-Supporting Information-

Seeded Growth of Two-Dimensional Dendritic Gold Nanostructures

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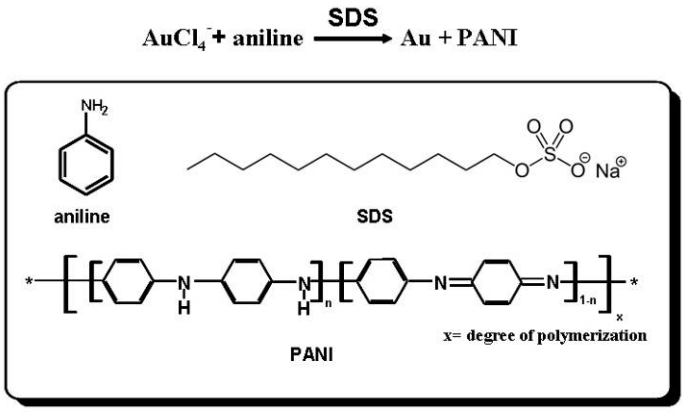
Experimental section

All solutions were prepared using ultra-pure water (resistivity > 18 MΩ·cm^{-1}). Aniline (99%, Alfa Aesar) were distilled before use and stored at 4 °C. Hydrogen tetrachloroaurate(III) (99.9%, Au 49% on metals basis, Alfa Aesar), sodium dodecylsulfate (SDS, 99.0%, Alfa Aesar), sodium citrate tribasic dihydrate (99.0%, Sigma), cetyl trimethylammonium bromide (CTAB, 99%, Sigma), L-ascorbic acid (99%, Sigma) and sodium borohydride (98%, Strem) were purchased and used without further purification. Copper specimen grids (300 mesh) with carbon film (referred to as TEM grids in the text) were purchased from Beijing XXBR Technology Co. Transmission electron microscopy (TEM) images were collected using JEM-1400 (JEOL) operated at 100 kV. High resolution Transmission electron microscopy (HRTEM) images were collected using JEOL JEM-2010 operated at 200 kV. Atomic Force Microscopy (AFM) images were collected from Veeco DI 3300 operates on the tapping mode.

Syntheses of seed nanoparticles. 60 nm Gold nanospheres (AuNPs) were prepared by the citrate-reduction method following previously reported procedures.[1] Short[2] and long[3] gold nanorods (AuNRs) were synthesized *via* seed mediated method reported previously.

Loading of Au seeds on TEM Samples. AuNPs were loaded on TEM grid directly by dropping 20 μL of as-synthesized AuNPs solution onto the carboneous side of the grid. A filter paper was used to wick off the excess solution on the TEM grid which was then dried in air for 5 minutes. For AuNRs, the loading procedures were identical except that excess CTAB was firstly removed by centrifugation (same purification method as the literature) before 20 μL of the purified rod solutions were applied onto the grid.

Seeded growth of 2D Au Dendritic Nanostructures (DNSs). The synthesis utilizes the chemical reaction between aniline and $HAuCl_4$ in the presence of stablizing agent SDS, yielding Au (0) and polyaniline (PANI) as products (Scheme 1).



Scheme 1. Chemical reaction between $HAuCl_4$ and aniline and molecular structures of aniline, SDS and PANI.

In a typical experiment (60 nm AuNPs as seeds), aqueous solutions (solution **1**) of aniline (300 μL, 0.1 M) and SDS (40 μL, 40 mM) were firstly mixed. Then solution **2** was prepared by addition of $HAuCl_4$ solution (100 μL, 1.2 mM) into solution **1**. Within 20 seconds, 20 μL of solution **2** droplet was quickly dropped onto the Au loaded TEM grids. Filter paper was used to wick off the excess solution on the TEM grid which was then dried in air for 30 minutes to ensure complete water evaporation.

Isolation of reaction intermediates. Reaction intermediates were trapped by washing the grid with water 2 minutes after the initiation of the reaction to dissolve the reactant residue.

References

1 G. Frens, *Nat. Phys. Sci.*, 1973, **241**, 20.
2 B. Nikoobakht and M. A. El-Sayed, *Chem. Mater.*, 2003, **15**, 1957.
3 B. P. Khanal and E. R. Zubarev, *J. Am. Chem. Soc.*, 2008, **130**, 12634.

