

## 1                   **Optically switchable organic light-emitting transistors**

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15 **Organic light-emitting transistors are pivotal components for emerging opto- and**  
16 **nano-electronics applications, such as logic circuitries and smart displays. Within**  
17 **this technology sector, the integration of multiple functionalities in a single**  
18 **electronic device remains the key challenge. Here we show optically switchable**  
19 **organic light-emitting transistors fabricated through a judicious combination of**  
20 **light-emitting semiconductors and photochromic molecules. The irradiation of the**  
21 **solution-processed films at selected wavelengths enables the efficient and**  
22 **reversible tuning of charge transport and electroluminescence simultaneously,**  
23 **with a high degree of modulation (on/off ratios up to 500) in the three primary**  
24 **colours. Different emitting patterns can be written and erased, through a non-**  
25 **invasive and mask-free process, on a length scale of few microns in a single device,**  
26 **thereby rendering this technology potentially promising for optically gated highly-**  
27 **integrated full-colour displays and active optical memory.**

28  
29       Organic light-emitting transistors (OLETs), combining in a single device the  
30 functions of light generation of organic light-emitting diodes (OLEDs) with the current  
31 modulation (and signal amplification) of organic thin-film transistors (OTFTs), have  
32 emerged as a promising new class of devices with significant potential for integrated  
33 optoelectronics, smart display technology, and organic lasers<sup>1-5</sup>. The emitting layer of  
34 the unencapsulated OLETs is easily accessible for comprehensive optical and electrical  
35 investigation of the fundamental physical processes, thereby providing powerful  
36 insights into device physics<sup>6,7</sup>. The fabrication of OLETs does not require multiple

37 metal evaporation steps that are potentially damaging for the interface between  
38 electrodes and active layers. As a result, the simplified device architecture enables its  
39 potential use in active matrix displays. Furthermore, the position of the recombination  
40 region in the channel of ambipolar OLETs can be shifted away from the electrodes as a  
41 function of the applied bias, avoiding the metal-induced quenching of excitons<sup>8-10</sup>.  
42 Capelli *et al.* recently demonstrated that the performance of OLET can be boosted by  
43 exploiting a trilayer heterostructure, surpassing the equivalent OLED efficiency over  
44 100 times<sup>11</sup>. OLETs with performance comparable to display pixels driven by  
45 polycrystalline-silicon backplane transistors have been reported, which can be operated  
46 at low-voltage and low-power consumption<sup>12</sup>.

47

48 Besides the efforts devoted to enhance the charge carrier mobility, efficiency, and  
49 brightness of OLETs<sup>13-16</sup>, the integration of further functionalities into a single device  
50 represents another important challenge with the prospect of realizing controllable  
51 integrated circuitry<sup>17,18</sup>. Electrically switchable chiral light-emitting transistors (LETs)  
52 have been demonstrated, in which the current direction can be used to control the  
53 polarization of light from *pn* junctions in tungsten diselenide (WSe<sub>2</sub>), which serves as  
54 a channel material of LETs<sup>19</sup>. Another example is an all-graphene based light-emitting  
55 field-effect device featuring an external electrical bias tuning of the emission  
56 spectrum<sup>20</sup>. However, these multifunctional LETs, based on two-dimensional (2D)  
57 materials differ in terms of the nature of the charge transport and mechanism of light  
58 generation compared to OLETs. The current approach to control “multifunctional”

59 LETs still relies on external electrical driving. Conversely, optical control offers various  
60 advantages, such as non-invasively, high spatial and temporal resolution, and the  
61 possibility to tune both wavelength and intensity of the emitted light<sup>21</sup>.

62

63 Some recent reports demonstrated that it is possible to fabricate optically  
64 switchable multifunctional OTFTs<sup>22-24</sup>, by blending organic semiconductors with  
65 photochromic diarylethenes (DAEs). Upon exposure to light of different wavelength,  
66 DAEs can be toggled between two isomers with different electronic properties, and they  
67 also show high thermal stability and fatigue resistance during continuous  
68 photoswitching<sup>25-27</sup>. Such optically responsive OTFTs exhibited high current switching  
69 ratios and large charge carrier mobilities, and have been applied for the fabrication of  
70 flexible non-volatile optical memory with over 256 distinct levels<sup>28</sup>.

