

Supporting Information

A New Quantum Dot-Platinum Conjugate for Self-Assembled Nanoconjugates by Coordination Bonding Mediated Recognition

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Experimental details

Synthesis of cis-Pt^{II}(DMSO)₂Cl₂: Cis-Pt^{II}(DMSO)₂Cl₂ was prepared by using the literature method.¹
² Briefly, dimethyl sulfoxide was added to Na₂[PtCl₄] in water to form the neutral platinum dimethyl sulfoxide complex as a yellow crystalline precipitate.

QD-Pt conjugates: Qdot605 functionalized with amino polyethylene glycol (PEG) (Invitrogen, Grand Island, NY, USA) were reacted with the linker which was derived from 10-(2,5-dioxopyrrolidin-1-yl)-10-oxodecanoic acid. Excess reagents were removed by using a 100 K microcon centrifugal filter (Millipore, Billerica, MA, USA). Ethylenediamine (Sigma-Aldrich, St. Louis, MO, USA), moiety to accommodate platinum metal was introduced at the end of the C8 linker. After 3 h incubation at room temperature, un-reacted reagents were removed by filtration using a 100 k microcon centrifugal filter. Finally, synthesized cis-Pt^{II}(DMSO)₂Cl₂ was added with borate buffer and then incubated at room temperature for 30 min to form the coordination complex. The fluorescent intensity of QD-Pt conjugates was measured by using FluoroLog-Modular Spectrofluorometer (HORIBA Jobin Yvon, Tokyo, Japan). ICP-MS analysis of platinum on QD-Pt conjugates was performed at the Korea Polymer Testing & Research Institute (Koptri, Seoul, Korea).

Chromosome labelling: CGH slides (Abbott Molecular Inc. Des Plaines, IL, USA) were denatured by using 70 % formamide and 10 % 20x SSC in distilled water at 73 °C for 5 min. The slides were dehydrated by washing with a gradient of ethanol (70, 85, 100 %) for 1 min each. After drying in air, QD-Pt conjugates and (amine-amide)-QDs (control) were added to the slides. The coverslips were immediately applied and sealed with diluted rubber cement. The slides were kept in a 37 °C incubator overnight. 0.4X SSC in 0.3% NP-40 washing solution was placed in the wash tank at 74 °C. Right after removal of the rubber cement seal and the coverslips, the CGH slides were placed in the first wash solution for 1-3 s. The slides were placed in the second wash solution which contains 2X SSC in 0.1 % NP-40 at room temperature. The slides were agitated for 1-3 s and then let stand for 5 s to 1 min. They were dried in air with protection from light. For counterstaining, DAPI solution (1:100 dilution of 1 mg/ml) was added to the CGH slides and incubated for 1 h. After several washes with 1x phosphate buffered saline (PBS, Invitrogen, Eugene, OR, USA), the coverslips were applied and sealed with the rubber cement. Epi-fluorescent microscopy (Nikon 90i) with a 100x magnification lens was used to observe chromosomes.

Glyoxal agarose bead conjugation: Glyoxal agarose beads (ABT Agarose Bead Technologies, Tampa, FL, USA) were isolated from preservative containing solution using Sigmaprep spin column

(Sigma-Aldrich, St. Louis, MO, USA) at 1,600 rpm and 30 s centrifuge. Cyanoborohydride coupling buffer (Sigma-Aldrich, St. Louis, MO, USA) was added to beads and stirred for 15 min. After removing the coupling buffer, fresh coupling buffer added to the beads and stirred for 15 min. Amine-C12-GGGGGG and amine-C12-TTTTTT oligonucleotides (Bioneer, Daejeon, Korea) were reacted with the beads in the coupling buffer by gentle shaking (1:1 ratio of glyoxal site to oligonucleotide). The beads were allowed to stir overnight. After removal of un-reacted oligonucleotides by washing with distilled water, un-reacted glyoxal sites were blocked by using ethanolamine (Sigma-Aldrich, St. Louis, MO, USA) for 1 h. QD-Pt conjugates and (amine-amide)-QDs (control) were added to ABs, 6G-ABs and 6T-ABs ABs (1:1 ratio of glyoxal site on ABs to QD-Pt conjugate or QD). They were observed using epi-fluorescent microscopy with 10x and 20x magnification lens.