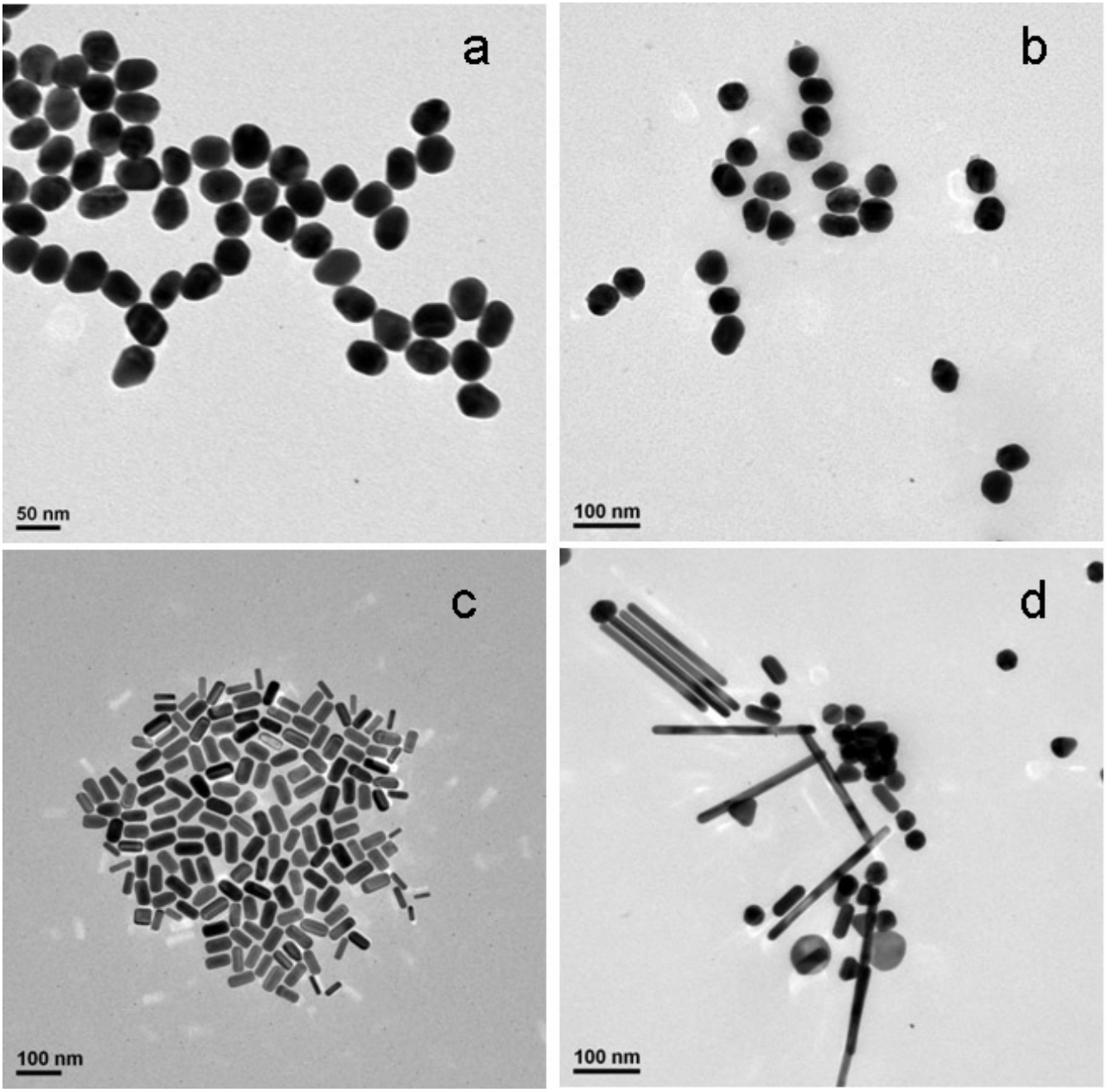


Figure S1. TEM images of (a) 40 nm and (b) 60 nm citrate-stablized AuNPs; (b) short AuNRs and (c) long AuNRs as colloidal Au seeds for synthesizing the 2D Au-PANI DNSs reported in the main text.

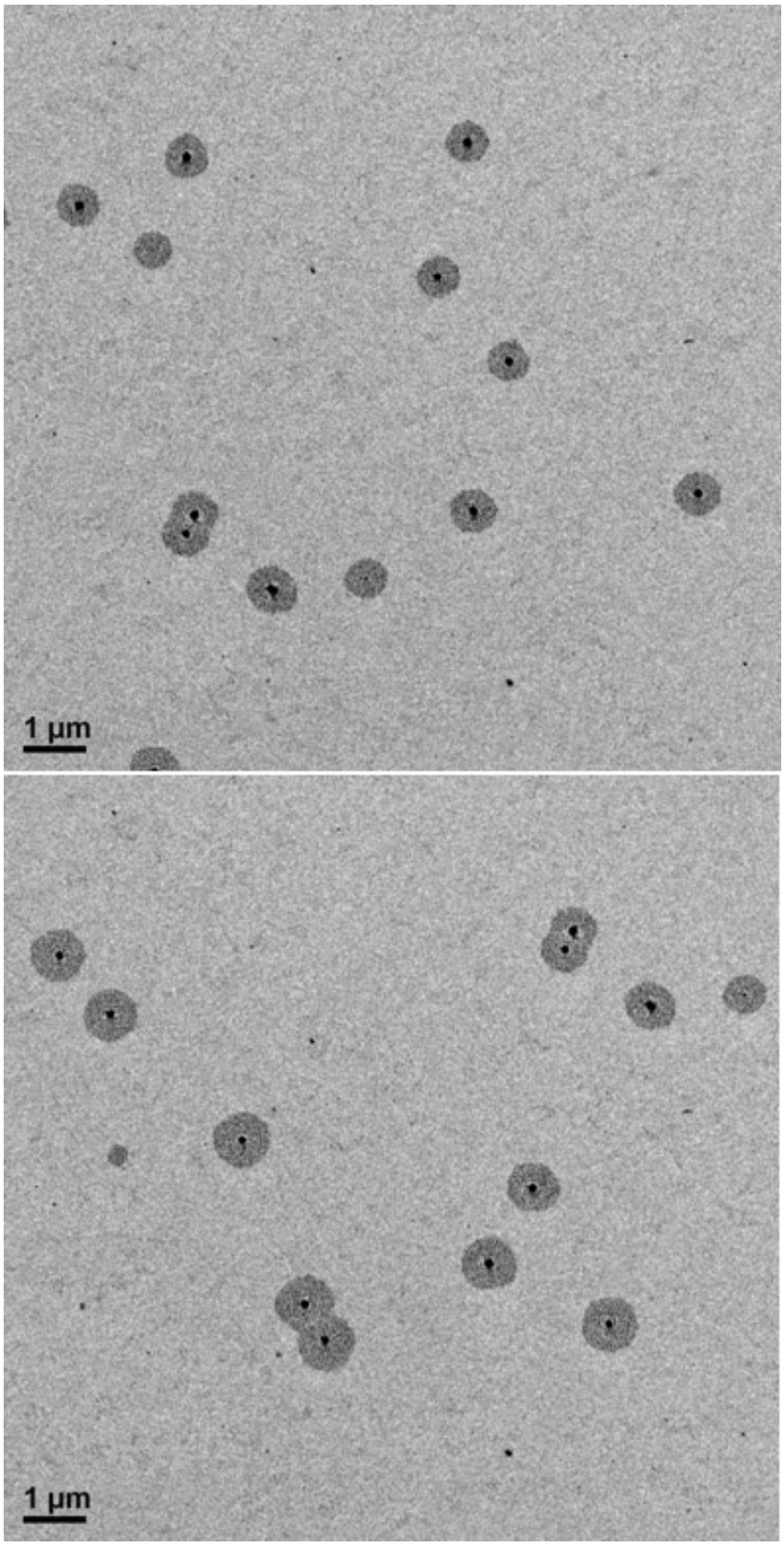


Figure S2. TEM images of 2D Au-PANI DNSs by using 60 nm AuNPs as seeds (low magnified view, a different batch from that shown in Figure 1a)