71

72 Here we report the fabrication and characterisation of the optically switchable  
73 organic light-emitting transistors (OSOLETs), by integrating DAEs into the light-  
74 emitting semiconducting layer of OLETs *via* simple solution processing. Both output  
75 current and electroluminescence (EL) are simultaneously modulated by irradiating the  
76 devices at distinct wavelengths. We demonstrate three classes of OSOLETs emitting  
77 over the entire visible spectrum (green, red, and blue), which can reversibly and  
78 remotely switch output current and EL on and off *via* visible and UV light irradiation.  
79 In addition, emitting patterns within one pixel of the OSOLET can be written and erased  
80 easily by using a light beam as an external, non-invasive, and mask-free writing tool

81 with a spatial resolution down to the far-field diffraction limit, i.e.  $\lambda/2NA < 1 \mu\text{m}$  (with  
82  $\lambda$  being the wavelength of visible light and NA the numerical aperture of the optical  
83 tool used). In view of current minimum pixel sizes, e.g. in the best “retina” displays  
84 ( $\sim 55.5 \mu\text{m}$ ), the present system holds particular potential of reversibly encoding high-  
85 density visual information into a single pixel of a high-resolution display.

86

### 87 **Mechanism and device fabrication**

88 Three commercially-available semiconducting light-emitting polymers poly(9,9-  
89 dioctylfluorene-*alt*-bithiophene) (F8T2), poly[2-methoxy-5-(3',7'-dimethyloctyloxy)-  
90 *para*-phenylenevinylene] (MDMO-PPV), and poly(9,9-dioctylfluorene) (F8) were  
91 used to fabricate OLETs having fluorescence emission ranging from blue to red (Fig.  
92 1a), thus covering the entire visible spectrum (supplementary Fig. S1 for the absorption  
93 and photoluminescence spectra). To enable the optical switching in OLETs, an energetic  
94 matching between the photochromic molecules and the emissive materials is required,  
95 i.e., the highest occupied molecular orbital (HOMO) levels of the emissive polymers  
96 should energetically be positioned in between those of the open and closed DAEs (Fig.  
97 1b). According to cyclic voltammetry (CV) measurements of the light-emitting  
98 polymers (see supplementary Fig. S2) and previous studies on DAEs<sup>23,29,30</sup>, the HOMO  
99 levels of DAEs in their open forms are slightly below the one of the green and blue-  
100 emitting hosts ( $\sim 100 \text{ meV}$ ) and comfortably below that of MDMO-PPV ( $\sim 200 \text{ meV}$ ).  
101 Conversely, the HOMO levels of the DAEs in their closed forms are  $> 600 \text{ meV}$  higher  
102 than the HOMO of the light-emitting polymers in all three binary components, and thus  
103 significant hole trapping is expected for the DAEs in their closed form. In view of the

104 different HOMO levels of the three polymers responsible for red, green, and blue light  
105 emission, we have selected two DAEs, i.e., DAE\_tBu and DAE\_F (Fig. 1a)<sup>29,30</sup>, having  
106 high fatigue resistance over repetitive photoswitching cycles in the solid state (Fig. S4).  
107 Based on the energetic considerations above, DAE\_tBu molecules act as switchable  
108 charge traps within the matrix of the emissive F8T2 and MDMO-PPV, whereas the  
109 lower HOMO level of DAE\_F makes it suitable in combination with the blue emitter  
110 (F8).

