Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supplementary Information

Long-range Solid-state Electron Transport through Ferritin Multilayers

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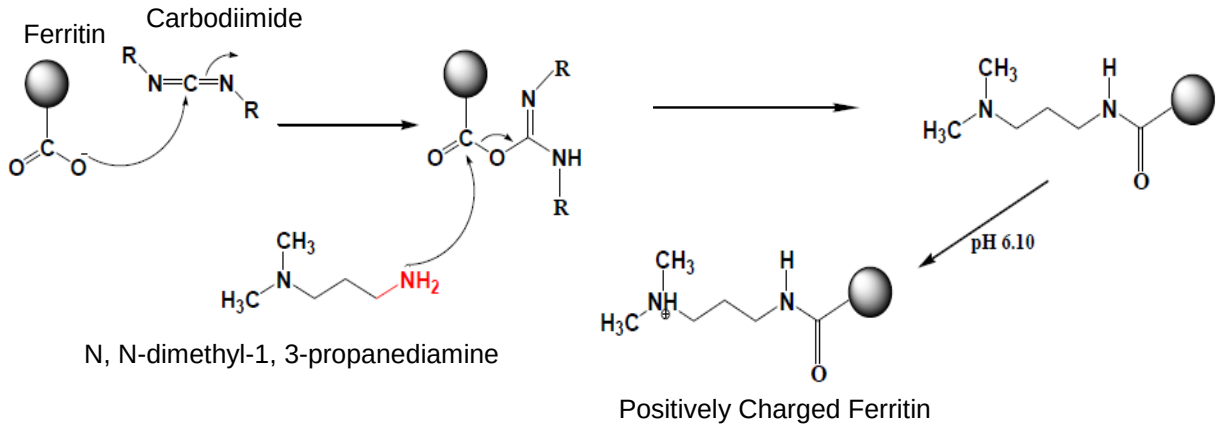


Scheme S1: Stepwise preparation of cationized ferritin from native ferritin (for both holo- and apoferritin)

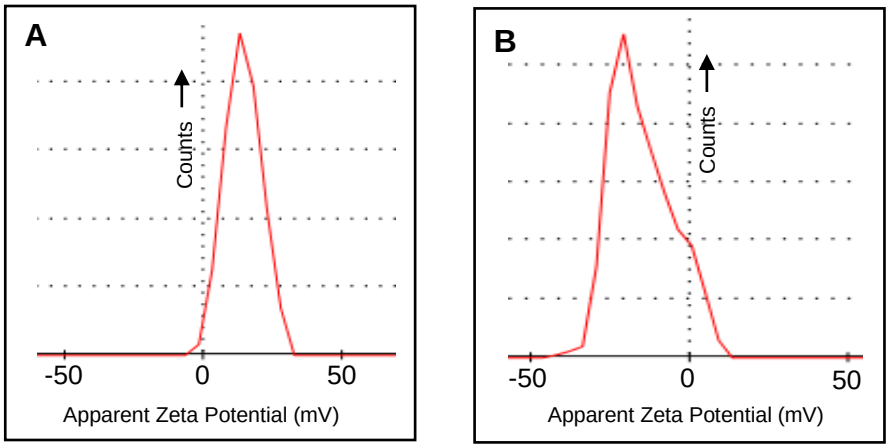


Figure S1**:** Zeta Potential distribution of (A) cationized holoferritin and (B) native holoferritin.