Oligonucleotide conjugation on MNPs and binding with QD-Pt(II) conjugate: 10 nm MNPs (iron oxide nanoparticles) with carboxyl groups were purchased from Ocean Nano Tech (Springdale, AR, USA). Amine-C12-GGGGGG (Bioneer, Daejeon, Korea) was reacted with MNPs using sulfo-N-hydroxysulfosuccinimide (NHS) (Pierce, Rockford, IL, USA) and EDC (Sigma-Aldrich, St. Louis, MO, USA) for 3 h. After removing unreacted DNA, QD-Pt(II) nanoconjugates were introduced to 6G-MNPs. They were incubated at room temperature for 3 h, and filtered by using a 100 K microcon centrifugal filter several times. DLS analysis was performed using Nano-ZS (Malvern, UK) at room temperature. For TEM analysis, each drop of mixture (QD-Pt, MNPs) and QD-Pt-6G-MNP conjugates was placed on the carbon film only TEM grid (EMS, Hatfield, PA, USA). The sample was investigated using the cryoTEM and Tecnai TEM (KIST, Seoul, Korea). The magnetic property of MNP and QD-MNP was measured by an alternating gradient magnetometer (AGM, KIST, Seoul, Korea).

Gel electrophoresis: 1% agarose gel with 0.5 X tris-buffered saline (TBS, Invitrogen, Grand Island, NY, USA) was prepared. The samples were mixed with 40 % glycerol (Sigma-Aldrich, St. Louis, MO, USA) and loaded to the electrophoresis system (Advance, Tokyo, Japan). The gel was stained by using GelCode Blue stain reagent (Pierce Biotechnology, Rockford, IL, USA) and imaged.

1. J. C. Alers, J. Rochat, P. J. Krijtenburg, H. van Dekken, A. K. Raap and C. Rosenberg, *Genes Chromosomes Cancer*, 1999, **25**, 301-305.
2. J. C. Wiegant, R. P. van Gijlswijk, R. J. Heetebrij, V. Bezrookove, A. K. Raap and H. J. Tanke, *Cytogenet Cell Genet*, 1999, **87**, 47-52.

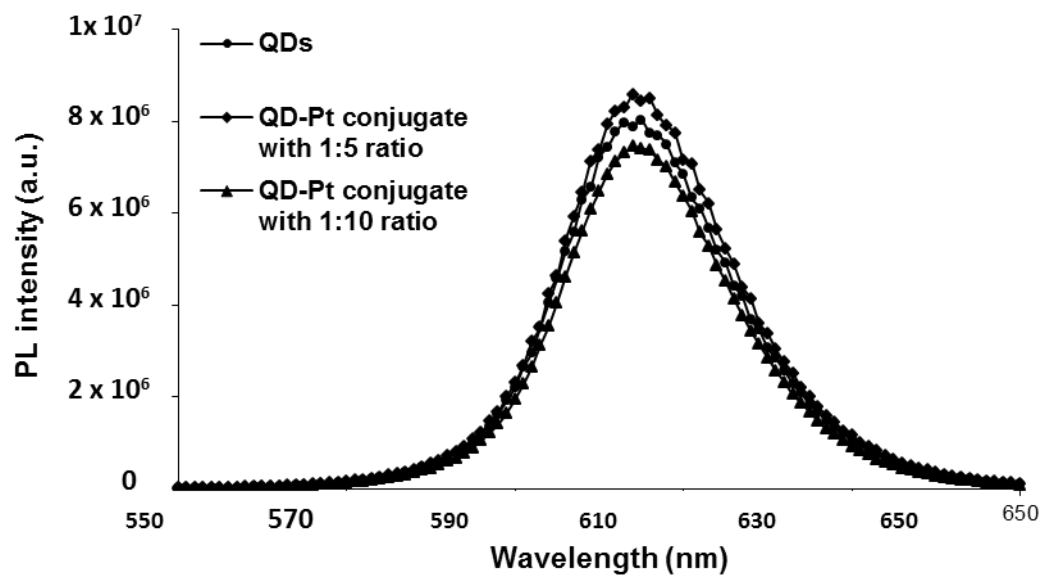


Fig. S1. Photoluminescent intensity of QD and QD-Pt conjugates (1:5 and 1:10 ratio of QD:Pt). There was no significant difference of fluorescence among QD and selective QD-Pt conjugates.