111

112 The OSOLETs were fabricated in a bottom-gate bottom-contact configuration with  
113 SiO<sub>2</sub>/Si as substrates and the pre-patterned gold interdigitated electrodes as source and  
114 drain contacts (Fig. 1c, see device fabrication in the supplementary information). To  
115 enhance the charge carrier mobility, self-assembled monolayers (SAMs) of octadecyl-  
116 trichlorosilane (OTS) were chemisorbed onto the SiO<sub>2</sub>/Si substrates<sup>31,32</sup> prior to spin-  
117 coating the solutions of the light-emitting polymers, followed by their thermal  
118 annealing at 170 °C to leverage their optoelectronic properties<sup>33</sup>. To avoid thermal  
119 degradation of the DAEs at such high temperature, the photochromic molecules were  
120 dissolved in solvents orthogonal to those used for the polymers and spun on top of the  
121 emissive layer. A gentle post-annealing process was applied to activate the thermal  
122 diffusion of DAE molecules into the polymer matrix (80 °C for 1 h in the case of F8T2  
123 and MDMO-PPV, while 40 °C for 1.5 h with regards to F8). The morphologies of the  
124 deposited light-emitting polymer/DAE bicomponent films were investigated by atomic  
125 force microscopy (AFM, see supplementary Fig. S3). The deposition of DAE\_tBu *via*  
126 this permeation process did not modify the morphology of F8T2 and no phase

127 separation was observed. Only minor morphology variations were monitored in the case  
128 of MDMO-PPV. However, the exposure of neat F8 to both the solvent and thermal  
129 treatment, helps the diffusion of DAE\_F into F8, and further promotes the formation of  
130 supramolecular structures (such as the crystalline phase<sup>34</sup> and the conformational  
131 isomer  $\beta$ -phase<sup>35</sup>) of F8, resulting in a rougher morphology (from root-mean-squared  
132 roughness  $R_{\text{rms}} = 3.0$  nm for the neat F8 film to  $R_{\text{rms}} = 12.3$  nm for the F8/DAE\_F film)  
133 due to the presence of micron-sized islands from the aggregation<sup>36</sup>.

134

135 We assessed the retained photoisomerization ability of DAEs in the solid state in  
136 the presence of the selected light-emitting polymers for the OSOLETs. UV/visible  
137 absorption spectroscopy on the light-emitting polymer/DAE bicomponent films  
138 revealed upon UV (312 nm) irradiation the appearance of the typical spectral features  
139 in the visible region for the closed DAE isomer that disappear upon green light (> 520  
140 nm) irradiation (see supplementary Fig. S5). These observations provide unambiguous  
141 evidence that after diffusion into the three polymer matrices the DAEs are still able to  
142 undergo reversible photoisomerization.

143

#### 144 **Characteristics of OSOLETs**

145 The performance of OSOLETs in the three primary colours was characterised by  
146 using EL spectroscopy as well as transfer curves of current density and luminance vs.  
147 gate voltage, as summarized in Fig. 2. The light generated within the channel was  
148 observed when OSOLETs were in operation, and thereby EL spectra and optical images

149 (inset) of the green, red and blue OSOLETs (channel length  $L = 2.5 \mu\text{m}$  and channel  
150 width  $W = 1 \text{ cm}$ ) were recorded (Figs. 2a-c). The emission peaks of the green and red  
151 OSOLETs are located at 540 nm (FWHM = 90 nm) and 630 nm (FWHM = 143 nm),  
152 respectively. Two emissive bands appear in the F8/DAE\_F based OSOLET with the  
153 main peak at 450 nm. The red-shift of EL spectra, compared to that of glassy F8 film  
154 with the  $S_1$  to  $S_0$  vibronic peaks at 420 nm, suggests a high fraction of  $\beta$ -phase chain  
155 conformations in the F8/DAE\_F binary component film<sup>35</sup>. Furthermore, we note the  
156 presence of an emission band at longer wavelengths, i.e. a green band, which is  
157 common in F8-based emissive devices due to the formation of inter-chain states and/or  
158 fluorenone defects<sup>37-40</sup>. Importantly, the emissive bands of the three OSOLETs cover  
159 well both the visible region (400-700 nm) and even stretch into the near infrared (NIR)  
160 up to 800 nm.

