Electronic Supplementary Material (ESI) for Inorganic Chemistry Frontiers.

Bi^{3+}/Sm^{3+} co-doped $LiTaO_3$ photochromic perovskites: An ultrafast erasable optical information storage medium

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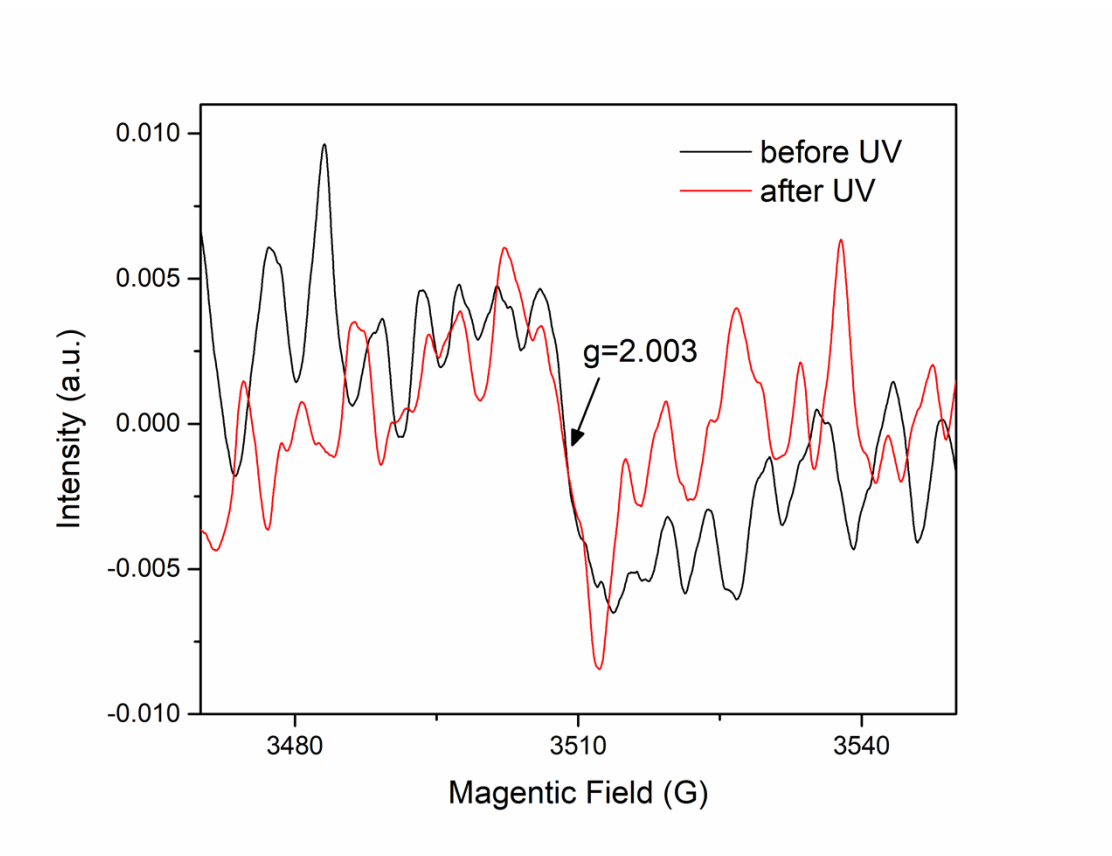

Figure S1. EPR spectra of $LiTaO_3$ samples before and after 254 nm light irradiation

