Supporting Information

Low-entropy lattices engineered through bridged DNA origami frames

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Materials

M13mp18 DNA was purchased from Bayou Biolabs, America. All short oligonucleotides were purchased from Sangon Biotech Co. Ltd (Shanghai, China). 10 nm AuNPs were purchased from Ted Pella Inc. Carbon-coated copper grids were purchased from Beijing Zhongjingkeyi Technology Co. Ltd (Beijing, China).

Design and synthesis of DNA origami frames

Octahedron, cube, hexagonal bipyramid and elongated octahedron DNA origami frames were designed by caDNAno software (downloaded from http://cadnano.org/). In the design, each edge of these frames was composed of a six-helix bundle. For the octahedral and cubic frames, the length of all the edges is 88 base pairs. For each hexagonal bipyramid, the bottom edges of the hexagonal pyramid are 46 base pairs in length, and the length of side edges was 67 base pairs. For an elongated octahedral frame, the length of four bottom edges is 88 base pairs that is equal to the octahedron’s, and its side edges are 109 base pairs in length.

DNA origami frames were folded by mixing 10 nM M13mp18 scaffold DNA, 100 nM of each designed staple oligonucleotide (including a certain number of capture DNAs for encaging 10 nm AuNPs inside) in a buffer solution containing 12.5 mM magnesium acetate, 1 mM EDTA and 40 mM tris acetate with a pH around 8.3. The mixed solution was then cooled by a gradient according to the annealing procedure below:

1. 90 ℃ 25 sec
2. 90 ℃ ~ 85 ℃ -0.1 ℃ / 5 sec
3. 85 ℃ ~ 65 ℃ -0.1 ℃ / 30 sec
4. 65 ℃ ~ 40 ℃ -0.1 ℃ / 4 min
5. 40 ℃ ~ 32 ℃ -0.1 ℃ / 2 min
6. 32 ℃ ~ 20 ℃ -0.1 ℃ / 1 min
7. Hold at 20 ℃

Prepared DNA origami frames were stored at room temperature.

DNA functionalization of gold nanoparticles

200 μM of 3'-thiolated oligonucleotides aqueous solution were incubated with tris-(2-carboxyethyl) phosphine (TCEP) in a ratio of 1:100 (DNA: TCEP). The mixed solution was kept in an ice bath for 1.5 hours, and then purified using a size exclusion column (G-25, GE Healthcare) to remove redundant TCEP. Treated thiolated oligonucleotides were mixed with 10 nm spherical gold nanoparticles with a ratio of 300:1, followed by buffering the solution to obtain 10 mM phosphate buffer (pH 7) after 1.5 hours. In the subsequent salt-aging process, 2

M NaCl solution was slowly added into the solution in five steps to reach a final NaCl concentration of 0.3 M. The solution was aged at room temperature for 18 hours. Excess oligonucleotides were then removed by centrifuging (20,000 rcf, 1h) the solution 4 times and resuspending with the washing buffer containing 0.1 M NaCl and 10 mM phosphate. The concentration of AuNPs was measured by UV-vis spectrometer and calculated with Lambert-Beer law.

Encaging AuNPs inside DNA origami frames for conjugated monomers

In order to insert AuNPs inside the DNA origami frames, functionalized AuNPs and prepared DNA origami frames were mixed at a ratio of 1.2:1. The mixed solution was then cooling from 50 ℃ to 20 ℃ at a rate of 0.6 ℃ h^{-1} to obtain a high yield.

Fabrication of 3D lattices and 2D planar structures

According to the design of each system, corresponding bridging DNA strands and functionalized AuNPs were added into the prepared DNA origami frame solution. The molar ratio between the frames, bridged DNA strands and AuNPs was 1:1:1.2. To reduce the effect of dilution, a few of 125 mM magnesium acetate solution was added to adjust the magnesium salt concentration to original 12.5 mM. The mixed solution was then slowly cooled by a gradient according to the annealing procedure below:

1. 20 ℃ ~ 50 ℃ +1 ℃ / min
2. 50 ℃ ~ 20 ℃ -0.2 ℃ / 1 h
3. Hold at 20 ℃

This procedure was repeated another two times to produce the final sample. Prepared 3D lattices and 2D planar structures were stored at 4 ℃.

Silicification of DNA frameworks

The supernatant of the prepared 3D lattice solution was pipetted out slowly without disturbing bottom aggregates, followed by buffering with a solution containing 7.0 mM magnesium acetate, 1 mM EDTA and 40 mM tris acetate to remove free staple DNAs and AuNPs. 0.79 μL of 10 % (v/v) N-trimethoxylsilylpropyl-N,N,N-trimethylammonium chloride (TMAPS) methanol solution was then mixed with the lattice solution and shaken at 20 ℃ for 20 min. Subsequently, 0.90 μL 10% (v/v) tetraethoxysilane (TEOS) methanol solution was added and kept shaking at 20 ℃ for 30 min.[1] After the shaking, the solution was allowed to stand for about 12 hours. The supernatant of the final solution was pipetted out and the aggregates were washed slowly with ultrapure water for several times.

TEM sample preparation and imaging

The sample solution of 5 μL was dropped onto a glow-discharged carbon-coated grid and deposited for 4 minutes. The droplet was then wicked away by a piece of filter paper along the edge of the grid. 5 μL of 2% (w/v) uranyl acetate aqueous solution was then dropped onto the carbon-coated grid. After staining for 8 seconds, the excess staining solution was wicked away in the same manner and dried in the air. The negative-stained sample was imaged by a JEM-2800 TEM operating at 200 kV.

SEM of siliconized samples

The silicon slice, as the SEM substrate, was carefully cleaned with ethanol and water in advance. 6 μL siliconized sample solution was dropped onto the silicon slice and dried under an infrared light. The sample was then imaged on the Zeiss Ultra Plus FE-SEM.

SAXS experimental methods

The SAXS measurements were conducted at the beamline BL19U2 at Shanghai Synchrotron Radiation Facility (SSRF). 50 μL of the sample solution was transferred to a glass capillary with an inner diameter of 1 mm. The capillary was sealed with wax to maintain the liquid phase and the aggregates sedimentated at its bottom. The 2D scattering data were collected on a Dectris Pilatus 2 M pixel-array detector with 12 keV (wavelength λ = 0.932 Å) incident X-rays.

Area images were integrated into a 1D I(q) scattering curve according to the function $\boldsymbol{q} = \boldsymbol{4\frac{\pi}{\lambda} sin\left(\frac{\theta}{2}\right)}$ of the scattering vector q, where θ is the scattering angle.[2] The structure factor S(q) was obtained by dividing I(q) by the corresponding particle form factor P(q).

The geometric models for polyhedral DNA origami frames

The polyhedral DNA origami frame geometric models are shown in Figure S2, and described using d_1, d_2, L_1, L_2, L_3 and L_4 as the width and length of the polyhedral edges. The exact values are calculated based on the following constants: the helix width of DNA is 2.0 nm and the distance between adjacent base pairs is 0.34 nm. Stereo modeling shows the simplified frame geometry accurate to each double helix (represented by the cylinder). Potential deformations are not involved in these models.

Close-packed models and bridge pattern models for 3D lattices

According to the pre-designed arrangements of polyhedral frames, we constructed a series of close-packed 3D lattice models with no gaps (Figures S15-S17 and S34). Considering the steric hindrance caused by adjacent structures, the vertices of DNA origami frames just touch each other. At bridged junctions, both the octahedral and cubic frames are illustrated with a pair of vertices as shown in Figures S6 and S8. Due to the difference in crystal growth directions, the hexagonal bipyramid and binary systems exhibit two non-identical crystallographic axis directions respectively (Figures S7 and S31). The lattice parameter values of these models calculated according to the space analytic geometry are as follows:

Geometric constants involved:

$\boldsymbol{d_1 = 5.5\,nm}$; $\boldsymbol{d_2 = 6.0\,nm}$;

$\boldsymbol{L_1 = 29.9\,nm}$; $\boldsymbol{L_2 = 22.8\,nm}$; $\boldsymbol{L_3 = 15.7\,nm}$; $\boldsymbol{L_4 = 37.1\,nm}$

Octahedron model:

$$\boldsymbol{a = b = c = \sqrt{2}(L_1 + d_1) = 50.1\,nm}$$

Cube model:

$$\boldsymbol{a = b = c = 2\left(L_1 + \frac{d_2}{2}\right) = 65.8\,nm}$$

Hexagonal bipyramid model:

$$\boldsymbol{a = b = 2(L_3 + d_1) = 42.4\,nm}$$

$$\boldsymbol{c = 2\sqrt{{L_2}^2 - {L_3}^2} + \sqrt{2}d_2 = 41.6\,nm}$$

Binary system model:

$$\boldsymbol{a = b = \sqrt{2}(L_1 + d_1) = 50.1\,nm}$$

$$\boldsymbol{c = \frac{\sqrt{2}(L_1 + d_1)}{2} + \sqrt{(L_4 + d_1)^2 - (\frac{\sqrt{2}(L_1 + d_1)}{2})^2} = 59.4\,nm}$$

SAXS model fitting and lattice parameter calculation

The theoretical scattering data of the lattice structures was calculated by using PowderCell software. For the simple cubic and body-centered cubic lattices with defined structural parameters, we calibrated the first SAXS peak (q_1) of the experimental data with the first peak in theoretical spectrums to compare the peak positions and the intensity ratio. We then calculated the experimental lattice parameters in cubic lattices ($\boldsymbol{a = b = c}$) based on the peak position of q_1. The three lattice parameters of the simple hexagonal and tetragonal structures are not equal ($\boldsymbol{a = b \neq c}$). We first calculated their experimental values using the first two SAXS peaks (q_1 and q_2), and then performed the calibration. The lattice parameter values calculated from the experimental data are as follows:

Simple cubic lattice, octahedron:

$$\boldsymbol{a = b = c = \frac{2\pi}{q_1} = 50.0\,nm\ (q_1 = 0.1258\,nm^{-1})}$$

Body-centered cubic lattice, cube:

$$\boldsymbol{a = b = c = \frac{2\sqrt{2}\pi}{q_1} = 65.9\,nm\ (q_1 = 0.1349\,nm^{-1})}$$

Simple hexagonal lattice, hexagonal bipyramid:

$$\boldsymbol{a = b = \frac{4\sqrt{3}\pi}{3q_2} = 43.0\,nm\ (q_2 = 0.1687\,nm^{-1})}$$

$$\boldsymbol{c = \frac{2\pi}{q_1} = 42.1\,nm\ (q_1 = 0.1494\,nm^{-1})}$$

Simple tetragonal lattice, binary system:

$$\boldsymbol{a = b = \frac{2\pi}{q_2} = 50.0\,nm\ (q_2 = 0.1258\,nm^{-1})}$$

$$\boldsymbol{c = \frac{2\pi}{q_1} = 58.4\,nm\ (q_1 = 0.1076\,nm^{-1})}$$

DNA Sequences

a. Staple strands of octahedral DNA origami frame

Oct-staple-1	TGTAGCATTCCAACGTTAGTAAATGAAGTGCCGCGCCACCCT
Oct-staple-2	CTTAAACAGCTTATATATTCGGTCGCTTGATGGGGAACAAGA
Oct-staple-3	AATAGCAATAGCACCAGAAGGAAACCTAAAGCCACTGGTAAT
Oct-staple-4	AGCTTTCATCAACGGATTGACCGTAAAATCGTATAATATTTT
Oct-staple-5	CTTCATCAAGAGAAATCAACGTAACAGAGATTTGTCAATCAT
Oct-staple-6	AAAGATTCATCAGGAATTACGAGGCATGCTCATCCTTATGCG
Oct-staple-7	ATAAATCATACATAAATCGGTTGTACTGTGCTGGCATGCCTG
Oct-staple-8	CAACGCTCAACAGCAGAGGCATTTTCAATCCAATGATAAATA
Oct-staple-9	AAACGAAAGAGGGCGAAACAAAGTACTGACTATATTCGAGCT
Oct-staple-10	AGAGCCTAATTTGATTTTTTGTTTAAATCCTGAAATAAAGAA
Oct-staple-11	GACAGGAGGTTGAAACAAATAAATCCGCCCCCTCCGCCACCC
Oct-staple-12	TCATATGGTTTACGATTGAGGGAGGGAAACGCAATACATACA
Oct-staple-13	GGTAGCTATTTTAGAGAATCGATGAAAACATTAAATGTGTAG
Oct-staple-14	GAAACATGAAAGCTCAGTACCAGGCGAAAAATGCTGAACAAA
Oct-staple-15	ATCAAAATCATATATGTAAATGCTGAACAAACACTTGCTTCT
Oct-staple-16	AACGGGTATTAAGGAATCATTACCGCCAGTAATTCAACAATA
Oct-staple-17	ACTGTTGGGAAGCAGCTGGCGAAAGGATAGGTCAAGATCGCA
Oct-staple-18	CAGAATCAAGTTTCGGCATTTTCGGTTAAATATATCACCAGT
Oct-staple-19	GCTCACAATTCCGTGAGCTAACTCACTGGAAGTAATGGTCAA

Oct-staple-20	TGATTGCTTTGAGCAAAAGAAGATGAAATAGCAGAGGTTTTG
Oct-staple-21	GGCCCTGAGAGAAGCAGGCGAAAATCATTGCGTAGAGGCGGT
Oct-staple-22	TTTGCGGATGGCCAACTAAAGTACGGGCTTGCAGCTACAGAG
Oct-staple-23	CAAATGCTTTAAAAAATCAGGTCTTTAAGAGCAGCCAGAGGG
Oct-staple-24	TTTGCGGAACAATGGCAATTCATCAATCTGTATAATAATTTT
Oct-staple-25	GTCACCAGAGCCATGGTGAATTATCACCAATCAGAAAAGCCT
Oct-staple-26	GGACAGAGTTACTTTGTCGAAATCCGCGTGTATCACCGTACG
Oct-staple-27	CAACATGATTTACGAGCATGGAATAAGTAAGACGACAATAAA
Oct-staple-28	AACCAGACGCTACGTTAATAAAACGAACATACCACATTCAGG
Oct-staple-29	TGACCTACTAGAAAAAGCCCCAGGCAAAGCAATTTCATCTTC
Oct-staple-30	TGCCGGAAGGGGACTCGTAACCGTGCATTATATTTTAGTTCT
Oct-staple-31	AGAACCCCAAATCACCATCTGCGGAATCGAATAAAAATTTTT
Oct-staple-32	GCTCCATTGTGTACCGTAACACTGAGTTAGTTAGCGTAACCT
Oct-staple-33	AGTACCGAATAGGAACCCAAACGGTGTAACCTCAGGAGGTTT
Oct-staple-34	CAGTTTGAATGTTTAGTATCATATGCGTAGAATCGCCATAGC
Oct-staple-35	AAGATTGTTTTTTAACCAAGAAACCATCGACCCAAAAACAGG
Oct-staple-36	TCAGAGCGCCACCACATAATCAAAATCAGAACGAGTAGTATG
Oct-staple-37	GATGGTTGGGAAGAAAAATCCACCAGAAATAATTGGGCTTGA
Oct-staple-38	CTCCTTAACGTAGAAACCAATCAATAATTCATCGAGAACAGA
Oct-staple-39	AGACACCTTACGCAGAACTGGCATGATTTTCTGTCCAGACAA
Oct-staple-40	GCCAGCTAGGCGATAGCTTAGATTAAGACCTTTTTAACCTGT
Oct-staple-41	CCGACTTATTAGGAACGCCATCAAAAATGAGTAACAACCCCA
Oct-staple-42	GTCCAATAGCGAGAACCAGACGACGATATTCAACGCAAGGGA
Oct-staple-43	CCAAAATACAATATGATATTCAACCGTTAGGCTATCAGGTAA
Oct-staple-44	AACAGTACTTGAAAACATATGAGACGGGTCTTTTTTAATGGA
Oct-staple-45	TTTCACCGCATTAAAGTCGGGAAACCTGATTTGAATTACCCA
Oct-staple-46	GAGAATAGAGCCTTACCGTCTATCAAATGGAGCGGAATTAGA
Oct-staple-47	ATAATTAAATTTAAAAAACTTTTTCAAACTTTTAACAACGCC
Oct-staple-48	GCACCCAGCGTTTTTTATCCGGTATTCTAGGCGAATTATTCA
Oct-staple-49	GGAAGCGCCCACAAACAGTTAATGCCCCGACTCCTCAAGATA
Oct-staple-50	GTTTGCCTATTCACAGGCAGGTCAGACGCCACCACACCACCC
Oct-staple-51	CGCGAGCTTAGTTTTTCCCAATTCTGCGCAAGTGTAAAGCCT
Oct-staple-52	AGAAGCAACCAAGCCAAAAGAATACACTAATGCCAAAACTCC
Oct-staple-53	ATTAAGTATAAAGCGGCAAGGCAAAGAAACTAATAGGGTACC
Oct-staple-54	CAGTGCCTACATGGGAATTTACCGTTCCACAAGTAAGCAGAT
Oct-staple-55	ATAAGGCGCCAAAAGTTGAGATTTAGGATAACGGACCAGTCA
Oct-staple-56	TGCTAAACAGATGAAGAAACCACCAGAATTTAAAAAAAGGCT
Oct-staple-57	CAGCCTTGGTTTTGTATTAAGAGGCTGACTGCCTATATCAGA
Oct-staple-58	CGGAATAATTCAACCCAGCGCCAAAGACTTATTTTAACGCAA
Oct-staple-59	CGCCTGAATTACCCTAATCTTGACAAGACAGACCATGAAAGA

Oct-staple-60	ACGCGAGGCTACAACAGTACCTTTTACAAATCGCGCAGAGAA
Oct-staple-61	CAGCGAACATTAAAAGAGAGTACCTTTACTGAATATAATGAA
Oct-staple-62	GGACGTTTAATTTCGACGAGAAACACCACCACTAATGCAGAT
Oct-staple-63	AAAGCGCCAAAGTTTATCTTACCGAAGCCCAATAATGAGTAA
Oct-staple-64	GAGCTCGTTGTAAACGCCAGGGTTTTCCAAAGCAATAAAGCC
Oct-staple-65	AATTATTGTTTTCATGCCTTTAGCGTCAGATAGCACGGAAAC
Oct-staple-66	AAGTTTCAGACAGCCGGGATCGTCACCCTTCTGTAGCTCAAC
Oct-staple-67	ACAAAGAAATTTAGGTAGGGCTTAATTGTATACAACGGAATC
Oct-staple-68	AACAAAAATAACTAGGTCTGAGAGACTACGCTGAGTTTCCCT
Oct-staple-69	CATAACCTAAATCAACAGTTCAGAAAACGTCATAAGGATAGC
Oct-staple-70	CACGACGAATTCGTGTGGCATCAATTCTTTAGCAAAATTACG
Oct-staple-71	CCTACCAACAGTAATTTTATCCTGAATCAAACAGCCATATGA
Oct-staple-72	GATTATAAAGAAACGCCAGTTACAAAATTTACCAACGTCAGA
Oct-staple-73	AGTAGATTGAAAAGAATCATGGTCATAGCCGGAAGCATAAGT
Oct-staple-74	TAGAATCCATAAATCATTTAACAATTTCTCCCGGCTTAGGTT
Oct-staple-75	AAAGGCCAAATATGTTAGAGCTTAATTGATTGCTCCATGAGG
Oct-staple-76	CCAAAAGGAAAGGACAACAGTTTCAGCGAATCATCATATTCC
Oct-staple-77	GAAATCGATAACCGGATACCGATAGTTGTATCAGCTCCAACG
Oct-staple-78	TGAATATTATCAAAATAATGGAAGGGTTAATATTTATCCCAA
Oct-staple-79	GAGGAAGCAGGATTCGGGTAAAATACGTAAAACACCCCCCAG
Oct-staple-80	GGTTGATTTTCCAGCAGACAGCCCTCATTCGTCACGGGATAG
Oct-staple-81	CAAGCCCCCACCCTTAGCCCGGAATAGGACGATCTAAAGTTT
Oct-staple-82	TGTAGATATTACGCGGCGATCGGTGCGGGCGCCATCTTCTGG
Oct-staple-83	CATCCTATTCAGCTAAAAGGTAAAGTAAAAAGCAAGCCGTTT
Oct-staple-84	CAGCTCATATAAGCGTACCCCGGTTGATGTGTCGGATTCTCC
Oct-staple-85	CATGTCACAAACGGCATTAAATGTGAGCAATTCGCGTTAAAT
Oct-staple-86	AGCGTCACGTATAAGAATTGAGTTAAGCCCTTTTTAAGAAAG
Oct-staple-87	TATAAAGCATCGTAACCAAGTACCGCACCGGCTGTAATATCC
Oct-staple-88	ATAGCCCGCGAAAATAATTGTATCGGTTCGCCGACAATGAGT
Oct-staple-89	AGACAGTTCATATAGGAGAAGCCTTTATAACATTGCCTGAGA
Oct-staple-90	AACAGGTCCCGAAATTGCATCAAAAAGATCTTTGATCATCAG
Oct-staple-91	ACTGCCCTTGCCCCGTTGCAGCAAGCGGCAACAGCTTTTTCT
Oct-staple-92	TCAAAGGGAGATAGCCCTTATAAATCAAGACAACAACCATCG
Oct-staple-93	GTAATACGCAAACATGAGAGATCTACAACTAGCTGAGGCCGG
Oct-staple-94	GAGATAACATTAGAAGAATAACATAAAAAGGAAGGATTAGGA
Oct-staple-95	CAGATATTACCTGAATACCAAGTTACAATCGGGAGCTATTTT
Oct-staple-96	CATATAACTAATGAACACAACATACGAGCTGTTTCTTTGGGG
Oct-staple-97	ATGTTTTGCTTTTGATCGGAACGAGGGTACTTTTTCTTTTGA
Oct-staple-98	GGGGTGCCAGTTGAGACCATTAGATACAATTTTCACTGTGTG
Oct-staple-99	CTTCGCTGGGCGCAGACGACAGTATCGGGGCACCGTCGCCAT

Oct-staple-100	TCAGAGCTGGGTAAACGACGGCCAGTGCGATCCCCGTAGTAG
Oct-staple-101	TTAGCGGTACAGAGCGGGAGAATTAACTGCGCTAATTTCGGA
Oct-staple-102	GATATTCTAAATTGAGCCGGAACGAGGCCCAACTTGGCGCAT
Oct-staple-103	TGTCGTCATAAGTACAGAACCGCCACCCATTTTCACAGTACA
Oct-staple-104	CGATTATAAGCGGAGACTTCAAATATCGCGGAAGCCTACGAA
Oct-staple-105	AACATGTACGCGAGTGGTTTGAAATACCTAAACACATTCTTA
Oct-staple-106	GTCTGGATTTTGCGTTTTAAATGCAATGGTGAGAAATAAATT
Oct-staple-107	GCCTTGAATCTTTTCCGGAACCGCCTCCCAGAGCCCAGAGCC
Oct-staple-108	CGCTGGTGCTTTCCTGAATCGGCCAACGAGGGTGGTGATTGC
Oct-staple-109	TGATTATCAACTTTACAACTAAAGGAATCCAAAAAGTTTGAG
Oct-staple-110	ACATAACTTGCCCTAACTTTAATCATTGCATTATAACAACAT
Oct-staple-111	GTAGCGCCATTAAATTGGGAATTAGAGCGCAAGGCGCACCGT
Oct-staple-112	TTATTTTTACCGACAATGCAGAACGCGCGAAAAATCTTTCCT
Oct-staple-113	TTTCAATAGAAGGCAGCGAACCTCCCGATTAGTTGAAACAAT
Oct-staple-114	GGGCGACCCCAAAAGTATGTTAGCAAACTAAAAGAGTCACAA
Oct-staple-115	AGCCGAAAGTCTCTCTTTTGATGATACAAGTGCCTTAAGAGC
Oct-staple-116	GTGGGAAATCATATAAATATTTAAATTGAATTTTTGTCTGGC
Oct-staple-117	CCCACGCGCAAAATGGTTGAGTGTTGTTCGTGGACTTGCTTT
Oct-staple-118	ATGACCACTCGTTTGGCTTTTGCAAAAGTTAGACTATATTCA
Oct-staple-119	TCCAAATCTTCTGAATTATTTGCACGTAGGTTTAACGCTAAC
Oct-staple-120	GGGTTATTTAATTACAATATATGTGAGTAATTAATAAGAGTC
Oct-capture-1	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTGGGGTGCCAGTTGAGACCATTAGATACAATTTTCACTGTGTG
Oct-capture-2	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTTCAGAGCTGGGTAAACGACGGCCAGTGCGATCCCCGTAGTAG
Oct-capture-3	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTTTAGCGGTACAGAGCGGGAGAATTAACTGCGCTAATTTCGGA
Oct-capture-4	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTTGATTATCAACTTTACAACTAAAGGAATCCAAAAAGTTTGAG
Oct-capture-5	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTGTAGCGCCATTAAATTGGGAATTAGAGCGCAAGGCGCACCGT
Oct-capture-6	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTAGCCGAAAGTCTCTCTTTTGATGATACAAGTGCCTTAAGAGC
Oct-capture-7	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTGTGGGAAATCATATAAATATTTAAATTGAATTTTTGTCTGGC
Oct-capture-8	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTCCCACGCGCAAAATGGTTGAGTGTTGTTCGTGGACTTGCTTT