161

162 Although light emission requires bipolar injection, most of the transport of our  
163 OSOLETs can be described as essentially unipolar, as inferred from the dependence of  
164 the drain current on the applied gate voltage, in line with previous literature on non-  
165 switchable OLETs<sup>41-43</sup>. While the holes are evenly distributed within the device channel,  
166 light emission provides indeed evidence for electron injection and diffusion ranging to  
167 several nm inside the channel. Yet electrons remain minority carriers up to the highest  
168 (gate and drain) voltages tested here, as their contribution to the overall current is never  
169 appreciable. For this reason, electron transport and light modulation thereof cannot be  
170 determined by using the chosen materials (lowest unoccupied molecular orbital

171 (LUMO) levels listed in Scheme S1). The corresponding light is emitted closely to the  
172 electrode in F8T2 based OLET with a longer channel width ( $L = 20 \mu\text{m}$ ) (see  
173 supplementary Fig. S6). However, owing to the resolution of our camera and the narrow  
174 channel width of the OSOLETs, the light emission was observed over the entire channel  
175 area in the optical images (Figs. 2a-c).

176

177

178 The transfer characteristics of green, red, and blue OSOLETs using DAEs as photo-  
179 switchable units were measured (Figs. 2d-f). When the DAEs are in their open forms,  
180 the hole mobilities extracted from the transfer characteristics in the saturation regime  
181 (see supplementary information for device characterisation) are about  $1.5 \times 10^{-3}$ ,  $1 \times 10^{-4}$ ,  
182  $4$ , and  $5 \times 10^{-7} \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ , respectively. For the sake of comparison, the field-effect  
183 mobilities in pristine green, red, and blue polymers based OLETs have been measured  
184 to be ca.  $5 \times 10^{-3}$ ,  $2.0 \times 10^{-4}$ , and  $8 \times 10^{-5} \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ , respectively (see supplementary Fig.  
185 S7). Clearly the hole mobility of F8T2 and MDMO-PPV is slightly reduced due to the  
186 scattering (and/or residual trapping) of DAEs in the polymeric matrix. However, the  
187 mobility in the blue OSOLETs with the open isomer of DAE\_F drops by two orders of  
188 magnitude with respect to the one using the neat polymer. It appears that domain  
189 boundaries and disordered interphase regions in the F8/DAE\_F bicomponent film result  
190 in a much rougher morphology, thereby hindering charge transport<sup>44</sup>.

191

192 The luminance of the OSOLETs was collected simultaneously during measurement  
193 of the transfer characteristics (Figs. 2g-i), and it shows a similar trend as drain current

194 vs. gate voltage ( $V_g$ ). It should be noted that the pristine F8T2 and MDMO-PPV based  
195 OLETs exhibit slightly higher EL intensity as bicomponent ones measured under  
196 identical conditions (see supplementary Fig. S7). Interestingly, in the case of F8/DAE\_F,  
197 despite the reduction of the output current with respect to the pristine material, we  
198 observe an increase of luminance, which can be ascribed to the higher  
199 photoluminescence efficiency ( $\eta_{PL}$ ) of F8 in the so-called  $\beta$ -phase as already reported  
200 by Perevedentsev and Hsu et al<sup>35,45</sup>. Therefore, F8T2 and MDMO-PPV based OLETs  
201 exhibit a minor variation of EQE, between pristine and bicomponent devices (EQE at  
202  $V_g = -80$  V for: MDMO-PPV  $2 \times 10^{-3}$  %, MDMO\_PPV/DAE\_tBu  $6 \times 10^{-3}$  %, F8T2  
203  $0.4 \times 10^{-2}$  %, and F8T2/DAE\_tBu  $1.0 \times 10^{-2}$  %). However, the big change in the  
204 morphology leads to a significant increase of the EQE (again at  $V_g = -80$  V) of the  
205 F8/DAE\_F bicomponent device (1.2 %) when compared to the neat F8 device ( $1.2 \times 10^{-2}$   
206 %). Although the controlled formation of the  $\beta$ -phase of F8 *via* dipping in solvent/non-  
207 solvent mixtures has already been exploited to improve the EQE of F8-based OLEDs<sup>46</sup>,  
208 no similar investigation has been reported on OLETs yet and we consider this as an  
209 additional benefit of combining F8 with DAE\_F. A lowering of the operating voltage  
210 and enhancement of the brightness is the subject of our future studies, which clearly  
211 target technological applications. It can be achieved *via* the careful selection of (i) the  
212 light-emitting materials, which should possess high charge carrier mobility and  
213 photoluminescence efficiencies, (ii) the dielectric materials, which should exhibit a  
214 high gate capacitance, (iii) the optimal device structures, with a shorter channel length

