Electronic Supplementary Information

Tunable Near White Light Photoluminescence of Lanthanide Ion (Dy^{3+}, Eu^{3+} and Tb^{3+}) Doped DNA Lattices†

Sreekantha Reddy Dugasani,[a] Byeongho Park,[b,c] Bramaramba Gnapareddy,[a] Sreedhara Reddy Pamanji,[d] Sanghyun Yoo,[a] Keun Woo Lee,[a] Seok Lee,[b] Seong Chan Jun,[b] Jae Hun Kim,[c] Chulki Kim,[*c] and Sung Ha Park[*a]

[a] Department of Physics and Sungkyunkwan Advanced Institute of Nanotechnology (SAINT), Sungkyunkwan University, Suwon 440-746, Korea
[b] Sensor System Research Center, Korea Institute of Science and Technology (KIST), Seoul 136-791, Korea
[c] School of Mechanical Engineering, Yonsei University, Seoul 120-749, Korea
[d] Department of Physics, Sri Venkateswara University, Tirupati 517502, India

Materials and Methods

O_2 Plasma Exposure. The activation of O_2 plasma on silica substrates introduces functional groups – mainly the silanol group (SiOH). This group changes the surface of the silica from hydrophobic to hydrophilic, and the processing parameters, such as the gas flow rate, activation power, generation time and operating pressure, can vary according to the given substrate. In the present study, an O_2 plasma cleaner (Femto Science, Gyeonggi, Korea) was used for which the chamber was initially evacuated and then the oxygen plasma activation commenced at a power of 50 W, base pressure of 5×10^{-2} torr, oxygen flow rate of 45 sccm, working pressure of 7.8×10^{-1} torr and plasma generation time of 5 min.

DNA Lattice Growth on a Given Substrate. Synthetic oligonucleotides of DNA molecules, purified via high performance liquid chromatography (HPLC), were purchased from BIONEER (Daejeon, Korea). The complexes were formed by mixing a 1× TAE/Mg^{2+} (40 mM Tris, 20 mM Acetic acid, 1 mM EDTA (pH 8.0), and 12.5 mM magnesium acetate) buffer solution that contains an equimolar mixture of 8 different DX strands. For annealing, the plasma treated silica substrates were inserted along with DNA strands into an AXYGEN-tube with a total sample volume of 250 µL. After that, the sample tube was placed in a Styrofoam box with 2 L of boiled water and was allowed to cool slowly from 95 to 25 °C over a period of 24 hours to facilitate hybridization. During annealing, DNA strands formed polycrystalline DX lattices on the substrate, and consequently, these structures achieved full coverage on the silica surfaces. We prepared a sample at a concentration of 50 nM, which was well above the DNA monomer saturation concentration of 20 nM, for full coverage of the DNA lattices.

Lanthanide Ion Doping. After growing the DNA lattices on the silica substrate, the appropriate amount of 1 M of $Dy(NO_3)_3 \cdot xH_2O$, $Eu(NO_3)_3 \cdot 5H_2O$, and $Tb(NO_3)_3 \cdot 6H_2O$ (Sigma Aldrich, USA) were introduced to obtain final concentrations 0, 0.5, 1, 2 and 4 mM, and the samples were then incubated at room temperature for 24 hours.

AFM Imaging. For the AFM measurement, a sample obtained through SAG was placed on a metal puck using instant glue. 30 µL 1× TAE/Mg^{2+} buffer were added onto the substrate, and another 20 µL of 1× TAE/Mg^{2+} of buffer were dispensed into the AFM tip (NP-S10, Veeco Inc., USA). The AFM images were obtained with a Multimode Nanoscope (Veeco Inc., USA) in the fluid tapping mode.

Photoluminescence Measurement. The excitation and emission spectra of Ln^{3+}-DNA lattices were obtained using a fluorescence spectrophotometer (LS-55, PerkinElmer Instruments, USA) at room temperature. The excitation spectra were obtained at fixed emission wavelengths in the visible region, and the emission spectra were measured by exciting the samples at different wavelengths of 350, 375, 400, 425, and 450 nm.