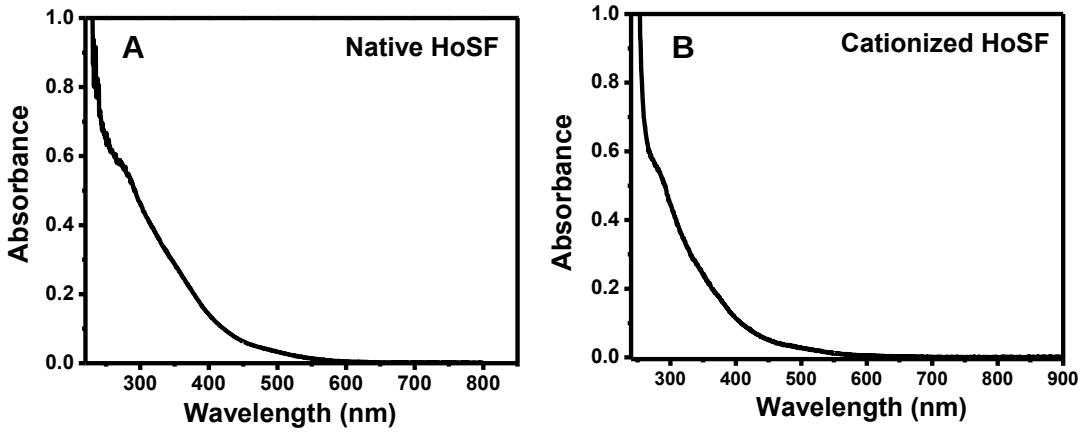


Figure S2: Solution phase UV-visible absorption spectra of (A) native holoferritin and (B) cationized holoferritin.

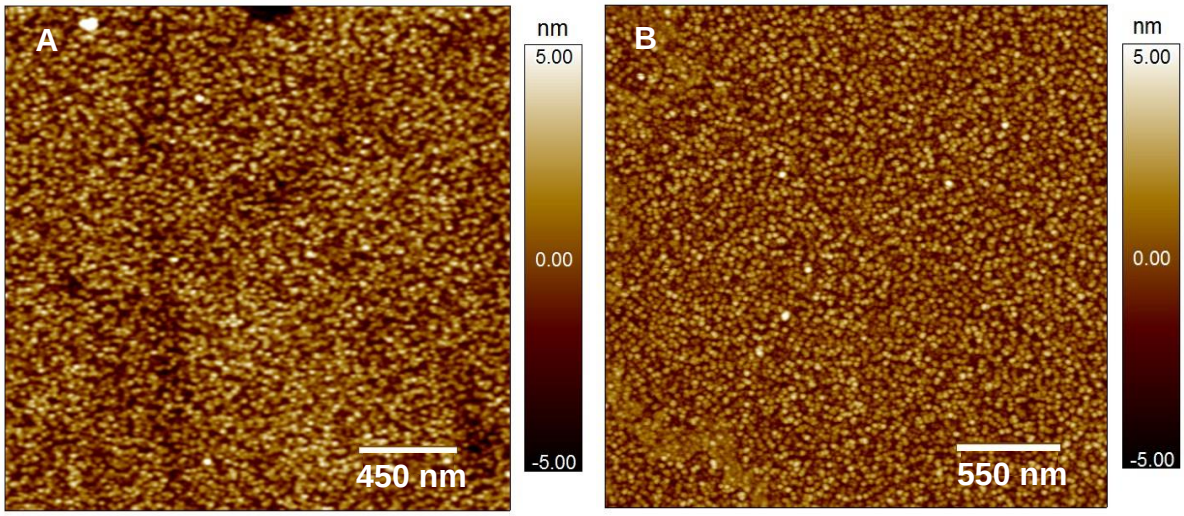


Figure S3: AFM topographic image of cationized holoferritin layer formed onto (A) quartz surface and (B) silicon surface.