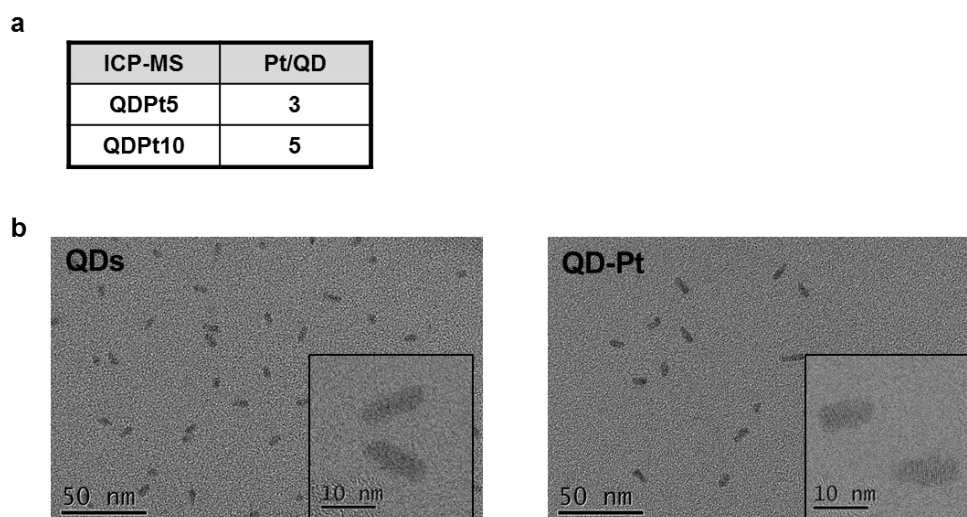


Fig. S2. ICP-MS measurement and TEM images of QD-Pt conjugates. (a) A table of ICP-MS data. It showed that there were three platinum on QDPt5 (1:5 ratio of conjugation) and five platinum on QDPt10 (1:10 ratio of conjugation). (b) TEM images of QDs and QD-Pt conjugates. The images indicate QDs morphology was not changed after conjugating with platinum.

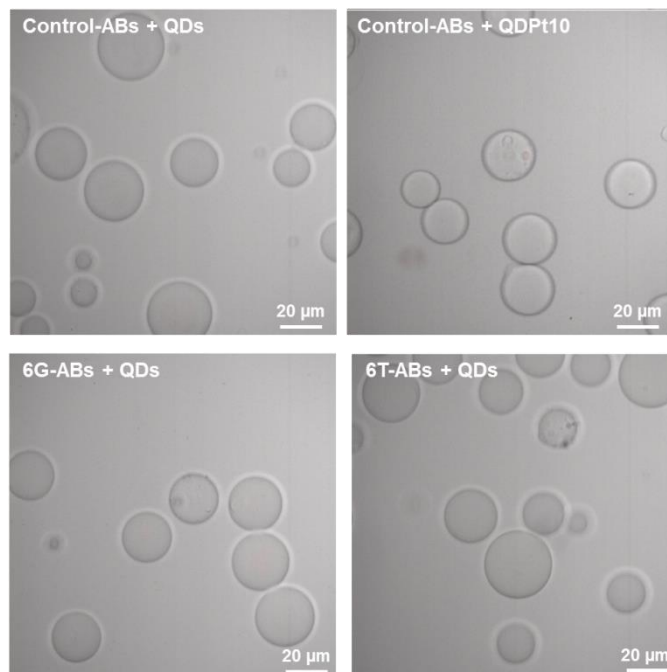


Fig. S3. Merged DIC and fluorescent images of ABs. There is no clearly emitted red fluorescence from the control ABs with control QDs (no platinum conjugation), control ABs with QDPt10, 6G-ABs with control QDs, and 6T-ABs with control QDs.

