Electronic Supplementary Material (ESI) for Lab on a Chip

Supplementary information

Bio-switchable optofluidic lasers based on DNA Holliday junctions

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DNA sample preparation

The 40-base single-stranded DNA samples were purchased from Integrated DNA Technology. The respective sequences and names are listed in Table S1. The Holliday junction DNA was assembled by mixing the four single-stranded DNA samples at a ratio of 1:1:1:1 in a buffer solution of 10 mM Tris-HCI, (pH 8.0).[1] After being heated to 80 ^{o}C for 30 minutes, the solution was allowed to cool slowly to room temperature for subsequent use in the OFRR laser.[2]

Experimental

During the experiment, 110 μL of Holliday junctions at 100 μM was stored in a vial. The solution was withdrawn into the OFRR capillary by a syringe pump at a flow rate of 1 μL/min. To fold the junctions, 200 mM magnesium chloride solution ($MgCl_2$) was added incrementally. After 4 μL of $MgCl_2$ was added, the concentration of Mg^{2+} reached 7.02 mM and the junctions folded completely. Then Mg^{2+} ions were removed by adding 200 mM tetrasodium ethylenediamine(tetraacetate) (Na_4 EDTA) gradually. After 4 μL of Na_4 EDTA was added, all Mg^{2+} ions were removed and the junctions unfolded completely.

Lasing threshold measurement

The lasing threshold curves for Cy3 and Cy5 are shown in Figure S1.

Fluorescence experiment

We also investigated the fluorescence spectra at various concentratons of magnesium ions. The results are shown in Figure S2.

Table S1. DNA sequences used in the experiment

Sample name	Sequence
BamHI	5'-/5Cy3/AGG GAT CCG TCC TAG CAA GCC GCT GCT ACC GGA AGC TTC T-3'
HindIII	5'-/5Cy5/AGA AGC TTC CGG TAG CAG CGA GAG CGG TGG TTG AAT TCC T-3'
EcoRI	5'-/5Cy3/AGG AAT TCA ACC ACC GCT CTT CTC AAC TGC AGT CTA GAC T-3'
XbaI	5'-/5Cy5/AGT CTA GAC TGC AGT TGA GAG CTT GCT AGG ACG GAT CCC T-3'

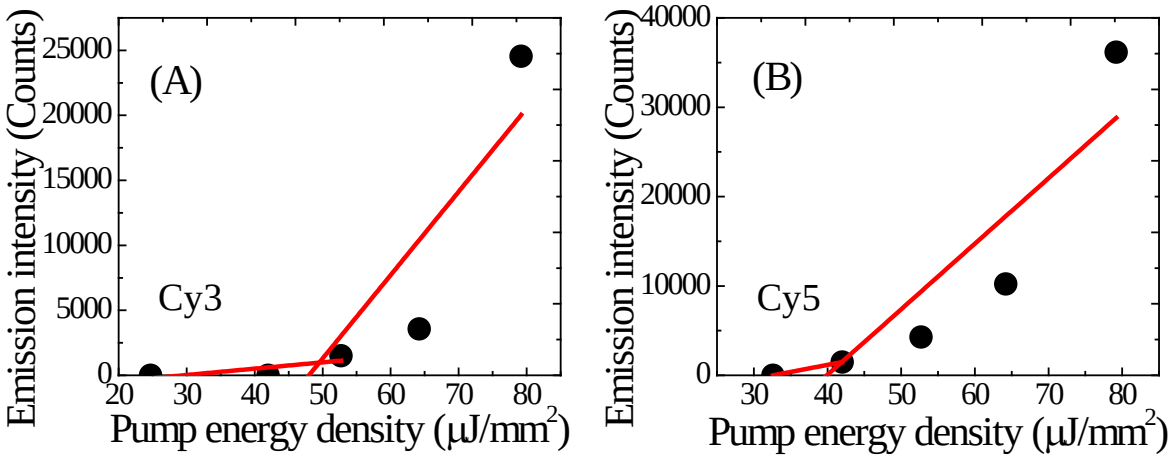

Figure S1 Laser emission vs. the pump energy density for Cy3 and Cy5. (A) In the absence of Mg^{2+} ions, the Holliday junction was open. The laser threshold of Cy3 was 49.5 μJ/mm^2. (B) When the concentration of Mg^{2+} ions reached 7.02 mM, the Holliday junction was folded to the maximal level. The laser threshold of Cy5 was 42 μJ/mm^2.