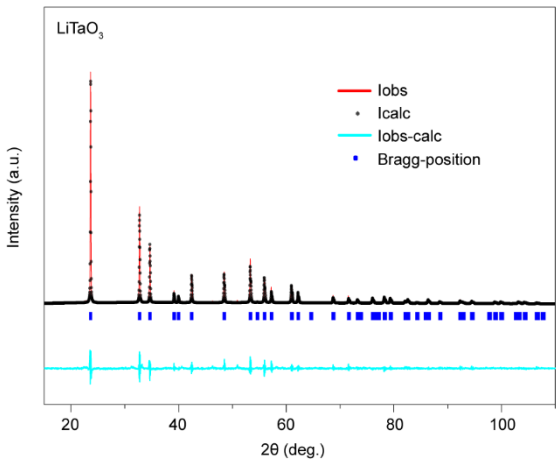

Figure S2. Rietveld refinement XRD patterns of $LiTaO_3$

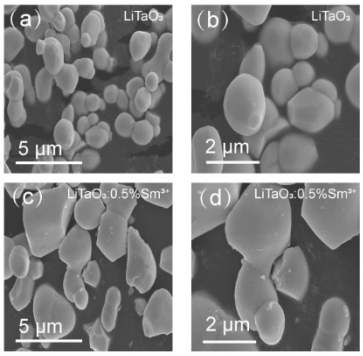

Figure S3. SEM images of $LiTaO_3$ under different scales: (a) 5 μm; (b) 2μm; SEM images of $LiTaO_3$: Sm^{3+} under different scales: (c) 5 μm; (d) 2μm.

Table S1. Rietveld refinement paraments of $LiTaO_3$: 0.5 mol% Sm^{3+}/ x mol% Bi^{3+} (x= 0, 0.25, 0.5, 0.75, 1.25, 1.5).

Parameter	$LiTaO_3$: 0.5 mol% Sm^{3+}	$LiTaO_3$: 0.5 mol% Sm^{3+}/ 0.25 mol% Bi^{3+}	$LiTaO_3$: 0.5 mol% Sm^{3+}/ 0.5 mol% Bi^{3+}	$LiTaO_3$: 0.5 mol% Sm^{3+}/ 0.75 mol% Bi^{3+}	$LiTaO_3$: 0.5 mol% Sm^{3+}/ 1.25 mol% Bi^{3+}	$LiTaO_3$: 0.5 mol% Sm^{3+}/ 1.5 mol% Bi^{3+}
Space group	R3c	R3c	R3c	R3c	R3c	R3c
Z	6	6	6	6	6	6
a (Å)	5.158	5.158	5.159	5.159	5.161	5.161
b (Å)	5.158	5.158	5.159	5.159	5.161	5.161
c (Å)	13.763	13.763	13.763	13.768	13.764	13.765
V ($Å^3$)	317.238	317.261	317.283	317.374	317.479	317.490
R_{wp} (%)	8.75	9.16	8.46	9.69	10.02	9.65
R_p (%)	5.96	7.21	7.07	6.96	7.32	7.98
χ^2	1.978	2.361	1.672	1.843	2.043	2.541

