

## Supporting Information

### A novel viologen-based hybrid crystalline material for photochromic glass film, information storage and anti-counterfeiting

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### Table of contents

**Fig. S1** TGA curve of compound **1** was investigated using powder samples under N<sub>2</sub>. The weight loss is 5.5 % up to 173 °C corresponding to the loss of one free H<sub>2</sub>O and one coordinated H<sub>2</sub>O.

**Fig. S2** PXRD pattern of compound **1** at different pH.

**Fig. S3** Photochromic behaviors of compound **1**. Label: **1a**: initial sample before photo irradiation; **1b-P**: the irradiated sample; **1b-P'**: the decolorated samples irradiated again.

**Fig. S4** IR spectra of compound **1** in different states. Label: **1a**: initial sample before photo irradiation; **1b-P**: the irradiated sample.

**Fig. S5** PXRD patterns of compound **1** in different states. Label: **1a**: initial sample before photo irradiation; **1b-P**: the irradiated sample; **simulated**: PXRD simulation of the compound.

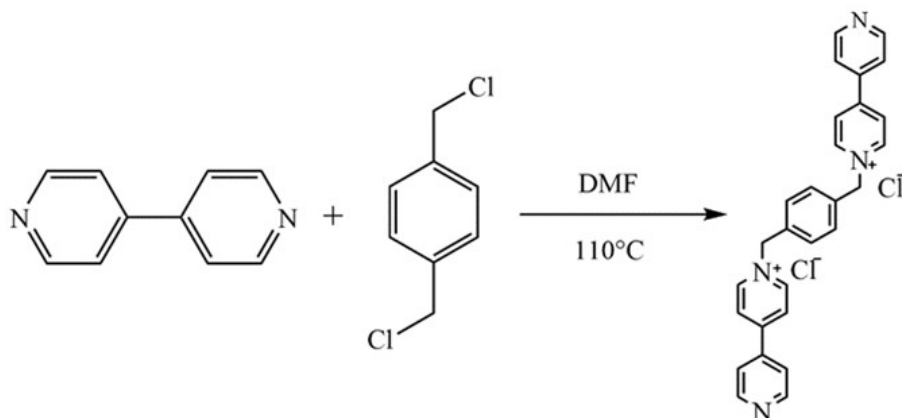
**Fig. S6** The discoloration of photochromic glass under ultraviolet light.

**Fig. S7** Printing effect and effective retention time of two-dimensional code information storage on photochromic glass.

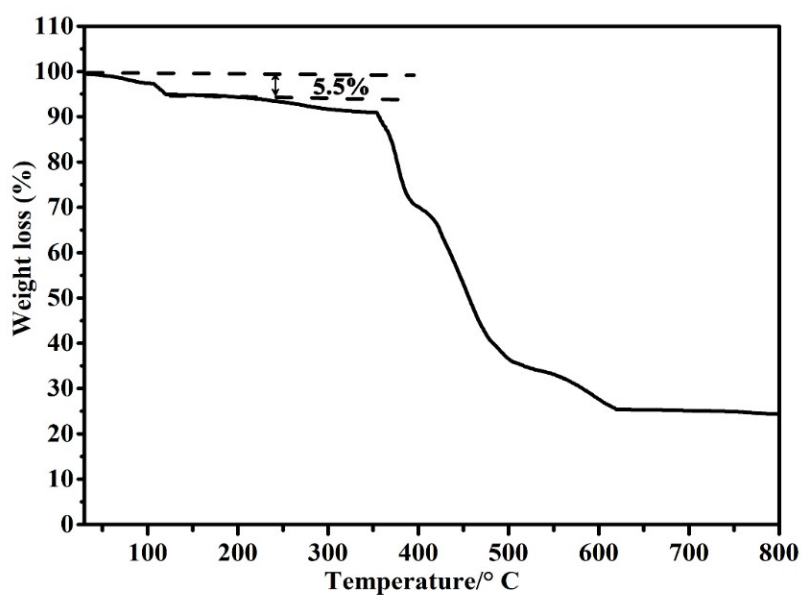
**Fig. S8** Number of cycles for information storage on glass film.