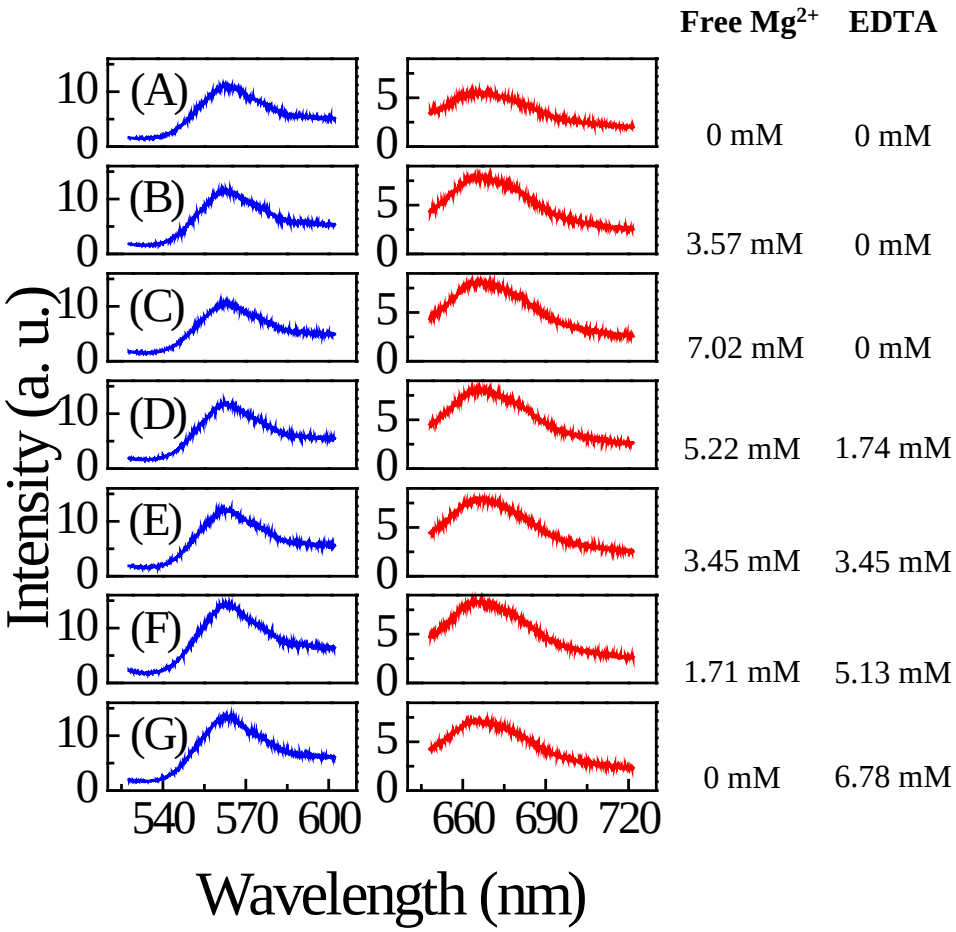

Figure S2 Fluorescence spectra of the Holliday junction at various concentrations of Mg^{2+} ions. Left column: Cy3. Right column: Cy5. From top to bottom, the concentration of free Mg^{2+} ions was increased to 7.02 mM first, and then gradually decreased to 0 mM after EDTA was added.

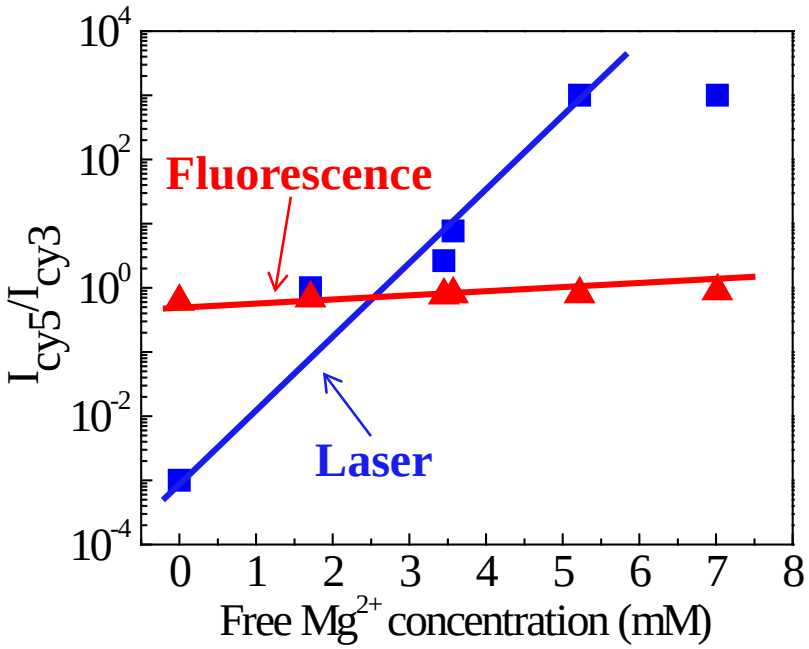

Figure S3 γ ($I_{Acceptor}/I_{Donor}$) for both laser and fluorescence signal at various concentrations of free Mg^{2+} ions based on the spectra in Fig. 3 and Fig. S2. Note that, upon complete wavelength switching from Cy3 (Cy5) to Cy5 (Cy3), the emission background in the Cy3 (Cy5) spectrum is nearly zero. Only instrument noise (at the level of 0.001) remains.

References

1. D. R. Duckett, A. I. H. Murchie, S. Diekmann, E. von Kitzing, B. Kemper and D. M. J. Lilley, *Cell*, 1988, **55**, 79-89.

2. A. Mount, C. Mountford, S. Evans, T. J. Su, A. Buck, P. Dickinson, C. Campbell, L. Keane, J. Terry and J. Beattie, *Biophys. Chem.*, 2006, **124**, 214-221.