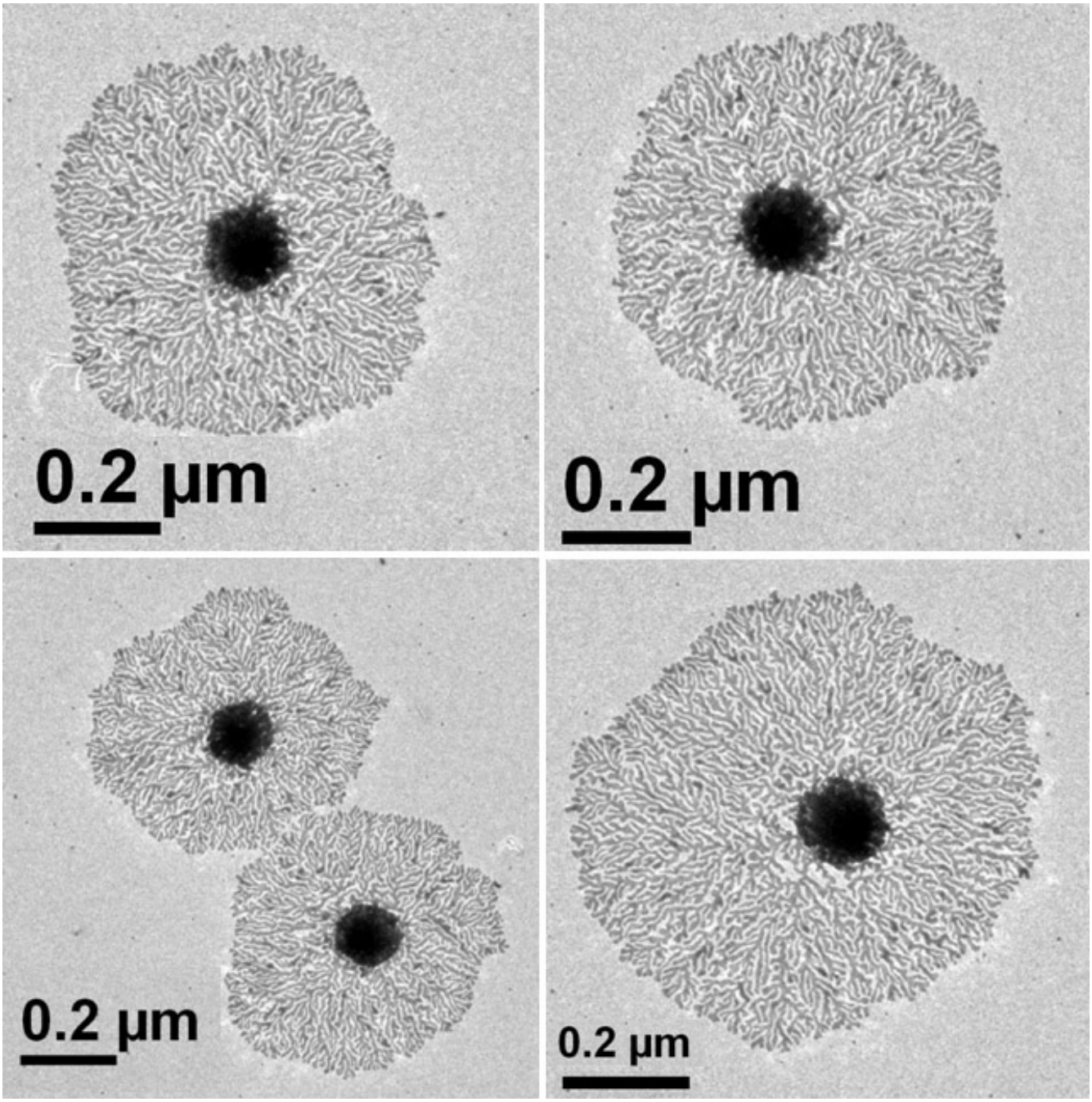


Figure S3. TEM images of typical 2D Au-PANI DNSs by using 60 nm AuNPs as seeds (high magnified view).

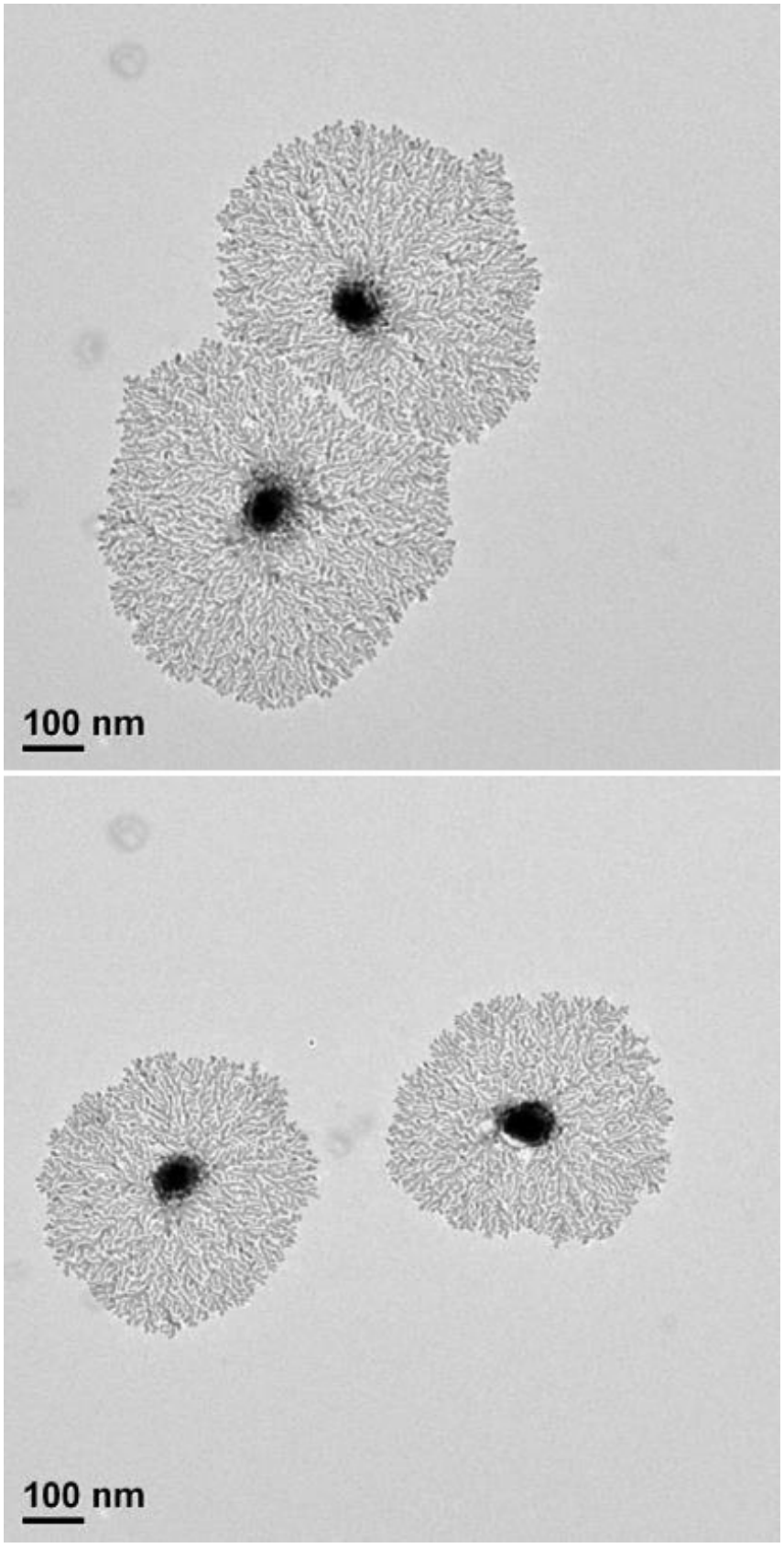


Figure S4. TEM images of 2D Au-PANI DNSs by using 40 nm AuNPs as seeds (high magnified view).