**Fig. S9** Ink-free printing effect of compound **1** under visible and ultraviolet light irradiation at the same time.

**Fig. S10** (a) PXRD patterns of compound **1** after fumigation with different amines; (b) Infrared spectra of **1** after fumigation with different amines.



**Scheme 1.** The synthesis scheme of viologen ligand pbpy·2Cl.



**Fig. S1** TGA curve of compound **1** was investigated using powder samples under N<sub>2</sub>. The weight loss is 5.5 % up to 173 °C corresponding to the loss of one free H<sub>2</sub>O and one coordinated H<sub>2</sub>O.

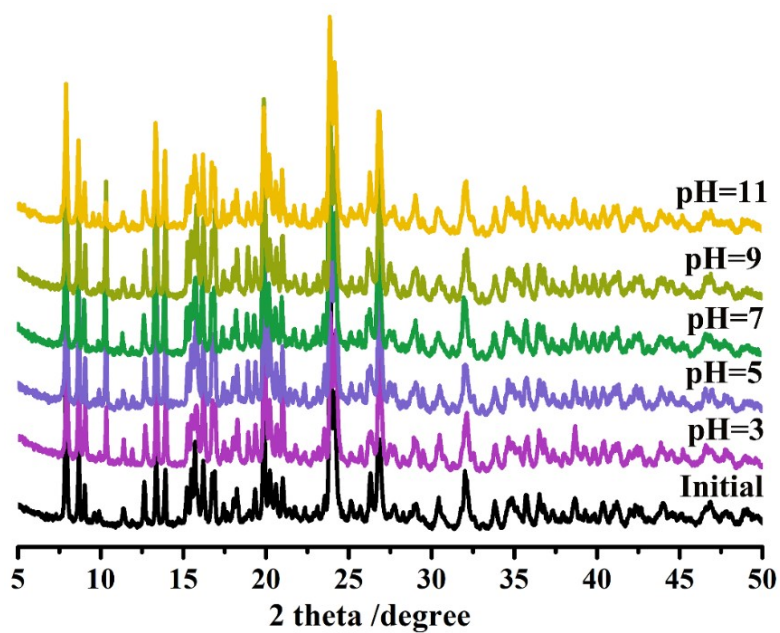


Fig. S2 PXRD pattern of compound 1 at different pH.

