Visible Light-Sensitive APTES-Bound ZnO Nanowire toward a Potent Nanoinjector Sensing Biomolecules in a Living Cell

By Jooran Lee\textsuperscript{a}, Sunyoung Choi\textsuperscript{a}, Seon Joo Bae\textsuperscript{b}, Seok Min Yoon\textsuperscript{c}, Joon Sig Choi\textsuperscript{b} and Minjoong Yoon*\textsuperscript{a}

\textsuperscript{a}Molecular/Nano Photochemistry and Photonics Lab, Department of Chemistry, Chungnam National University, Daejeon 305-764, South Korea, \textsuperscript{b}Department of Biochemistry, College of Natural Sciences, Chungnam National University, Daejeon 305-764, South Korea, \textsuperscript{c}Department of Chemistry, Northwestern University, Evanston, Illinois 60208, United States. *e-mail: mjyoon@cnu.ac.kr

\textbf{Fig S1.} SEM images of ZnO NWs (A), APTES-ZnO NWs (B), ss DNA-APTES-ZnO NWs (C) and ds DNA-APTES-ZnO NWs (D). White scale bars indicate 400 nm.
**Fig S2.** Layout of laser confocal scanning microscope (LCSM)-coupled spatial and ps-time-resolved PL system. The sample is mounted on a piezoelectric x, y scanning stage. Light from a laser is coupled onto the single-mode optical fiber, illuminating the sample through the objective lens.
Fig S3. Bright-field and PL images of different single ZnO NWs. Emission spectra were collected from the tip and body of the selected single ZnO NW (A), APTES-ZnO NW (B), ss DNA-APTES-ZnO NW (C), complementary ds DNA-APTES-ZnO NW (D) and non-complementary ds NA-APTES-ZnO NW (E). Excitation wavelength was 410nm. (a): tip of the selected single ZnO NW (b): body of the selected single ZnO NW.
Fig S4. PL decay profiles of APTES-ZnO NWs (a) and complementary ds DNA-APTES-ZnO NWs (b). The fluorescence decays were measured with 410 nm light by using time-correlated single photon counting method with a self- mode-locked femtosecond Ti:sapphire laser (Coherent model Mira 900) pumped by a Nd:YVO₄ laser (Coherent Verdi).

<table>
<thead>
<tr>
<th></th>
<th>$\lambda_{em} = 650\text{nm}$</th>
<th>$\tau_1$ (ns) (%)</th>
<th>$\tau_2$ (ns) (%)</th>
<th>$\tau$ (average)</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>APTES-ZnO NWs</td>
<td></td>
<td>0.41 (25.2)</td>
<td>3.72 (74.8)</td>
<td>2.89</td>
<td>1.040</td>
</tr>
<tr>
<td>dsDNA-APTES-ZnO NWs</td>
<td></td>
<td>0.47 (33.5)</td>
<td>3.02 (66.5)</td>
<td>2.17</td>
<td>1.050</td>
</tr>
</tbody>
</table>
**Fig S5.** Bright-field confocal microscopic images of a single APTES-ZnO NW in 293 cell. The scale bar is 10μm.
**Fig S6.** Bright-field confocal microscopic images of a single APTES-ZnO NW in HeLa cell. The scale bar is 10μm.
Fig S7. Effect of APTES-ZnO NWs on viability of HEK 293 cells which were seeded $2 \times 10^4$ cells per well in a 96 well plate. After 24 hours seeding, the cells were exposed to the indicated concentrations of each carrier for 2 days. Relative cell viability was calculated, regarding the absorbance at 570 nm of intact HEK 293 cells as 100%. The absorbance is directly proportional to the number of living cells. (a) APTES-ZnO NWs, (b) PEI 25KDa.