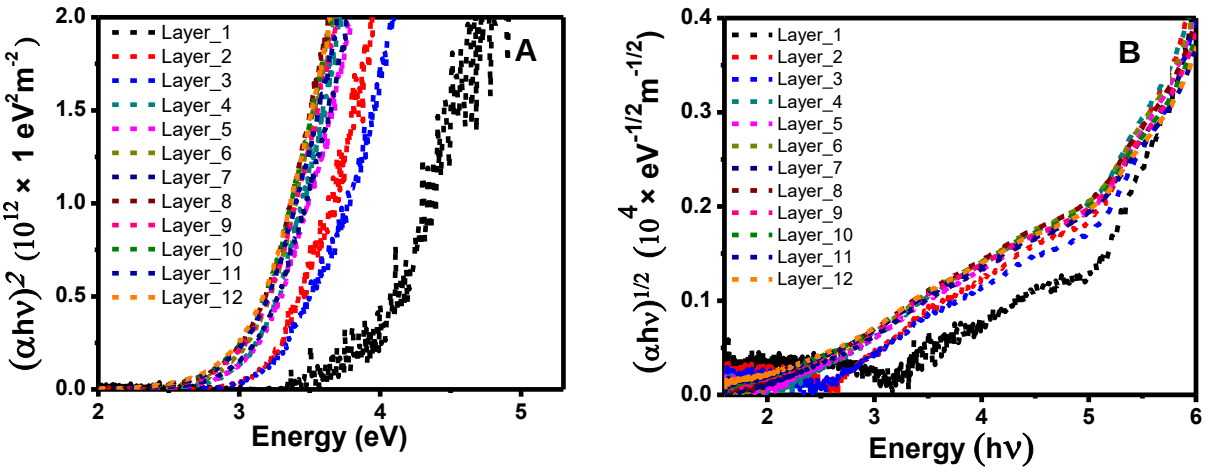


Figure S4: Tauc plot of different holoferritin layers on quartz, (A) direct transition, and (B) indirect transition.

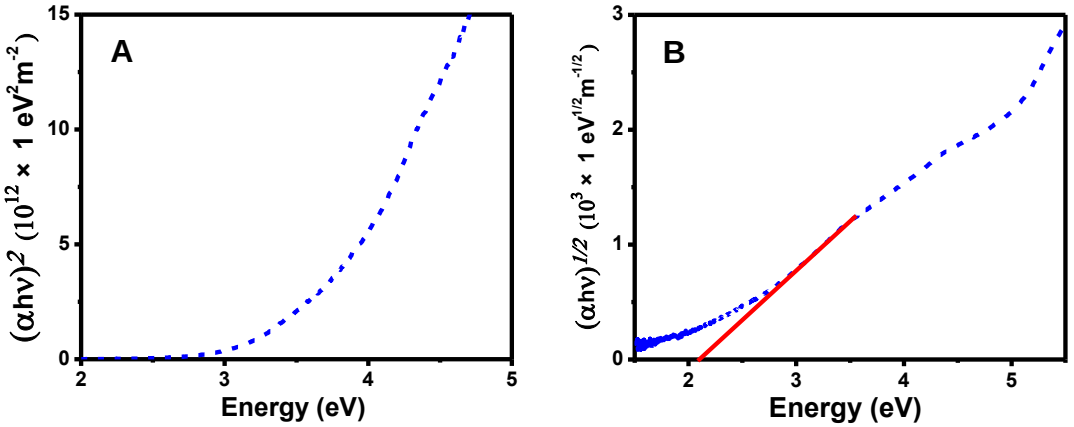


Figure S5: Tauc plots of holoferritin twelve layers - (A) direct transition and (B) indirect transition with linear fit to obtain the indirect band gap.

The plot of $(\alpha h\nu)^{1/2}$ vs. absorbed light energy ($h\nu$) gives the indirect band gap after extrapolation of linear part (linear fit) at the longer wavelength edge absorption for the holoferritin multilayer (twelve layers). In a similar manner, determination of direct band gap could be possible using the plot of $(\alpha h\nu)^2$ vs. $h\nu$ plot.

