Electronic Supplementary Material (ESI) for ChemComm.


# An enzyme-free and DNA-based Feynman gate for logically reversible operation

## Materials and Instruments

DNA were purchased from Sangon Biotechnology Co., Ltd (Shanghai, China). NMM was purchased from Porphyrin Products (Logan, UT, USA). Other chemicals were of reagent grade and were used without further purification.The sequence of oligonucleotides used in this work was shown in Table S1. The oligonucleotide was dissolved in water as stock solution and quantified by UV−Vis absorption spectroscopy with the following extinction coefficients ($\varepsilon_{260\ nm}$, $M^{-1}cm^{-1}$): A = 15400, G = 11500, C = 7400, T = 8700. UV-vis absorbance measurements were performed on a Cary 500 Scan UV/Vis/NIR Spectrophotometer (Varian, USA). Fluoromax-4 Spectrofluorometer (HORIBA Jobin Yvon, Inc., NJ, USA) was used to collect the fluorescence emission spectra of GO/F-DNA complexes in Tris-HCl buffer (20 mM Tris-HCl, 200 mM KCl, 10 mM MgCl2, pH 8.0) under room temperature by irradiating FAM at 494 nm and NMM at 399 nm.

## Experimental Section:

Preparation of DNA Circuits: Sequences of DNA strands are listed in Table S1 in Supporting Information. The oligonucleotides were dissolved in water as stock solution and diluted with Tris-HCl buffer (20 mM Tris-HCl, 200 mM KCl, 10 mM $MgCl_2$, pH 8.0) for hybridization in the logic circuit. In logic operation, the DNA solutions diluted with Tris-HCl buffer were first heated at 90℃ for 10 min and then gradually cooled down to room temperature. The platform was prepared by mixing GO (8 μg/mL), F-DNA (100 nM) and NMM (1 μM) for 10 min at room temperature. Inputs DNA strands (350 nM) was added in step and incubated under room temperature for 30 min for each addition and the fluorescence responses of the system were measured to implement the function of reversible logic gate.

**Table S1** Sequences of the oligonucleotides used in this work.

| Name | DNA Sequence(from 5’ terminal to 3’ terminal) |
|---|---|
| F-DNA | TAACG TGTGT TTGCA CTATG CTTTC A |
| IN1 | AATAT ATGAA AGCAG ATTGC AAAAC CAAGT AGCGG GTGGG TGGGT GGG |
| IN2 | GCTAC TTGGT AAAGC AATCT GCAAA CATAT ATT |

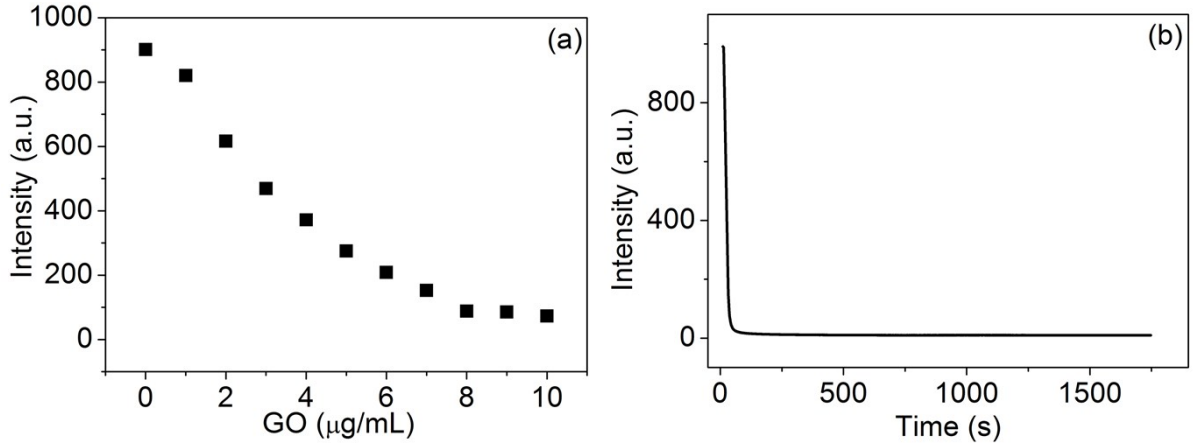


**Figure S1.** (a) The FAM fluorescence response of F-DNA in the presence of different concentration of GO. (b) The interval of reaching stability state of reaction between F-DNA and GO.