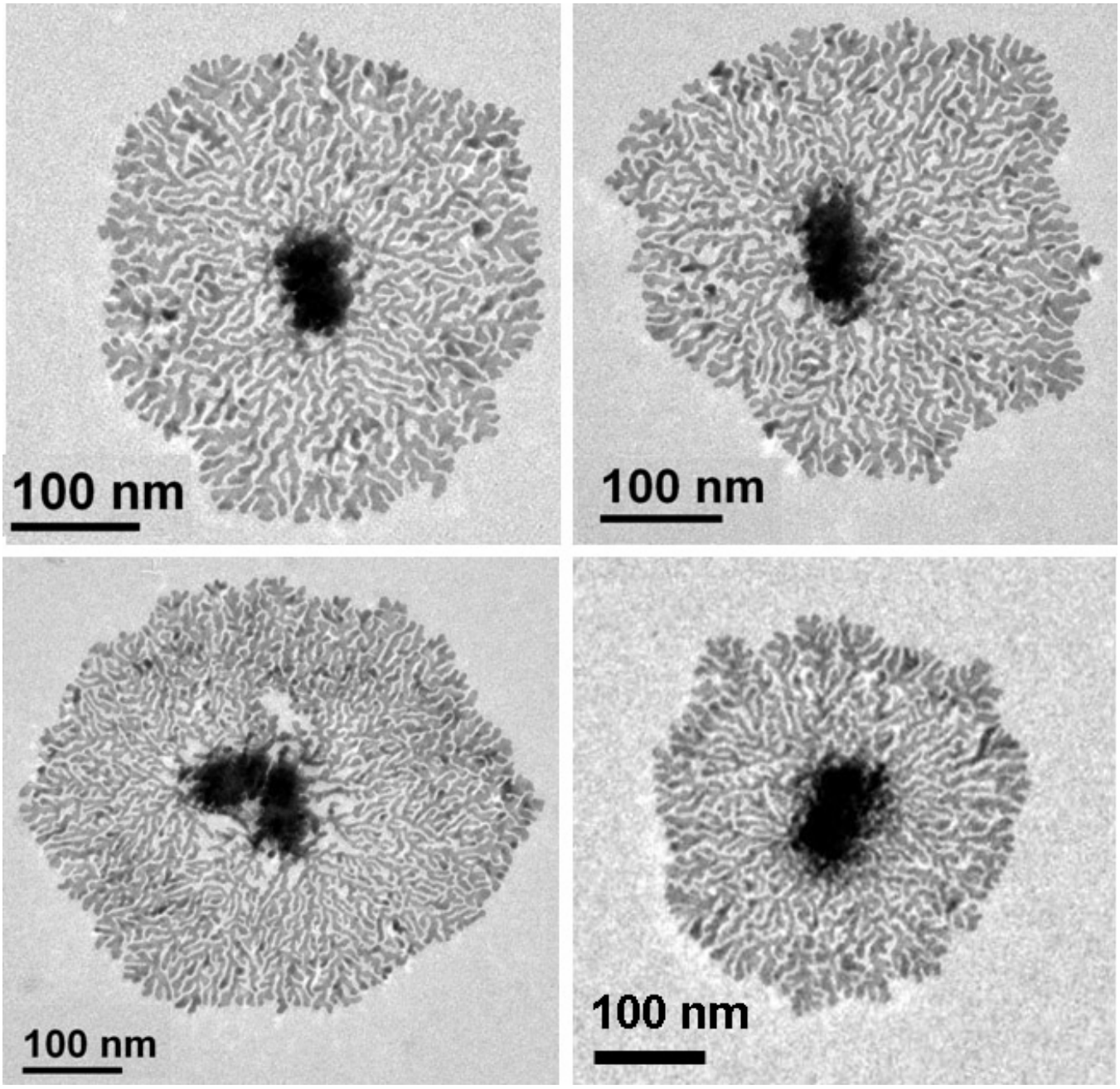


Figure S5. TEM images of 2D Au-PANI DNSs with short AuNRs seeds.