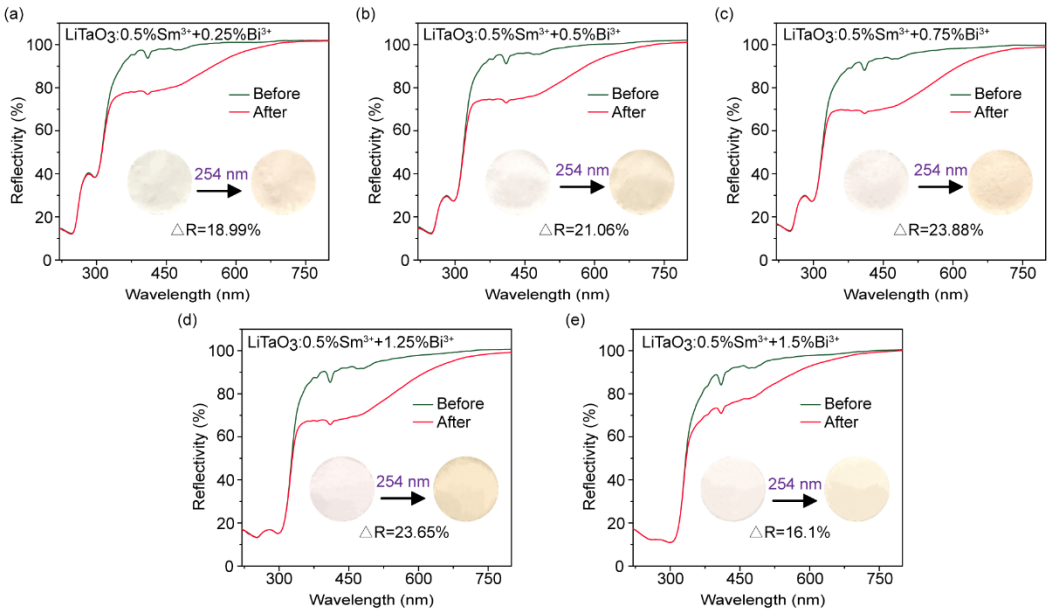

Figure S4. DRS and color change photos of $LiTaO_3$: 0.5 mol% Sm^{3+}/ x mol% Bi^{3+} powders before and after 254 nm light irradiation: **(a)** x=0.25; **(b)** x=0.5; **(c)** x=0.75; **(d)** x=1.25; **(e)** x=1.5.

Table S2. Coloring wavelength and time required for complete coloring of inorganic Photochromism materials reported in recent years

Material	coloring wavelength	Time	Reference
$LiNbO_3:Bi^{3+}/Pr^{3+}$	365 nm	5 s	[1]
$Na_{0.5}Bi_{2.5}Nb_2O_9:Ho^{3+}$	407 nm	5 s	[2]
$Na_{0.5}Bi_{4.5}Ti_4O_{15}$:Re (Re = Sm, Pr, Er)	407 nm	5 s	[3]
$YbNbO_4/ErNbO_4$	365 nm	10 s	[4]
$YNbO_4:Er^{3+}/Tm^{3+}/Yb^{3+}$	365 nm	15 s	[5]
$K_{0.5}Na_{0.5}NbO_{3:}Eu^{3+}$	420 nm	~20 s	[6]
$K_{0.5}Na_{0.5}NbO_3:Nd^{3+}$	365 nm	20 s	[7]
$LiTaO_3$: Bi^{3+}/Sm^{3+}	254 nm	25 s	**This work**
$BaMgSiO_4$: Eu^{2+}	405 nm	30 s	[8]
$PbWO_4:Yb^{3+}$, Er^{3+}	532 nm	40 s	[9]
$SrHfO_3:Ho^{3+}$	254 nm	60 s	[10]
$Bi_7Ti_4NbO_{21}:Er^{3+}$	405 nm	60 s	[11]
$LiTaO_3:Bi^{3+}/Dy^{3+}$	254 nm	60 s	[12]
$BaMg_{0.28}Zr_{0.16}Ta_{0.56}O_3$: Dy^{3+}	365 nm	2 min	[13]
$KSr_2Nb_5O_{15}:Sm^{3+}$	365 nm	2 min	[14]
$Ba(Zr_{0.16}Mg_{0.28}Ta_{0.56})O_3$:0.05%$Pr^{3+}$	365 nm	2 min	[15]
	254 nm	2 min	[16]
$NaYTiO_4:Bi^{3+}/Er^{3+}$	254 nm	2 min	[17]

$SrHfO_3:Er^{3+}$	280 nm	2 min	[18]
$Ca_2SnO_4:Eu^{3+}$	254 nm	16 min	[19]
$CaWO_4:Yb^{3+}/Er^{3+}/Bi^{3+}$	254 nm	20 min	[20]
$SrWO_4:Yb^{3+}/Er^{3+}/Bi^{3+}$			
$TiO_2:Yb^{3+}/Er^{3+}$	405 nm	27 min	[21]

Table S3. Reported inorganic photochromic materials that can be Photobleaching, bleaching wavelength, optical power density and bleaching time