The optimal concentration of GO is found by monitoring the fluorescence intensity changing of FAM at 519 nm as a function of GO concentration. The fluorescence intensity of FAM decreases along with increasing the concentration of GO and reaches a plateau at 8 μg/ml GO, Figure S1 (a). Thus, 8 μg/ml of GO was selected for the following experiments. The fluorescence intensity of FAM decreases quickly at the beginning and then reaches a plateau, as showed in Figure S1 (b). Here, 10 min was selected as incubation time for preparing of the GO/F-DNA logic platform.

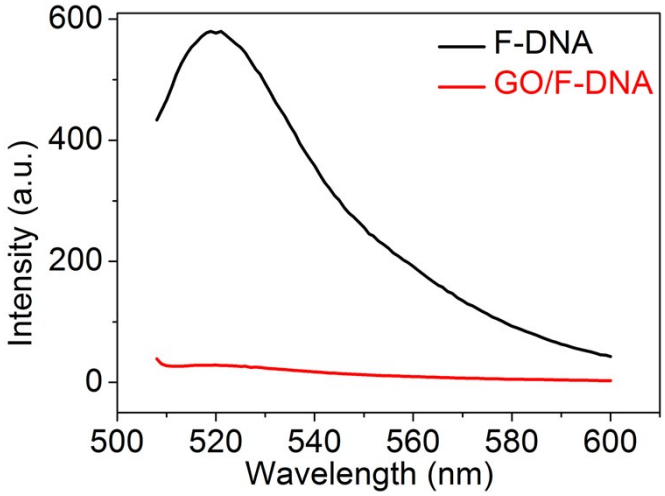


**Figure S2.** Comparison of FAM fluorescence signal of F-DNA (100 nM) before and after addition of GO (8 μg/mL).

Once F-DNA binding on GO the fluorescence intensity of FAM is significantly quenched via noncovalent π-π stacking interaction.

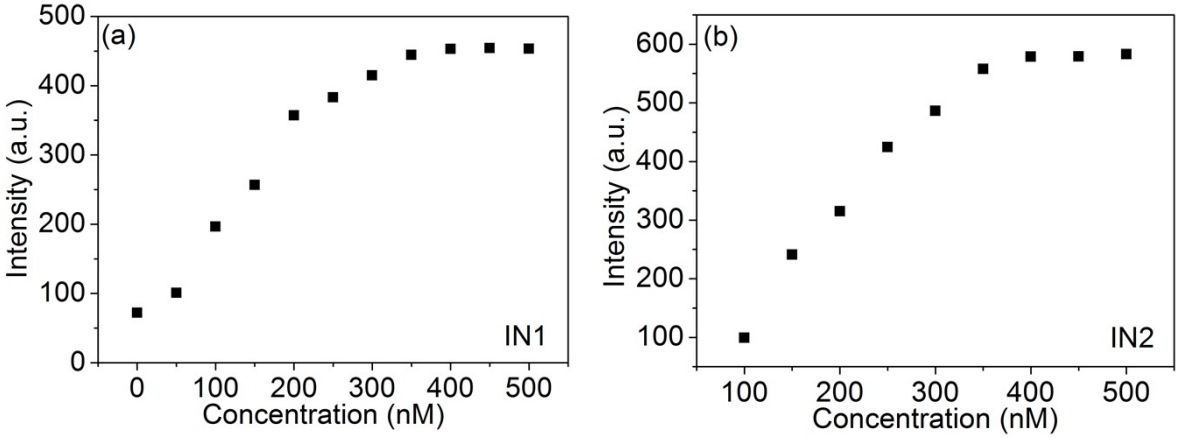


**Figure S3.** The FAM fluorescence response of GO/F-DNA at 519 nm with increasing the concentration of IN1 (a) and IN2 (b).

The fluorescence of FAM is generally recovered and reaches a platum with increasing the concentration of IN1 (a) or IN2 (b). Here, 350 nM was used for both IN1 and IN2.