Note: In order to position one gold nanoparticle in the body center of the octahedral frame, 'ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTT' sequence was added in the blue marked staple DNA strands.

b. Bridging strands of octahedral DNA origami frame

Oct-bridge-1	TGTAGCCTTTTGTCAGAGGGTAATTGAGAACACCAAAATAG

Oct-bridge-2	CTATTATTCTTTTTGTTAAAATTCGCATTATAAACGTAAACTAG
Oct-bridge-3	CATTATCATTTTTCAGGTCGACTCTAGAGCAAGCTTCAAGGCG
Oct-bridge-4	AACATCCATTTTTTCACGTTGAAAATCTTGCGAATGGGATTT
Oct-bridge-5	AACGCCTTTTGTAAAGATTCAAAAGGCCTGAGTTGACCCT
Oct-bridge-6	CGGAGAGTTTTCAGAGCCACCACCCTCTCAGAACTCGAGAG
Oct-bridge-7	GCGCATTTTATTGCGTAGATTTTCAAAACAGATTGTTTG
Oct-bridge-8	GTCTTTCCTTTTCTCCAGCCAGCTTTCCCCTCAGGACGTTGG
Oct-bridge-9	TTCGCCTTTTAAGGGAACCGAACTGAGCAGACGGTATCAT
Oct-bridge-10	GCTGACTTTTAAGCCTTAAATCAAGACTTGCGGAGCAAAT
Oct-bridge-11	ACAGGTAGTTTTGATAAGTCCTGAACAACTGTTTAAAGAGAA
Oct-bridge-12	ATTCCAAGTTTTATTTTAAGAACTGGCTTGAATTATCAGTGA
Oct-bridge-13	GTATAAAGCTTTTGGTAATAGTAAAATGTAAGTTTTACACTAT
Oct-bridge-14	CCCCCTTTTTAGGCGTTAAATAAGAAGACCGTGTCGCAAG
Oct-bridge-15	AGTGAATTTTTTTTCAAAGCGAACCAGACCGTTTTATATAGTC
Oct-bridge-16	CCAACCTATTTTGTAAATCGTCGCTATTGAATAACTCAAGAA
Oct-bridge-17	CAGCATTTTTTGCTTTGAGGACTAAAGAGCAACGGGGAGTT
Oct-bridge-18	AGGTCATTTTTTTCAGAACCGCCACCCTCTCAGAGTATTAGC
Oct-bridge-19	GTAGCGATTTTTAACCTGTTTAGCTATTTTCGCATTCATTC
Oct-bridge-20	TGTTATCCTTTTAGCACCATTACCATTACAGCAAATGACGGA
Oct-bridge-21	CCGCCTTTTTTAAAGGTGGCAACATAGTAGAAAATAATAA
Oct-bridge-22	AATAGAAAATTTTTTTGCGTATTGGGCGCCCGCGGGGTGCGCTC
Oct-bridge-23	AACAATGATTTTGTCCACTATTAAAGAACCAGTTTTGGTTCC
Oct-bridge-24	GTGAATTTTTTTAAGTTTTAACGGGGTCGGAGTGTAGAATGG

c. Staple strands of cubic DNA origami frame

cub-staple-1	GAGTAACAGTGCCATGAAAGTATTAACACGCATAAAGACAGC
cub-staple-2	TAAATAAGGCGTTAGAAAAAGCCTGTACTACCTACGCGAGAA
cub-staple-3	ATAGCTGTTTCCATAAAGTGTAAAGCTGTTGGGCCAGTCACG
cub-staple-4	ATTAGACGGGAGGAGAGATAACCCACTTGATGGGGAACAAGA
cub-staple-5	ACCAGTAGCACCCCGTAATCAGTAGCATTATACATGTTACTT
cub-staple-6	ACGTAATGCCACCATCTTTGACCCCCCAGGAGGAGTCTCTGA
cub-staple-7	AATCGTCATAAAAGTTCAGAAAACGAATAACGCATAGCGAGA
cub-staple-8	TACGCAGTATGTAAAGACACCACGGAAGAATTATTTTGCGGG
cub-staple-9	CGTTTTAGCGAATTGCACCCAGCTACATCCCATGAACAAGCA
cub-staple-10	ATCGCACTCCAGCCATTCAGGCTGCGGCCATCAGCGGATTGA
cub-staple-11	GGTTTATCAGCTATGACAACAACCATTCATAGTGGAGTGAGA
cub-staple-12	TTTGCGGAACAATGGCAATTCATCAATTATCCTATCCCAATC
cub-staple-13	CTCAGAGCCACCAGCCGCCGCCAGCAGAATCAAATCTTTTCA
cub-staple-14	AGCTTAGATTAAAAATCATAGGTCTGACAAACAAATATATGT
cub-staple-15	GAACTAACGGAATTCAACTAATGCAGATTGCTGCAGTTGATT

cub-staple-16	ATTTAAATTGTATTTTTAACCAATAGGGTGCCTCTGCATTAA
cub-staple-17	CTGATTGCCCTTAGCAGGCGAAAATCCCGGAGAATGAACGGT
cub-staple-18	TTGGGGCGCGAGATCATACAGGCAAGTGCTCATACTTTAATC
cub-staple-19	TGATTGCTTTGAGCAAAAGAAGATGATATCATACAACGCCAA
cub-staple-20	AGATTCAAAAGGCTAGCTGATAAATTATTGAGTAGCAGATAG
cub-staple-21	AGAGAGTACCTTCGGATGGCTTAGAGGACCATAAGCCCGAAA
cub-staple-22	AGGCGCATAGGCAAATCAACGTAACAGTTTATTGAGGGAAGG
cub-staple-23	GACGACAATAAACTGAACAAGAAAAAATCCTGAAATAAAGAA
cub-staple-24	CCCAATAGGAACGCATTCCACAGACACTGAGACGTGTATCAC
cub-staple-25	GAGAAGGGCCTGTACCATGTACCGTAACCCACCCTCCACCCT
cub-staple-26	GCTATTACTTTTTCATTTAACAATTTCCAGCTGGCGAAAAA
cub-staple-27	TAATAATTTGCTAATGTCGTCTTTCCAGATGCTTGATACCGA
cub-staple-28	GAAACAAAGCAGCAATTACCATTAGCAAATTTGGGCAATCAT
cub-staple-29	AATCAATATTACCCTGGCTGACCTTCATGAGGACATTAAAGG
cub-staple-30	GAAATCGAATATCAAATTAACTGAACACAGAATAATCCAACG
cub-staple-31	GACCATTCGGTGTCATGTTTTAAATATGGAATCAGTTGAGAT
cub-staple-32	AGGTCAGAAACACTTACGAAGGCACCAAGGAAGTTTACATGG
cub-staple-33	GTAACAAATCGTAACCGTGACCAGACCGGAAAATGTGAGCGA
cub-staple-34	AAGCAAAGACATCTGCCAGTTTGAGGGGCCGCTTCTGGTGAG
cub-staple-35	TACAAATTACCTGAATACCAAGTTACAATCGGGAGTTCGAGC
cub-staple-36	AATCAGGATTTTTGTAATTGCTCCTTTTGAAGCAATCGAGCT
cub-staple-37	TACGAGCTGCTATTCCTCCCGACTTGCGTTATCCGGAATCAT
cub-staple-38	TAACCCTGTAAAATCTCCAAAAAAAAGGATTTCTTAAACACA
cub-staple-39	TGAATATTATCAAAATAATGGAAGGGTTGCGCCTGTTTATCA
cub-staple-40	AAATAAATGATACAAGACTTTTTCATGACCTAAAACGAAAAA
cub-staple-41	AGGCCGCGGACTAAGGAGTGTACTGGTAAATGCCCCCTGCAC
cub-staple-42	TAAAGTAAGATACACAGTCAGGACGTTGGTAGAAAGATTCAC
cub-staple-43	ATCTTCTTGATGCAGGGTTATATAACTACTCAGTACCAGGCC
cub-staple-44	AATAATAAACCGTTGTGAGAAAGGCCGGGCAATGCACCGAGG
cub-staple-45	CAGTAATGGGCTTAAGTATAAAGCCAACAGGCGAATTATTCA
cub-staple-46	CTTTTGATCCTCATGCCTTGATATTCACTTGAGGCAAAAGAA
cub-staple-47	TCGGTTGGAACCCTCGGAATACCCAAAAAATACATACATAAA
cub-staple-48	GAATTACATTCTAGAGGATCCCCGGGTAATCCGCTCACAATT
cub-staple-49	TGCATGCGATTAAGCTTCGCTATTACGCATTTCCACACAACA
cub-staple-50	GGTAATACGTTTACGTAAGAGCAACACTACGTTAGTAAATCT
cub-staple-51	AAACGCACTTACCGGAAACAATGAAATATACACCATCAATAT
cub-staple-52	ACCCCGGTGAGAGTCTACAAAGGCTATCTCGCAAGCGGTCCA
cub-staple-53	ATAAGGCCCAATAACTGAAAAGGTGGCAAATAACCTTAAGAA
cub-staple-54	AAAAATGAGTTACAGCGTCTTTCCAGAGAATCATCATATTCC
cub-staple-55	ACCAACGCAGATGAAGAAACCACCAGAATTTAAAATAACGTC

cub-staple-56	TTCGCGTCCATTCGCCAGCTTTCCGGCAACGACGAGTGTAGA
cub-staple-57	CTCCGGCTAATTACTAAATAAGAATAAAAATGGTTTAATTTC
cub-staple-58	CCTGATACCGAACTCACCGACTTGAGCCGGCCGGAAACGTCG
cub-staple-59	TAGCTATATAATAACATATATTTTAAATAGACAGTCAAATAA
cub-staple-60	TAAATGCGAACCGCCACCCTCAGAGCCAACTGAGTTTCGTTG
cub-staple-61	CCGGAACGGTCATAGTAGCGCGTTTTCACGGCTGTCTTTCCC
cub-staple-62	ATCGGTGCGGAAGCTGTGTGAAATTGTTCCGAGCTCCAAGCT
cub-staple-63	TTTAGCGCCACCAGACCCTCAGAGCCGCGAGCCGCGCCACCA
cub-staple-64	CTGGCTCAAATTGGGACGAGAAACACCACAATAGTAGTAGCA
cub-staple-65	AACAAAATTTATCAGACGCTGAGAAGAGCTTAGAAAATCGTC
cub-staple-66	TTGCGTATTTCCAGTAATTGCGTTGCGCAGATTAAATTTTTG
cub-staple-67	TCAAAGGGAGATAGCCCTTATAAATCAACCCAGAGGGTAATT
cub-staple-68	ATAGCCCGCGAAAACAGCCTTTACAGAGCCTGAACAAAGTTA
cub-staple-69	AAGGGAAAATTGTGCGGAGATTTGTATCAGCACCAATGAAAC
cub-staple-70	TAAGCAAGAAACGCTAGCAAACGTAGAAGAACTGGGATAAAA
cub-staple-71	TGCTGTATACCACACAACATTATTACAGGGAAGAATTAGTTT
cub-staple-72	ACGATCTGCCGACATGCTTTCGAGGTGACTCCAAATTGCGAA
cub-staple-73	TCAAAGCGCGGATTCCTGACTATTATAGTTCATCAACATTTA
cub-staple-74	AGAACGGCCCAATAGCAAGCCTCCCTCACACTTATCATTCCA
cub-staple-75	TGGGCGCCCCGTCGTCCTGTAGCCAGCTTCCCGGAAACCAGG
cub-staple-76	TGCCCGCTTGGGCGTCAGAAAAGCCCCAGTTAAAATTCGCGT
cub-staple-77	CCAAAGATCACCGTGACCAACTTTGAAACAAGAGTAATCTCG
cub-staple-78	CATTTTCCGCAAATCAGATATAGAAGGCGGAGGTTTTGAAGG
cub-staple-79	AACAGTAAAGAGAACAGTACCTTTTACAAATCGCGCAGAGAA
cub-staple-80	GTCGAGAGCCACCCTCAGACCTAAATTTCACGGATAAGTGCC
cub-staple-81	TGAATTACAAAAGGTCATATGGTTTACCATTGACAAGAACCG
cub-staple-82	ATTTTTATACCAAATCAGAGCATAAAGCGCAAGGTGGCAACA
cub-staple-83	GATTATAATAAGTCCAACATGTTCAGCTAAAAGGTCGTCAGA
cub-staple-84	ATATTCGTCTGAAACCGTATAAACAGTTATAAGTTTACAGAG
cub-staple-85	AATTACGTTTAAACTATTCATTGAATCCAGACTGGCAGAGGG
cub-staple-86	GCAAGGCCTGCAGGTCGACTAATTTTCCTCGGGGGATGTGCT
cub-staple-87	TACCGCGGTATTAAAACCAATCAATAATTCGCCTTAAATCAA
cub-staple-88	CATTGCCTTGATAACCAGGGTGGTTTTTGAGAGAGTTGCAAC
cub-staple-89	TGGGATTTTTTTCACGTTGAAAATGTTTCCGAATTTTCTGTA
cub-staple-90	CCTACCAACAGTAATATAAAGTACCGACAATGCAGAACGCTC
cub-staple-91	GAGCTAAAGCTCATAACGTTAATATTTTAAAACAGAGGCGGT
cub-staple-92	ATTTGCCAAAATAGACCGTCTATCAAATGGAGCGGAATTAGA
cub-staple-93	TATTTTTTTGCCCCCACCGCCTGGCCCTCTTTTCACATATGT
cub-staple-94	GAGTAGTATTATACTTTCGCAAATGGTCTCAATTCTACTAAC
cub-staple-95	CAGAACCGGGTTGATTAGCGGGGTTTTGTACACCAGTACAAA

cub-staple-96	GCTTTGATTTTGCGAGGCTTGCAGGGAGAACTATTTCGGAAC
cub-staple-97	GATATTCAGAGCAAAAGCCCTTTTTAAGGAAGGAACTGAGTA
cub-staple-98	TACGAGCCGGGCCTTTGGGTAACGCCAGGCCAGTGCGAATTC
cub-staple-99	TTAAATCCTCACATTCGGGAAACCTGTCCGGGGAGGAAGATT
cub-staple-100	TTAGGAAGCTCAACTGGAAGTTTCATTCAGTAGATAAATCTA
cub-staple-101	TAGTTGCAAAGTTTACAACTTTCAACAGAAAGGAAAGGAGCC
cub-staple-102	CGCTGGTGAGAGATCTGGAGCAAACAAGTGTCAATCCAGTGA
cub-staple-103	AGAGGTCTCTTTACGCATCAAAAAGATTTTTTAATACTCCAA
cub-staple-104	TAGTGAATTAATTAAATGGAAACAGTACTTCTGTATCCTTGA
cub-staple-105	GAGCGCTGCAAAATGGTTGAGTGTTGTTCGTGGACCATAAAA
cub-staple-106	CTACAACATTAGGATATAAGTATAGCCCAGTACCGCATTTTC
cub-staple-107	AGAACCATCAGACTGCCCCCTTATTAGCAACCAGACACCCTC
cub-staple-108	CTATTATGTCGCTGGGATCGTCACCCTCCAACGGCTTAACGG
cub-staple-109	ACAATAGCTTCTGAATTATTTGCACGTAGGTTTAAAAAGTAA
cub-staple-110	TATAAAATAAAGCCAACATTATGACCCTACGCAAGCATGATT
cub-staple-111	CAAAGCGCTGGCCTGATTCTCCGTGGGACACGTTGCAGTATC
cub-staple-112	GATATTCAGAAAATGCGACATTCAACCGTTATTCAGATGAAC
cub-staple-113	TTTCAATTCTTACCATTGAGAATCGCCAAGGCATTAAACAAT
cub-staple-114	CAAATGCAGGCATACAGACGACGATAAAGTTTTGCATAGCGT
cub-staple-115	TACACTAACGATTGTAAAGCCAGAATGGAGCGTCATCCATTA
cub-staple-116	TGATTATCTAACGAAAATAAACAGCCATTTTTGTTGTTTGAG
cub-staple-117	CATCGATAGTACAATCGAAATCCGCGACAGACGGTAATTAGA
cub-staple-118	GGAATCATTAGGTTAATCCAATCGCAAGTTTTAGTTGAAATA
cub-staple-119	GATTAGTATGTAGAACCAAGTACCGCACATCGTAGGTATTCT
cub-staple-120	TTAACATTTGCCCTGCTTGAGATGGTTTTGCGATTTGTTTAG
cub-capture-1	TCACTTCATACTCTACCTTCTTCTTCTTCTTCTTCTCTTCTTACAATAGCTTCTGAATTATTTGCACGTAGGTTTAAAAAGTAA
cub-capture-2	TCACTTCATACTCTACCTTCTTCTTCTTCTTCTTCTCTTCTTTTAAATCCTCACATTCGGGAAACCTGTCCGGGGAGGAAGATT
cub-capture-3	TCACTTCATACTCTACCTTCTTCTTCTTCTTCTTCTCTTCTTTTAGGAAGCTCAACTGGAAGTTTCATTCAGTAGATAAATCTA
cub-capture-4	TCACTTCATACTCTACCTTCTTCTTCTTCTTCTTCTCTTCTTCTATTATGTCGCTGGGATCGTCACCCTCCAACGGCTTAACGG
cub-capture-5	TCACTTCATACTCTACCTTCTTCTTCTTCTTCTTCTCTTCTTTTAACATTTGCCCTGCTTGAGATGGTTTTGCGATTTGTTTAG
cub-capture-6	TCACTTCATACTCTACCTTCTTCTTCTTCTTCTTCTCTTCTTTTTCAATTCTTACCATTGAGAATCGCCAAGGCATTAAACAAT
cub-capture-7	TCACTTCATACTCTACCTTCTTCTTCTTCTTCTTCTCTTCTTTACACTAACGATTGTAAAGCCAGAATGGAGCGTCATCCATTA
cub-capture-8	TCACTTCATACTCTACCTTCTTCTTCTTCTTCTTCTCTTCTTCGCTGGTGAGAGATCTGGAGCAAACAAGTGTCAATCCAGTGA

Note: In order to position one gold nanoparticle in the body center of the cubic frame, 'TCACTTCATACTCTACCTTCTTCTTCTTCTTCTTCTCTTCTT' sequence was added in the blue marked staple DNA strands.

d. Bridging strands of cubic DNA origami frame

cub-bridge-1	TTCGCCTTTTAGAAGCCTTTATTTCAGTAATACGCAAAAT
cub-bridge-2	TACAGACCTTTTCATGTAATTTAGGCAGTATTTAATGCGTTA
cub-bridge-3	CGTGTGATTTTTAAATATTGACGGAAAATTGAGGTTGTCAC
cub-bridge-4	TATATTTTCATTTTTAACTTTTTCAAATATAACAAAGATTTTAAC
cub-bridge-5	ATAGCGATTTTTATTGTGAATTACCTTAAATTTCATCAGTGA
cub-bridge-6	ACTCCTTATTTTTGAGTGAATAACCTTGCATAAATCTCAAGAA
cub-bridge-7	TTAATAAAACTTTTAGCCGTTTTTATTTTCTCATCGACCTAATT
cub-bridge-8	CATTATCATTTTTCCCAATTCTGCGAACGCATATAAAATATAA
cub-bridge-9	TCAGGATTTTTTCAAATAAGAAACGATTATTATTTGAATCTT
cub-bridge-10	TCCAGACTTTTGACTTCAAATATCGCGAAGAGGAAATCAAA
cub-bridge-11	CTGCGGTTTTATTGCGTAGATTTTCAAAACAGATTGTTTG
cub-bridge-12	GCGAGGTTTTGGCTTTTGCAAAAGAAAACCAAACAAAAGG
cub-bridge-13	GTGCCTTTTTTGTCCACTATTAAAGAACCAGTTTTGGTTCC
cub-bridge-14	TGTAGGTAATTTTATCGGAACGAGGGTAGAGCAGCGAACCGAT
cub-bridge-15	TAATTGTATCTTTTCCGAACAAAGTTACCAAAAAGTATAAGCCC
cub-bridge-16	GCAACAGTTTTATAGAAAGGAACAACTTTTCAGCTAGCGTA
cub-bridge-17	ATAGCAAGTTTTAATCGTAAAACTAGCAAGAATCGGGGTAGC
cub-bridge-18	AAGCGCTTTTCGTACTCAGGAGGTTTGGAATAGTCCTCAA
cub-bridge-19	TAAGCAAATTTTTAGCCGGAACGAGGCGCCTGCTCCCAAGCGC
cub-bridge-20	GCCACCTTTTTGAATCGGCCAACGCGGTGCCAGAATGAGT
cub-bridge-21	CATGGTCTTTTTAATCAAAATCACCGGGTTTGCCGTTTGCC
cub-bridge-22	GGGTAAAATTTTTACGTTGTAAAACGACGGGTTTTCAAGGGCG
cub-bridge-23	TCAGGAAGTTTTATTTACCGTTCCAGTAAAAGCGCTTGAGGC
cub-bridge-24	GCAAAATCTTTTCCGTAATGGGATAGGTACAAACGAAAATAA

e. Staple strands of hexagonal bipyramid DNA origami frame

hb-staple-1	GTGGCATCAGATGACGAAAAACCGTCAAAACATTATGAAAAG
hb-staple-2	AGTCAGAAGCAAATCAAAAAGATTAAATCCCCCTGACCATAA
hb-staple-3	TCATCAGTTGAGATGATGGTTTAATTCTTAAATCATTTATTT
hb-staple-4	CAATCGCAAGACTTAGTTAATTTCATGCGAAAGACGACGTTG
hb-staple-5	TAATTTAATTAATTACCTGAGCAAAAACAATAAACTAGGGCT
hb-staple-6	GCCTTTAAGCAAGAGAATTGAGTTAAGCAGGTAATAGAGGAG
hb-staple-7	CAGATGAGATCGAGCTTCAAAGCGAACCAGAGAGTGCTCCTT
hb-staple-8	TTTTTAACCAATTCAAAAATAATTCGAATTATTGAGCCATTT
hb-staple-9	GAAACCTCGAATGTGAGCGAGTAACAACTTGACCGGGTCACG

hb-staple-10	CGGTAATCGTAAATAATCAGAAAAGCATGATATGATCTACAA
hb-staple-11	AGCCGTTAGATTAGCGGGAGGTTTTGAAAAAAGAAATTCTGA
hb-staple-12	GCCCGTATAAACTATTCTGAAACATGGCCAGAATTGATGATA
hb-staple-13	AATAATGAATAAGGATAAGGGAACCGAATAATAAGCAGAGAG
hb-staple-14	AAAAAAAGGCTCGCTTGCTTTCGAGGTTGTCGTTTCAACAGT
hb-staple-15	TAAGTGCTGTTTCCCTGAGAAGAGTCCTTTTTCAAAGGCGAT
hb-staple-16	TGAATCTAATGCGTTCATAATACCGACCCACCGGATAAACAG
hb-staple-17	TACATAAATCCGCGAAATACGTAATGACCGATTGAAAATACA
hb-staple-18	GACGTTATTTATCACAAAAGGAGCCTTTTAATTTTGAACAAC
hb-staple-19	AGCATCGGAACGTAAAGACTTTTTCATTTCTTACATAACCGA
hb-staple-20	TAAAGGAGCTCTGTATGGGATTTTGCTATAGAAAGTTCACGT
hb-staple-21	GGCTTGATTAGGAAGGTAGAAAGATTCAACGTTAAGTCAGGA
hb-staple-22	AGCGCCAAAGACAAGGTAAATATTGACAGTATGCAAAGACAC
hb-staple-23	TTACCTTGTATCGGGTAAATGAATTTCTATTTCGGTCTGAAT
hb-staple-24	TAGCGACTCAGAGCAGAGCCACCACCGGCGGTTTGTTAGCCT
hb-staple-25	TCAAATATAATGCTTGGCTTAGAGCTTAACTAATTACCTTGT
hb-staple-26	ATGTACCAGCTCAGAACCGCCACCCTCACCCAATAAGTTTTG
hb-staple-27	TAGATACATTTCAATAACCTGTTTAGTATTAAGTAGCGGGGT
hb-staple-28	AAGGGTGAGAAAAGTCAAATCACCATCACCCTCCACCACCAG
hb-staple-29	ACGGGTAACCTGCTCTGATAAATTGTGTAGCGCGATCTTTGA
hb-staple-30	TTCATCACCAACTGACCAACTTTGAAAGTAGGCTGACCGGAT
hb-staple-31	CTTTTTTCGGAAGATGATGAAACAAACATTCATTTATCAATA
hb-staple-32	CCAGCTTCGACGACCCGTGCATCTGCCATCGGATATAATGGG
hb-staple-33	ACGAGCCCCAGGGTGGAGAGGCGGTTTGGTCGTGCTGCCCGC
hb-staple-34	TTGTATCATCGCCCATGTTACTTAGCGAAGTTTGAAAGAGGC
hb-staple-35	AACATTATTACATACCACATTCAACTCGAGTAGTATGCGATT
hb-staple-36	TAAGACGTGTGTGACGTAATCATGGTCAGTCGACTGGTTGGG
hb-staple-37	GAGCGGAATTATTCATCAATATAATCGTGGACTTATTAAATC
hb-staple-38	CCACCCTGAGAGACGGCCGTAAAAATTTTGAGTAAGGTTGAG
hb-staple-39	CCACCACAGCCCTCAATTACGAGGCACCAATACTGAGAACCG
hb-staple-40	CCGAAATGTGCCGGAGAGGGTAGCTATTGCCTGAGAAACAAG
hb-staple-41	TTTCCAGGTTGTAAAGCCTGGGGTGCCTCGCTCACCAGCTGC
hb-staple-42	TTATATAAAAATAGTGAATTTATCAAAACGGCTTACTAGAGG
hb-staple-43	TAACCTTGCTTCAGAATCCTTGAAAAGGCGAATAACAAAATT
hb-staple-44	TCAACAGAACATGTTTCTGTCCAGACGAAATAAGAAGTAATG
hb-staple-45	CTTTAAAAAATTGCAGCGGGTCCTGAACCATGTAGATAATCG
hb-staple-46	CATTTTTGCGGAGTAGCTCAACATGTAAGCCCGAAGCAAACT
hb-staple-47	GGCGCATCGTAAAGTATCGGCCTCAGTGGCCTTATTCTCCGT
hb-staple-48	CGAGCTCGAATTAATTGTTATCCGCTGCGATAGTCTGAGAGA
hb-staple-49	GTCAATCCTTGCCCAAAGCTGCTCATTCGACAAGAGCTGACC