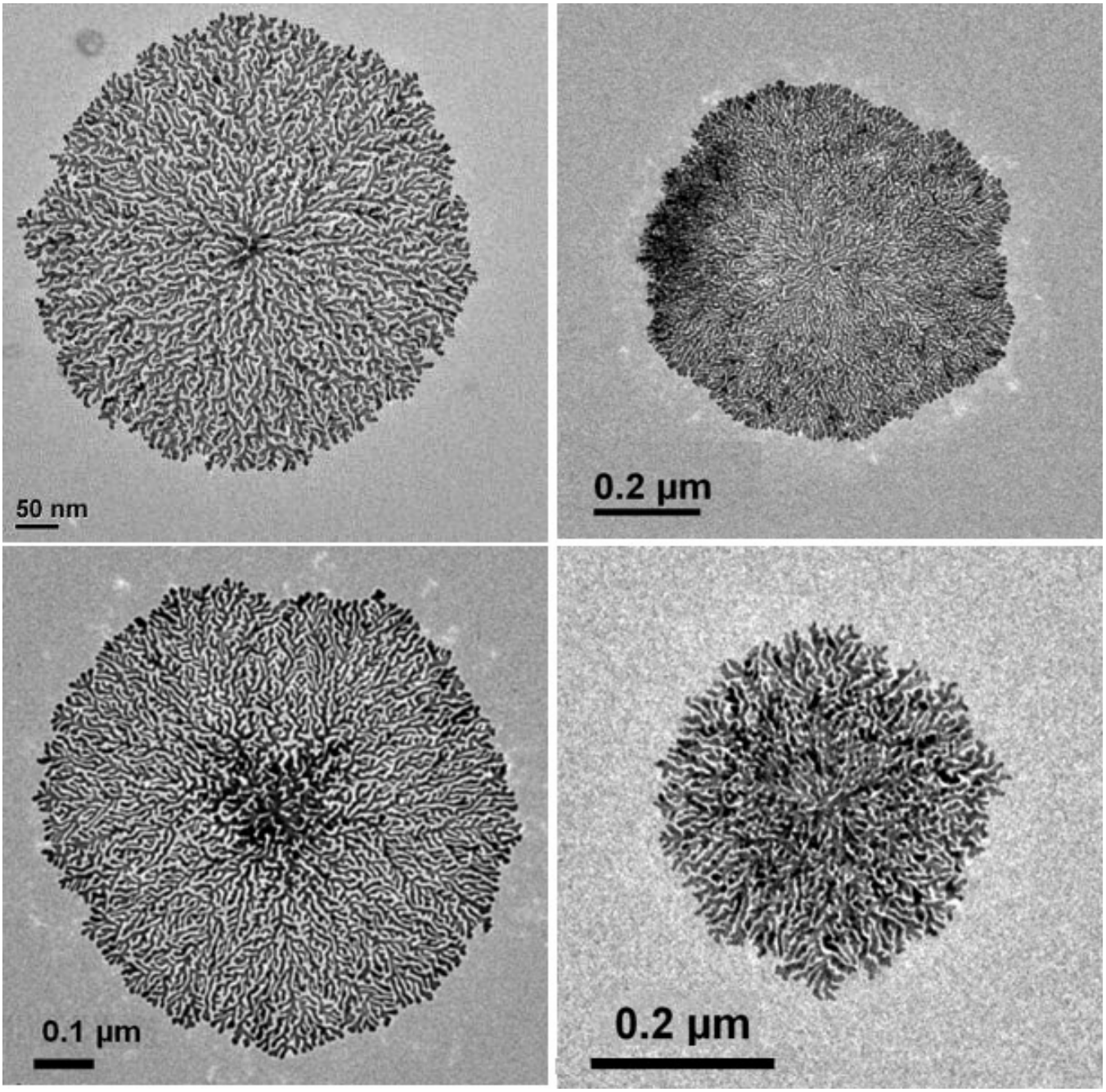


Figure S6. Typical TEM images of 2D Au-PANI DNSs synthesized in the absence of seeds. The DNSs were much rarer on the TEM grid; their size varies significantly, but the dendritic feature is similar to those with seeds.

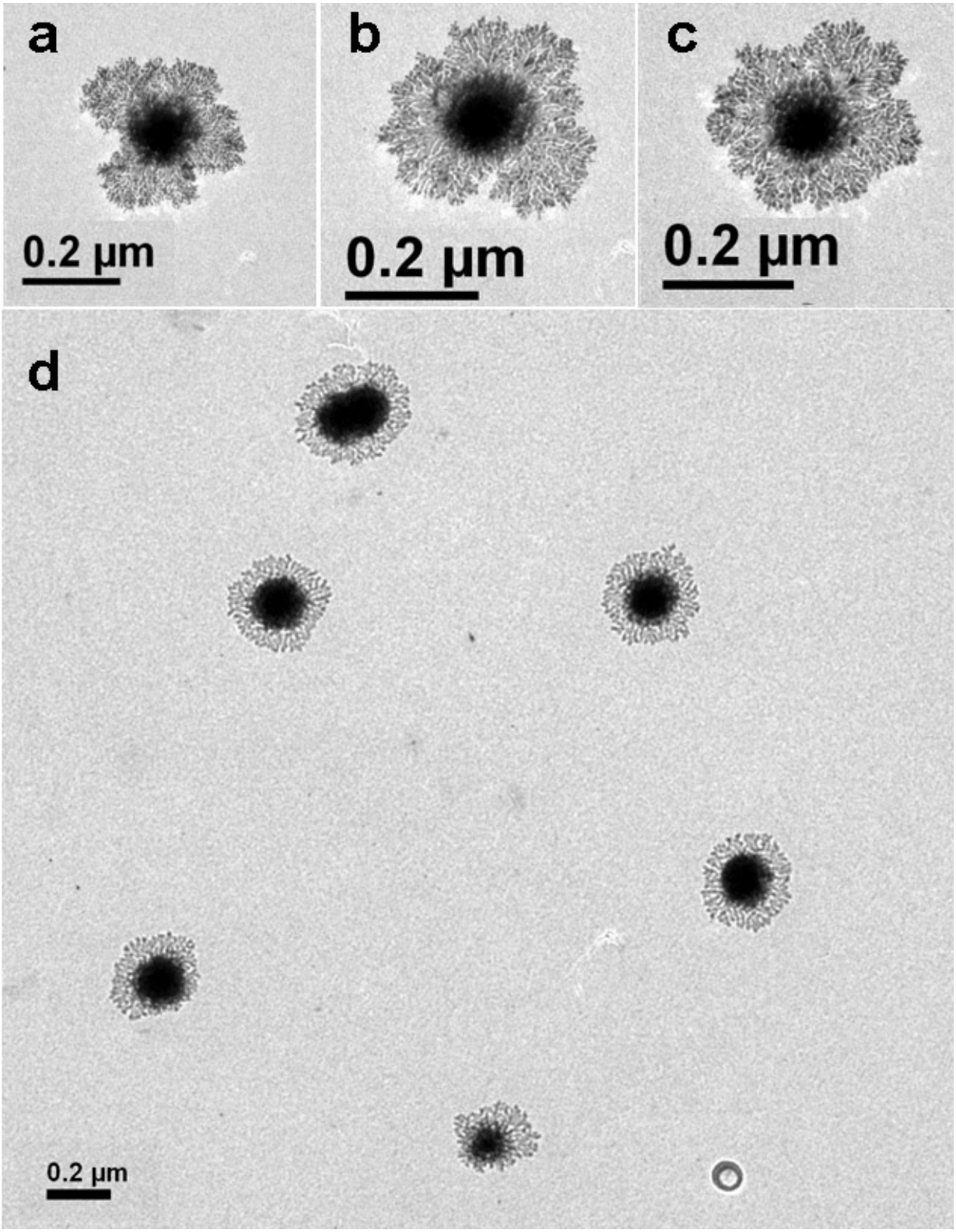


Figure S7. TEM images of the two batches of samples obtained when the TEM grid was washed with water after 2 minutes after initiation of the reaction. (a-c): batch 1; d: batch 2.