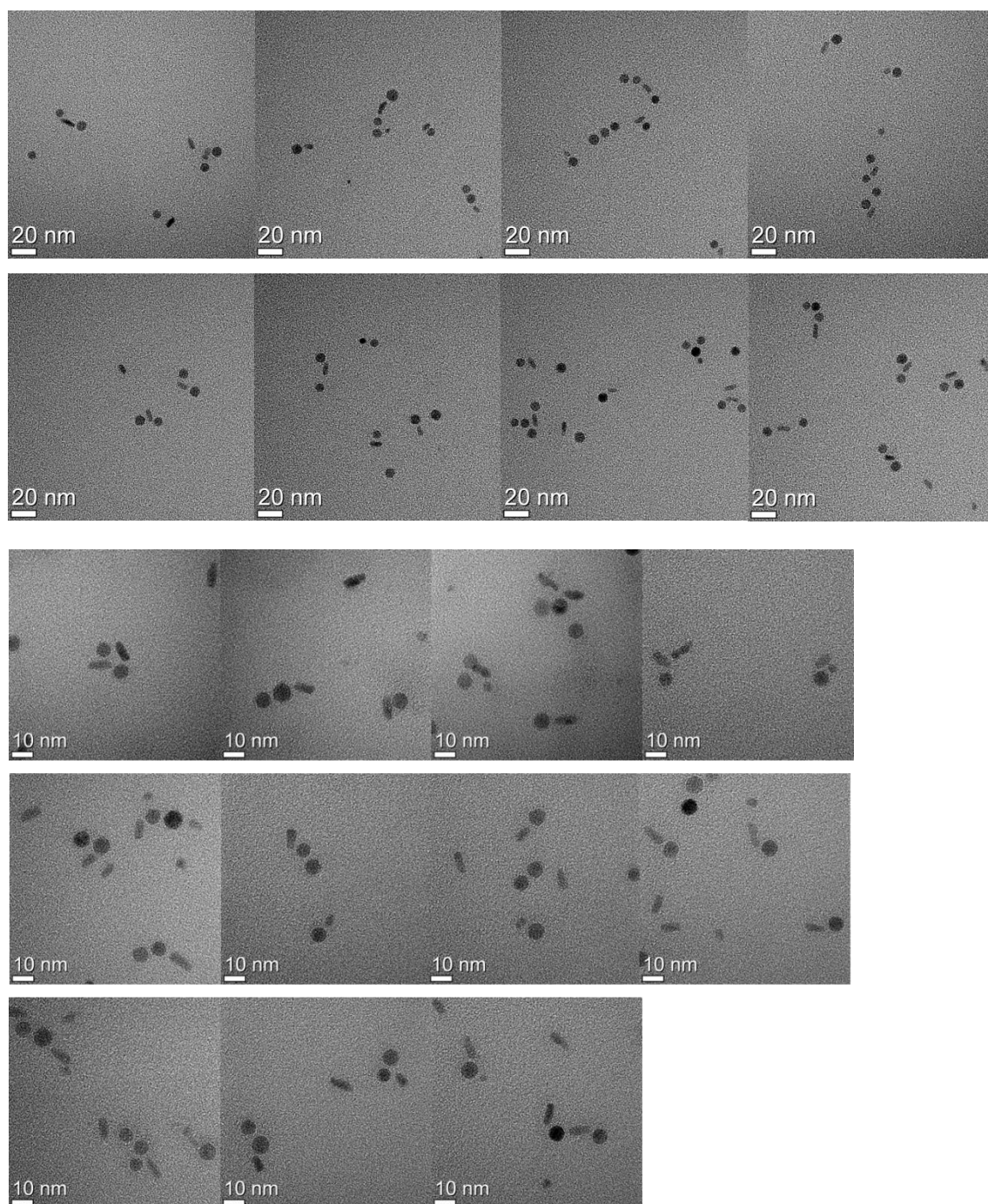


Fig. S4. TEM images of QD-Pt(II)-6G-MNP nanoconjugates. MNPs are sphere-shaped and QDs are rod-shaped. TEM images showed that a new nanoconjugate of 6G-MNP and QD-Pt(II) was formed.

