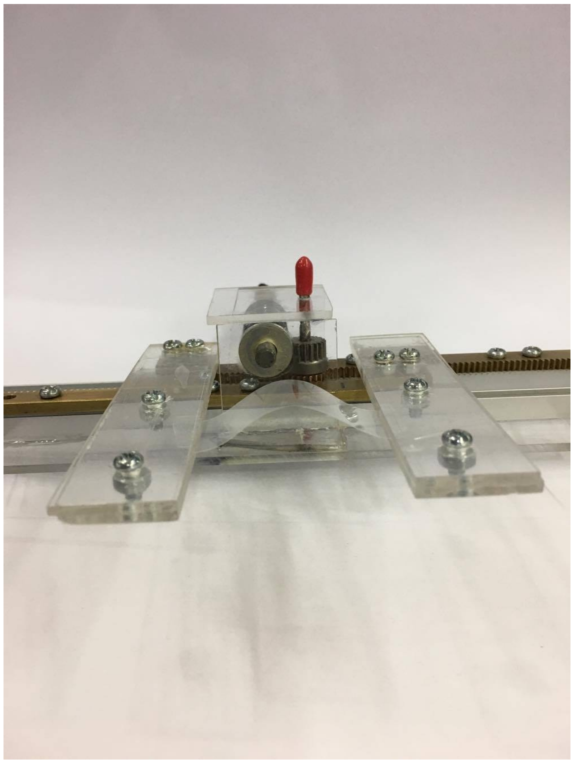

Figure S2. Homemade tool to control the bending strain exerted on the PET substrate.

Estimation of bending curvature on the PET substrate

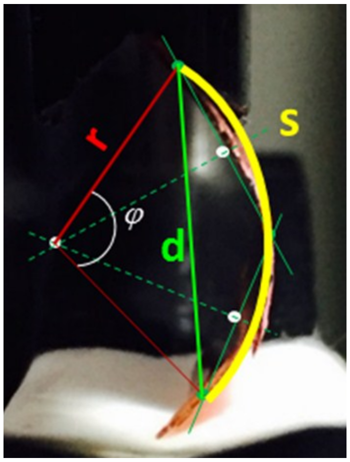

Figure S3. A schematic diagram illustrating how we estimate the curvature, κ, on the bending PET substrate.

Figure S3 shows a schematic diagram to illustrate how we estimate the curvature on the bending PET substrate, where S represents the arc length, which is a fixed constant and determined by the geometry of fabricated sample. d is the reduced or shrinkage length after a bending force was applied on the sample. r is the radius of the curvature, and is equivalent to reciprocal of curvature κ, i.e. r = 1/κ. The central angle measured in radians, φ, subtending the arc length, S, with radius r can be expressed as $\varphi = \frac{S}{r}$. According to the configuration shown in the figure, we can obtain $r \cdot sin(\frac{\varphi}{2}) = \frac{d}{2}$, and that can be further expressed as $d = 2r \cdot sin(\frac{S}{2r})$ by substituting $\varphi = \frac{S}{r}$ into it. As previous mention that S is a constant, we can immediately determine the values of r (, or κ) by a direct measurement of d, when different degrees of bending strains are applied on the sample.

L-L curves of random lasers fabricated by using 0.06 and 0.10 M $Zn(NO_3)_2 \cdot 6H_2O$ under different bending curvatures

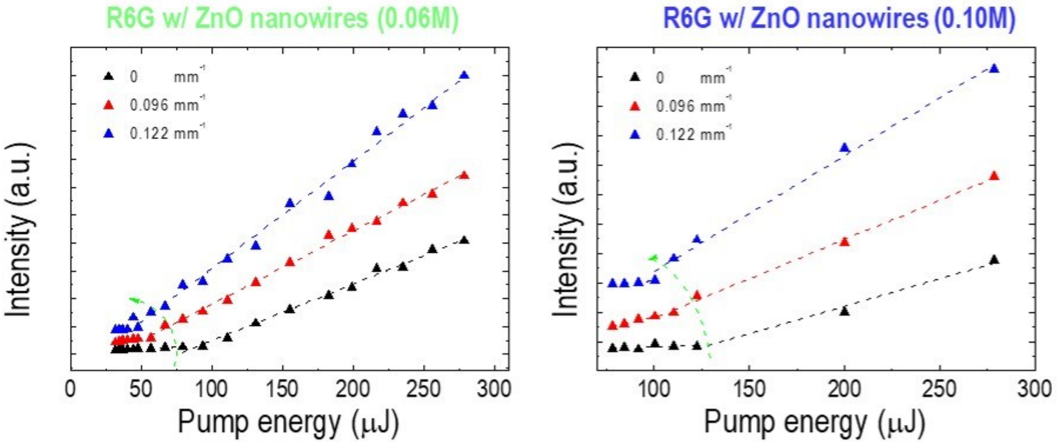

Figure S4. L-L curves of random lasers fabricated by using $Zn(NO_3)_2 \cdot 6H_2O$ concentrations of (a) 0.06 and (b) 0.10 M under different bending curvatures of $\kappa = 0$, 0.096, and 0.122 mm^{-1}.

The random lasers fabricated using the other $Zn(NO_3)_2 \cdot 6H_2O$ concentrations of 0.06 and 0.10 M also exhibit similar tunable effects on the pump threshold. By bending the PET substrate from $\kappa = 0$ to $\kappa = 0.122$ mm^{-1}, the threshold of the pump energy is tunable from ~80 (120) to ~40 (100) μJ for the random laser fabricated using a $Zn(NO_3)_2 \cdot 6H_2O$ concentration of 0.06 (0.10) M. In this study we mainly demonstrate the random laser fabricated using 0.02 M $Zn(NO_3)_2 \cdot 6H_2O$ since it shows the largest tuning range in the threshold of the pump energy (from 169 μJ to 82 μJ).