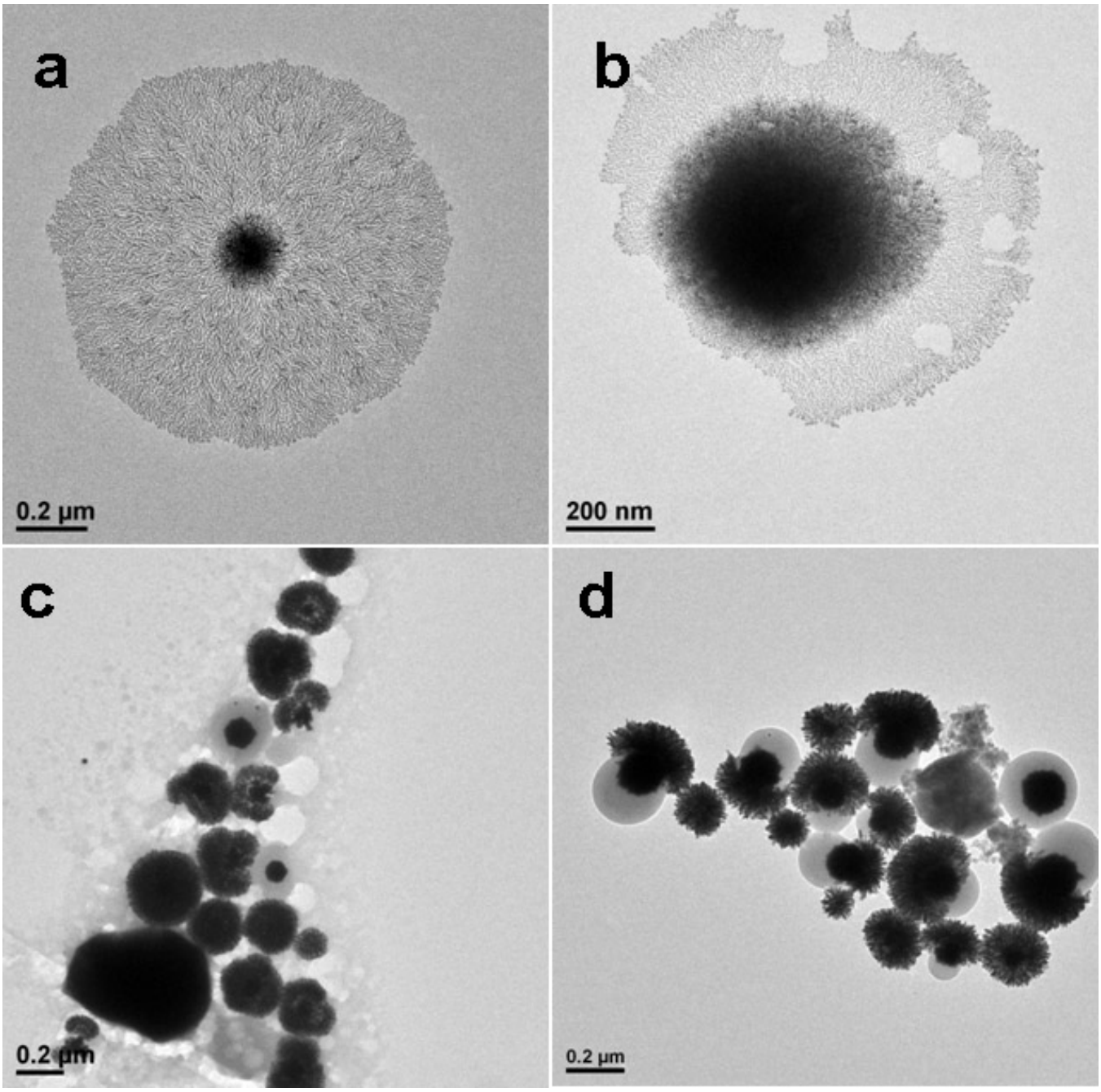


Figure S8. TEM images of the products obtained where the reaction mixture was applied to the grid (a) directly without incubation; (b) after 30 min of incubation (the same batch of product as Figure 1c) and (c) 60 min of incubation (the same batch of product as Figure 1c inset); (d) the 3D dendritic Au nanostructure synthesized in solution in the absence of Au seeds (the synthesis was following our previous work in ref 3a).