hb-staple-50	AAAATCTTCGTAGGAATCATTACCGCGCATCCGGTCGCGAGG
hb-staple-51	CGGGAGAAACAAGTTACAAAATCGCGTTGTTTGTGCACGTAA
hb-staple-52	AGTTTCAGAGGCTTGATAGTTGCGCCCCGCCTCCCAGAATCA
hb-staple-53	TTTGCGGTAGCCTTTAGCGTCAGACTGTCCCCTTACCATCTT
hb-staple-54	TGCTGCAATATATTAAAGAACGCGAGAAACTATATTTGCATG
hb-staple-55	TCCCAATCCAAATTTTTTGTTTAACGTGACCTAAAATAAGGC
hb-staple-56	AATCAACGTAACTGACGAGAAACACCACGAGGCATGAACGGT
hb-staple-57	TATACCACGAAAGGTGGCAACATATAAATTTGTCAAAAATTC
hb-staple-58	TTCAATTTTCCCTTTGTAAATCGTCGCTTACATAAGAATTAC
hb-staple-59	CATTATATTGGGCGGGAAGCATAAAGTTGAGGGGATCATCAA
hb-staple-60	GATAACCCACAAAACAATGAAATAGCAAATGAAGGGAGAATT
hb-staple-61	CGCAGTCAACCTATAGTTAATGCCCCCTATGGGGTTTAACTG
hb-staple-62	AAGGTAAAGTAATCAGCTAATGCAGATATAAAGACATGTAAT
hb-staple-63	GAAACAGATGAGAATCGCCATATTTAACTCGAGCCGAATATA
hb-staple-64	CGAATAAAAGTTCCAGTAAGCGTCATACATAAGTTCAGTGCC
hb-staple-65	TAAAGGCAAGACAATGACAACAACCATCGGCTTGCACCCTCA
hb-staple-66	GCCAACGCGCGGGGTTTTTCTTTTCAATTCCACGAGCTAACT
hb-staple-67	ATACCCAAAAGATTAAGACTCCTTATATCGCACCGGAAACCA
hb-staple-68	ATCACCGGAACCCGCCACCCTCAGAAAGCACCGTTTCATCGG
hb-staple-69	ATAGTAAAATGTGTCATAAATATTCAAGGTTTACACCCTCAT
hb-staple-70	TAGCAAGGCCGGAATGAAACCATCGAAAAACAGACGTTAATA
hb-staple-71	GCTGATTGAACAAGTAGGGTTGAGTGTTCGGCAAATCCTGTT
hb-staple-72	TTAATTCCAGTTTGGCCCTTCACCGCATATGTACCTGATAAA
hb-staple-73	TAATCTTAGCATAAAAACAGGGAAGCGCCAAAGTCTGAGCGC
hb-staple-74	TGATGGTTCCTGGCCCTGAGAGAGTTGCGCGAAAAATCCCTT
hb-staple-75	TATCATTCCAAGAAACCAAGTACCGCGCCTGTTATAATATCC
hb-staple-76	GCCCTTTCGCCTCTGCGGGGCACCGCTTCCATTCAGAAACGC
hb-staple-77	CACCCTCCGGAATCTTAGACTGGATAGCCAAAAGAGGAACCC
hb-staple-78	AAACTACAACGCGCGTAACGATCTAACAGATACTCGTTTACC
hb-staple-79	CTTCTGAATACCAATAACGGATTCGCCTATATACAGATTTTC
hb-staple-80	GCCTGTTTAGTATATACAAATTCTTACTACAATTCTTTCCAG
hb-staple-81	CAAAAGGATAGTTACTGTAGCATTCCACGTAACACGCGAGAG
hb-staple-82	TTGAGTACATATCATACAAACAATTCGATTAATTTACAAAGA
hb-staple-83	CCCCCAGCACCACTACGAAGGCACCAACACACTCAAACAAAG
hb-staple-84	TGATACCTGAGGACAGGGTAGCAACGGCGATCGTCAGGGAGT
hb-staple-85	CGTTGGGGCTCAACTTTAATCATTGTGATATACCATAAAACG
hb-staple-86	TTAATTTGCTTTGAATAATGGAAGGGTGCTGAATATCGCGTT
hb-staple-87	CAAAGGGTGGCAATCATCATATTCCTGATTGCGGATAAAAGT
hb-staple-88	CCTCCCGACTTGTTGCTATTTTGCACATCGAGACAAGCAAAT
hb-staple-89	AGAGCATAAAGCGTAATACTTTTGCGATTTTCATAACATCCA

hb-staple-90	AGGGCGATCGGTTCGCTATTACGCCAGCTATCTTAGCCGAAC
hb-staple-91	ATTGGCCTTGATAAATAAATCCTCATAAGCCTTCCTCATATA
hb-staple-92	ACGTAGAGGGAGGGAAAAGGGCGACATTCGAATAGCAATCAT
hb-staple-93	AATAGCCCGAGAAGTCCACTATTAAATGAGACGGGTCCACGC
hb-staple-94	TTCTAGCCCGGTTGAACTAGCATGTCAAGGGGAGCAGTCTTT
hb-staple-95	CGCGAGCTGACCCTTAAATCGGTTGTACACAGCAAGAATTAT
hb-staple-96	CCTGCAGTATGGGTAACGCCAGGGTTTTGCCAAGCGTAAATG
hb-staple-97	GACTCCTGTTGGTCGCAAACTGGAAGTTCGAACGAGTGCCGT
hb-staple-98	TATCATTTTATCAATTCTACTAATAGTAAGGCAAAAATTAAG
hb-staple-99	AGGTTTAATTTAGAACCTACCATATCAATTGCGTAGTAACAG
hb-staple-100	GCTTTTGGTTAGTAAGAGCAACACTATCCAAAATATGAGTTT
hb-staple-101	GGTGAATCACGCCAAGGAAAATATTTAAATTAAATCCAGTAG
hb-staple-102	TATAAGTATAGCTGTATCACCGTACTAATATGCATATAACAG
hb-staple-103	TATATTCGGTCGCTGAGCCCACGAACAGCT
hb-staple-104	TGGTTTGCCCCAGCAGAGCAAGCGGCAACA
hb-staple-105	TTAAGAACTGGCTCATATTACCTTAAATTG
hb-staple-106	AATTACATTTAACAATTCAAGAATATTCAT
hb-capture-1	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTGTACGGTCAATAGGCCGGAAGAGAAGGACGGATAAGTAGATT
hb-capture-2	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTACGCAAGCACAAACATTCAGAGCCGCCAGACAGGATGTGTAG
hb-capture-3	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTGTATAAGTATCACCAAACGTCACCGTCAAAAATCATTTTGTT
hb-capture-4	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTAGCTTTCTTCATGAACTGGAAGAAAAGTAACCGAGGGCTGCG
hb-capture-5	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTTGGTTTGTAAACGATAAGACCAACGCTATACAAAAATCATAA
hb-capture-6	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTAATAGATCAGTATTAACGGGTTCAGAAATTAATCAAAACCAC

Note: In order to position one gold nanoparticle in the body center of the hexagonal bipyramid frame, ‘ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTT’ sequence was added in the blue marked staple DNA strands.

f. Bridging strands of hexagonal bipyramid DNA origami frame

hb-bridge-1	GGGTTGATTTTGGGAATTAGAGCCAGCCCGACTTCATTAAA
hb-bridge-2	AGCTCATTTTTTTGATTCCCAATTCTGTCATTCCAACTAAA
hb-bridge-3	ATAAGAGGTTTTTGGGAACAAACGGCGGACCGTCGGCCTGTAG
hb-bridge-4	TGTAGATGTTTTCCAACAGGTCAGGATTAGACCGGAAAGACT
hb-bridge-5	TGACTATTATTTTTGGCAAAGCGCCATTCGCTGGTGCTCCAGCC
hb-bridge-6	ATAACGGATTTTATCAAAAATCAGGTCTACGAGAATCAAATG
hb-bridge-7	GGGGGTATTTTCACGGAATAAGTTTATAGAAACGTTAGCAA
hb-bridge-8	GGTTTACCTTTTTTTCAGGGATAGCAAGGAGCCACGTACCGC

hb-bridge-9	AAGATTCAATTTTCATCCTAATTTACGAGAAGAAAATATCAAC
hb-bridge-10	TCTTTCCTTTTTAGCCGCCGCCAGCATTCCAGAACAGAGCCA
hb-bridge-11	TCGATGAATTTTTTAGGCAGAGGCATTTAACGCCACCAACGC
hb-bridge-12	CCGACAATTTTAGGCTATCAGGTCATTTTTGAGATCAACCG
hb-bridge-13	CATTACCATTTTTAGCCTAATTTGCCAGTACGAGCGTTTATCC
hb-bridge-14	CTAGAAAAATTTTTTTTGTTAAAATTCGCATTGTAAGAAGATT
hb-bridge-15	CATAATCAAATTTTCAGATATAGAAGGCTTCCAATAGACAAGCA
hb-bridge-16	TAGCGAATTTTCATTTTCGGTCATAGCAGCGCGTTAATCAG
hb-bridge-17	TTGACCATTTTTGTTAAATAAGAATAAAGTGTGATAATTTAA
hb-bridge-18	CATATTATTTATTTTTTTGCTCAGTACCAGGTTAGGATAGGCTGA
hb-bridge-19	AAGCCTCTTTTTAAAACGACGGCCAGTCCCAGTCGGGGATG
hb-bridge-20	TGCAAATCTTTTATAAATCATACAGGCAGTAGCATTTTGGGG
hb-bridge-21	TCAGACGTTTTAAAGTTACCAGAAGGAAAGCAGATACCGAA
hb-bridge-22	GTTGGGATTTTTTTTAAATGCAATGCCTTAGAACTATTTCA
hb-bridge-23	GTAACAGTTTTTAACTGAACACCCTGAAATTAGACAATAGCA
hb-bridge-24	TATCAGAGATTTTCAGGAGTGTACTGGTAATGGCTTTGGAAAG
hb-bridge-25	CTTTTACATTTTTAGACGACGATAAAAACATAACCCATAACGC
hb-bridge-26	ACCAGTACTTTTAACAGAAATAAAGAAAAATTATTGATTATA
hb-bridge-27	ACCAGAAGTTTTTTCAGCGGAGTGAGAAAACAACTCTTTCCA
hb-bridge-28	AATCTCCATTTTCTTTGCCCGAACGTTACAACTCGCCAACGT
hb-bridge-29	ATGAATCGTTTTAAAAGAATACACTAAACTAAAACCCATTAA
hb-bridge-30	CGGAGATTTTTCACATTAATTGCGTTGAATGAGTACAACAT
hb-bridge-31	CGGGTACTTTTGTACAGACCAGGCGCAAGGACAGGCAGACG
hb-bridge-32	ATTACCCATTTTCTACCTTTTTAACCTCTCATAGGCTTAGAT

g. Staple strands of elongated octahedral DNA origami frame

loct-staple-1	AAAGTACAACGGGTTACTTAGCCGGACTCAGCAATACGTAAT
loct-staple-2	TACTGCGGAATCTCAGGTCTTTACCCTATTCTGGGGTTGATA
loct-staple-3	ATAGTTGCGCCGTTTTGCGGGATCGTGTTAGCGAGGAATTGC
loct-staple-4	ATTAAGCAATAAAATACTTTTGCGGGAGTTTCATATTTTCAT
loct-staple-5	TTTAATGCGCGAAAGATAAAACAGAGCCAGCCAACCAGTAAT
loct-staple-6	TGGGATAGGTCAAGATCGCACTCCAGCGGTTGAAATAGGAAC
loct-staple-7	GTGAATTACCTTAACGGAACAACATTGGCGCAGGATATTCAT
loct-staple-8	TAATAAGTTTTAGCCTATTTCGGAACTTGATGGGGAACAAGA
loct-staple-9	TAAGAATAAACAAATTCTTACCAGTACCTTATTGGAATAAGT
loct-staple-10	AACCAATCAATAGTTTTTATTTTCATGCCAACGTAATTCTGT
loct-staple-11	CGTGGCGAGAAAGTCACGCTGCGCGTCCACCACTCCTCATTA
loct-staple-12	CGGATGGCTTAGTAAAGTACGGTGTCCTTTCCGTCGGTGCGG
loct-staple-13	GAAATTGCGTAGGGAGAAACAATAACGTTATTAGCAATTCAT
loct-staple-14	ACCACCGGAACCTCAGAGCCGCCACCAAAATCACTTTAGCGT

loct-staple-15	CGACGTTGTAAACGGGTACCGAGCTCTATTATAGAGCTTCAA
loct-staple-16	AGGTCATTGCCTTGTCAATCATATGTGCCTTTAGCCGGAGAC
loct-staple-17	TAACCGTTGTAGTCCAGAACAATATTTCGCCTGAACAAAATT
loct-staple-18	CAATAGATAATATAAATCCTTTGCCCGGCGGTCTCAATCAAT
loct-staple-19	TCACCAGTGAGAAGCAGGCGAAAATCTCGTAATTTAATTGCG
loct-staple-20	AAGGTAAATATTTTGGGAATTAGAGCTTTTTAAGAAAACTTT
loct-staple-21	CCTTTTTAAGAAACTGGCATGATTAAATATTATAACACCCTG
loct-staple-22	TCTTACCAACGCGTTACAAAATAAACGGAATCAGAACCTCCC
loct-staple-23	TTAATTTTCCCTTAGGTCTGAGAGACACCACACTAAACAGGA
loct-staple-24	TTTTCAGGGATACCACAGACAGCCCTCAGGTAGATCATAACC
loct-staple-25	ACAGCATGCTCCATAGATTTGTATCATCCCCAGCGAAACGAA
loct-staple-26	GAAATCGGCCCCCTACGGGGTCAGTGCCCTTTTGATCCAACG
loct-staple-27	AACGGGTCCTGAACAAGAAAAATAATATCTTATCATTCCAAG
loct-staple-28	AAAAGCCCTCAGGACGTTGGTGTAGATGGGGAACAGGCCTTC
loct-staple-29	ATTAAATCAGCTTTCATCAACATTAAATTTGTTAAAATTCGC
loct-staple-30	TACATTTAATAGTACATCCAATAAATCAAAGCTAACCAAAAA
loct-staple-31	GCCCAATTTTGCCATAACGAGCGTCTTTGCACCCATTAAATC
loct-staple-32	ATAGCGAAATTACGTAGGAATACCACATCAGTACAGTACCGT
loct-staple-33	GTTGGGATGAAAGAGGACAGATGAACGGAGTAGATCATTAGA
loct-staple-34	CTTTTTCAAAGAATACTCATCTTTGACCGCCTGATGAAATCC
loct-staple-35	AAGCCTGCGTGCCAGCTGCATTAATGAAAAGCATAAAGTGTA
loct-staple-36	TCAGTGATCATCAAGAACTGACCAACTTAGAAAAATCTACGT
loct-staple-37	TAACAGTACCCTGTAGCCTCAGAGCATATACAGGCGCATCAA
loct-staple-38	CTAATGCGAATATAAGAATCGCCATATTTACCGCACTCATCG
loct-staple-39	ATAGCTGTTGCCCCCGGGCAACAGCTGAATTGGGCGTCGGGA
loct-staple-40	GCCGCCATGTAGCGGGAAGGGAAGAAAGAGAGCTTTCTGAAT
loct-staple-41	GGAATTAAATGGAACTACCATATCAAAACGTCAGAGTAACAG
loct-staple-42	TCTGAATTCATCATTTATCATTTTGCGGTAATACATGAATGG
loct-staple-43	AGAGGCAATGAGGAAGGGTAGCAACGGCAGGTGTCAAATTCC
loct-staple-44	CGTTCTATAGGTAATTTTAGAACCCTCAAGGATGAACGGTAA
loct-staple-45	TTCTACTCGCAAATCAATTCTGCGAACGTGTTGTAATCGGTA
loct-staple-46	AGGAAAACCAGCAGACTGATAGCCCTAAACAATATAGATAGA
loct-staple-47	GAGCCGGTCGTAAGAAAGCGGCCAACGCTGATCGTGCTCAAG
loct-staple-48	AAACAGGAGATAACCCACAAGAATTGAGAGAGAATAACATAA
loct-staple-49	GTGCATCACAACCCGTCGGATTCTCCGTGGCGCATCGTAACC
loct-staple-50	CTAAAGTAGGCCGCACAATGACAACAACTGAATTTAAATCTC
loct-staple-51	AATCCAACAAAAGAAAGTAAGCAGATAGAATAGCACGCTAAT
loct-staple-52	TAACGTGAGAATCCGTGAGTGAATAACCACATAGCGATAGCT
loct-staple-53	GGATTATTGACCTGAATACGTGGCACAGAACATCGTACCGAA
loct-staple-54	GTACGCCCTTTCCTTACAGGGCGCGTACAGAGTCAATAGTGA

loct-staple-55	ATCATTTCGAAAGGAGCGGGAATAGCCCGCGAAAAAGCGTCA
loct-staple-56	TTAATTGATATAATGCTGTGGAAGCCCGATTAGAGAAGGCGA
loct-staple-57	ATCATAAACGAACTATGCGATTTTAAGAATGGTTTTGCTCAT
loct-staple-58	AAGCATCGAGGAAGATATCTTTAGGAGCGAAGTATAAACAAT
loct-staple-59	AAAGTATTCAAAAAGTCATAAATATTCAAAATGTTATCACCG
loct-staple-60	GCAAGGAACTAGCAGAGAGTCTGGAGCATTTTTGAATTCAAC
loct-staple-61	ATCAGAGGAAGCGCACGATTTTTTGTTTACGCAATAATAACG
loct-staple-62	CACCATTACCACCCGCCTCCCTCAGAGCTAATCAAGCATTTT
loct-staple-63	TTTGCTAAAAGCGTTTATTTTGTATCGGATACCATATGAAAT
loct-staple-64	TAATGTGGCTGATAAATTATGCTATTTTCCGCAATGCCTGAG
loct-staple-65	TAGATTAAATATATTGAGAAGTGTTTTTTGGACGAGCACGTA
loct-staple-66	CGAGGAAAACGTCAAAAATGAAAATAGCTACAGAGCTAAAGA
loct-staple-67	ATGTTAGTTATACACCGGAATCATAATTGACCGTGAATTCAT
loct-staple-68	CAAAAGGGAGGCTTGCCACCCTCAGAACAACCCATAACTACA
loct-staple-69	AAGATTAGTATTCTAAATCAGATATAGATATATTTTAAATAG
loct-staple-70	AACCGATTTTATCAGCTTGCTTTCGAGGCATCGCCCACGCAT
loct-staple-71	CAAAAAACGGAGTGTCTTTCCAGACGTTCTGAGGCTTGCAGG
loct-staple-72	TCGGTCGAGTAAATGAATTTTCTGTATGGTCACCACGATAGC
loct-staple-73	CAGACCAAAATTAAGTAGCCACCAGAACGGTTGACTTAGTAC
loct-staple-74	CAGAGGCAAAGAACGGGTTTAGATAAGTATACCAGAAACCTA
loct-staple-75	GTTTCAGAAGGCTCCAAAAGGAGCCTTTAACAACTTTCAACA
loct-staple-76	AACCTGTGGGTGCCTGTGAAATTGTTATCAGCAAGCGGTCCA
loct-staple-77	CAGAAGGAATAAGAGCAAGAAACAATGACCGAACAAAGTTAC
loct-staple-78	TTTACAGTTAAAACACACTAAGCCCAATAAGAGGAGCTTTAC
loct-staple-79	GTAGGGCGCAAGCCATCGGCTGTCTTTCCCCATCCTGTTCAG
loct-staple-80	AAGTTTGTACATCGATTTTCAGGTTTAATTATTTGTTATACT
loct-staple-81	ACTTGCCATAATCAACAGTACATAAATCAGATTTCTATTCAC
loct-staple-82	TAATATTGTCTAAAGTTATGAGCGAGTATGATGAAAGCAACC
loct-staple-83	ATGGTTTACATATAAGAAAATACATACAAACTGTTTAGTATC
loct-staple-84	CGGTCATTAATCAGGCAAGGCCGGAAACGGAACCGCTCAGAT
loct-staple-85	ACCCTTCTTACATTTGGAAATACCTACAATAAAAACCATTAC
loct-staple-86	CAGTTCAGAGAAGGATTAGTTTCGTCACTCAACTAATAACGC
loct-staple-87	GGTCAGGAAAGACTATCAAAAAGATTAACACCTGCAGGTCGA
loct-staple-88	TGAGCAAAATGGAAGTGAGGCCACCGAGTTAGTAACTATCGG
loct-staple-89	AGAGTTGCCGCTCACAATTCCACACAACTTTTGACCTGAAAT
loct-staple-90	AGCACCGAGCCCCCTTGCCATCTTTTCACGCCACCCCACCCT
loct-staple-91	CTTTTTTAAGAAGACAAAATCGCGCAGAACTCAAATAACATC
loct-staple-92	AGGAATTACCTTGCAGTGCCACGCTGAGACTTTACTAGACGT
loct-staple-93	CCAGTCAGAGTAGTAAATTGGGCTTGAGACTGGCTCATTATA
loct-staple-94	GCAAAGCGGATCCCACGACGGCCAGTGCGGGTAACTCCAACA

loct-staple-95	AACACTGCAGAACCTTGCAAAAGAAGTTTAGATACATGCAAA
loct-staple-96	CCACCCTAGGATTAGCGGGGTTTTGCTCGAGGTTTAGGGGGT
loct-staple-97	GCTGAGATATGGTTGCTTTAGTAGAAGAGGCGAATAATTACC
loct-staple-98	AGTTTGAAAGCAAATATTTAAATTGTAAAGCCAGCAAATCTA
loct-staple-99	GCTTAATAAAATCATAGAATCCTTGAAATTGCTTCAGGAACG
loct-staple-100	TCAAAGGGAGATAGCCCTTATAAATCAAAGGCCCGTATAAAC
loct-staple-101	TTCTGGTATGCAACAGCTTAATTGCTGACTCCTTTGGCGAAA
loct-staple-102	AATAAGAAGAACGCGCCTGTTTATCAACATTTTCGAGCCAGT
loct-staple-103	CTTAGGTGAGCCATGACGGAAATTATTCGCGACATCATCTTC
loct-staple-104	AAATACCACTAGAAAAAGCTGCTGATGCAATTTAACCAAAGA
loct-staple-105	TGAATACGGTAATACAATACTTCTTTGATAAAAGAGAATTAC
loct-staple-106	TGACCTAAAATCCATATAACTATATGTATATTATCACCGTCA
loct-staple-107	CTGTAGCTTTTGTTCAGGAAGATTGTATGGGGACGACGACAG
loct-staple-108	GGGGGATCAGGCTGACCAGGCAAAGCGCGAAGCTCAACATGT
loct-staple-109	ACACCGCCTCGTATCATTTGAGGATTTAACTAACAAGTTGAA
loct-staple-110	CTGGCCCGCGGGGAGAGGCGGTTTGCGTTTGCCCTTCACCGC
loct-staple-111	TACTCAGAGTACCACTGAGACTCCTCAAGAAAACGAGAATGA
loct-staple-112	AATAGTATTGAATCCCCCTCAAATGCTTTTGCCAGAGTACCG
loct-staple-113	CAAAAGGATTAAAGGTGAAAAGGTGGCAACCAGCGTGGTTTG
loct-staple-114	TTACCGTTTGGCCTCAGGAGGTTGAGGCAAGCGCTAGGGCGC
loct-staple-115	TACATGGTTGAGTAACAGTGTCAGACGATCCAGTAACCGTCT
loct-staple-116	TTAAGTTCAAGCTTGCATGTTCGCCATTGTGCTGCAGTACCT
loct-staple-117	TTATCCGGTATGCCGGAGAGGGTAGCTAAACAAGAGAATCGC
loct-staple-118	CTGACCTATAAGGCTTGCCCTGACGAGAGGCGCATAGGCTGG
loct-staple-119	AACCAAGTAACAACGCCAACATGTAATTAACAAAGAAGGAGC
loct-staple-120	CATCAGTTAGCATTGCAAGCCCAATAGGCGCCACCAACCAAA
loct-staple-121	AGTTAATGCAAAATGGTTGAGTGTTGTTCGTGGACTGATACA
loct-staple-122	GAATACCATAAGAAATTAGACGGGAGAAAATTGAGATAGCTA
loct-staple-123	GCGACCTCGGAACGAGTTTCCATTAAACCAACCTAATTATAC
loct-staple-124	TATCGGCCCAAAAAAAATCAGCTCATTTCGCGTCTAACGGCG
loct-staple-125	TCGTAAATAAAAATAGATTCAAAAGGGTATATGATGAGATCT
loct-staple-126	CATTATGTGATTCCGGTCAATAACCTGTAAAGGTGAAGGCAA
loct-staple-127	AGAACAATTAATTGAAGTACCGACAAAAAACAACATAATTTA
loct-staple-128	ATATGCGCAAACGTAAAGAAACGCAAAGAATAGAATGATAAA
loct-staple-129	CCGACTTTGGGTTAATCGCAAGACAAAGTTAATTTTCAACCG
loct-staple-130	ACGCCTGTGAGATTAGGCATAGTAAGAGCGATAAACTCAGAG
loct-staple-131	CGCTGGTTTTCCTGTAATGAGTGAGCTACTTTCCAGCCAGGG
loct-staple-132	CGAACCAACGCTCAGGCAGATTCACCAGCCAACAGTTTTGAA
loct-staple-133	TAATAAAGGGAACCGAGTAATCTTGACAACAAAGCAATTTCA
loct-staple-134	CCTTGCTCAAGTTATGATGAAACAAACATTCATTTGTCTGTC