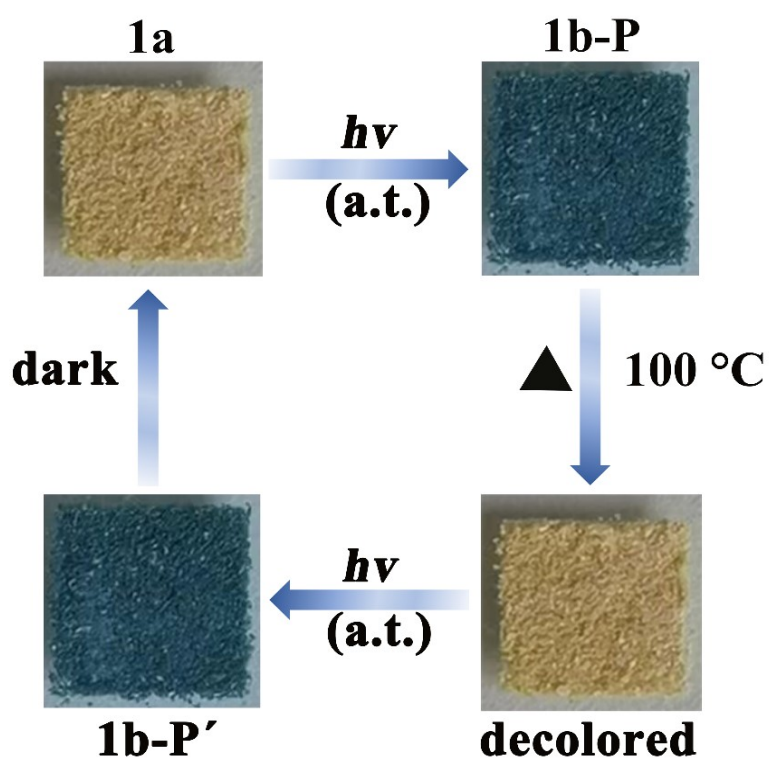
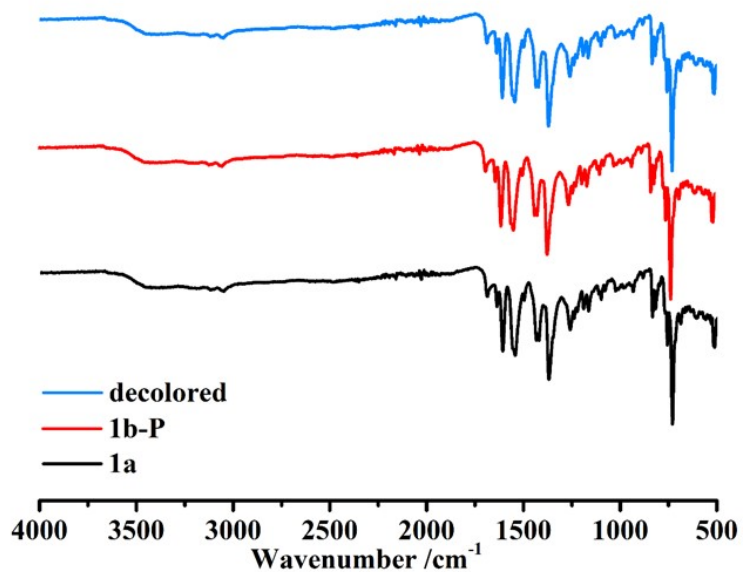
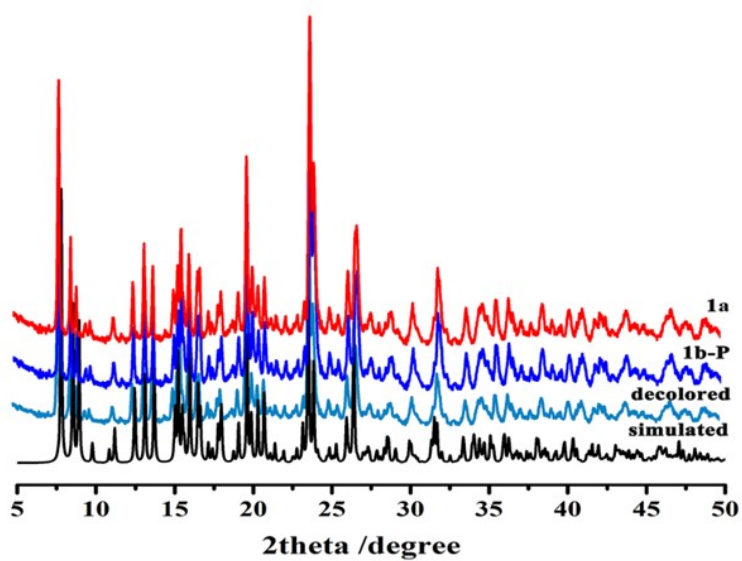


