Electronic Supplementary Material (ESI) for Dalton Transactions.


Supporting Information

# Stable Supercapacitor Electrode based on Two-dimensional High Nucleus Silver Nano-cluster as Green Energy Source

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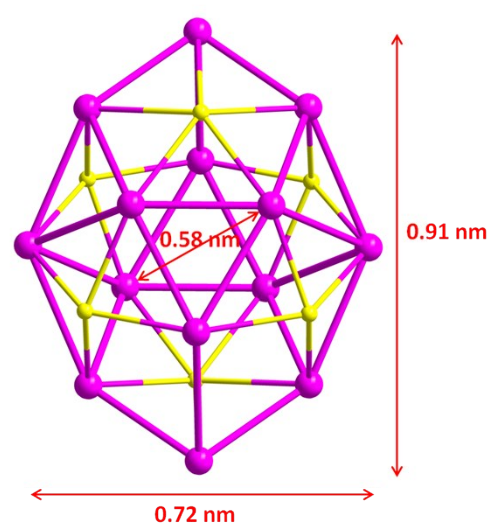


Figure S1. The size of the nanocluster $[Ag_{14}(SPr^{i})_6(C_9F_{14}O_4)_4(DMF)_8]\infty$ (SPc).

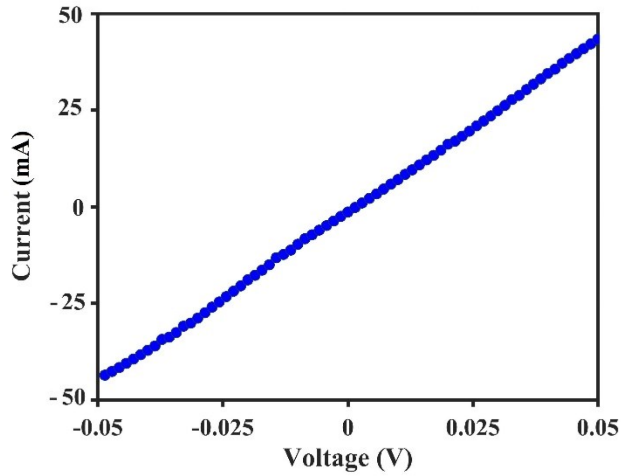


Figure S2. I-V curve of the SPc pellet employed for the conductivity measurements.

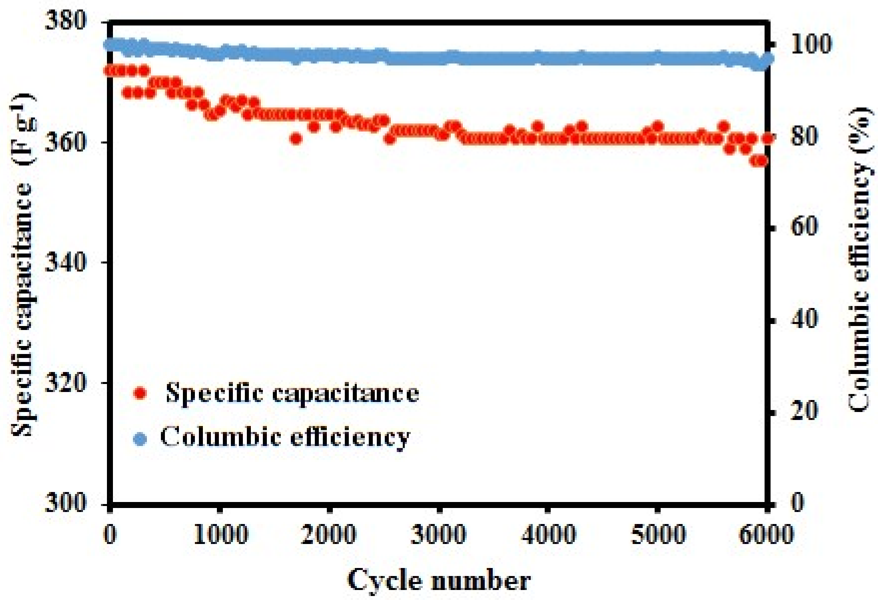


Figure S3. The columbic efficiency of the SPc at 4.5 A $g^{-1}$ for 6000 cycles.

Table S1. contributions of capacitive and diffusion-controlled currents to total charge storage at different scan rates for SPc electrode.

| **Scan Rate ($mV\ s^{-1}$)** | **Redox controlled capacity (%)** | **(%) Capacitive** |
|---|---|---|
| 50 | 1.65 | 98.35 |
| 100 | 1.17 | 98.83 |
| 200 | 0.83 | 99.17 |
| 400 | 0.59 | 99.41 |
| 600 | 0.48 | 99.52 |
| 800 | 0.42 | 99.58 |
| 1000 | 0.37 | 99.63 |

## 1. Electrochemical measurements

The cyclic voltammetry (CV) measurement like other electrochemical characterization includes of galvanostatic charge-discharge (GCD) and electrochemical impedance spectroscopy (EIS) was achieved with the same equipment, PalmSens3 electrochemical workstation using a three electrode system at ambient temperature. In which, Ag/AgCl and high-surface-area Pt electrode applied as the reference and counter electrodes, respectively.