loct-staple-135	GAGTTAATTTGTCGAGAATAGAAAGGAAACGTTGACTTAAAC
loct-staple-136	TGGCAAGGCATTGATGATATTCACAAACCGCAGTCGACGGGG
loct-staple-137	TCGACAACTGCAACTGAACCTCAAATATAATCAACACTAATA
loct-staple-138	AGCCTAAAGCAAGCAAGAACGCGAGGCGTGAAGCCGCTACAA
loct-staple-139	CAGAGCCACCATTATAGCGACAGAATCATTCATCGAATCACC
loct-staple-140	TACCTTTAGTAACAATTCCTGATTATCAGTTTGGACACGTAA
loct-staple-141	CTCTAGAGGATTGCTCAAATATCGCGTTAGCAAACGCCAGGG
loct-staple-142	TTTAAATGCCGGAACGCAACTGTTGGGAGCCAGCTTGATAAG
loct-staple-143	ATTTATCGCGCCGCCGTTAGAATCAGAGTTTAGACTGTAAAT
loct-staple-144	CCATAAATAAGAGGGGCGGATAAGTGCCTAGGTGTTAGACTG
loct-capture-1	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTAGCCTAAAGCAAGCAAGAACGCGAGGCGTGAAGCCGCTACAA
loct-capture-2	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTTCGTAAATAAAAATAGATTCAAAAGGGTATATGATGAGATCT
loct-capture-3	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTATATGCGCAAACGTAAAGAAACGCAAAGAATAGAATGATAAA
loct-capture-4	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTCCGACTTTGGGTTAATCGCAAGACAAAGTTAATTTTCAACCG
loct-capture-5	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTAGTTAATGCAAAATGGTTGAGTGTTGTTCGTGGACTGATACA
loct-capture-6	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTTGGCAAGGCATTGATGATATTCACAAACCGCAGTCGACGGGG
loct-capture-7	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTCTCTAGAGGATTGCTCAAATATCGCGTTAGCAAACGCCAGGG
loct-capture-8	ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTTTTTAAATGCCGGAACGCAACTGTTGGGAGCCAGCTTGATAAG

Note: In order to position one gold nanoparticle in the body center of the elongated octahedral frame, ‘ATCCATCACTTCATACTCTACGTTGTTGTTGTTGTTGTT’ sequence was added in the blue marked staple DNA strands.

f. Bridging strands of the binary system

bs-bridge-1	CGTCCAATTTTTCAGAACCGCCACCCTCTCAGAGTATTAGC
bs-bridge-2	CCAGTCATTTTAGCACCATTACCATTACAGCAAATGACGGA
bs-bridge-3	GTTTTTCTTTTTTTTAAAGGTGGCAACATAGTAGAAAATAATAA
bs-bridge-4	TGTACTGGTTTTAAGTTTTAACGGGGTCGGAGTGTAGAATGG
bs-bridge-5	CCGAAGCTTTTGCTTTGAGGACTAAAGAGCAACGGGGAGTT
bs-bridge-6	TATCCTGAATTTTTAACCTGTTTAGCTATTTTCGCATTCATTC
bs-bridge-7	GCATGTAGATTTTTTGCGTATTGGGCGCCCGCGGGGTGCGCTC
bs-bridge-8	GCGTTAAATTTTGTCCACTATTAAAGAACCAGTTTTGGTTCC
bs-bridge-9	GGGAGGGTTTTGTTAAAATTCGCATTATAAACGTAAACTAG
bs-bridge-10	CGCTATTAATTTTCTCCAGCCAGCTTTCCCCTCAGGACGTTGG
bs-bridge-11	GGCGAATTTTCAGGTCGACTCTAGAGCAAGCTTCAAGGCG
bs-bridge-12	CAGAGCCTTTTGTAAAGATTCAAAAGGCCTGAGTTGACCCT

bs-bridge-13	AGGCTATCTTTTGTCAGAGGGTAATTGAGAACACCAAAATAG
bs-bridge-14	GACCGTAATTTTATTGCGTAGATTTTCAAAACAGATTGTTTG
bs-bridge-15	TCATTTTTGTTTTTTCACGTTGAAAATCTTGCGAATGGGATTT
bs-bridge-16	ATTAGCAAATTTTCAGAGCCACCACCCTCTCAGAACTCGAGAG
bs-bridge-17	CAGAAATAAATTTTATTTTAAGAACTGGCTTGAATTATCAGTGA
bs-bridge-18	AGCCGTTTTTGGTAATAGTAAAATGTAAGTTTTACACTAT
bs-bridge-19	GCTATTAGTCTTTTTCAAAGCGAACCAGACCGTTTTATATAGTC
bs-bridge-20	CGCAAATTTTTAAGGGAACCGAACTGAGCAGACGGTATCAT
bs-bridge-21	GCGAAACTTTTGATAAGTCCTGAACAACTGTTTAAAGAGAA
bs-bridge-22	CTTTAATCATTTTTTAGGCGTTAAATAAGAAGACCGTGTCGCAAG
bs-bridge-23	ACCCTCATTTTGTAAATCGTCGCTATTGAATAACTCAAGAA
bs-bridge-24	TGATACCGTTTTAAGCCTTAAATCAAGACTTGCGGAGCAAAT
bs-bridge-25	AGGTCATTTTTTAACAAAGTCAGAGGGTTTAACTGTTATCCC
bs-bridge-26	TTGTTATCCTTTTGACTTGCGGGAGGTTTTTTTAGCTTACCGC
bs-bridge-27	CCGCCTTTTTCCAGACGACGACAATAGGTAAAGCTCAACA
bs-bridge-28	GGTGAATTTTTTTTTATTTTGTCACAATCACACCACACGCAGT
bs-bridge-29	CCAGCATTTTTTTAAGTATAGCCCGGAAGTCGAGAAAACATG
bs-bridge-30	GTAGCGATTTTAGCGAACCAGACCGGATTAATTCGTCAGAA
bs-bridge-31	AATAGAAAATTTTTTTGCGCTCACTGCCCGACTCACACATGGTC
bs-bridge-32	AAACAATGATTTTGTCCACTATTAAAGAACCAGTTTTGGTTCC
bs-bridge-33	CTATTATTCTTTTTAGTCAAATCACCATCAGAGAAAGTTTCAAC
bs-bridge-34	GTCTTTCCTTTTGCCATCAAAAATAATTTTTAACCTAATCAG
bs-bridge-35	ACATTATCATTTTTGCCTCTTCGCTATTACAGGGCGAGCACCGC
bs-bridge-36	CAACGCCTTTTTTGGGGCGCGAGCTGATTAGCTATTCCATA
bs-bridge-37	CTGTAGCCTTTTTTCAAATATATTTTAGAACGCGACCTCCGG
bs-bridge-38	TGCGCATTTTGGCCGATTAAAGGATCGGGAGCCCGCCGC
bs-bridge-39	AACATCCATTTTAAGCCAGAATGGAAAGAAATAAACAGAGCC
bs-bridge-40	CGGAGAGTTTTCAGACTGTAGCGCGTTAGTTTGCCCAGTAG
bs-bridge-41	CATTCCAAGTTTTGCCACTACGAAGGCACGGGTAAAGCGAAAG
bs-bridge-42	GTATAAAGCTTTTTACCCAAATCAACGTAAGAACCGACGGTCA
bs-bridge-43	AGTGAATTTTTTTCTCGTTTACCAGACGACAACACTAAAGATT
bs-bridge-44	ATTCGCCTTTTGAATAATAATTTTTTCCAACTAATAACGAT
bs-bridge-45	ACAGGTAGTTTTCAATATAATCCTGATTGATGATGATTTTAA
bs-bridge-46	TCCCCCTTTTTATCTGGTCAGTTGGCACAAACCCAGTATTA
bs-bridge-47	CCAACCTATTTTAAAAGGGACATTCTGGTCACACGTTGCAAC
bs-bridge-48	GGCTGACTTTTAATTACATTTAACAATTCAAGAAATTGCTT

g. Staple strands of anisotropy control

vex-capture-1	ATCCATCACTTCATACTATGACCACTCGTTTGGCTTTTGCAAAAGTTAGACT ATATTCA

vex-capture-2	ATCCATCACTTCATACTCGATTATAAGCGGAGACTTCAAATATCGCGGAAGCCTACGAA
vex-capture-3	ATCCATCACTTCATACTACATAACTTGCCCTAACTTTAATCATTGCATTATAACAACAT
vex-capture-4	ATCCATCACTTCATACTGATATTCTAAATTGAGCCGGAACGAGGCCCAACTTGGCGCAT
vex-capture-5	ATCCATCACTTCATACCATAACCTAAATCAACAGTTCAGAAAACGTCATAAGGATAGC
vex-capture-6	ATCCATCACTTCATACAGAAGCAACCAAGCCAAAAGAATACACTAATGCCAAAACTCC
vex-capture-7	ATCCATCACTTCATACATAAGGCGCCAAAAGTTGAGATTTAGGATAACGGACCAGTCA
vex-capture-8	ATCCATCACTTCATACCGCCTGAATTACCCTAATCTTGACAAGACAGACCATGAAAGA
fc-staple-1	CGCCTGAATTACCCTAATCTT
fc-staple-2	CAGCCTTGGTTTTGTATTAAG
fc-staple-3	GTTTGCCTATTCACAGGCAGG
fc-staple-4	AGCCGAAAGTCTCTCTTTTGA
fc-staple-5	ACATAACTTGCCCTAACTTTA
fc-staple-6	TGTCGTCATAAGTACAGAACC
fc-capture-1	ATCCATCACTTCATACTTCAGACGCCACCACACCACCC
fc-capture-2	ATCCATCACTTCATACTATCATTGCATTATAACAACAT
fc-capture-3	ATCCATCACTTCATACTGACAAGACAGACCATGAAAGA
fc-capture-4	ATCCATCACTTCATACTGCCACCCATTTTCACAGTACA
fc-capture-5	ATCCATCACTTCATACTTGATACAAGTGCCTTAAGAGC
fc-capture-6	ATCCATCACTTCATACTAGGCTGACTGCCTATATCAGA

Note: In order to position one gold nanoparticle near a vertex of the octahedral frame, ‘ATCCATCACTTCATACT’ sequence or ‘ATCCATCACTTCATAC’ sequence was added in the red marked staple DNA strands. In order to position one gold nanoparticle in the center of a triangular face of the octahedral frame, ‘ATCCATCACTTCATACT’ sequence was added in the green marked staple DNA strands.

h. Modified DNA sequence attached on gold nanoparticles

ThioM-1	GAAGTGATGGATGAT-SH
ThioM-2	GTAGAGTATGAAGTGATGGATGATGATGATGAT-SH

Figures S1-S35

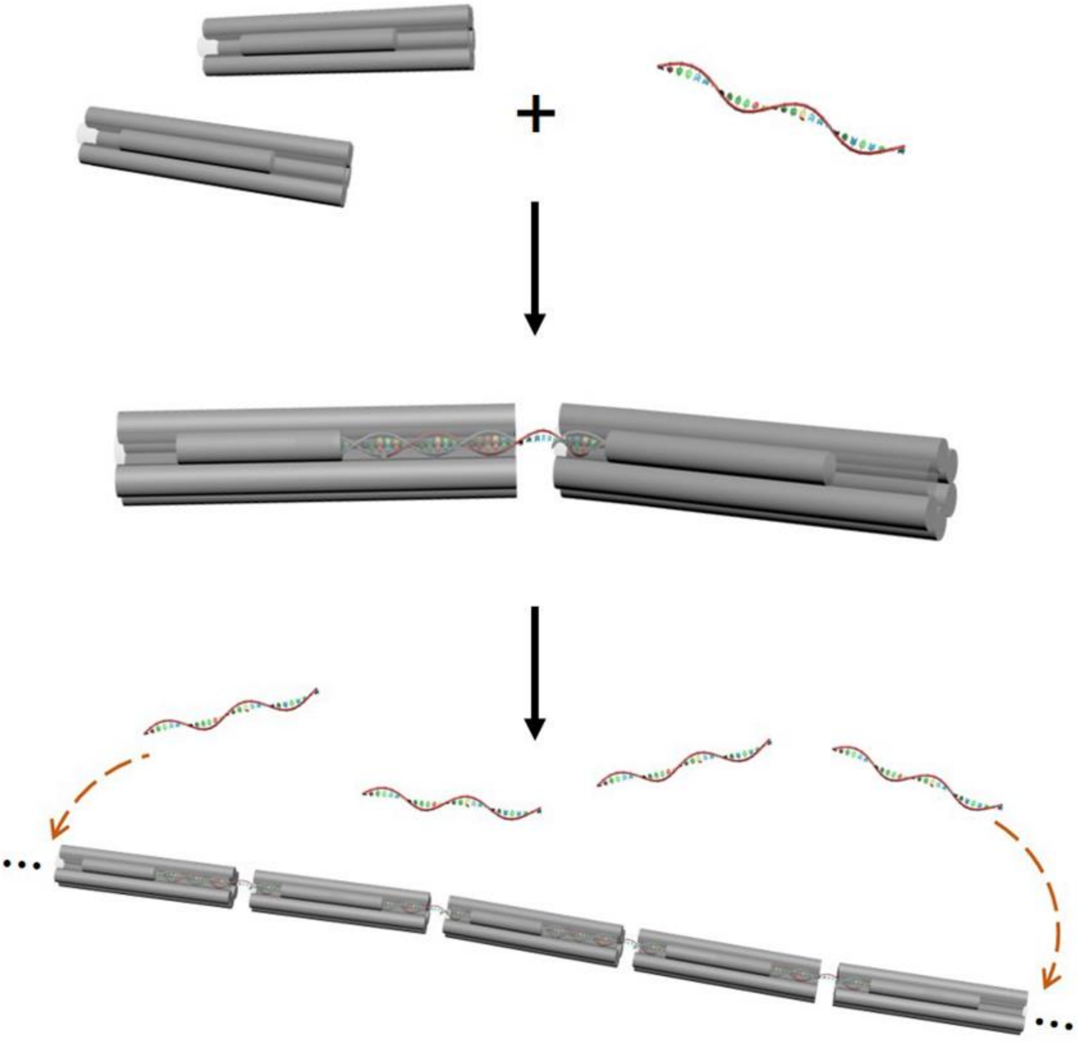

Figure S1. Schematics of the bridge pattern for a six-helix rod-shape model. Hybridization regions are designed inside the two ends of rods. Bridging strands hybridize with two adjacent rods to form a DNA bridge and further expand into a one-dimensional linear structure.

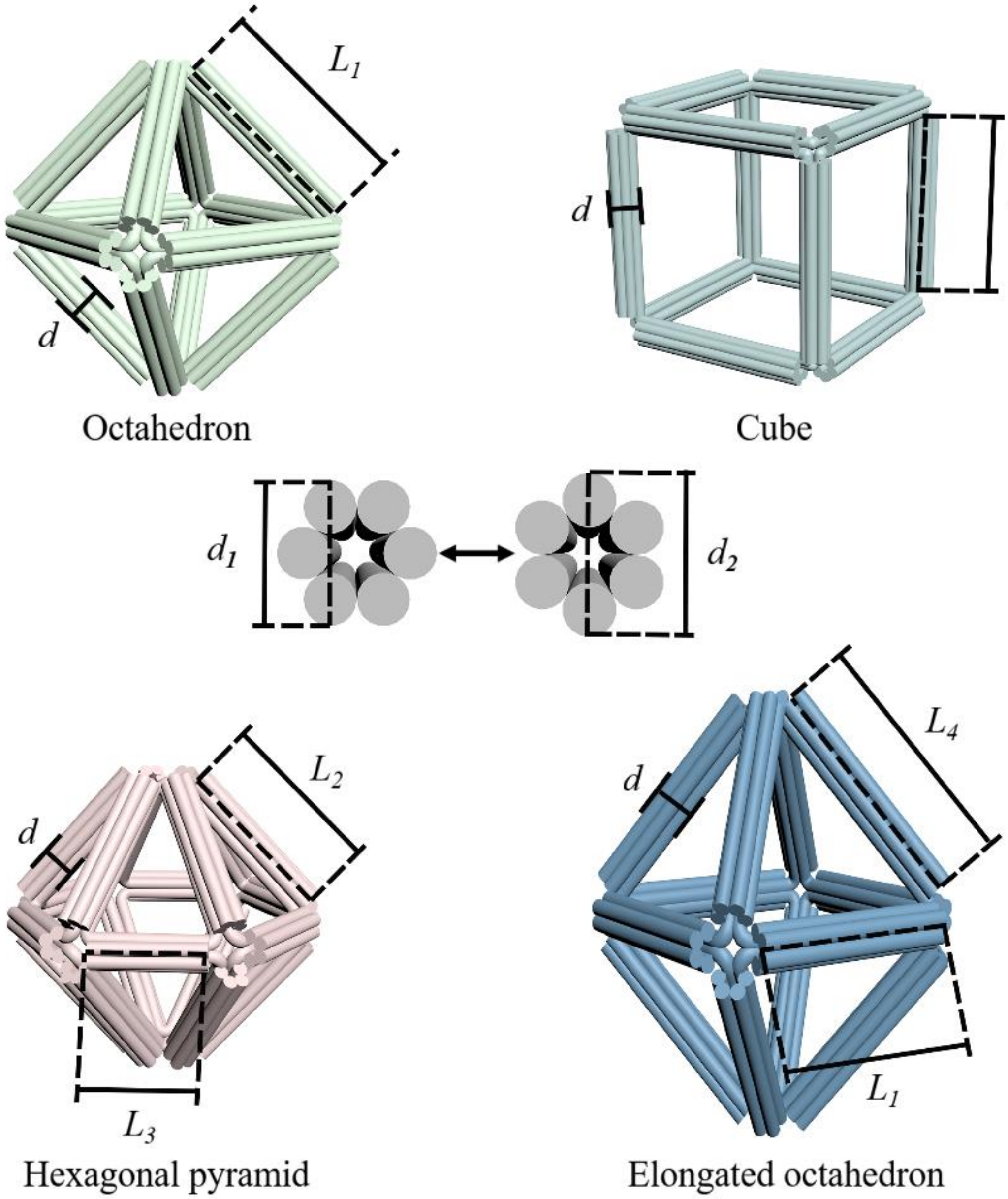

Figure S2. Geometric models for the four polyhedral DNA origami frames are octahedron, cube, hexagonal bipyramid, and elongated octahedron. d_1, d_2, L_1, L_2, L_3 and L_4 represent the width and length of the edges and their values are as follows: d_1 = 5.5 nm; d_2 = 6.0 nm; L_1 = 29.9 nm; L_2 = 22.8 nm; L_3 = 15.7 nm; L_4 = 37.1 nm.

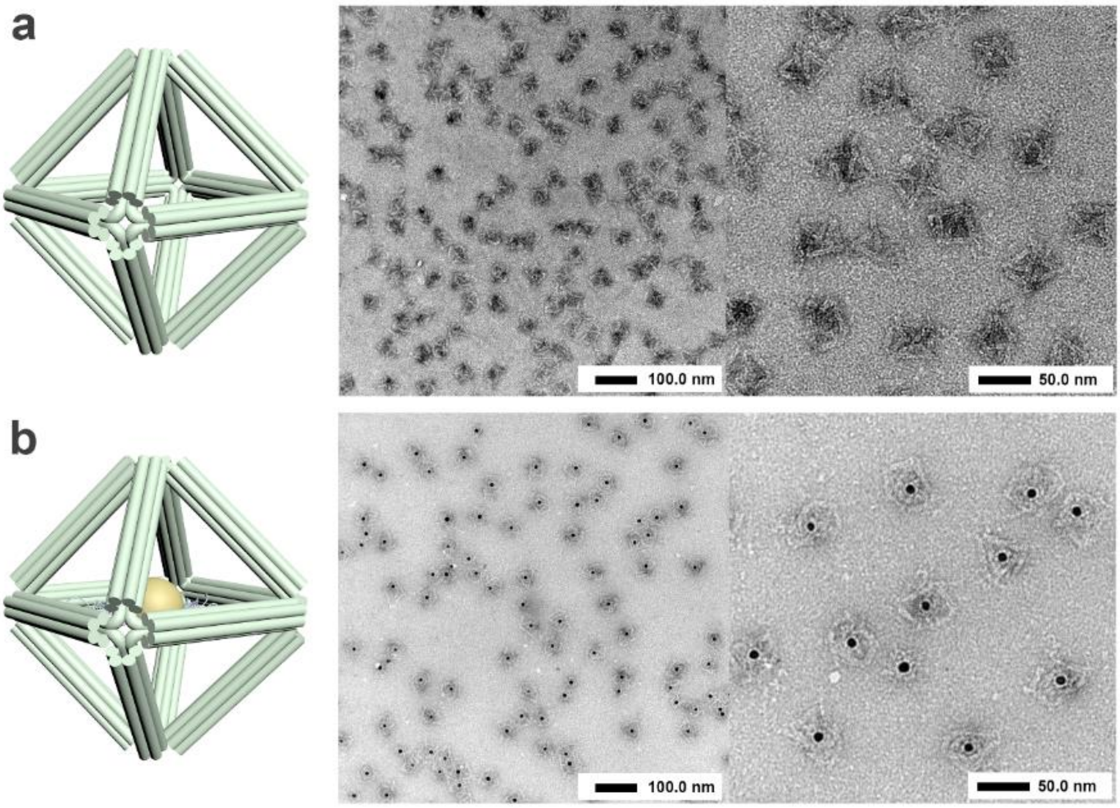

Figure S3. a) Representative negative-stained TEM images of octahedral DNA origami frames. b) Representative negative-stained TEM images of AuNP-octahedron monomers. Corresponding schematics are shown on the left.