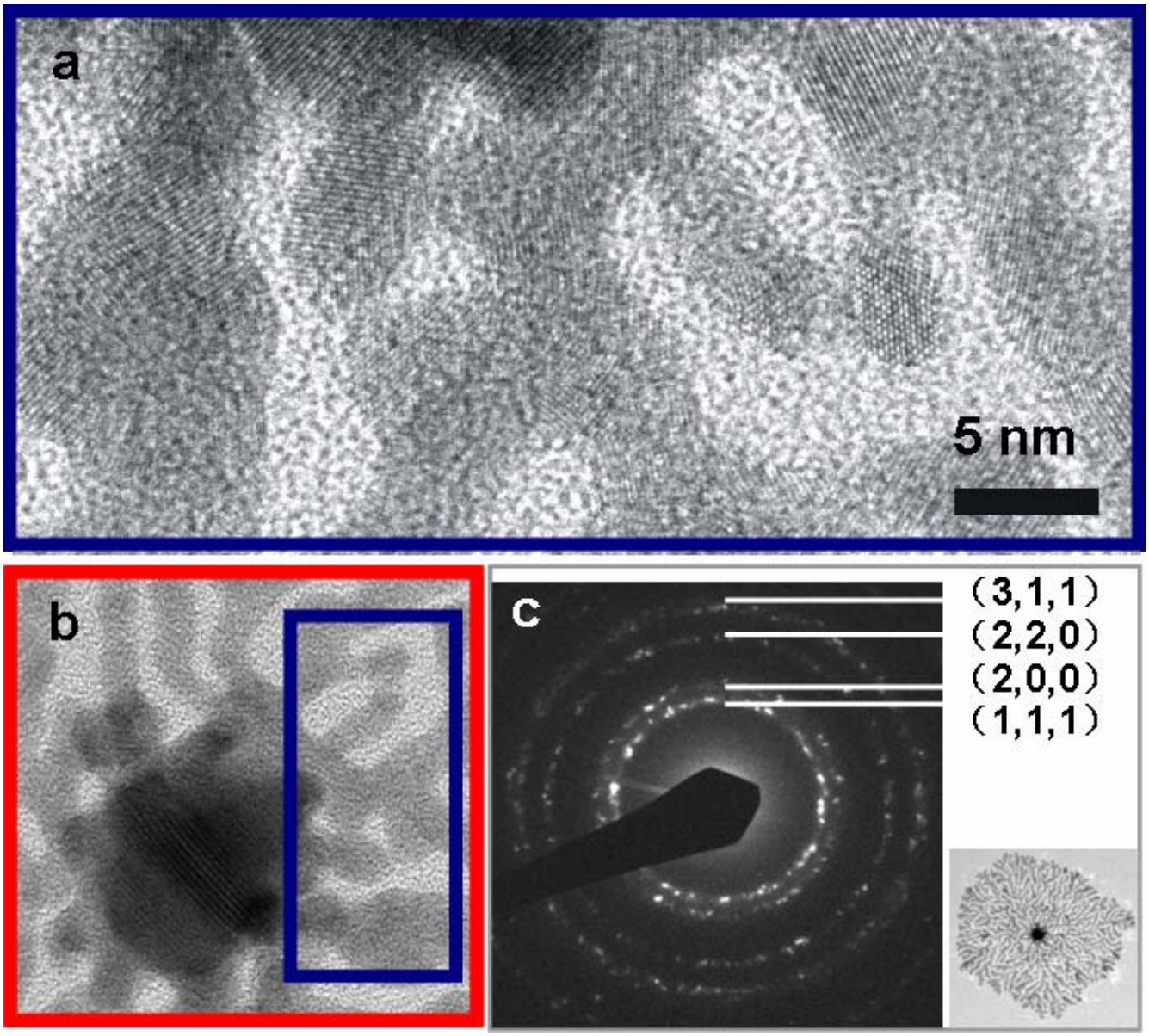


Figure S9. (a) Figure 2a in a larger size for a clearer view of the lattice fringes; (b) The parent Au-PANI DNSs whose region is within the blue square is figure S8a; (c) SAED diffraction image with assignment of each diffraction ring of the inset particle.

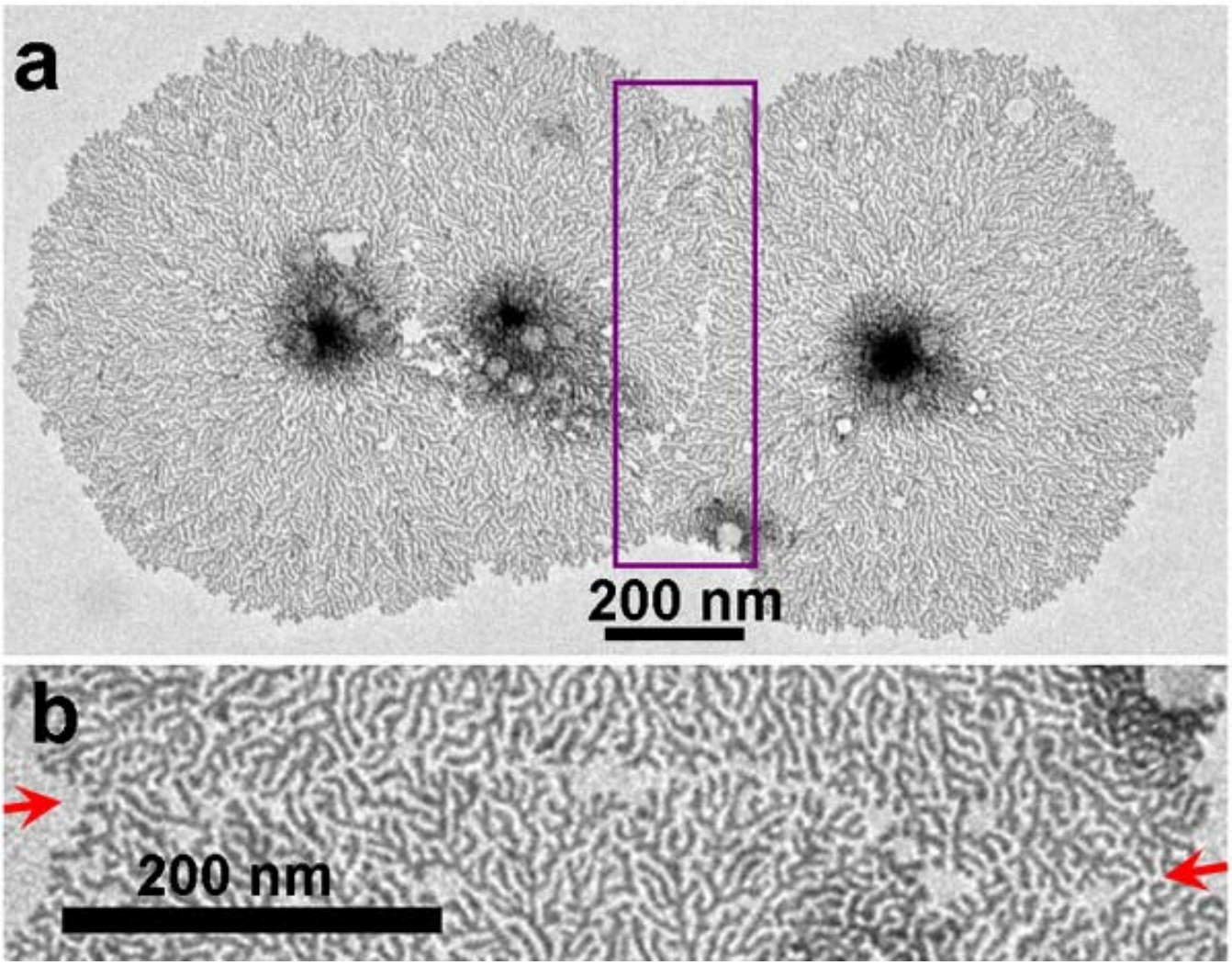


Figure S10. (a, b) Magnified view of the Figure 2b and 2c, respectively.