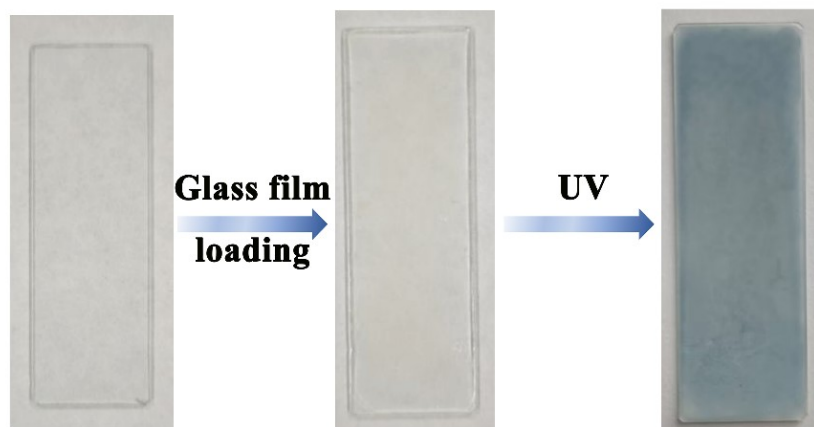
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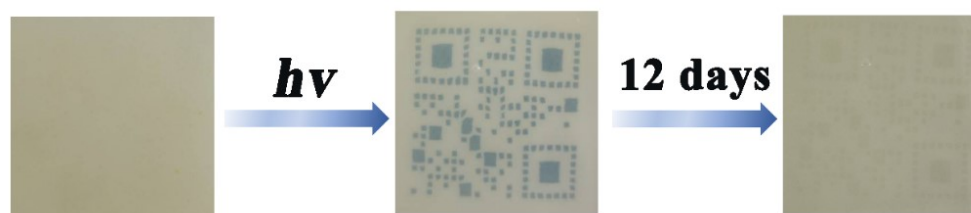
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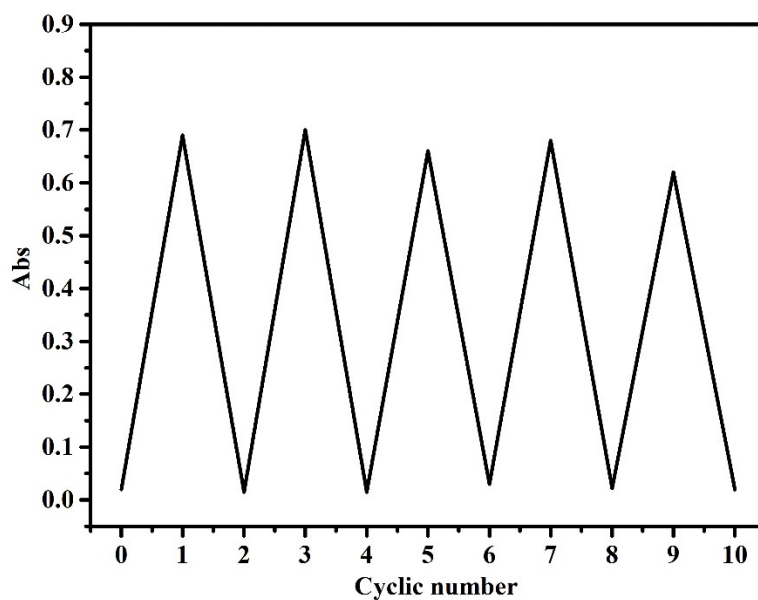
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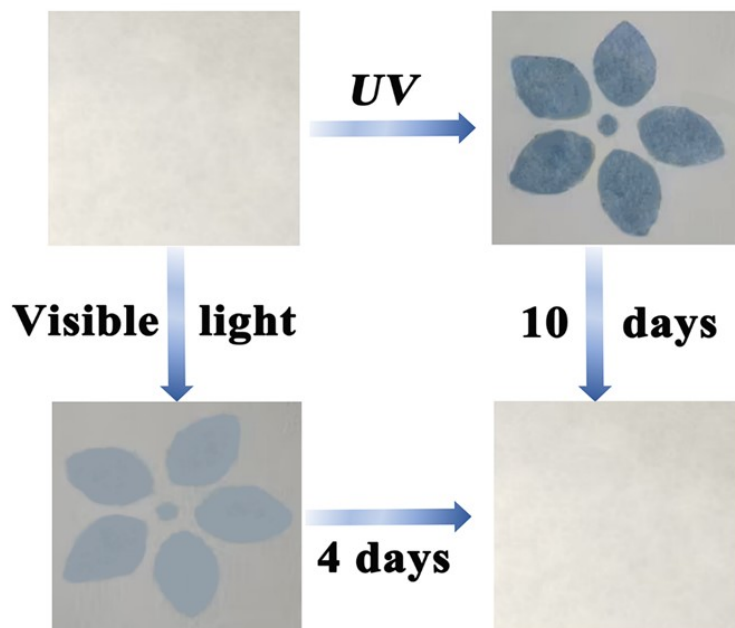
**Fig. S6** The discoloration of photochromic glass under ultraviolet light.