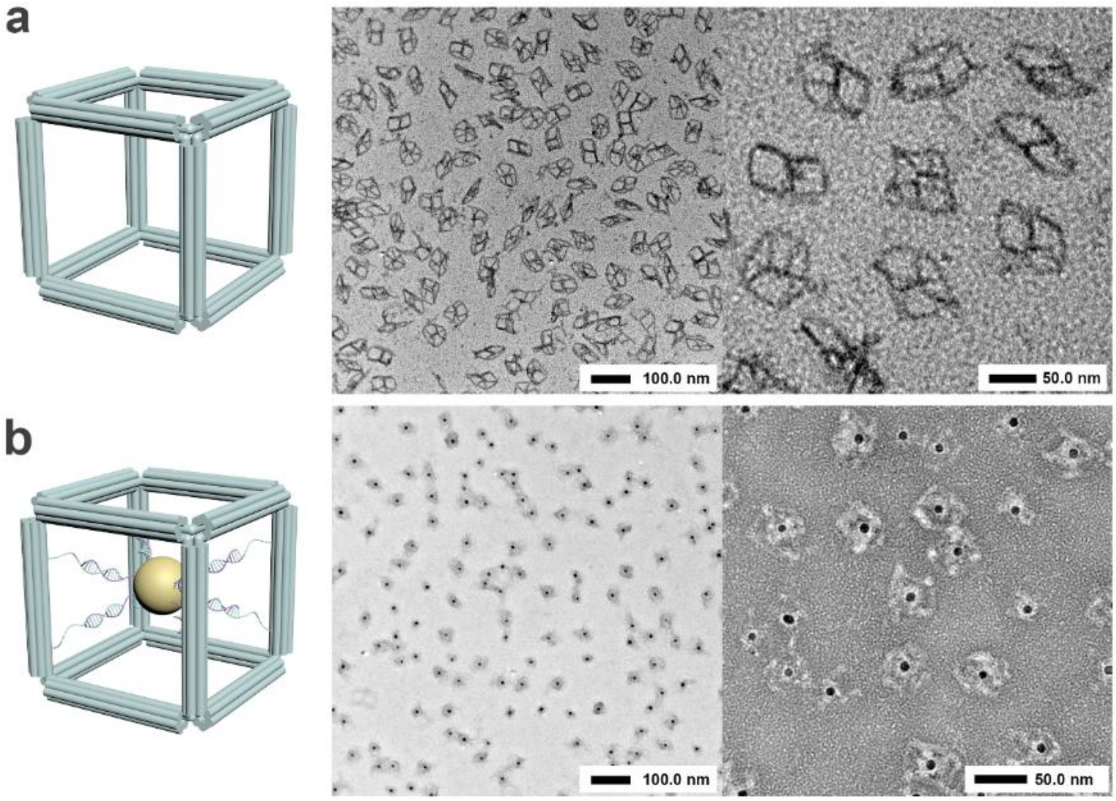

Figure S4. a) Representative negative-stained TEM images of cubic DNA origami frames. b) Representative negative-stained TEM images of AuNP-cube monomers. Corresponding schematics are shown on the left.

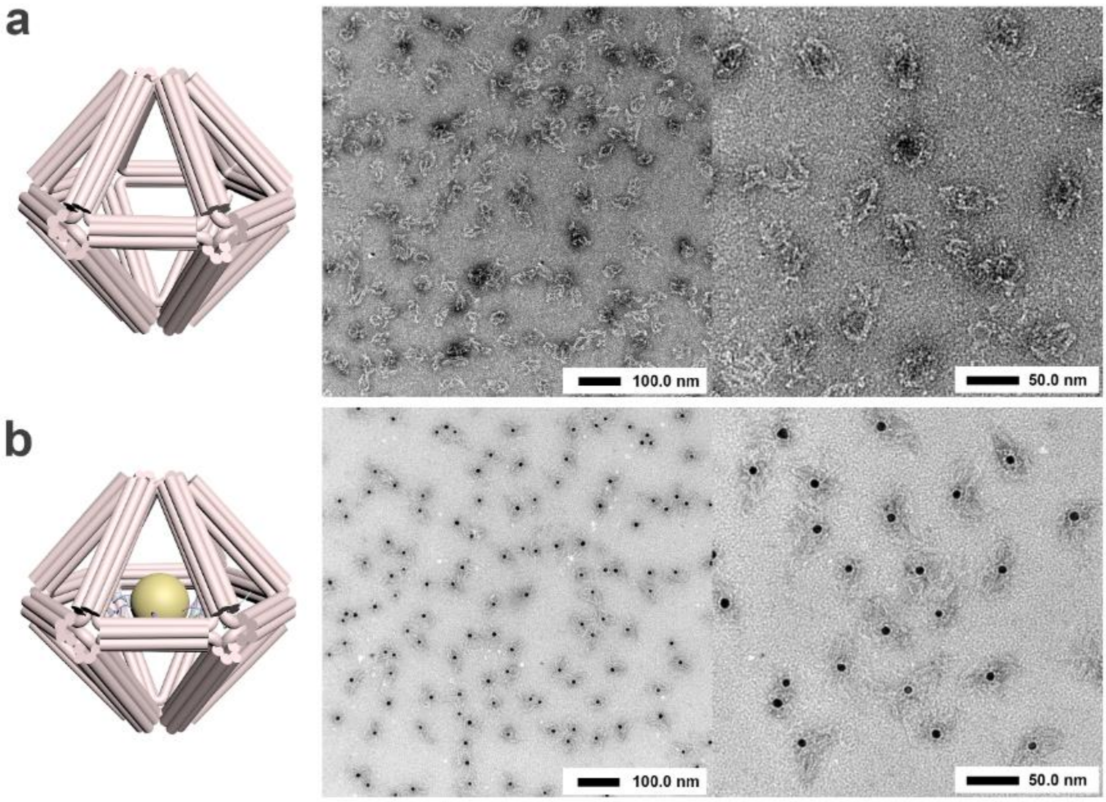

Figure S5. a) Representative negative-stained TEM images of hexagonal bipyramid (HB) DNA origami frames. b) Representative negative-stained TEM images of AuNP-HB monomers. Corresponding schematics are shown on the left.

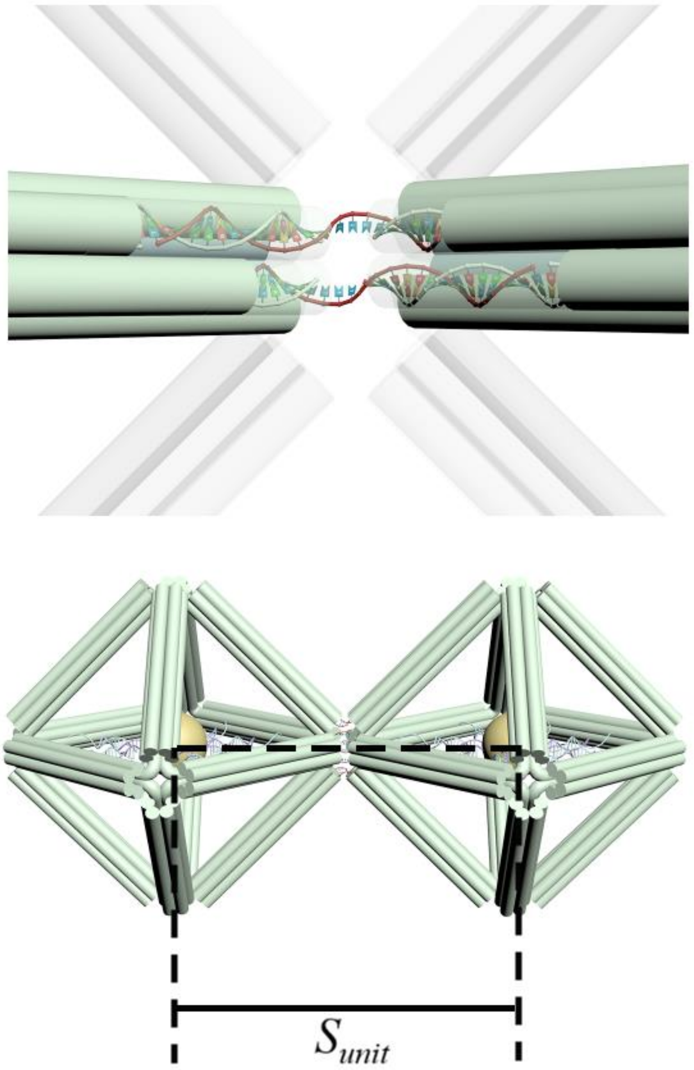

Figure S6. The magnified schematics of the bridge pattern for octahedral frames at vertex junctions. S_{unit} represents the distance between the body centers of adjacent frames in equivalent crystallographic axis directions.

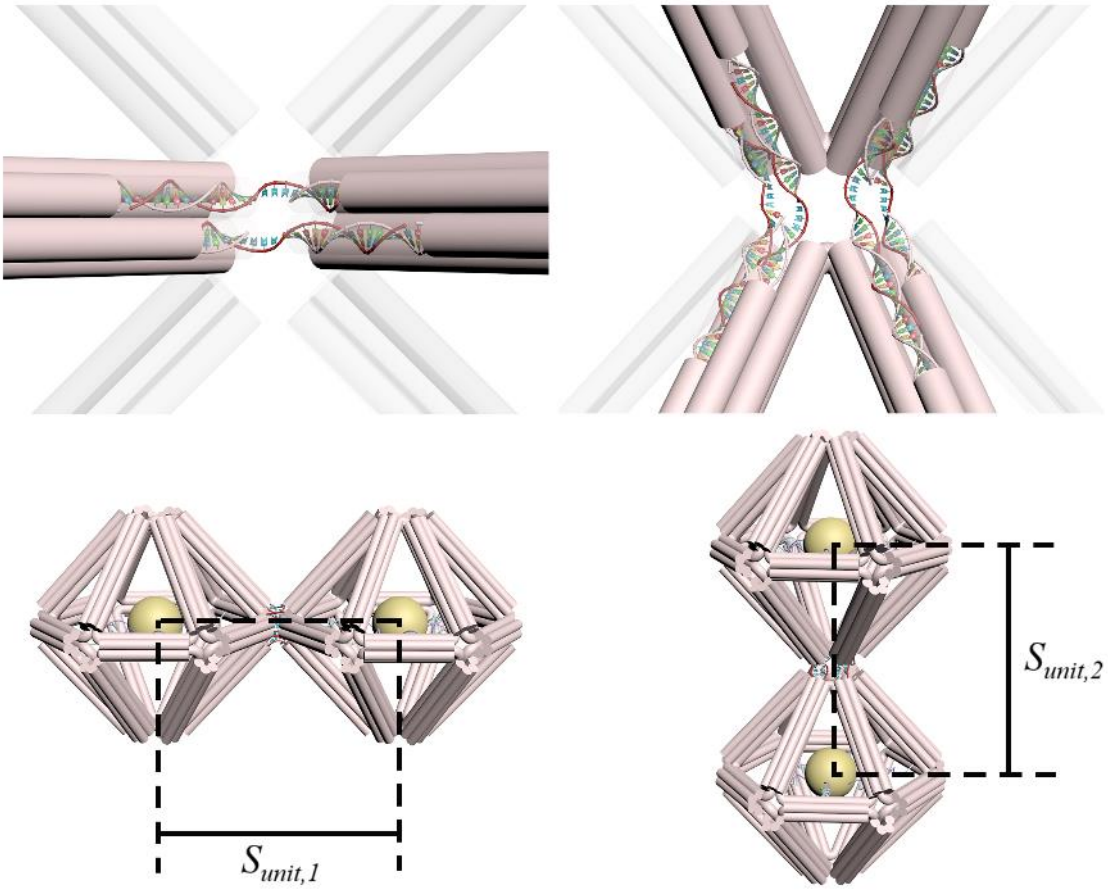

Figure S7. The magnified schematics of the bridge pattern for hexagonal bipyramid frames at vertex junctions. $S_{unit,1}$ and $S_{unit,2}$ respectively represents the distance between the body centers of adjacent frames in non-identical crystallographic axis directions.

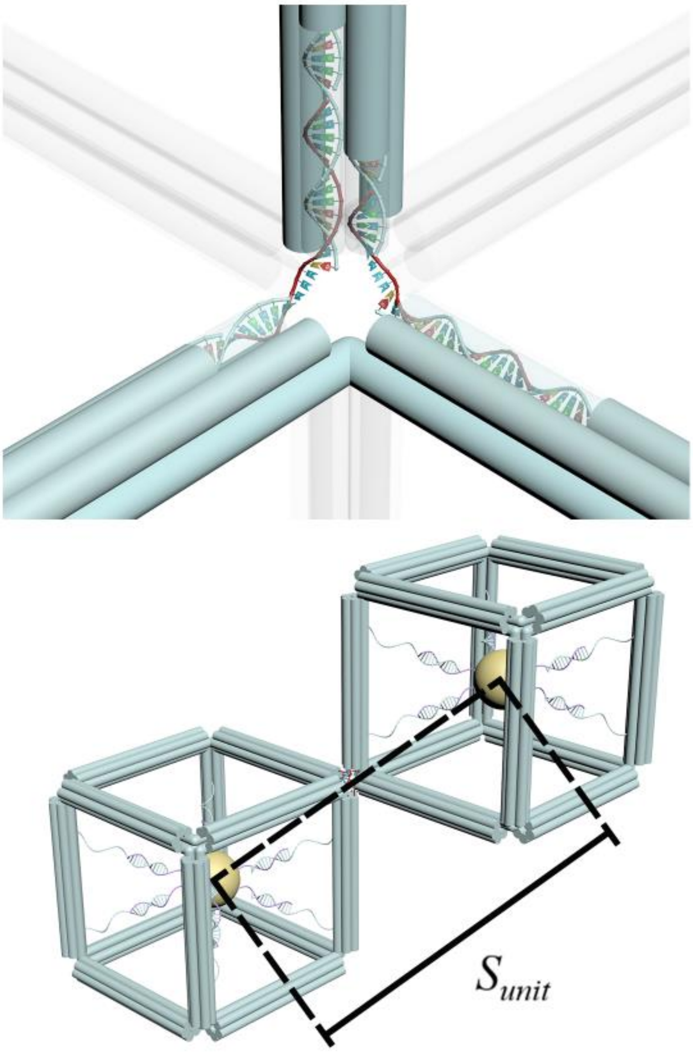

Figure S8. The magnified schematics of the bridge pattern for cubic frames at vertex junctions. S_{unit} represents the distance between the body centers of adjacent frames in equivalent crystallographic axis directions.

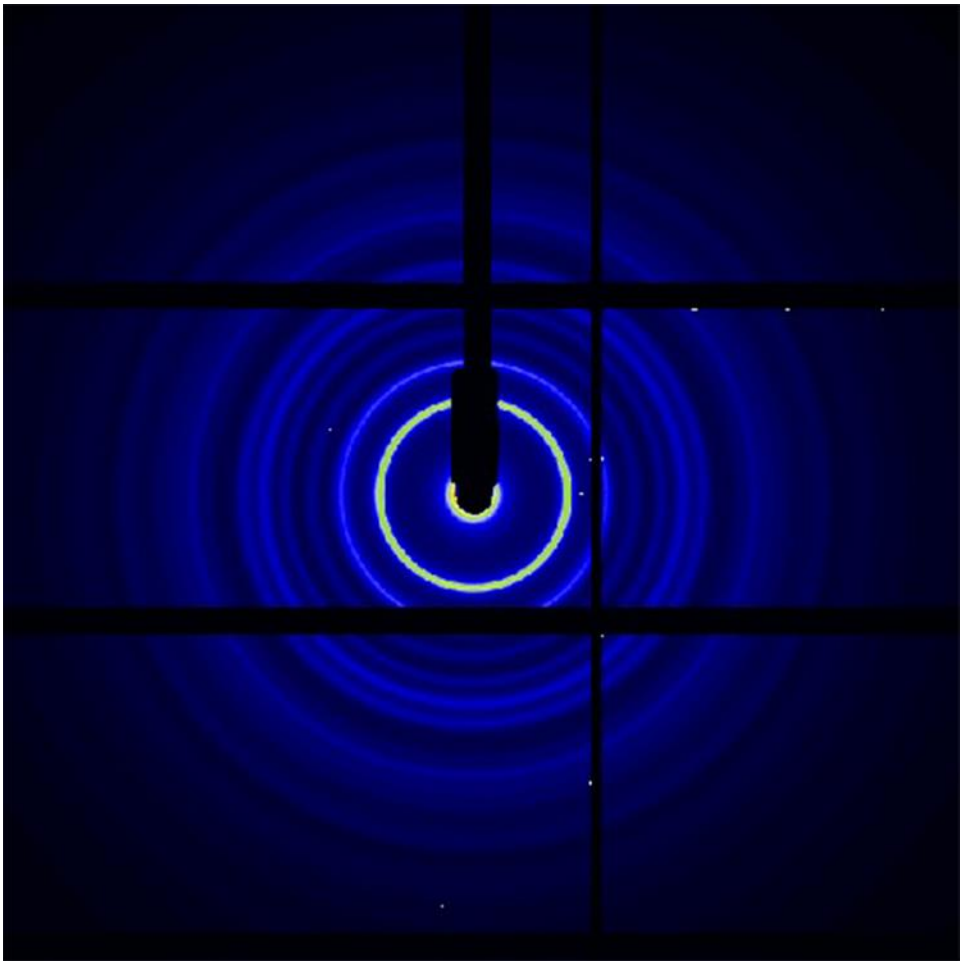

Figure S9. 2D pattern of the AuNP lattice formed by octahedral frames measured by SAXS.

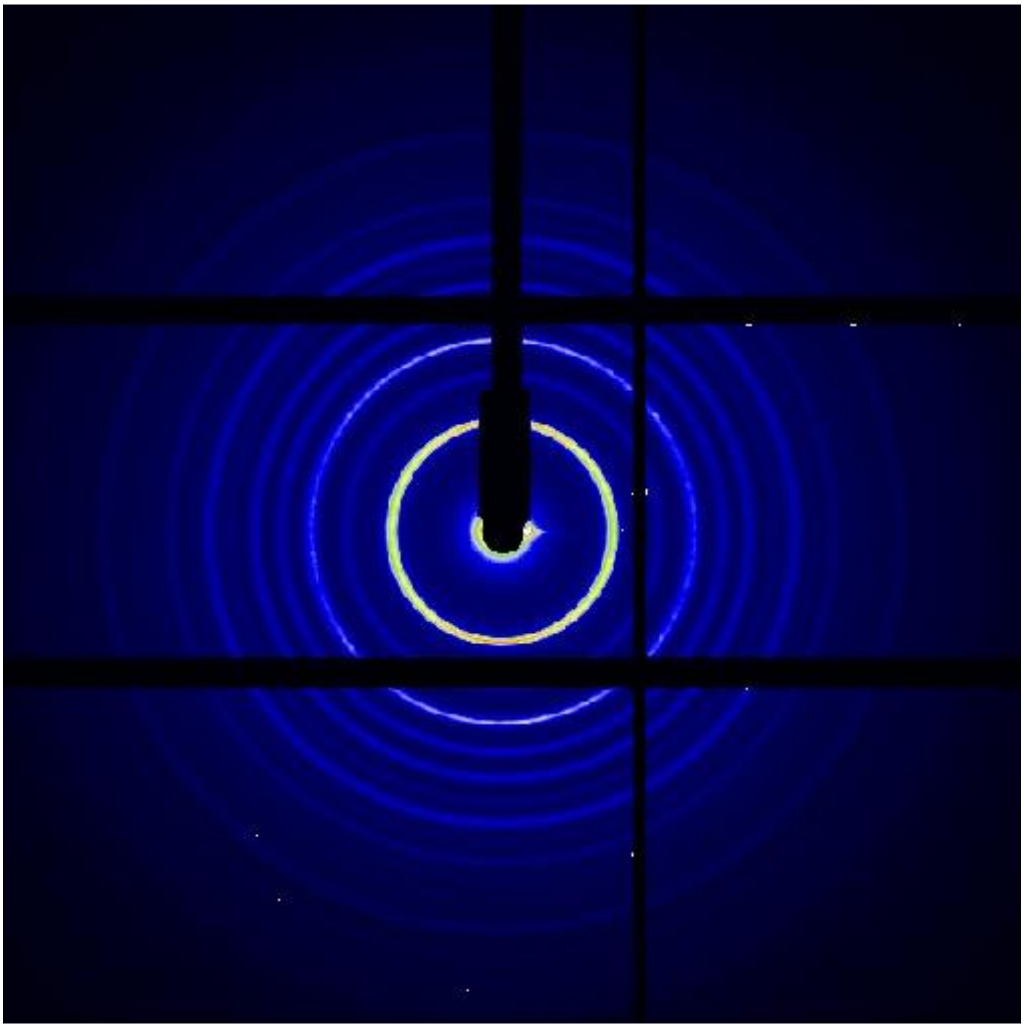

Figure S10. 2D pattern of the AuNP lattice formed by cubic frames measured by SAXS.

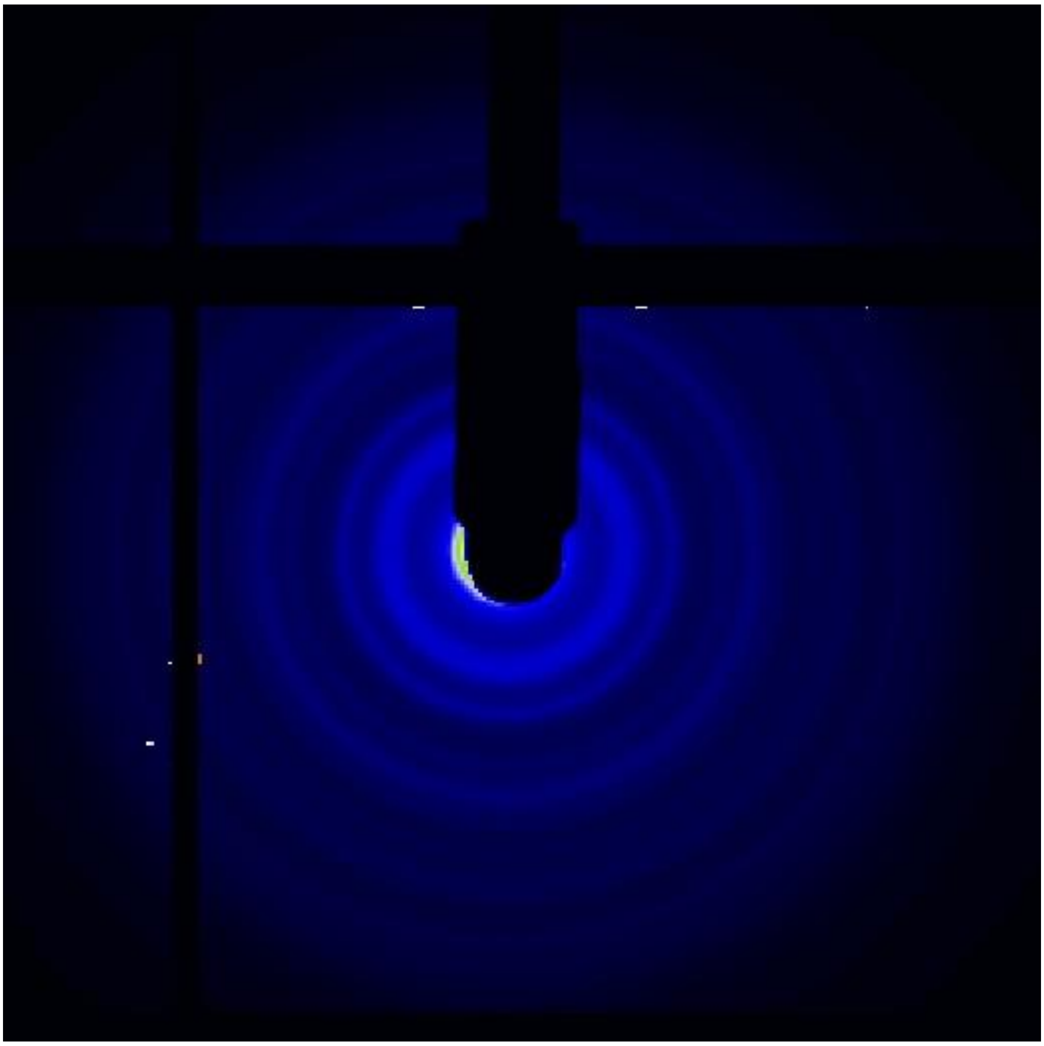

Figure S11. 2D pattern of the AuNP lattice formed by hexagonal bipyramid frames measured by SAXS.

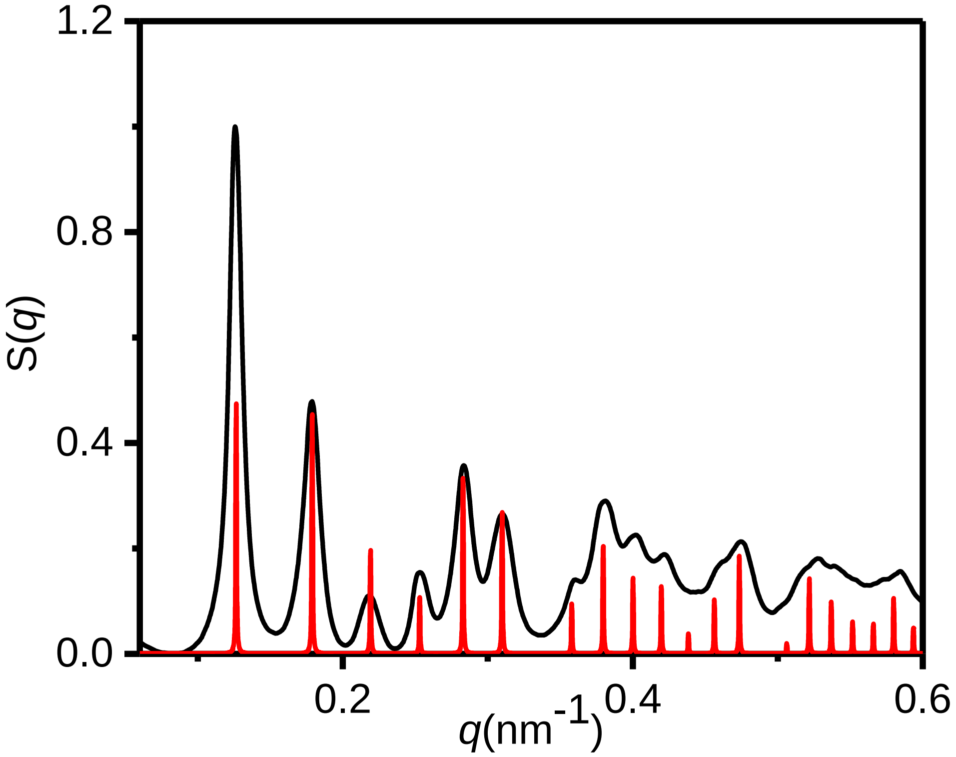

Figure S12. Enlargement of structure factor result for the simple cubic lattice shown in Figure 2d: black curve for the experimental data and red curve for the model.