Material	Bleaching wavelength	Power	Time	Reference
$LiTaO_3$: Bi^{3+}/Sm^{3+}	365 nm	40.8 mW/cm²	~1 s	**This work**
$CaWO_4$:Yb^{3+}/Er^{3+}/Bi^{3+}	473 nm	66.72 W/cm²	5 s	[19]
$SrWO_4$:Yb^{3+}/Er^{3+}/Bi^{3+}	473 nm	186.84 W/cm²	10 s	[20]
$SrHfO_3$:Ho^{3+}	405 nm	800 mW	1 min	[10]
$LiTaO_3$:Bi^{3+}/Dy^{3+}	365 nm	384 μW/cm²	1min	[12]
$LiNbO_3$:Bi^{3+}/Pr^{3+}	500 nm	-	2 min	[1]
$BaMgSiO_4$:Eu^{2+}	532 nm	3.25 W/cm²	2 min	[8]
$Ba(Zr_{0.16}Mg_{0.28}Ta_{0.56})O_3$:0.05%$Pr^{3+}$	450 nm	1 W/cm²	2 min	[15]
$KSr_2Nb_5O_{15}$:Sm^{3+}	532 nm	5 mW	＞2 min	[14]
$BaMg_{0.28}Zr_{0.16}Ta_{0.56}O_3$: Dy^{3+}	450 nm	450 mW	＞2 min	[13]

$TiO_2:Yb^{3+}/Er^{3+}$	808 nm	3 mW/cm²	170 s	[21]
$SrHfO_3:Er^{3+}$	405 nm	5.1 W/cm²	4 min	[17]
$ErNbO_4$	405 nm	1.03 W/cm²	5 min	[4]
$Ca_2SnO_4:Eu^{3+}$	585 nm	2 mW/cm²	5 min	[18]
$Sr_2SnO_4:Yb^{3+}/Ho^{3+}$	480 nm	-	＞8 min	[22]
$BaMgSiO_4$:M (M=Ce^{3+}, Mn^{2+}, or Nd^{3+})	590 nm	1.6 W/cm²	9 min	[23]
$YNbO_4:Er^{3+}/Tm^{3+}/Yb^{3+}$	405 nm	1.03 W/cm²	10 min	[5]
$Bi_7Ti_4NbO_{21}:Er^{3+}$	532 nm	12 mW/cm²	10 min	[11]
$NaYTiO_4:Bi^{3+}/Er^{3+}$	450 nm	-	10 min	[16]
Ca_2SnO_4: Sm^{3+}	520 nm	-	＞10 min	[24]

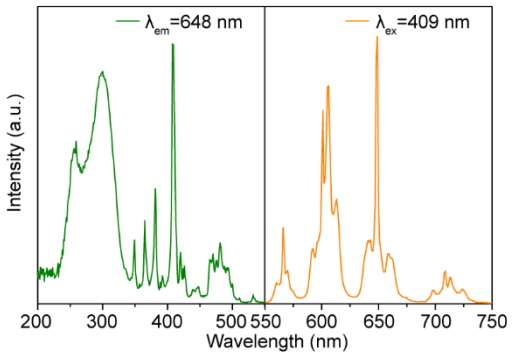

Figure S5. Excitation and emission spectra of $LiTaO_3$: 0.5 mol% Sm^{3+}/ 1 mol% Bi^{3+}