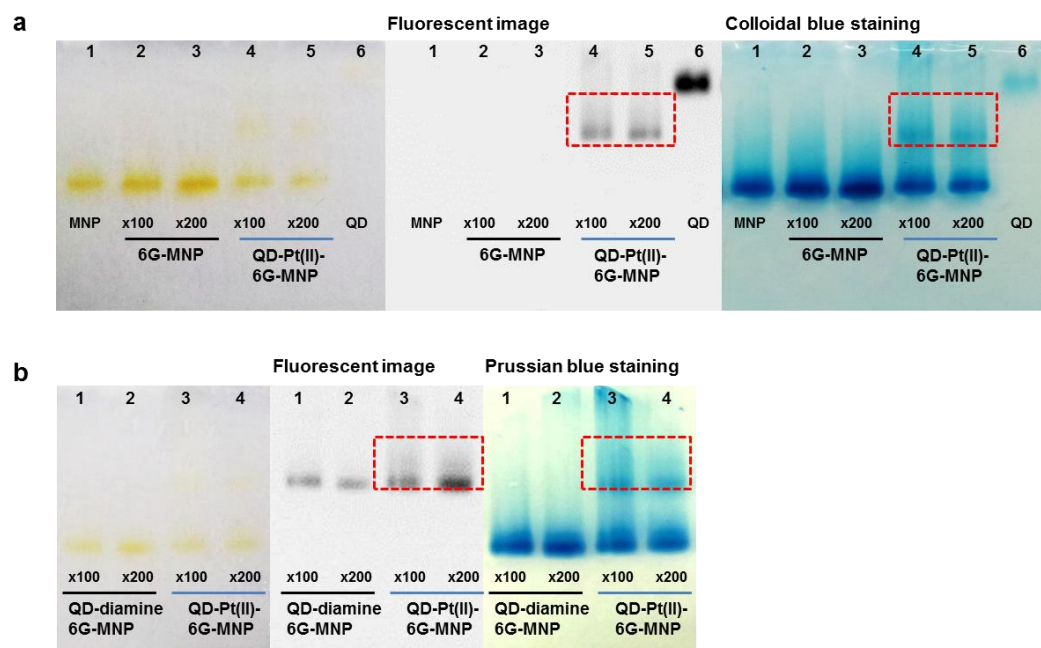


Fig. S5. Gel electrophoresis data. (a) MNPs (lane 1), 6G-MNP (lane 2 with 100 equivalent oligonucleotide (x100), lane 3 with 200 equivalent oligonucleotide (x200)), QD-Pt(II)-6G-MNP (lane 4 and 5), and QDs (lane 6). A fluorescent image showed QDs in QD-Pt(II)-6G-MNP have increased mobility which may be caused by adjacent MNPs that are negatively charged. Colloidal blue staining indicates that QD-Pt(II)-6G-MNP has a broad band located between QDs and MNPs (red rectangle). (b) A mixture of QD-diamine and 6G-MNPs (lane 1 and 2), and QD-Pt(II)-6G-MNP conjugates (lane 3 and 4) were compared. From Prussian blue staining, MNPs in QD-Pt(II)-6G-MNP were dispersed broadly rather than them in the mixture. This result indicates the new nanoconjugates with various sizes were formed.

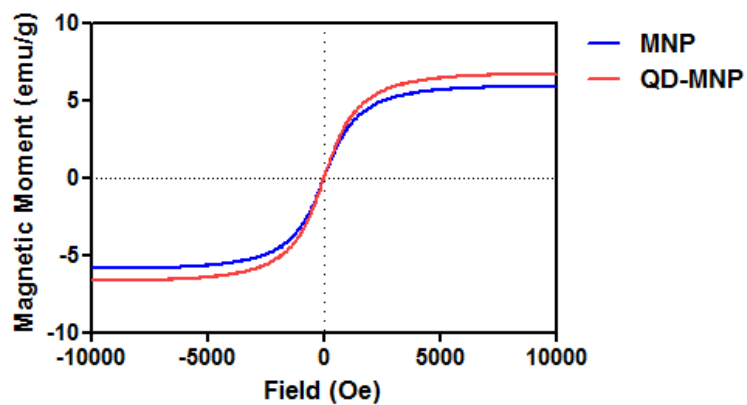


Fig. S6. Magnetization curve of MNP and QD-MNP at room temperature. Superparamagnetic property of MNP was preserved even after conjugation with QD.