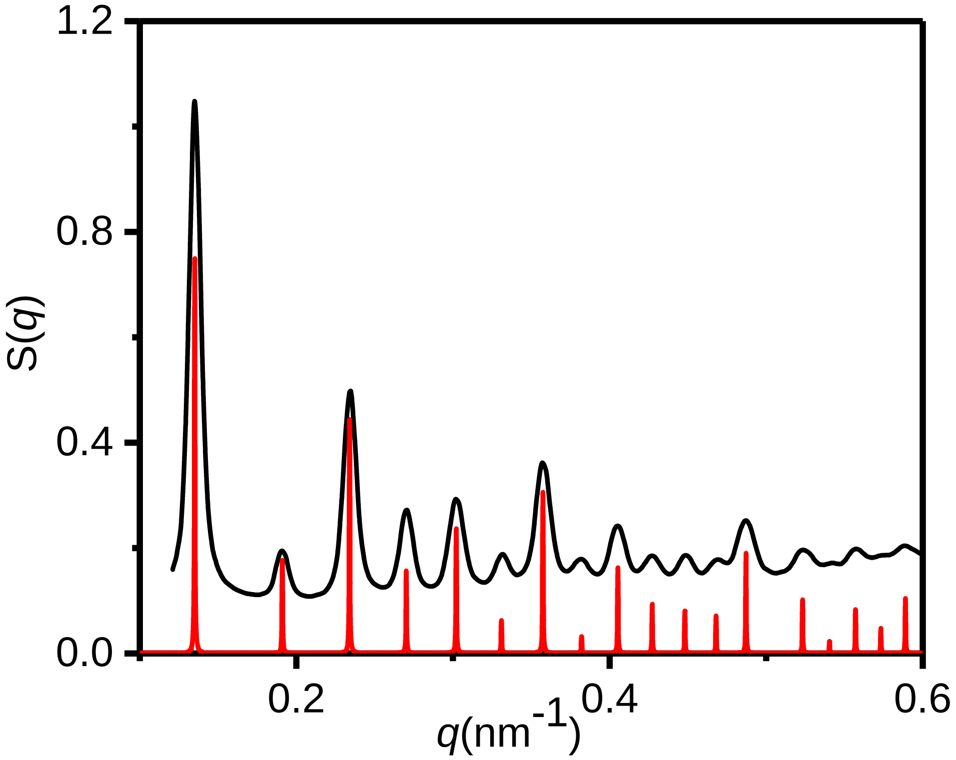

Figure S13. Enlargement of structure factor result for the body-centered cubic lattice shown in Figure 2e: black curve for the experimental data and red curve for the model.

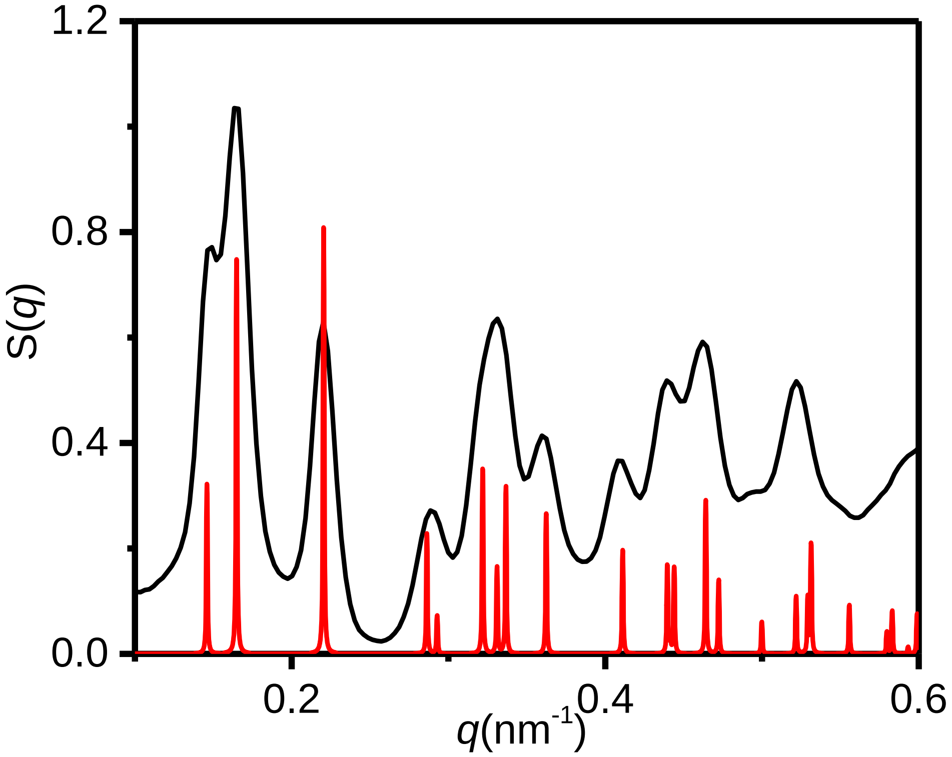

Figure S14. Enlargement of structure factor result for the simple hexagonal lattice shown in Figure 2f: black curve for the experimental data and red curve for the model.

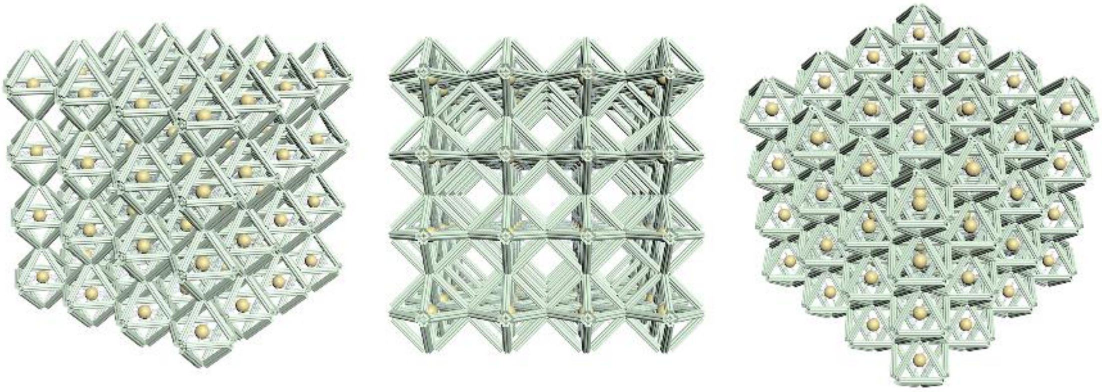

Figure S15. The close-packed models of simple cubic lattice formed by octahedral frames in different angles.

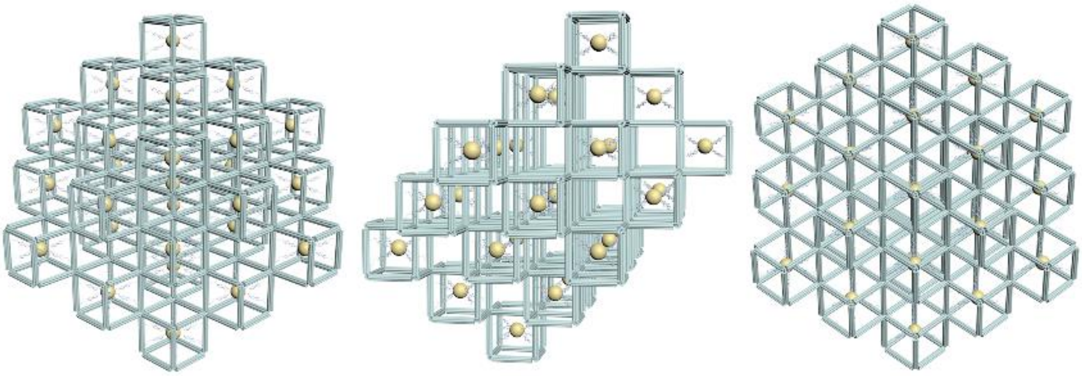

Figure S16. The close-packed models of body-centered cubic lattice formed by cubic frames in different angles.

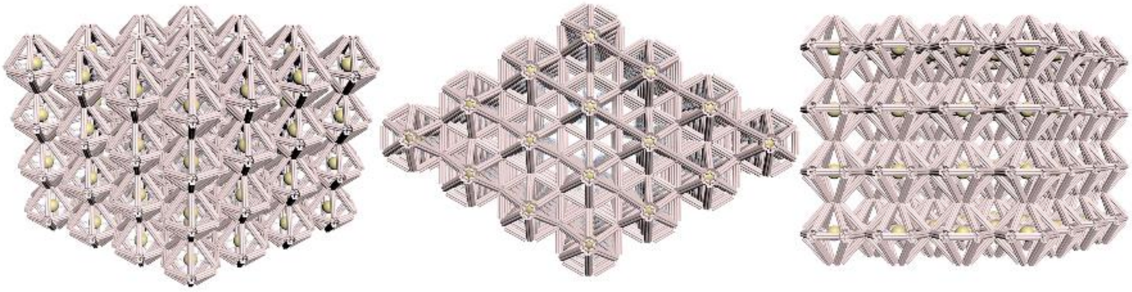

Figure S17. The close-packed models of simple hexagonal lattice formed by hexagonal bipyramid frames in different angles.

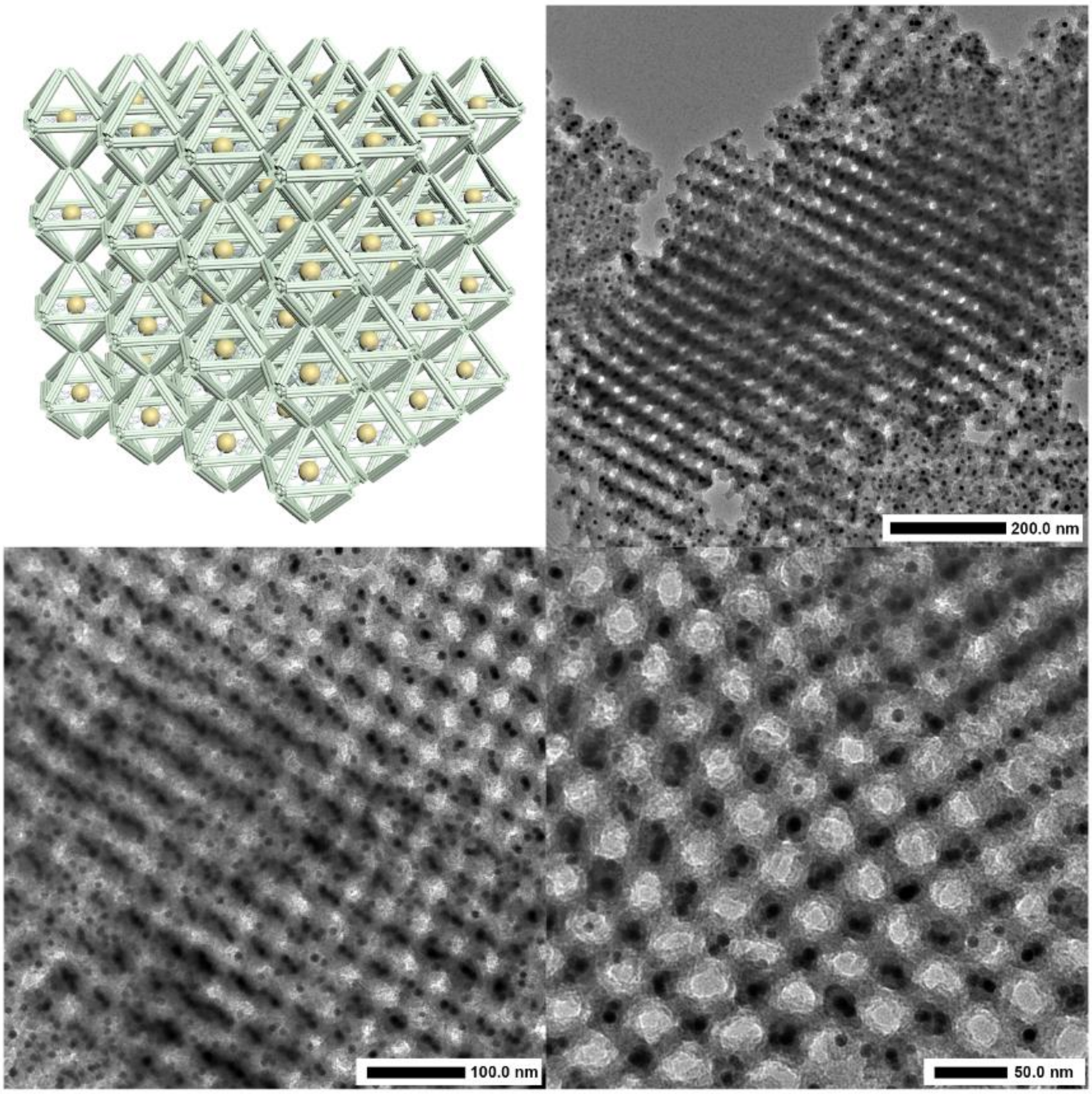

Figure S18. Representative TEM images of siliconized 3D lattices for octahedral frames. The schematic of the corresponding lattice model is shown on the upper left.

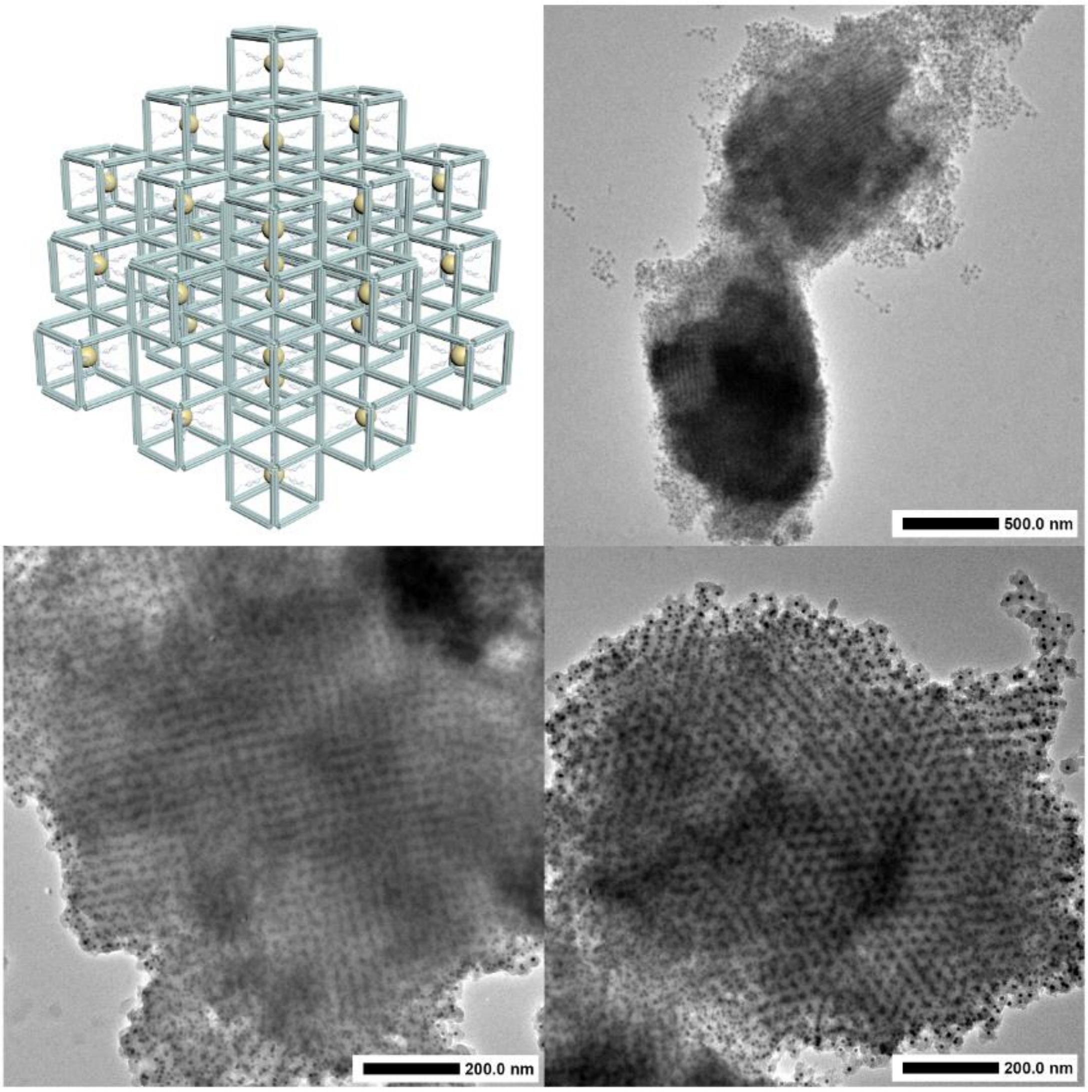

Figure S19. Representative TEM images of siliconized 3D lattices for cubic frames. The schematic of the corresponding lattice model is shown on the upper left.

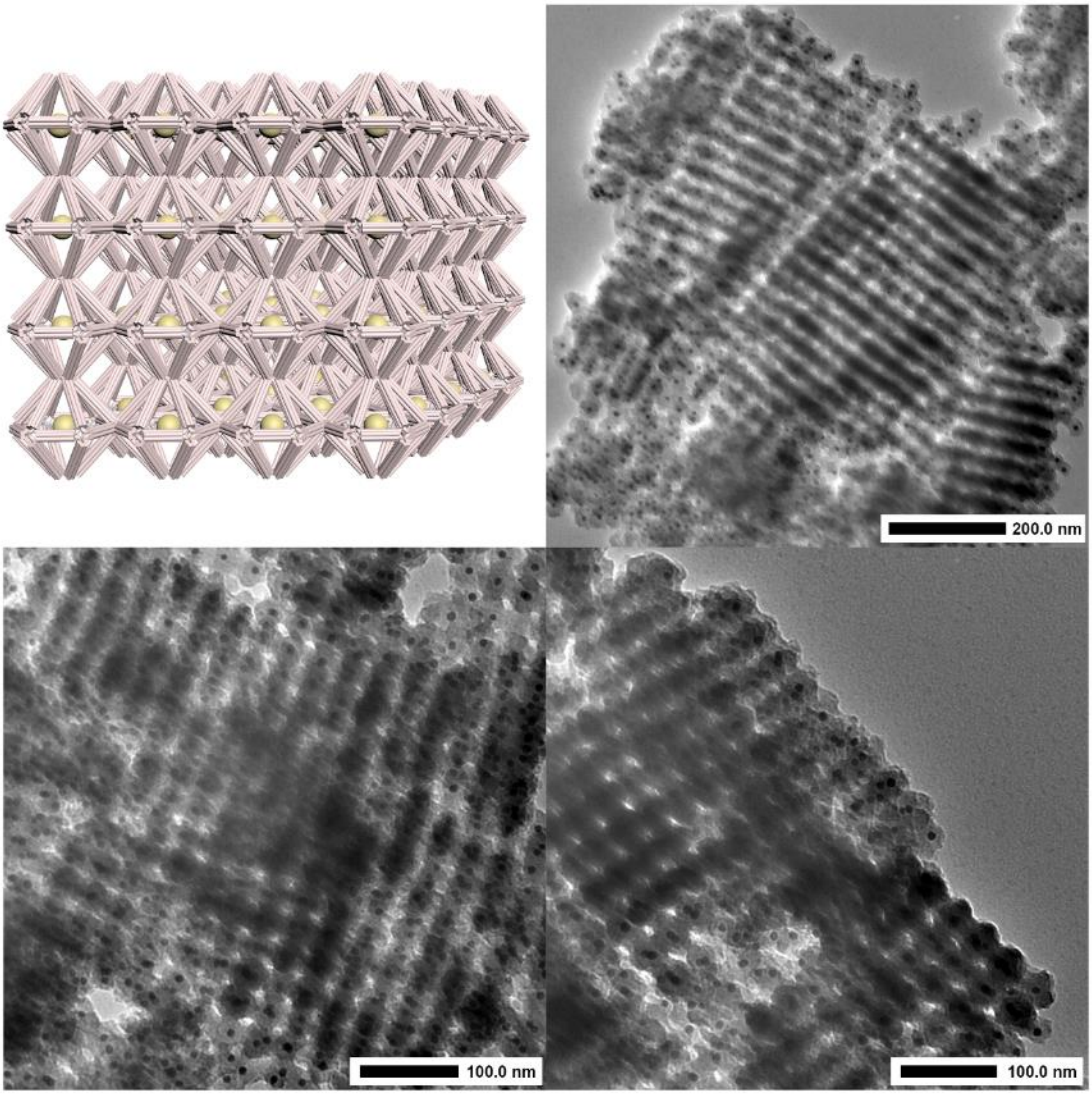

Figure S20. Representative TEM images of siliconized 3D lattices for hexagonal bipyramid frames. The schematic of the corresponding lattice model is shown on the upper left.

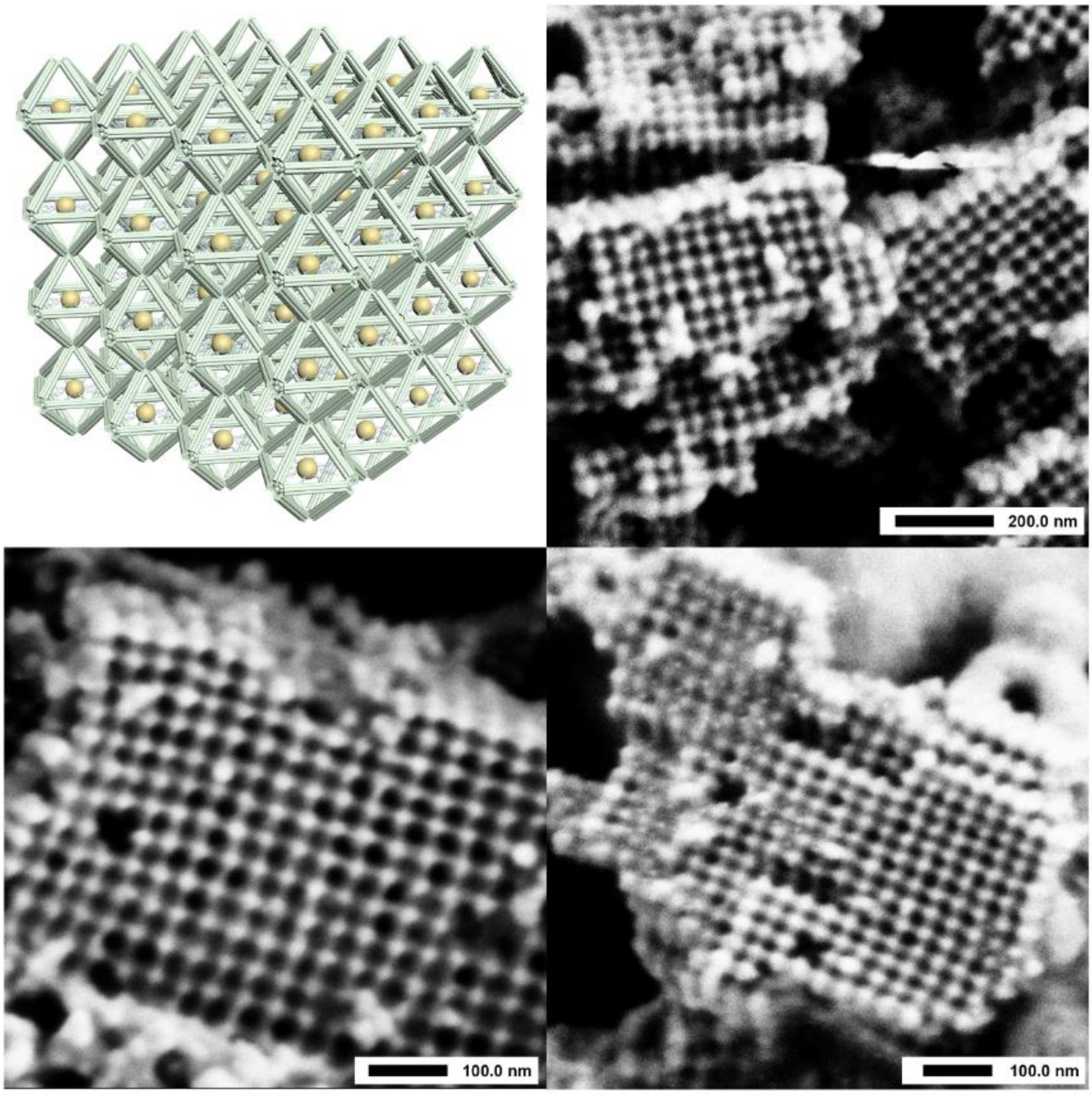

Figure S21. Representative SEM images of siliconized 3D lattices for octahedral frames. The schematic of the corresponding lattice model is shown on the upper left.

