Electronic supplementary information

Facile Approaches to built Ordered Amphiphilic Tris(phthalocyaninato) Europium Triple-Decker Complex Thin Films and their comparative performances as the ozone sensor

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Fig. S1  (A) UV-vis spectra of QLS Eu$_2$[Pc(15C5)$_4$]$_2$[Pc(OC$_{10}$H$_{21}$)$_8$] films (a-d), (a: 2 layers; b: 3 layers; c: 4 layers; d: 6 layers). (B) The relationship between the absorption intensity at 654 nm and the number of layers.
Fig. S2  FTIR in ATR mode spectra of (A) SA films; (B) QLS films; (C) cast films and (D) bulk Eu$_2$[Pc(15C5)$_4$]$_2$[Pc(OC$_{10}$H$_{21}$)$_8$] adsorbed at ITO/glass substrates in the region of 2600-3200 cm$^{-1}$ with 2 cm$^{-1}$ resolution.
Fig. S3. Alternation of exposure and static recovery periods showing the conditioning stage (cycles 1–3) which is a prerequisite to obtain reproducible measurements of cast Eu$_2$[Pc(15C5)$_4$]$_2$[Pc(OC$_{10}$H$_{21}$)$_8$] films. (Similar situation took place for another two types of films and have been omitted for clarity). Dotted line: concentration of ozone.
Fig. S4 The time-dependent current plots for 2-4 layers of QLS Eu₂[Pc(15C₅)₄]₂[Pc(OC₁₀H₂₁)₈] films exposed to O₃ at varied concentration in the range of 0-300 ppb (exposure: 1 min, recovery: 4 min), while the bottom rectangular pulses represent the O₃ concentration as a function of time.
Fig. S5 The kinetics plots of 2-4 layers of QLS Eu₂[Pc(15C₅)₄][Pc(OC₁₀H₂₁)₈] films: \( \ln(I_f - I_t) \) versus time is predominantly linear for different concentration of O₃, suggesting first-order kinetics. Arrows indicate the direction of change with decreasing concentration of ozone.
Table S1. Characteristics of electrical conductivity and gas sensing behavior from three types of Eu$_2$[Pc(15C5)$_4$][Pc(OC$_{10}$H$_{21}$)$_8$] films at room temperature.

<table>
<thead>
<tr>
<th>Type of films</th>
<th>film-thickness (nm)</th>
<th>electrical conductivity (S·cm$^{-1}$)$^a$</th>
<th>Sensor response (% ppb$^{-1}$)</th>
<th>Average sensor response rate constant (s$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA films</td>
<td>4.6 $^b$</td>
<td>~more than 10$^{-4}$ $^c$</td>
<td>0.0376</td>
<td>0.0498</td>
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<tr>
<td>QLS films</td>
<td>4.42–13.26$^d$</td>
<td>~10$^{-5}$</td>
<td>0.0267$^e$</td>
<td>0.0574</td>
</tr>
<tr>
<td>Cast films</td>
<td>92</td>
<td>~10$^{-6}$ $^f$</td>
<td>0.0721</td>
<td>0.0486</td>
</tr>
</tbody>
</table>

$^a$ Calculated by Eq: (1) in experimental section
$^b$ Thickness was obtained by AFM measurement.
$^c$ Electrical conductivity was calculated with an estimated channel coverage less than 50%.
$^d$ Thickness was deduced from the value of layer spacing obtained by XRD and the number of layers in a 2-6 layers range.
$^e$ Calculated for 6-layer QLS films
$^f$ The thickness of electrode of 20nm is preferred since the thickness of cast films calculated is ca. 92nm.