215 and asymmetric electrodes, and (iv) a hole transport layer and/or an electron transport  
216 layer integrated as active component<sup>11-15</sup>.

217

## 218 **Photoswitching**

219 The remote control *via* light irradiation of the electrical and optical OSOLETs  
220 output was investigated. UV (315 nm) irradiation of the OSOLETs yields a significant  
221 decrease of both drain current and luminance, which we attribute to ring-closing of the  
222 DAEs and subsequent efficient trapping of the majority of carriers. In the case of  
223 F8T2/DAE\_tBu bicomponent devices, the on/off ratios (the ratio of the  
224 current/luminance in the initial state and after UV irradiation) in both transport current  
225 and EL exceed 500 (see Figs. 2d and 2g). Such a large degree of modulation is  
226 comparable with the reports of photo-programmable OLEDs and non-volatile organic  
227 memories<sup>47,48</sup>. A high modulation of the drain current and luminance was also observed  
228 for MDMO-PPV/DAE\_tBu OSOLET devices (85 % decrease in current and 87 %  
229 decrease in luminance, at  $V_g = -120$  V, see Figs. 2e and 2h) as well as F8/DAE\_F  
230 OSOLET devices (65 % decrease in current and 75 % decrease in luminance, at  $V_g = -$   
231 100 V, see Figs. 2f and 2i). Deeper investigations into the amount of incorporated  
232 photochromic molecules, energy levels matching, irradiation dose, and the thickness of  
233 active film, will surely enable further improvement of the ON/OFF ratios<sup>22,47-48</sup>. Further  
234 irradiation with green (528 nm) light converts the DAEs back to their open form, and  
235 leads to full recovery of the initial state in all three-colour OSOLETs. Under the same

236 irradiation conditions, neat polymer based OLETs did not show any modulation of  
237 output current and EL (see supplementary Fig. S7).

238

239 It should be noted that the energy transfer from the light-emitting polymers to  
240 DAEs in their closed form, favoured by the spectral overlap of the emission of the  
241 polymers with the absorption of the DAEs in ring-closed form, can also contribute to  
242 the modulation of the intensity of the emitted light. Indeed, a slight modulation of the  
243 photoluminescence spectra was detected on the light-emitting polymer/DAE films upon  
244 UV and visible irradiation (see supplementary Fig. S9). However, as the switching  
245 phenomenon can be observed both on charge transport and light emission, we conclude  
246 that energy transfer is not the main operating principle of OSOLETs. Nevertheless, the  
247 energy transfer process might help further modulate the intensity of EL, which can be  
248 used to explain the larger modulation degree of the luminance than of the current.

249

250 The effect of DAE photoswitching on both output current and luminance of the  
251 OSOLETs was monitored over three cycles with alternative UV and visible irradiation  
252 (Fig. 3). The large modulation of both maximum drain current and luminance of the  
253 three-colour OSOLETs, normalized to the initial value for each measurement, is  
254 reversible and the optical switching behaviour of OSOLETs is stable over several cycles.  
255 Reference OLETs prepared with pristine light-emitting polymers did not show any  
256 optically induced modulation, neither on drain current nor on luminance by UV or  
257 visible irradiation (see supplementary Fig. S8).