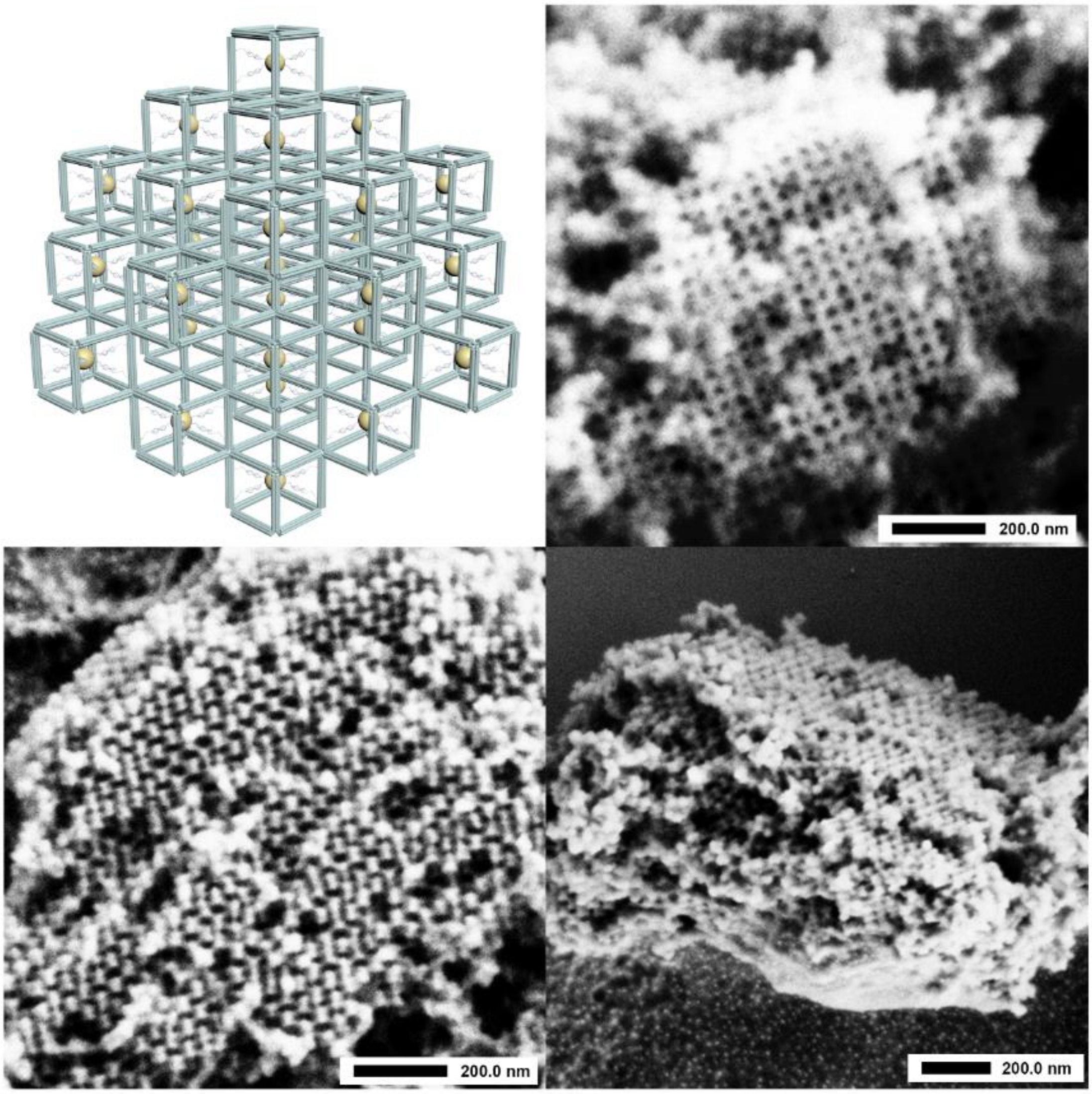

Figure S22. Representative SEM images of siliconized 3D lattices for cubic frames. The schematic of the corresponding lattice model is shown on the upper left.

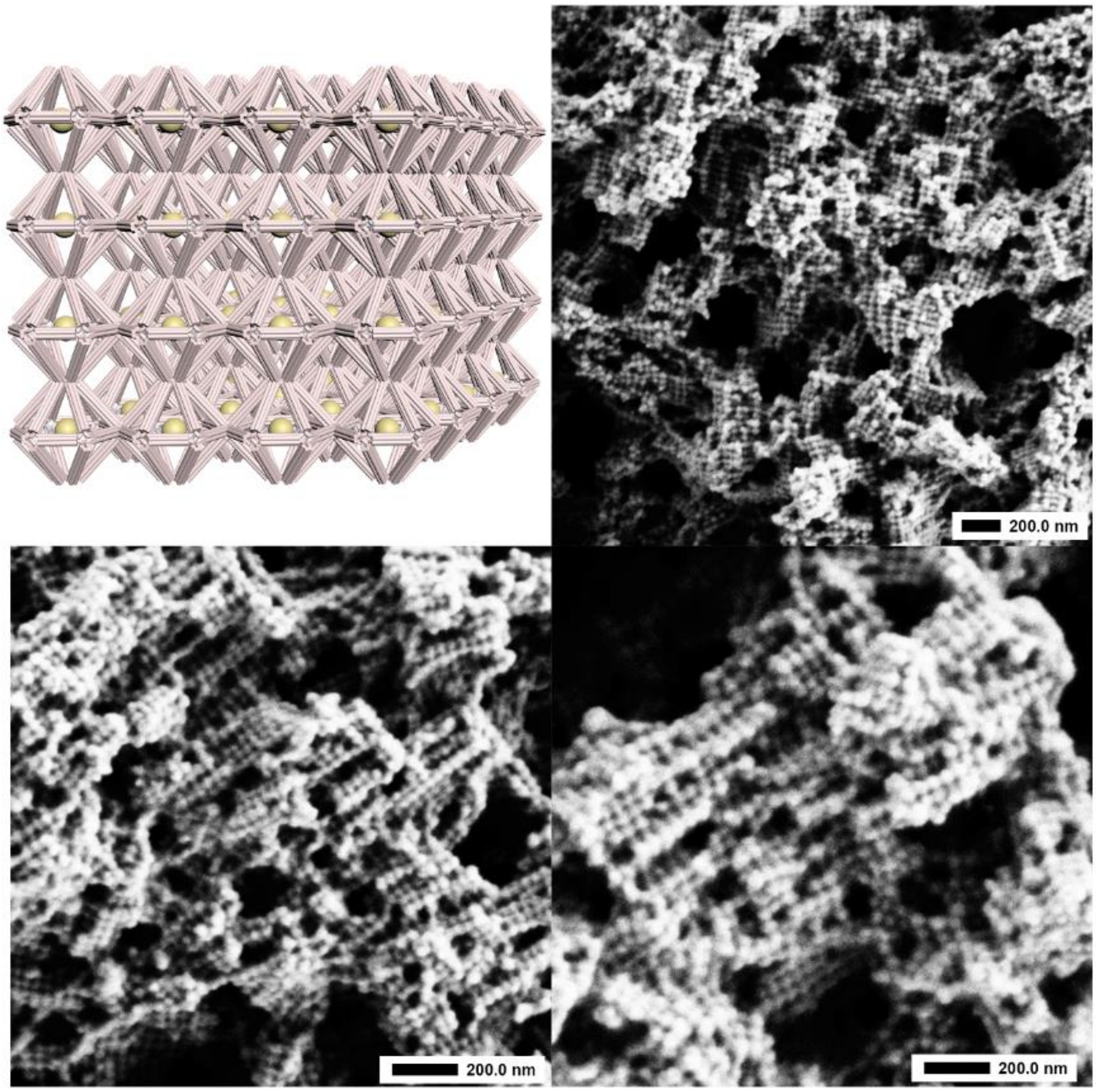

Figure S23. Representative SEM images of siliconized 3D lattices for hexagonal bipyramid frames. The schematic of the corresponding lattice model is shown on the upper left.

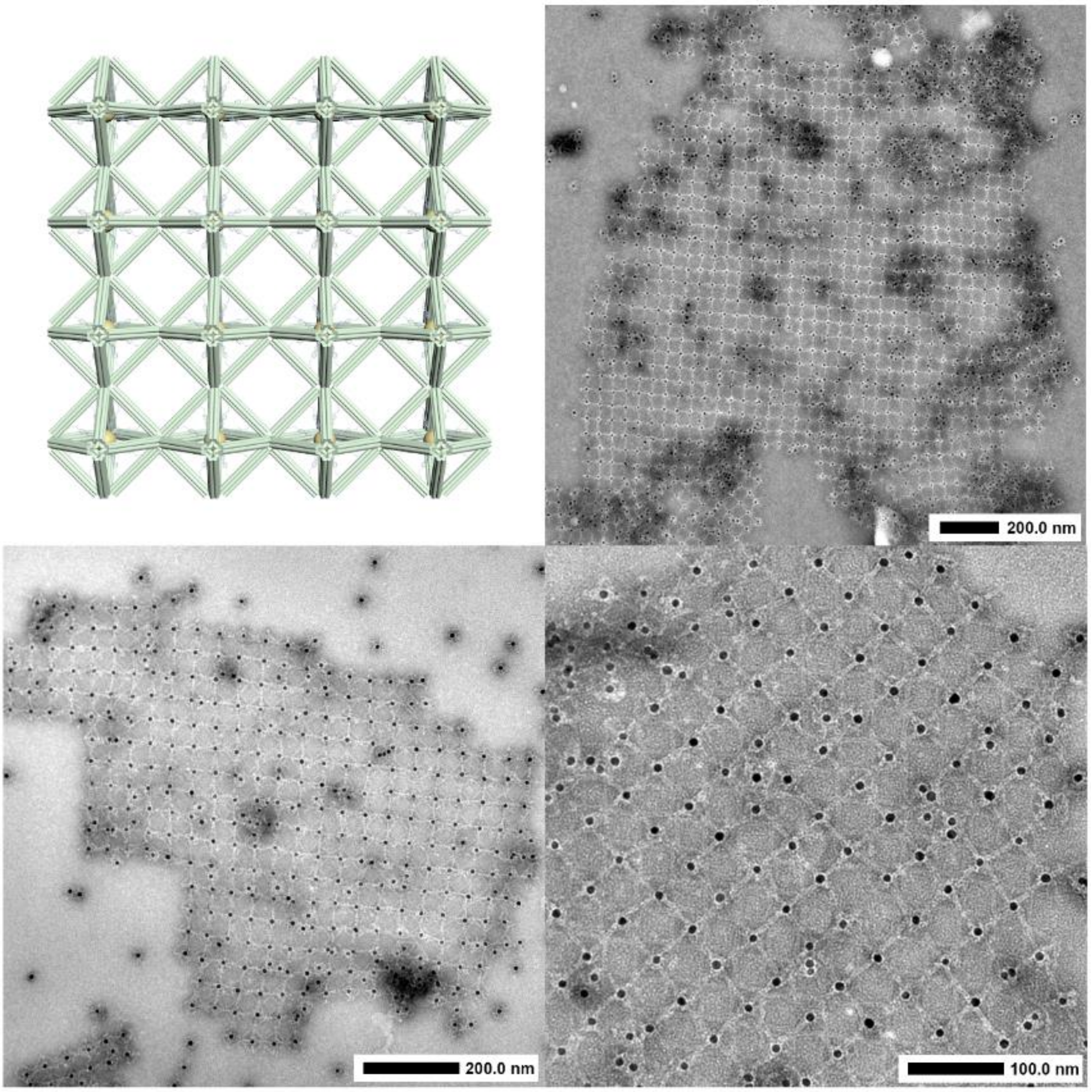

Figure S24. Representative negative-stained TEM images of 2D planar structures formed by AuNP-octahedron monomers. The corresponding schematic is shown on the upper left.

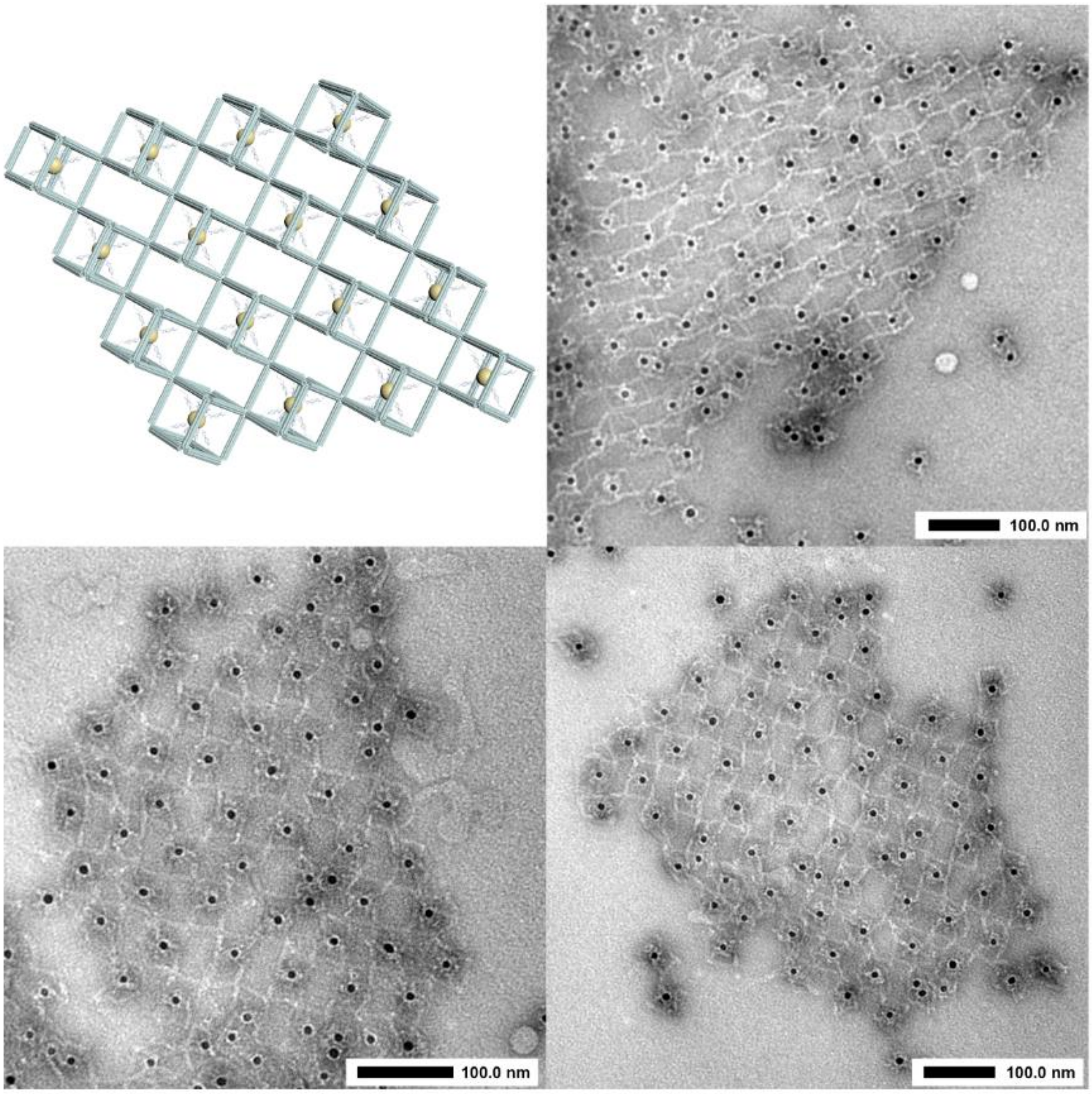

Figure S25. Representative negative-stained TEM images of 2D planar structures formed by AuNP-cube monomers. The corresponding schematic is shown on the upper left.

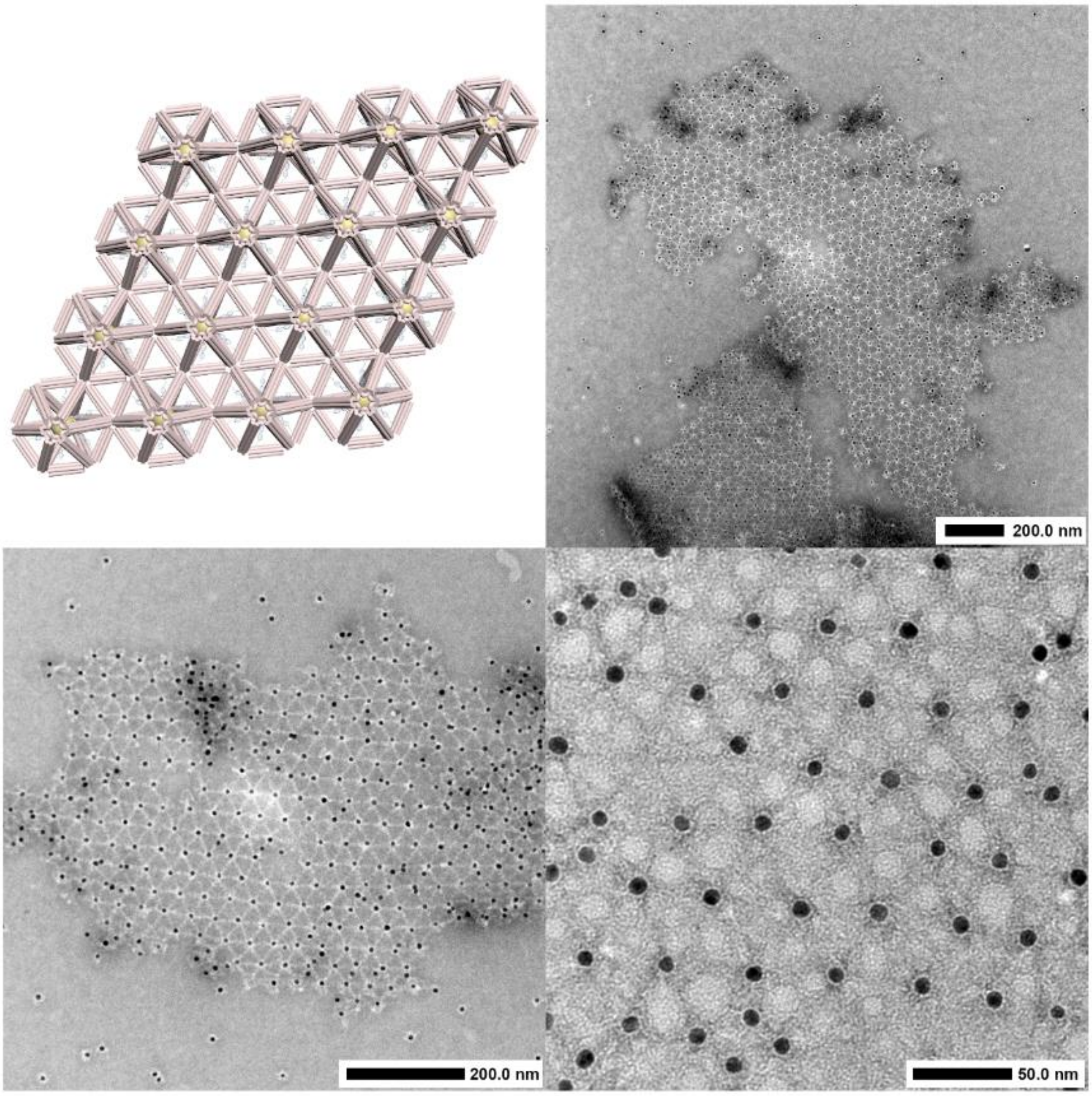

Figure S26. Representative negative-stained TEM images of 2D planar structures formed by AuNP-hexagonal bipyramid monomers. The corresponding schematic is shown on the upper left.

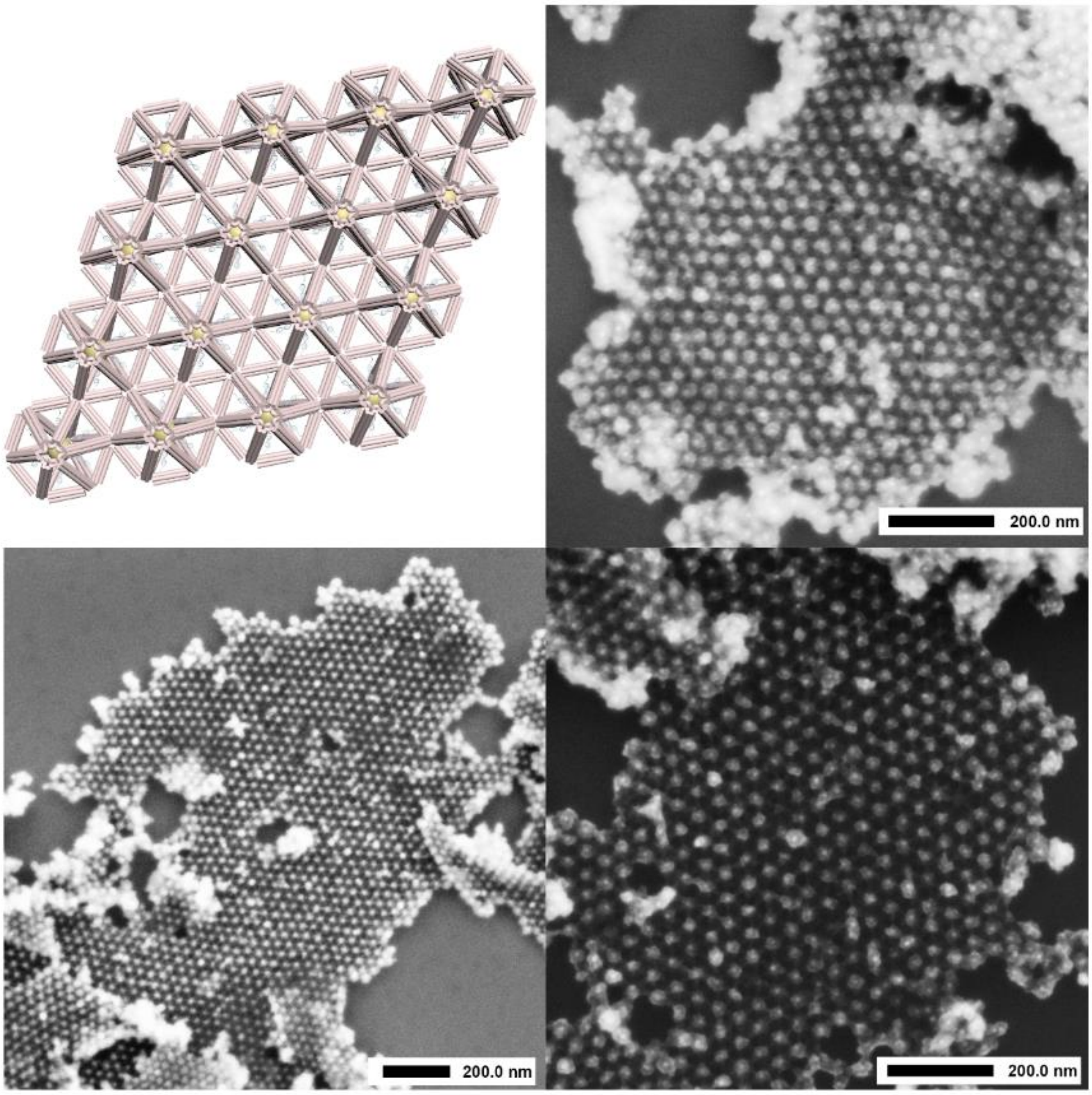

Figure S27. Representative SEM images of siliconized 2D planar structures formed by AuNP-hexagonal bipyramid monomers. The corresponding schematic is shown on the upper left.