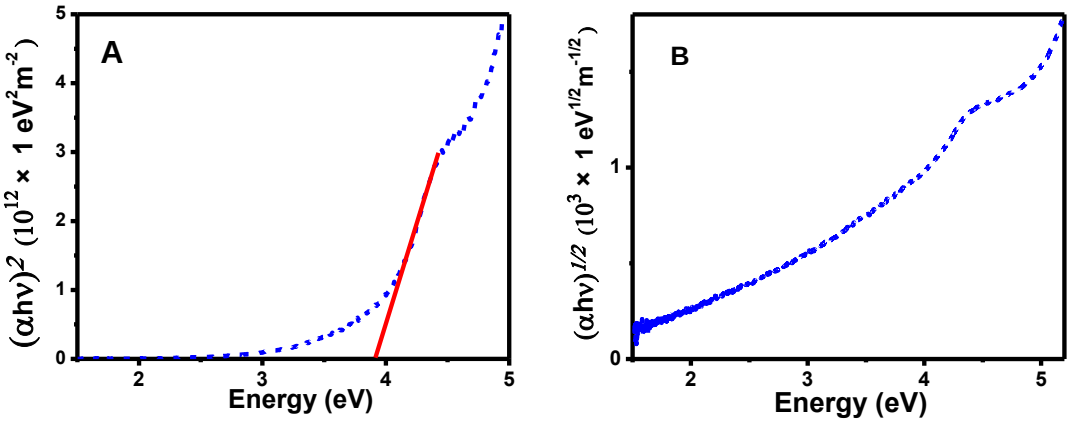


Figure S6: Tauc plots of apoferritin twelve layers - (A) direct transition and linear fit to obtain direct band gap and (B) indirect transition.

The plot of $(\alpha h\nu)^2$ vs. absorbed light energy ($h\nu$) gives the direct band gap after extrapolation of linear part at the longer wavelength edge absorption for apoferritin multilayer (twelve layers). In a similar manner, determination of indirect band gap is not possible using the plot of $(\alpha h\nu)^{1/2}$ vs. $h\nu$ plot. Because there is no single significant extendable linear part at the longer wavelength edge absorption of $(\alpha h\nu)^{1/2}$ vs. $h\nu$ plot, apoferritin is characterized by the direct band gap.

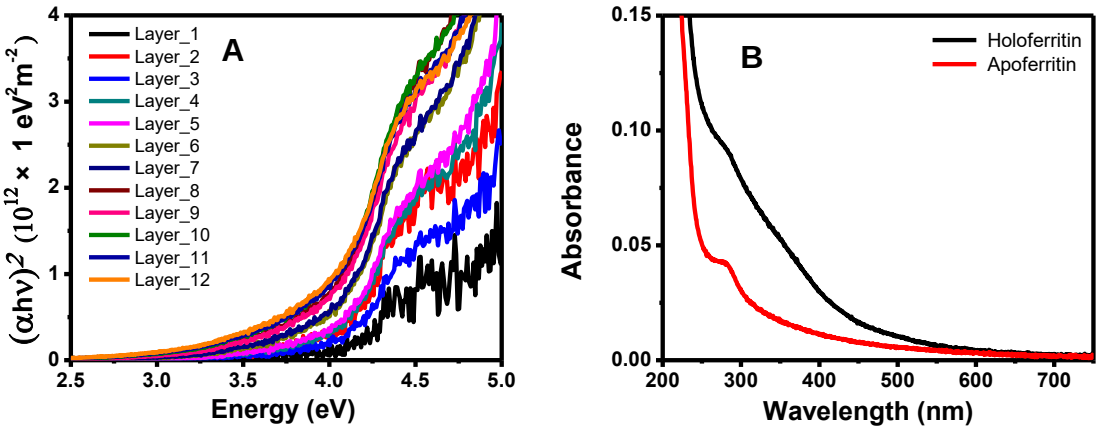


Figure S7: Solid-state UV-visible scan of twelve apoferritin layers deposited on optically transperant quartz; (A) Tauc plot (direct transition) of different apoferrtin layers, (B) overlay of UV-visible spectra of twelve layer apo and holo ferritin multilayer.