258

259 **Reversibly write and erase emitting patterns** More importantly, since light is used  
260 as an external control of our OSOLETs, it is possible to generate emitting patterns with  
261 high spatial and temporal resolution on a single transistor as demonstrated by optical  
262 images of patterns created and erased in a single OSOLET (Fig. 4). In the initial  
263 configuration, the F8T2/DAE\_tBu OSOLET was in an all light-emitting on-state (Fig.  
264 4a). Then, the device was irradiated homogenously using UV light yielding a dark state  
265 (Fig. 4b). More interestingly, a well-focused green laser (532 nm) can be used to form  
266 patterns on the OSOLET with the aid of a microscope. Fig. 4c shows a light-emitting  
267 on-area with a pattern of 'H' shape on the same device. Subsequently, the irradiation of  
268 the entire device with green light erased the patterns and the all light-emitting on-state  
269 can be seen again (Fig. 4d). The second pattern can be written in the same pixel with  
270 another step of UV irradiation and followed by one more laser writing step. Fig. 4f  
271 exhibits a pattern image of an array of dots in the same area, demonstrating the  
272 reversible and reproducible patterning of emissive features up to the micron/sub-micron  
273 scale. This demonstration using an optimized combination of photoswitch and emissive  
274 polymer illustrates the great potential of our approach to reversibly encode high-density  
275 visual information in a single display pixel.

276

## 277 **Conclusions**

278 We have fabricated a novel OLET device in which the transport current and  
279 electroluminescence, emitting in the range of the three primary colours, can be switched  
280 efficiently and reversibly using light as an external stimulus. The active layer in such

281 optically switchable organic light-emitting transistor comprises an organic light-  
282 emitting semiconductor and a photochromic DAE, in which the photo-tunable energy  
283 levels of DAEs can either transport or trap the charge carriers, toggled by UV and  
284 visible light irradiation. Such a dual external control is achieved through the  
285 engineering of the energy levels of the light-emitting polymers and those of the DAEs  
286 isomers. We are able to write and erase emitting patterns in a single OSOLET through  
287 a non-invasive and mask-free process, with a spatial resolution of a few micrometres,  
288 and a response on the microsecond time scale<sup>22</sup>. The stimuli-responsive multifunctional  
289 devices proposed in this work are all readily fabricated *via* solution processing, thus  
290 potentially transferrable to roll-to-roll compatible or ink-jet printing lines to produce  
291 low-cost and flexible stimuli-responsive (nano)electronics on a large scale. Ink-jet  
292 printing appears being a most suitable deposition method to fabricate full-colour  
293 displays by precisely positioning red, green, and blue emissive inks on each sub-pixel.

294 In principle, light emission from OLETs in any region of the visible spectrum can  
295 be tuned by choosing appropriate photochromic molecules in combination with suitable  
296 light-emitting polymers. Future efforts will be directed towards optically switchable  
297 OLETs that can be operated at a lower driving power/voltage and yield stronger  
298 brightness and a higher ON/OFF ratio. Our approach opens intriguing perspectives  
299 towards the development of novel optically gated, integrated full-colour displays,  
300 micro-sized light sensors, active optical memories, light controlled inverters, and logic  
301 circuitries.

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303

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411

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422

## 423 **Author contributions**

424 L.H., X.Z., and P.S. conceived the experiments. M.H., B.M.S., M.P., and S.H.  
425 synthesized the DAEs. L.H. did UV/visible absorption and PL measurements, and X.Z.  
426 performed AFM (the F8/DAE\_tBu sample by G.C.) and CV measurements. L.H. and  
427 X.Z. designed the devices, performed the electrical experiments and carried out  
428 emitting patterns writings. G.F.C., G.C., and F.C. designed and built the device  
429 characterisation setup. G.F.C., G.C., and L.H. performed the quantitative OLET device  
430 characterisation. All authors discussed the results and contributed to the interpretation  
431 of data. L.H., X.Z., and P.S. co-wrote the paper with inputs from all co-authors.

432

## 433 **Data available statement**

434 The data that support the plots within this paper and other findings of this study are  
435 available from the corresponding author upon reasonable request.