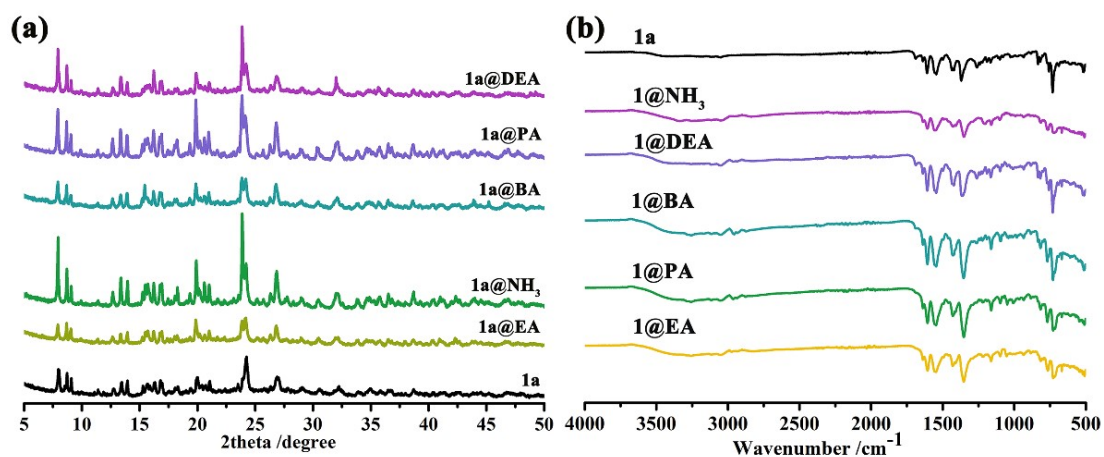
**Fig. S7** Printing effect and effective retention time of two-dimensional code information storage on photochromic glass.



**Fig. S8** Number of cycles for information storage on glass film.



**Fig. S9** Ink-free printing effect of compound **1** under visible and ultraviolet light irradiation at the same time.



**Fig. S10** (a) PXRD patterns of compound **1** after fumigation with different amines; (b) Infrared spectra of **1** after fumigation with different amines.

**Table S1.** Comparison of properties of **1** with existing photochromic materials

Compound	Response rate	Application performance	Fading time	Reference
1	1 s	Waterproof photochromic glass film Amine-selective detection Information storage and anti-counterfeiting	10 days	
[Zn <sub>4</sub> (BTC) <sub>3</sub> (bcbpy) <sub>2</sub> ] $\cdot$ 5H <sub>2</sub> O	5 s	The detection of benzenes and NO <sub>2</sub> <sup>-</sup>	/	a
[Cd(bcbpy)Cl <sub>2</sub> ] $\cdot$ H <sub>2</sub> O	30 s	The sensing of organic amines and benzenes	/	b
{[Cd <sub>2</sub> (bcbp)(pta) <sub>2</sub> (H <sub>2</sub> O)] $\cdot$ 2H <sub>2</sub> O} <sub>n</sub>	20 min	Detection of MnO <sub>4</sub> <sup>-</sup> Chemochromism	6 h	c
[Cd <sub>2</sub> (bcbpy)(m-BDC) <sub>2</sub> (H <sub>2</sub> O) <sub>4</sub> ] $\cdot$ 5H <sub>2</sub> O	30 s	Inkless and erasable prints Amine-selective sensing	2 days	d
(H <sub>2</sub> AV)[H <sub>2</sub> (P <sub>2</sub> W <sub>18</sub> O <sub>62</sub> )] $\cdot$ 9.5H <sub>2</sub> O	30 s	Raman spectroscopy detection of EDA	7 days	e
[Zn(bcbpy) <sub>0.5</sub> (pma) <sub>0.5</sub> (H <sub>2</sub> O)] $\cdot$ 3H <sub>2</sub> O	/	Amine detection Ultraviolet light detection Inkless and erasable prints	18 h	f
Zn (CV) <sub>0.5</sub> $\cdot$ (BDC) <sub>0.5</sub> $\cdot$ Br	5 s	Smart window Inkless and erasable printing Anti-counterfeiting applications	6 days	g