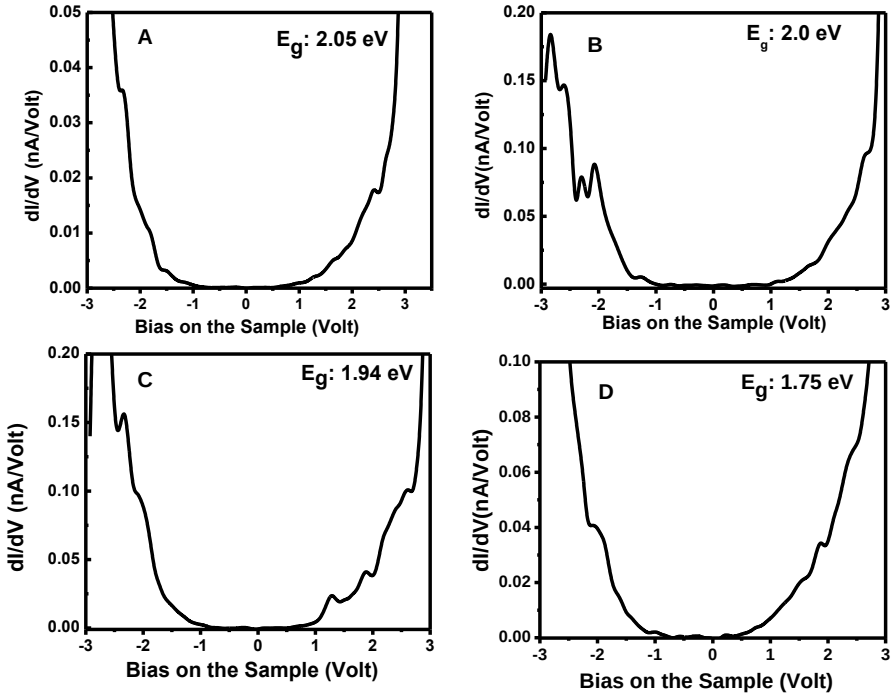


Figure S8: Representative differential conductance plot and transport band gap of different holoferritin layers, (A) monolayer, (B) bi-layer, (C) tri-layer, (D) tetra-layer under low force (8-10 nN) by C-AFM.

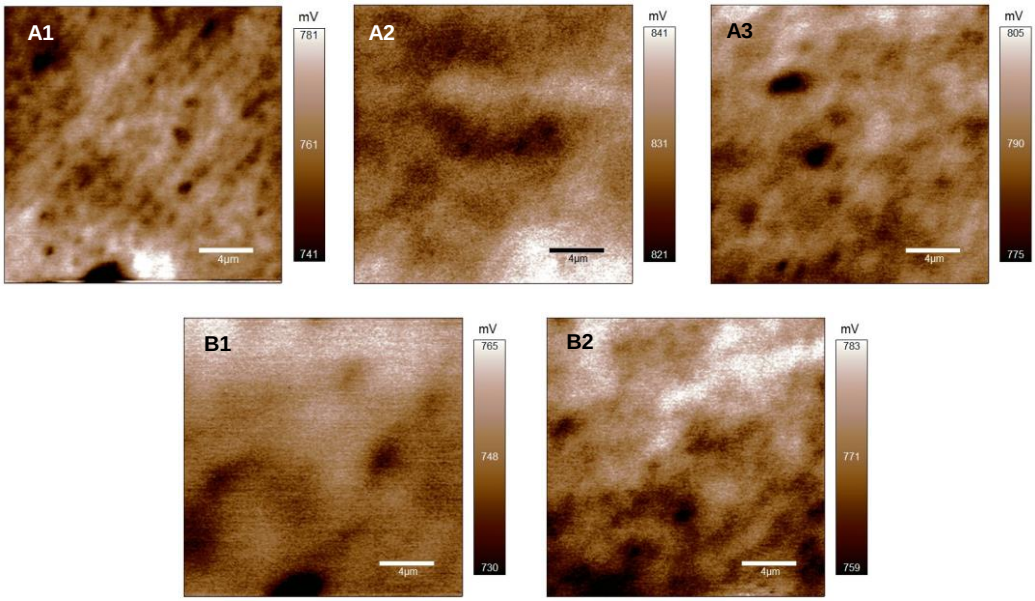
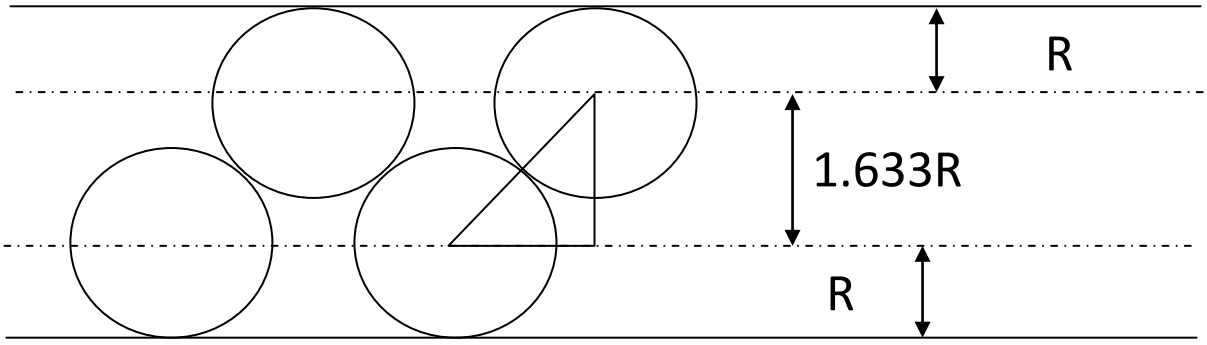
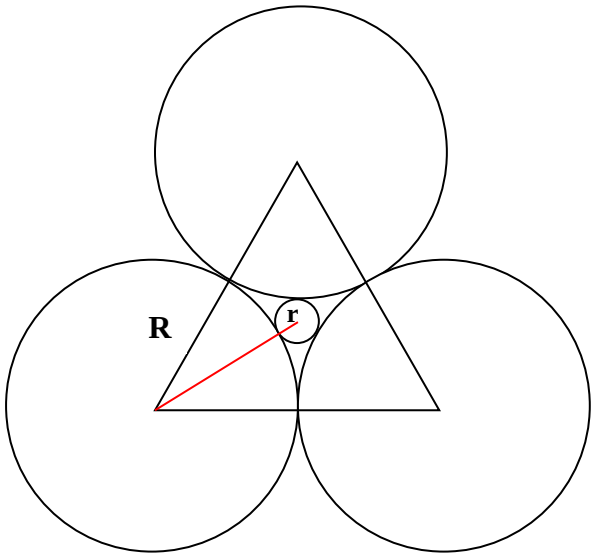