436

## 437 Competing interests

438 The authors declare no competing financial interests

439

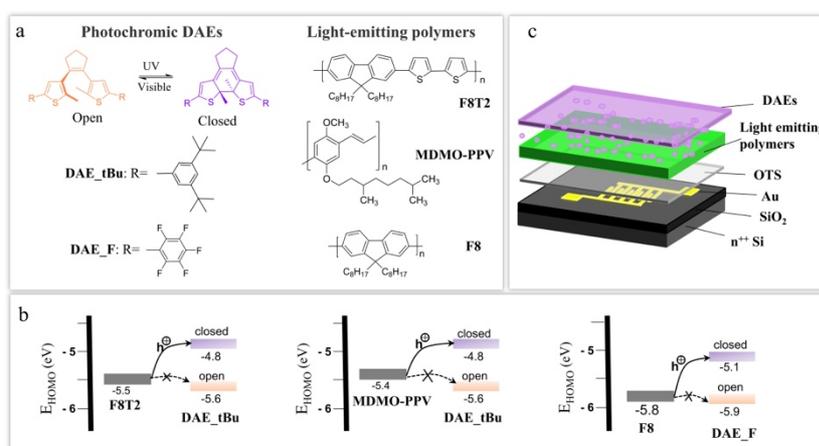
## 440 Additional information

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443 Correspondence and requests for materials should be addressed to P.S.

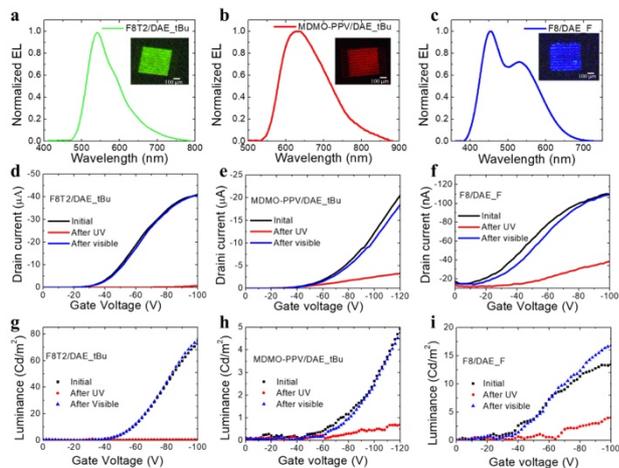
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## 445 Figure captions



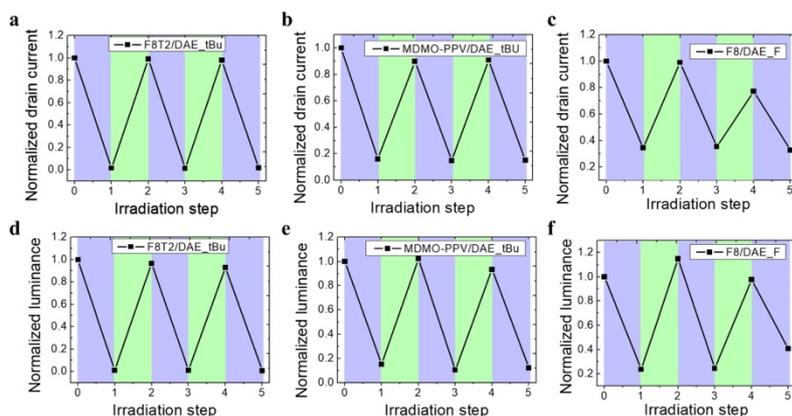
446

447 **Fig. 1 | Molecules, energetics, and device structure of optically switchable organic**  
448 **light-emitting transistors.** **a**, Chemical structures of photochromic diarylethenes  
449 (DAE\_tBu and DAE\_F) and light-emitting polymers (green: F8T2; red: MDMO-PPV;  
450 blue: F8). **b**, Schematic illustration of the switchable charge trapping mechanism of  
451 OSOLETs based on the HOMO energy levels of DAEs. As an illustrative example, for  
452 F8T2, its hole transport is greatly favoured to the closed form of DAE\_tBu but not to  
453 the open form of the latter. Thus, there is minimal trapping for the open form, while it  
454 is significant for the closed form of DAE\_tBu. **c**, Structure of the OSOLETs (substrate,  
455 dielectric layer, source and drain electrodes are the same for all the devices, while the  
456 light-emitting polymers and DAEs are varied).