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**Table S2.** Data response of compound **1** to different amines

<b>Object</b>	<b>Response time</b>	<b>Response condition</b>
NH <sub>3</sub>	30 s	evident
EA	1 min	evident
PA	3 min	evident
BA	3 min	light
DEA	5 min	lighter
Dipropylamine	no	no
Triethylamine	no	no
Tri-n-butylamine	no	no



## Crystallographic Data

**Table S3.** Crystal Data and Structure Refinements for compound **1**

Empirical formula	C <sub>23</sub> H <sub>20</sub> CdClN <sub>2</sub> O <sub>9</sub>
CCDC number	2222406
Formula weight	616.26
Temperature/K	273.15
Crystal system	triclinic
Space group	<i>P</i> $\bar{1}$
<i>a</i> /Å	10.3601(9)
<i>b</i> /Å	11.2364(11)
<i>c</i> /Å	12.0547(12)
$\alpha$ /°	71.233(2)
$\beta$ /°	79.299(3)
$\gamma$ /°	74.139(3)
Volume/Å <sup>3</sup>	1270.7(2)
<i>Z</i>	2
$\rho_{\text{calc}}$ g/cm <sup>3</sup>	1.611
$\mu$ /mm <sup>-1</sup>	1.018
F(000)	618.0
Goodness-of-fit on F <sup>2</sup>	1.034
Final R indexes [ <i>I</i> >= 2 $\sigma$ ( <i>I</i> )]	R <sub>1</sub> = 0.0463, wR <sub>2</sub> = 0.1221
Final R indexes [all data]	R <sub>1</sub> = 0.0516, wR <sub>2</sub> = 0.1257

**Table S4.** Important bond lengths of compound **1**

Bond	Length/Å	Bond	Length/Å
Cd1-Cl1	2.5315(14)	Cd1-O2	2.434(3)
Cd1-N1	2.413(4)	Cd1-O6	2.488(3)
Cd1-O3	2.369(3)	C1-C5	1.527(5)
Cd1-O4	2.439(3)	C1-O1	1.274(5)
C11-N1	1.362(6)	C14-N1	1.360(5)
C10-O2	1.270(5)	C10-O6	1.280(5)

**Table S5.** Important bond angles of compound 1

Bond Angles	Angle/°	Bond Angles	Angle/°
N1-Cd1-Cl1	165.43(10)	O4-Cd1-Cl1	88.66(8)
N1-Cd1-O2	86.67(12)	O2-C10-O6	121.4(4)
N1-Cd1-O4	81.67(11)	N1-C11-C7	123.4(4)
N1-Cd1-O6	95.83(12)	C11-N1-Cd1	123.3(3)
O3-Cd1-Cl1	99.49(9)	C14-N1-C11	116.7(4)
O3-Cd1-N1	82.48(12)	C14-N1-Cd1	118.0(3)
O3-Cd1-O2	82.53(10)	C1-O3-Cd1	100.8(2)
O3-Cd1-O4	144.21(10)	C10-O6-Cd1	91.0(2)