Figure S9. KPFM image (surface potential) of large area of the cationized holoferritin layers (A1) monolayer, (A2) tri-layer, and (A3) seventh-layer and native holoferritin layers (B1) bilayer, (B2) sixth-layer.



$$\boldsymbol{Thickness\ of\ the\ ferritin\ nth\ layer = 9.798\ (n-1) + 12\ \ nm}$$

A



'R' is the radius of ferritin protein molecule, 'r' be the radius of an imaginary sphere fitted inside the void between three closely spaced ferritin molecules in *hcp* 2D molecular packing.

$$\boldsymbol{r = \left(\frac{2}{\sqrt{3}} - 1\right) R = 0.1547\ R = 0.9282\ nm}$$

B

Figure S10: (A) Determination of layer thickness of three dimensional FCC packed ferritin molecules in layer by layer configuration. (B) Determination of void dimension from closely packed ferritin 2D array.

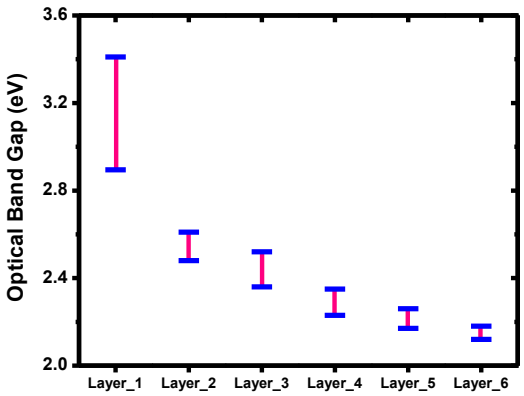


Figure S11. Optical band gap variation of different holoferritin layers, considering intra- and inter-assay deviations.