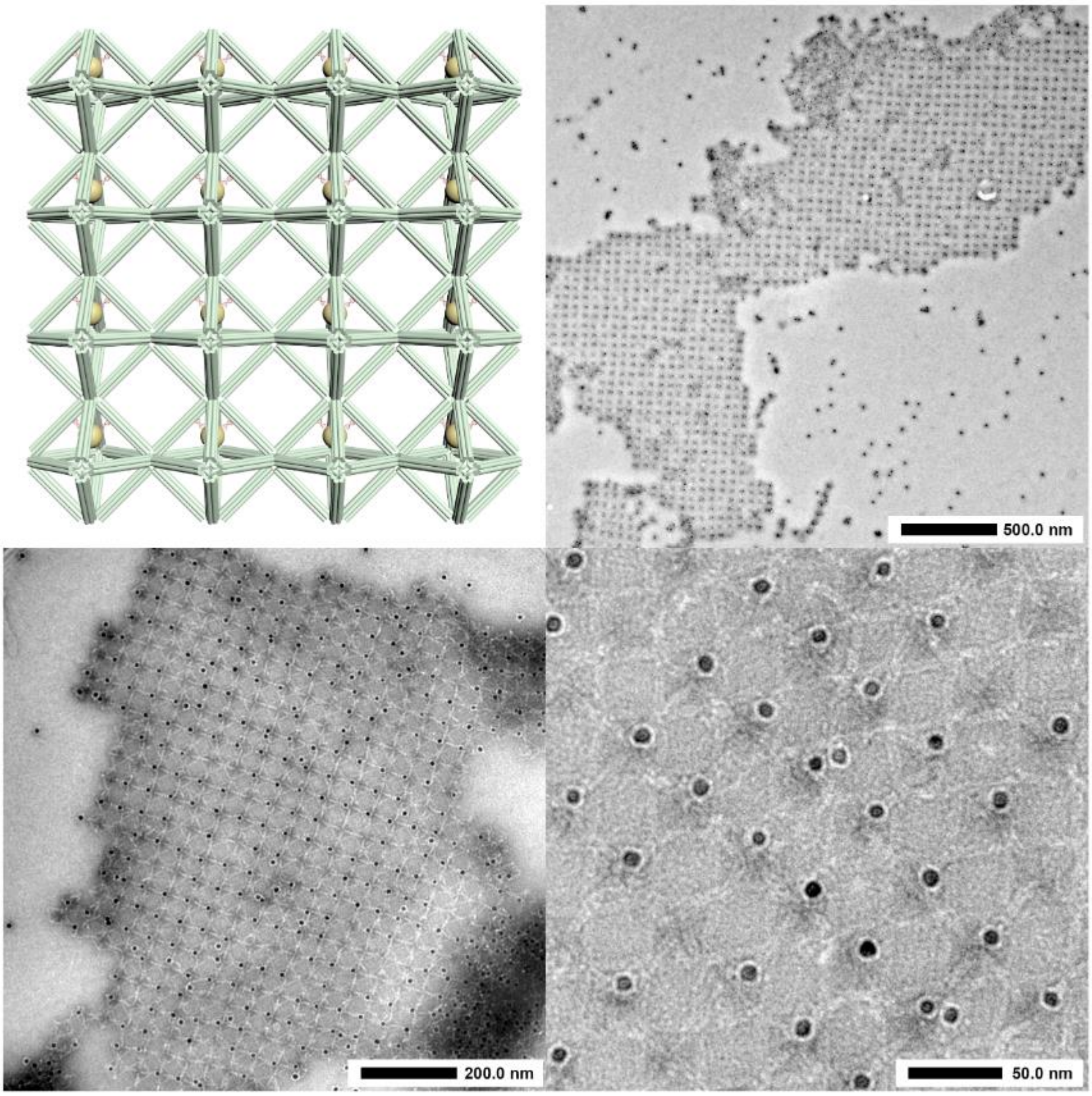

Figure S28. Representative negative-stained TEM images of 2D planar structures for the conjugated monomer with AuNPs near the vertex. The corresponding schematic is shown on the upper left.

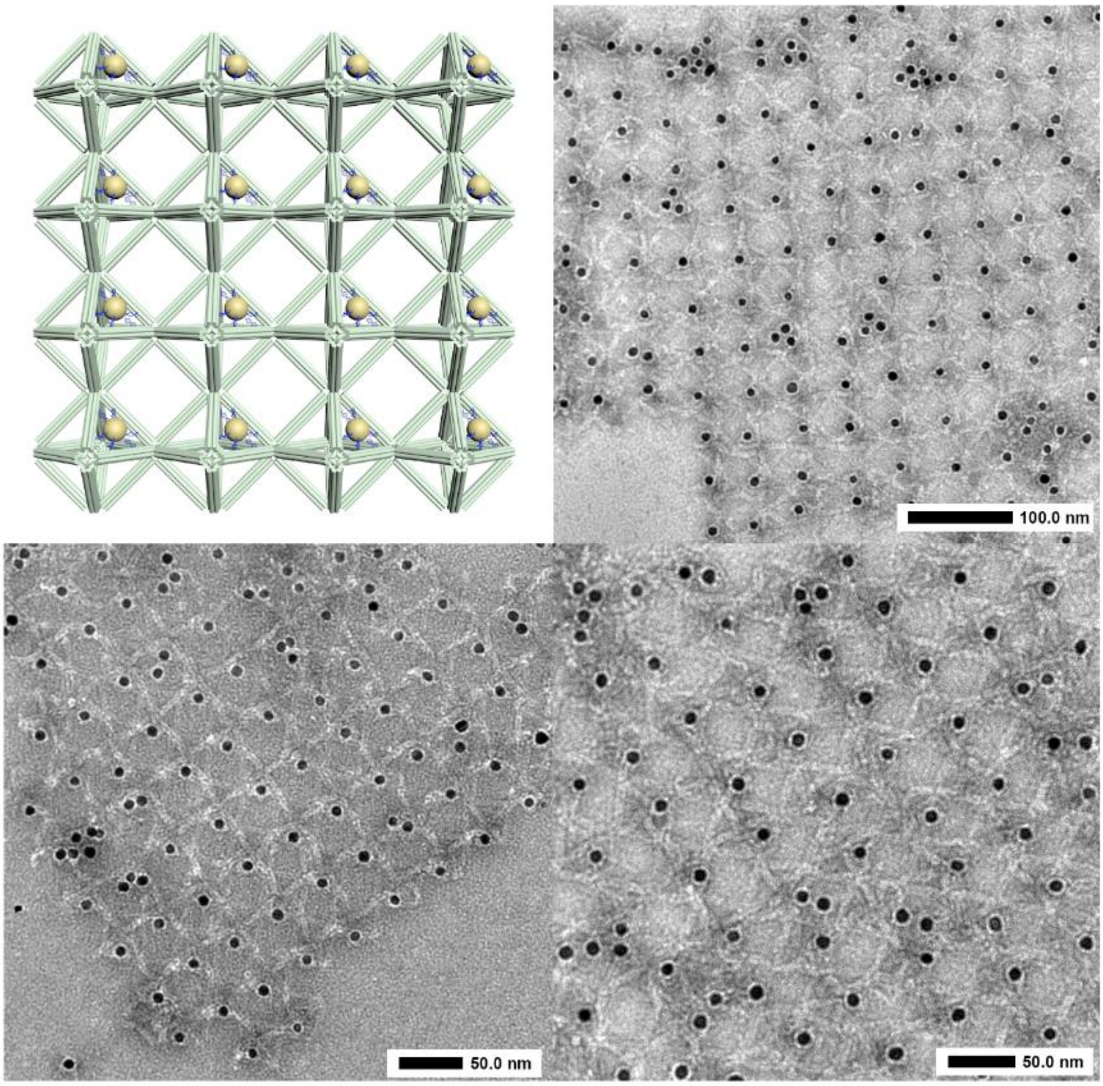

Figure S29. Representative negative-stained TEM images of 2D planar structures for the conjugated monomer with AuNPs in the face center. The corresponding schematic is shown on the upper left.

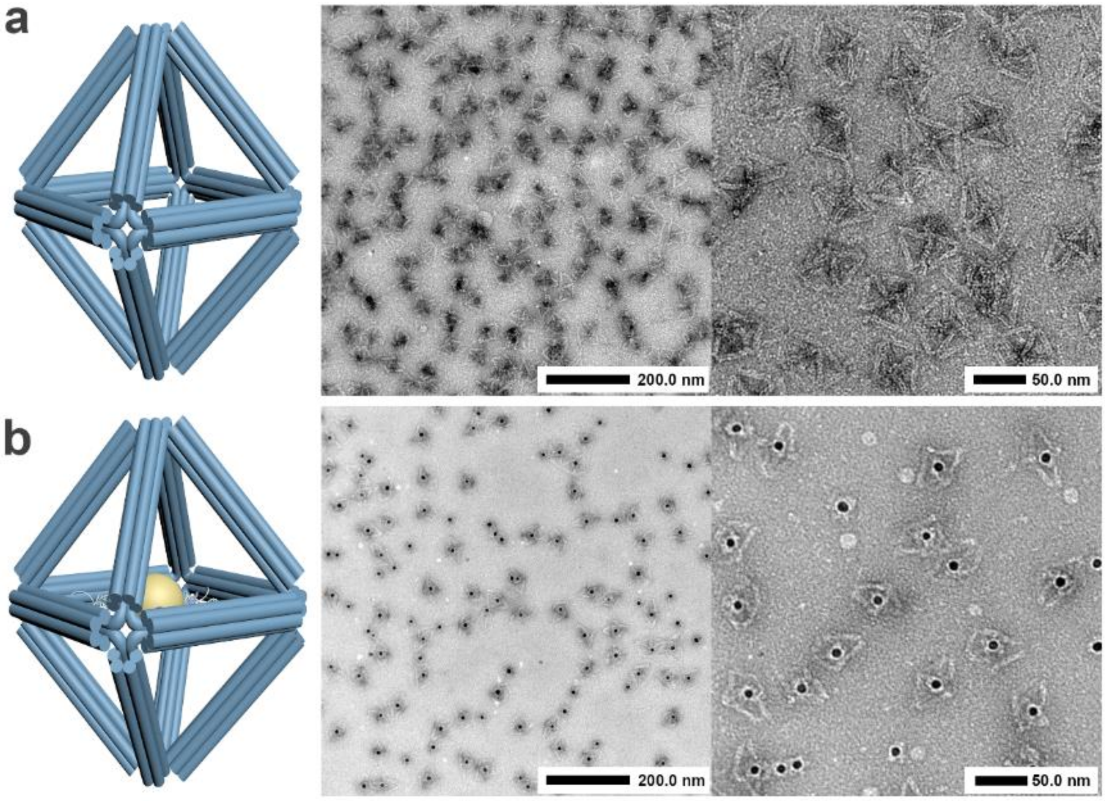

Figure S30. a) Representative negative-stained TEM images of elongated octahedral DNA origami frames. b) Representative negative-stained TEM images of AuNP-elongated octahedron monomers. Corresponding schematics are shown on the left.

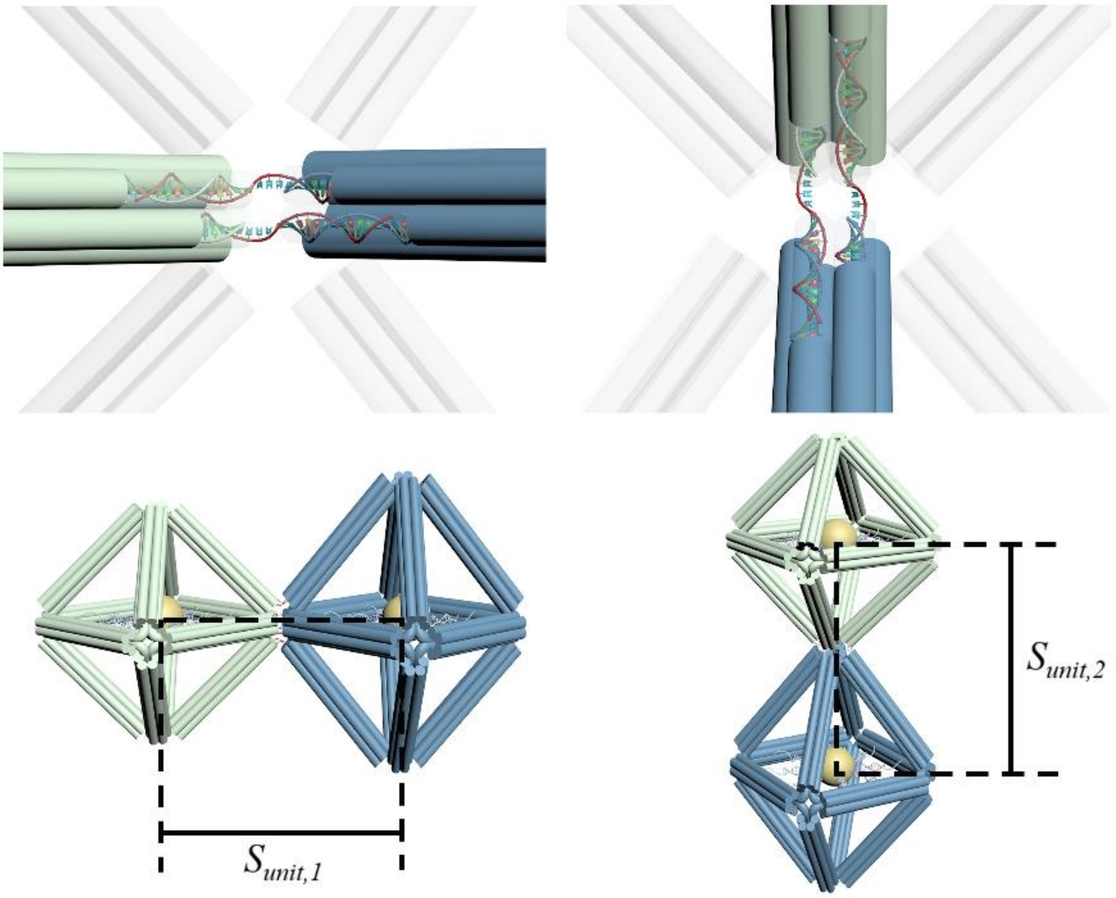

Figure S31. The magnified schematics of the bridge pattern for the binary system at vertex junctions. $S_{unit,1}$ and $S_{unit,2}$ respectively represents the distance between the body centers of adjacent frames in non-identical crystallographic axis directions.

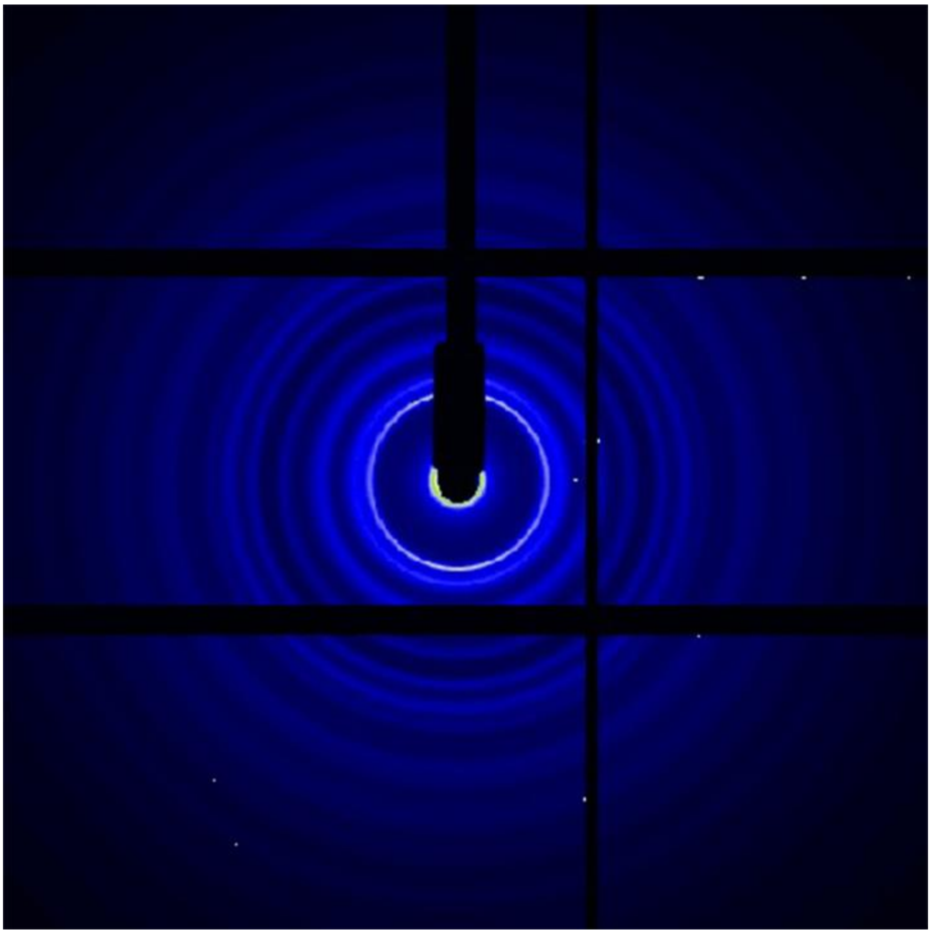

Figure S32. 2D pattern of the AuNP lattice in the binary system measured by SAXS.

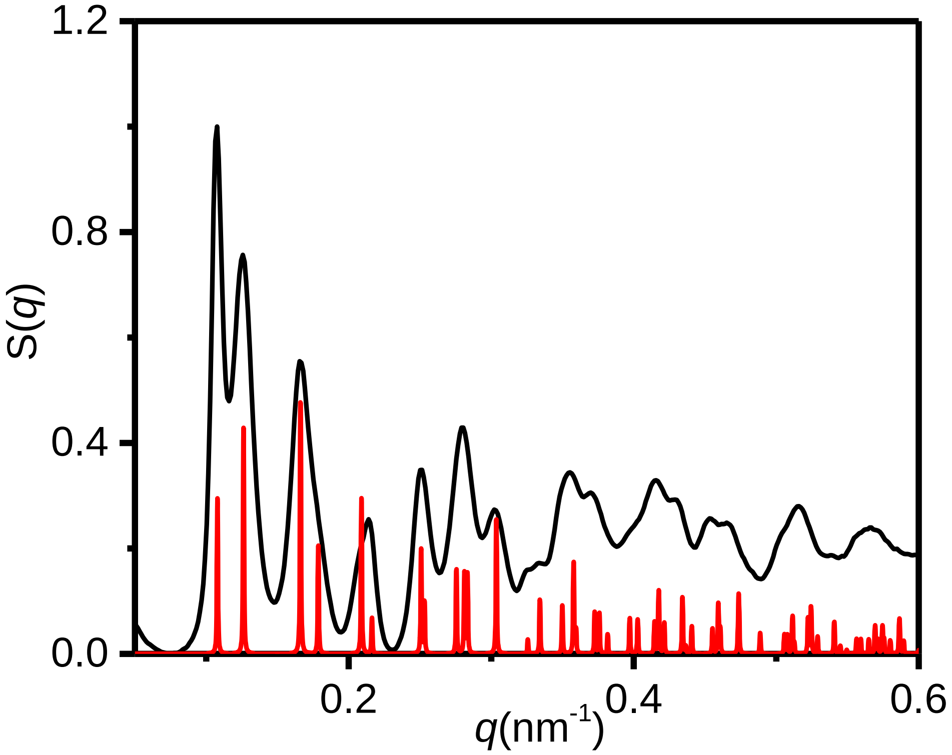

Figure S33. Enlargement of structure factor result for the tetragonal lattice shown in Figure 5b: black curve for the experimental data and red curve for the model.

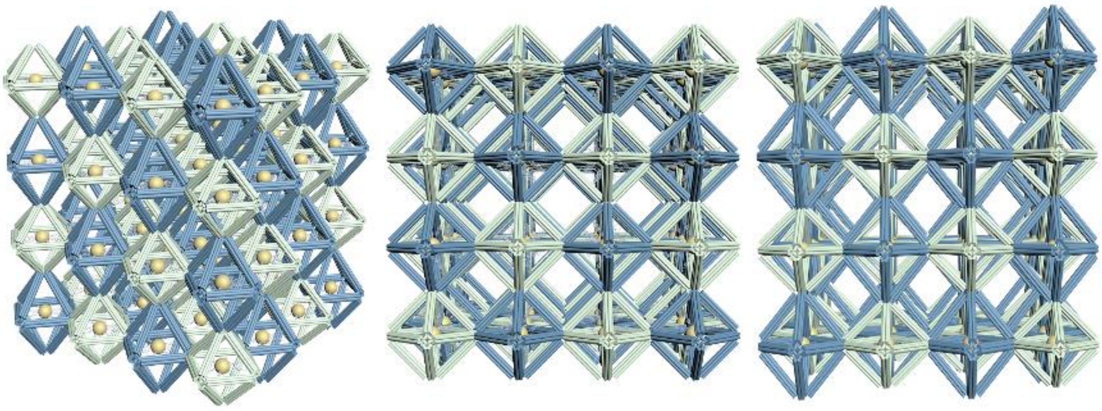

Figure S34. The close-packed models of tetragonal lattice of the binary system in different angles.

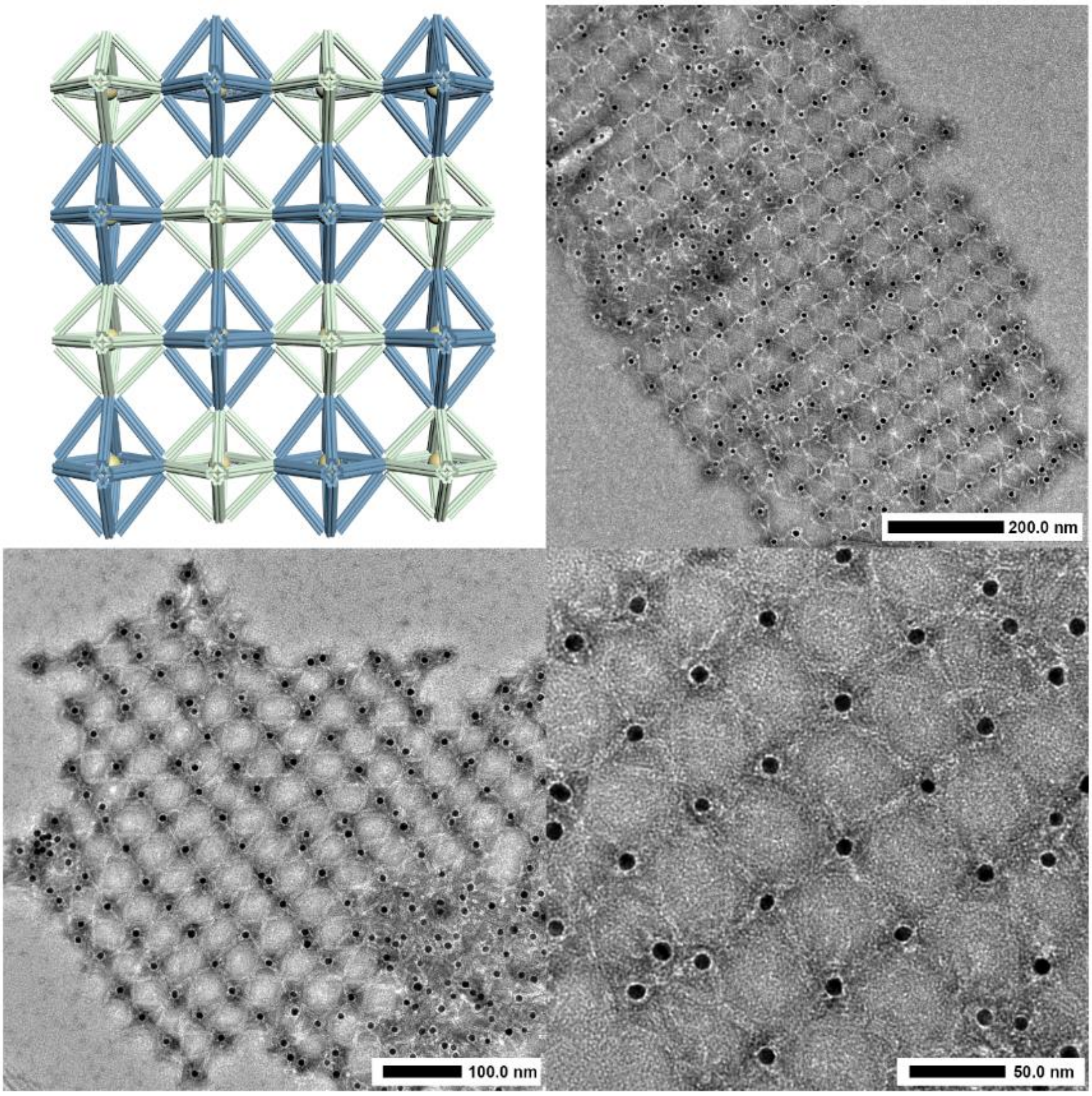

Figure S35. Representative negative-stained TEM images of 2D planar structures of the binary system. The corresponding schematic is shown on the upper left.

Assembly method	**Bridge pattern**		**Sticky-end hybridization (Nat. Mater., 2020)**	
Frame shape	Octahedron	Cube	Octahedron	Cube
Lattice type	SC	BCC	SC	BCC
Identifiable peaks in SAXS	~15	~18	~25	~15
Average size of ordered grains	~ 1 μm		~ 3-5 μm	
Anisotropy control	Yes		No	

Table S1. Comparison of bridging method and sticky-end hybridization method (Nat. Mater., 2020, 19, 789-796.).

References

1. X. Liu, F. Zhang, X. Jing, M. Pan, P. Liu, W. Li, B. Zhu, J. Li, H. Chen, L. Wang, J. Lin, Y. Liu, D. Zhao, H. Yan and C. Fan, Nature, 2018, 559, 593-598.
2. Y. Tian, J. R. Lhermitte, L. Bai, T. Vo, H. L. Xin, H. Li, R. Li, M. Fukuto, K. G. Yager, J. S. Kahn, Y. Xiong, B. Minevich, S. K. Kumar and O. Gang, Nat. Mater., 2020, 19, 789-796.