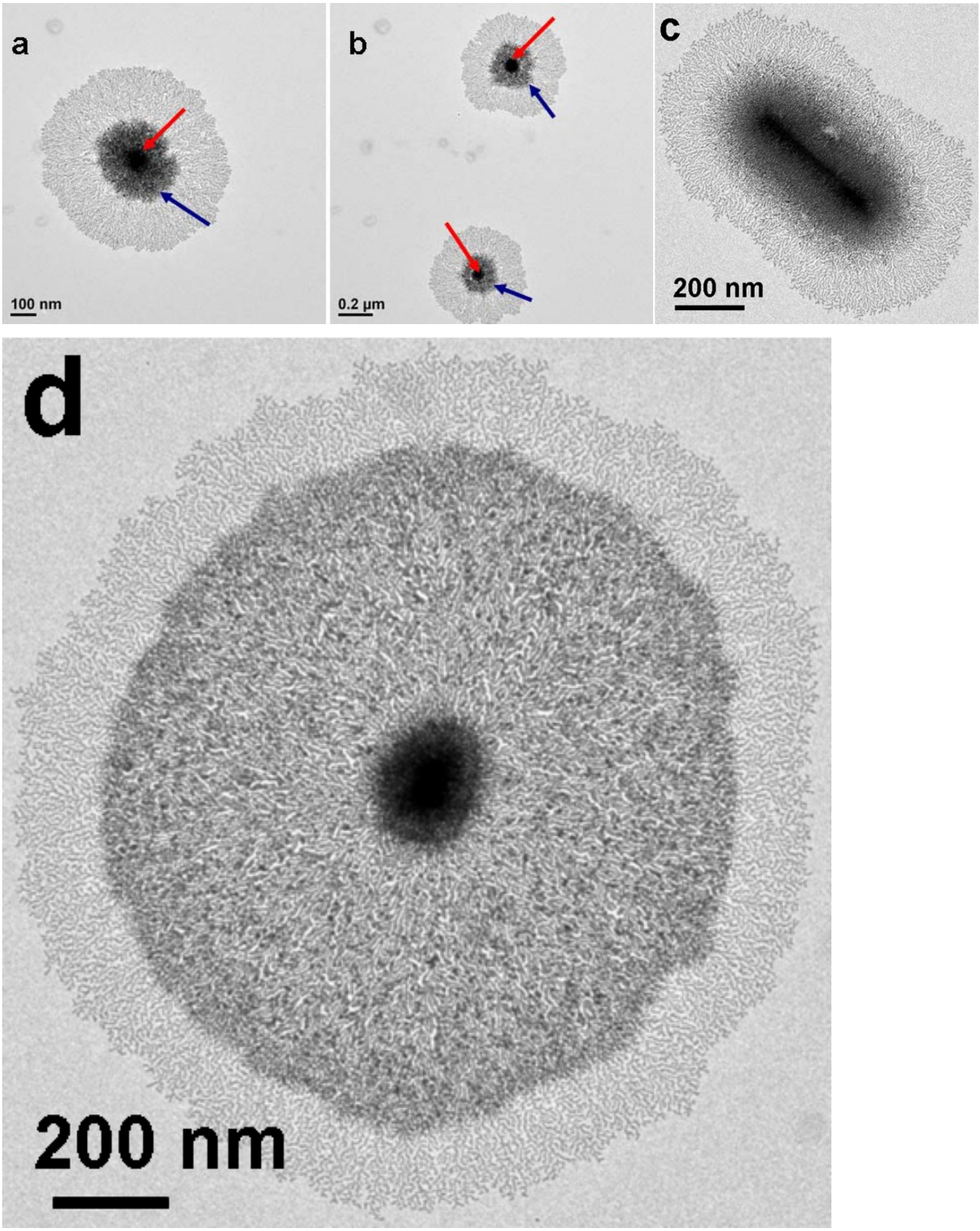


Figure S11. (a, b) Typical TEM images of multi-ring Au-PANI DNSs from two different batches. Red arrow indicates the boundary between core and inner ring, blue arrow indicates the boundary between inner ring and outer ring. **(c, d)** Magnified view of Figure 3b, 3a, respectively.

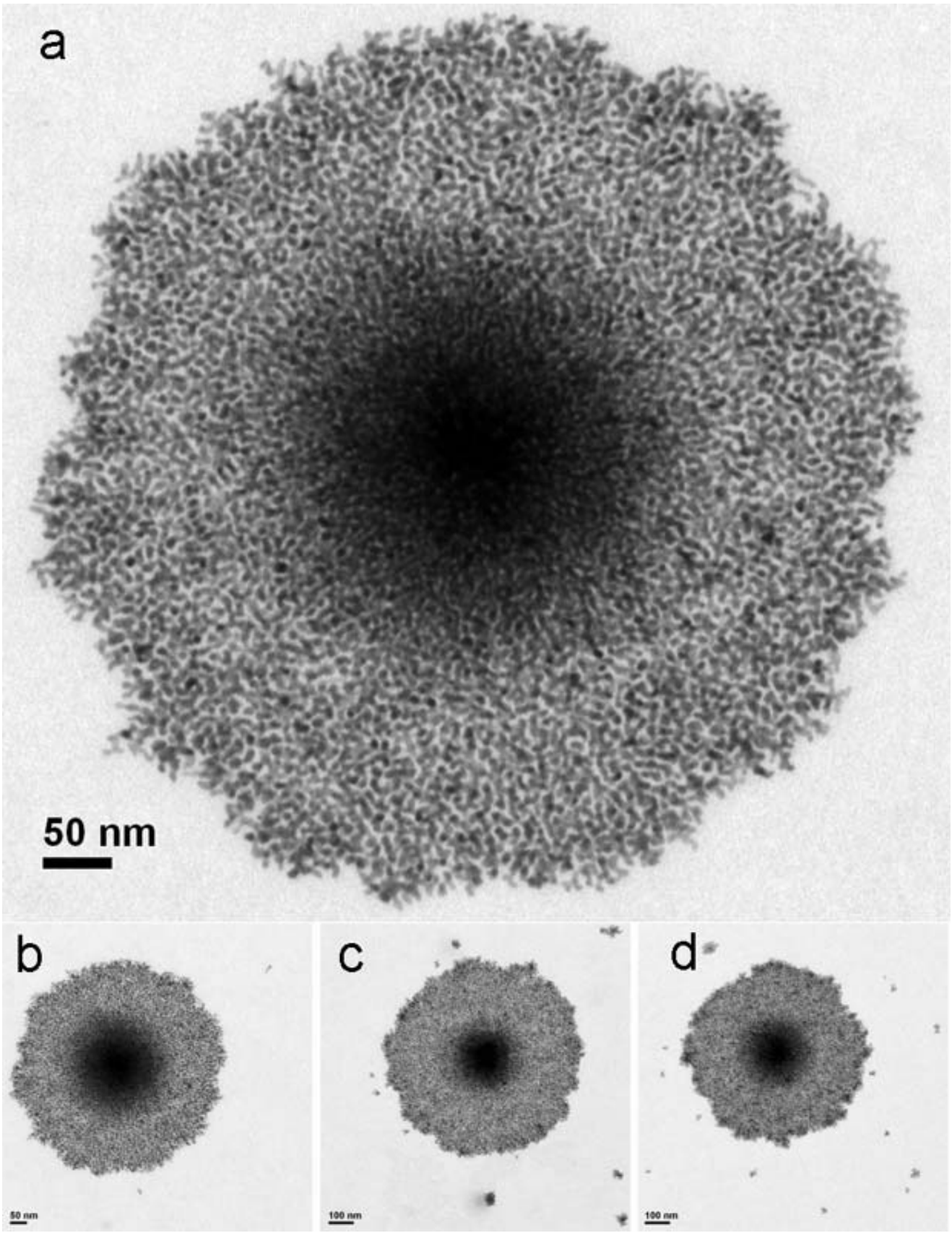


Figure S12. (a) Magnified TEM image of b; and (b-d) TEM image of typical 2nd generation 2D DNSs grown by using the 1st generation 2D DNSs as the seeds.