457

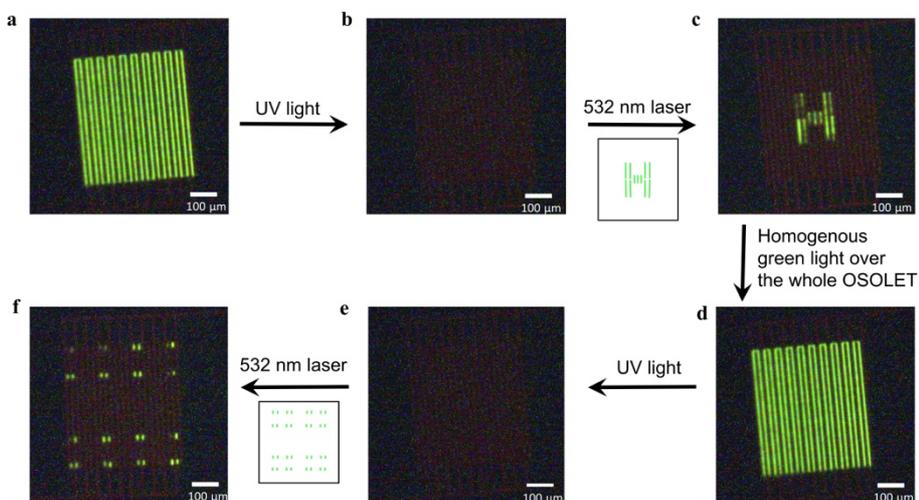
458 **Fig. 2 | Electroluminescence spectra, optical micrographs, and optoelectronic**  
 459 **characteristics. a to c**, EL spectra and emitting images of F8T2/DAE\_tBu, MDMO-  
 460 PPV/DAE\_tBu and F8/DAE\_F containing OSOLETs. The scale bar in the inset is 100  
 461  $\mu\text{m}$ . **d to f**, Transfer characteristic curves of F8T2/DAE\_tBu OSOLET ( $V_d = -100$  V),  
 462 MDMO-PPV/DAE\_tBu OSOLET ( $V_d = -120$  V) and F8/DAE\_F OSOLET ( $V_d = -100$   
 463 V), and light-triggered current switching upon UV and visible light irradiation. **g to i**,  
 464 Luminance and light-triggered switching of the luminance in green, red and blue  
 465 OSOLETs upon UV and visible light irradiation.



466

467 **Fig. 3 | Reversible modulation of optically switchable organic light-emitting**  
 468 **transistors' current and luminance during irradiation cycles. a-c** Drain current and  
 469 **d-f** luminance of green, red, and blue OSOLETs over three irradiation cycles with UV  
 470 light (315 nm, 0.6 mW, 10 min, violet shaded areas) and visible green light (528 nm,

471 7 mW, 90 s, green shaded areas). All values are normalized to initial value before any  
472 irradiation and the connecting lines serve as 'guides to the eye'.



473

474 **Fig. 4 | Emitting pattern created and erased within a single optically switchable**  
475 **organic light-emitting transistor.** **a**, Optical image of a F8T2/DAE\_tBu OSOLET  
476 device biased with  $V_d = V_g = -100$  V. **b**, Optical image of a dark state in the same  
477 device after UV light irradiation. **c**, Optical image of an 'H' shape emitting pattern from  
478 the OSOLET written with a well-focused green laser (532 nm). **d**, Optical image of the  
479 second all light-emitting on-state upon homogenous green light irradiation to erase the  
480 pattern. **e**, Optical image of the second dark state after homogenous UV irradiation. **f**,  
481 Optical image of an array of dots emitting patterns written by the irradiation with a  
482 532 nm laser. The dark area in the pattern is due to the variation of the intensity and/or  
483 focus of the laser.