The cyclic voltammetry curves were plotted with different scan rates from 50-1000 $mVs^{-1}$ in potential window between 0 to +1 V. The EIS spectroscopy were carried out in the frequency range from 50 kHz to 50 mHz in OCP (AC perturbation was 10 mV). The GCD test was fulfilled at various current densities (4.5 to 13.0 $A.g^{-1}$). The capacities of the electrode materials were calculated by GCD curves (discharge part) based on equation 1, where I, $\Delta t$, $\Delta V$ and m are the discharge current and time (s), the potential window (V) and mass of the electroactive material (g), respectively :

$C_{sp} = I \times \Delta t / \Delta V \times m$ **(equation 1)**

### *2. Electrode and device Preparation*

The working electrode assembled by mixing the complex, acetylene black and binder (polytetrafluoroethylene) with 85:10: 5 mass ratios. The obtained viscous slurry after 5 minutes ultrasonication was deposited on a 1 × 1 $cm^2$ size Ti foam, then pressed under 10 MPa pressure and dried under vacuum for 10 h at 80 ℃ before any electrochemical test. The working electrode assembled by mixing the SPc, acetylene black and binder (polytetrafluoroethylene) with 85:10:5 mass ratios.

A paper soaked and saturated in KOH (2M) was placed between two electrodes and both electrodes were completely attached to the paper by clamps.

**Table S2.** Crystal data and structure refinement for **SPc**

| | |
|---|---|
| Chemical formula | $C_{39}H_{49}Ag_7F_{28}N_4O_{12}S_3$ |
| formula mass | 2149.09g/mol |
| *T* (K) | 150(2) |
| Wavelength | 0.71073 Å |
| Crystal system | Triclinic |
| space group | P-1 |
| *a* (Å) | 14.4362(8) |
| *b* (Å) | 14.7992(8) |
| *c* (Å) | 16.4497(8) |
| α (deg) | 95.979(2) |
| β (deg) | 114.333(2) |

| | |
|---|---|
| γ (deg) | 91.691(3) |
| V (Å$^3$) | 3174.6(3) |
| Z | 2 |
| $\mu$ $_{calcd}$.(mg/m$^3$) | 2.248 |
| Absorption coefficient | 3.538 mm$^{-1}$ |
| F(000) | 2072 |
| Reflections collected | 55364 / 12476 [R(int) = 0.0481] |
| Refinement method | Full-matrix least squares on F$^2$ |
| Goodness-of-fit on F$^2$ | 1.017 |
| R indices (all data) | R$_1$$^a$ =0.0452, wR$_2$$^b$= 0.1044 |

[a] $R_1$ = [Σ abs(abs(Fo) - abs(Fc))]/ [Σ abs(Fo)]. [b] $w$R2 = [Σ($w$(Fo$^2$ - Fc$^2$)$^2$)/ Σ[$w$(Fo$^2$)$^2$]$^{0.5}$.

**Table S3.** Selected bond lengths [Å] and angles [°] for **SPc**

| | |
|---|---|
| O(101)-Ag(1)-S(2) | 115.89(14) |
| O(101)-Ag(1)-S(1) | 96.27(14) |
| S(2)-Ag(1)-S(1) | 145.60(5) |
| O(101)-Ag(1)-O(1) | 83.42(16) |
| S(2)-Ag(1)-O(1) | 106.72(11) |
| S(1)-Ag(1)-O(1) | 87.92(11) |
| O(101)-Ag(1)-Ag(2) | 126.86(13) |
| S(2)-Ag(1)-Ag(2) | 108.73(4) |
| S(1)-Ag(1)-Ag(2) | 53.65(3) |
| O(1)-Ag(1)-Ag(2) | 56.52(11) |
| O(101)-Ag(1)-Ag(6) | 84.06(13) |
| S(2)-Ag(1)-Ag(6) | 113.43(4) |
| S(1)-Ag(1)-Ag(6) | 55.47(3) |
| O(1)-Ag(1)-Ag(6) | 139.48(11) |
| Ag(2)-Ag(1)-Ag(6) | 103.71(2) |
| O(101)-Ag(1)-Ag(5) | 139.09(13) |
| S(2)-Ag(1)-Ag(5) | 51.16(4) |

| | |
|---|---|
| Ag(1)-O(101) | 2.373(5) |
| Ag(1)-S(2) | 2.4854(16) |
| Ag(1)-S(1) | 2.5660(16) |
| Ag(1)-O(1) | 2.575(4) |
| Ag(1)-Ag(2) | 2.9655(7) |
| Ag(1)-Ag(6) | 2.9874(7) |
| Ag(1)-Ag(5) | 3.1047(7) |
| Ag(1)-Ag(7) | 3.1563(8) |
| Ag(2)-O(5) | 2.342(5) |
| Ag(2)-S(3) | 2.5141(17) |
| Ag(2)-S(1) | 2.5216(15) |
| Ag(2)-Ag(3) | 2.9092(7) |
| Ag(2)-Ag(5) | 3.0236(7) |
| Ag(2)-Ag(7)#1 | 3.2515(10) |
| Ag(3)-O(8) | 2.313(5) |
| Ag(3)-O(6) | 2.365(5) |
| Ag(3)-S(2)#1 | 2.5280(16) |
| Ag(3)-S(1) | 2.6981(16) |
| Ag(3)-Ag(4) | 2.9123(7) |
| Ag(3)-Ag(7)#1 | 3.1743(8) |
| Ag(4)-O(7) | 2.324(5) |
| Ag(4)-O(4) | 2.361(5) |
| Ag(4)-O(301) | 2.418(5) |
| Ag(4)-S(1) | 2.5672(15) |
| Ag(4)-Ag(6) | 2.8985(8) |
| Ag(4)-Ag(5)#1 | 3.3222(7) |
| Ag(5)-O(2) | 2.409(5) |
| Ag(5)-S(3) | 2.4706(19) |
| Ag(5)-S(2) | 2.4774(16) |