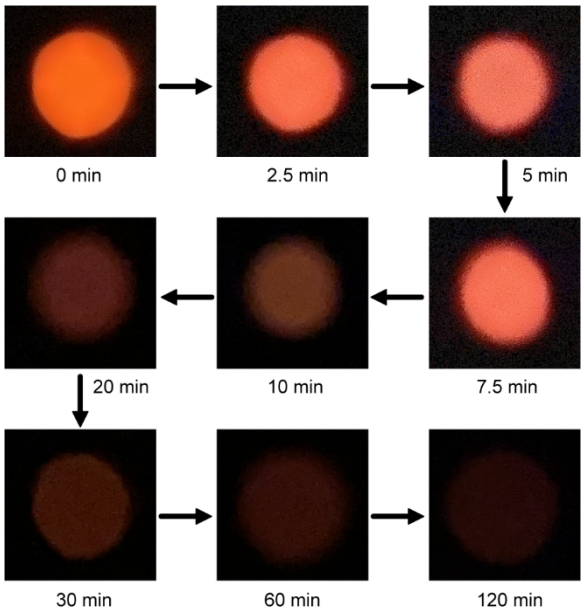

Figure S6. After irradiation of $LiTaO_3$: 0.5 mol% Sm^{3+}/ 1 mol% Bi^{3+} with 254 nm light for 30 s, photos of afterglow at different times in a dark environment.

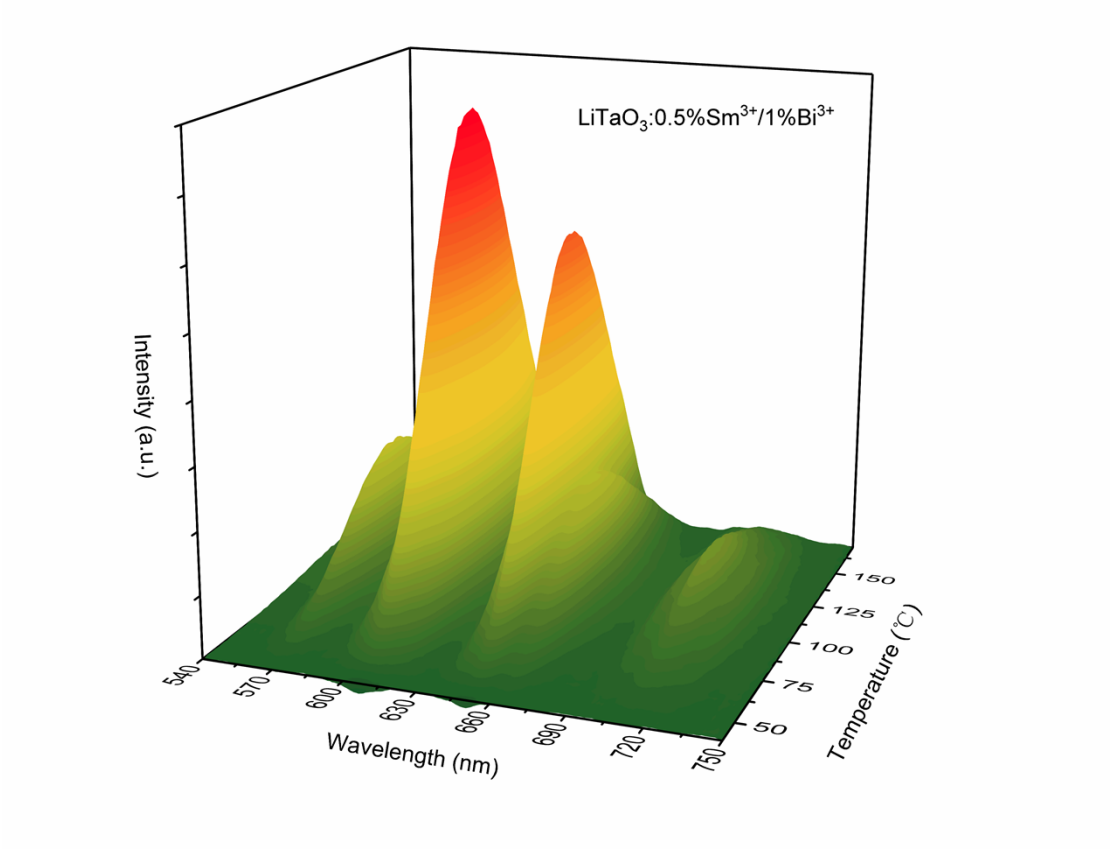

Figure S7. Emission spectra of the $LiTaO_3$: 0.5 mol% Sm^{3+}/ 1 mol% Bi^{3+} sample samples during TL measurements.

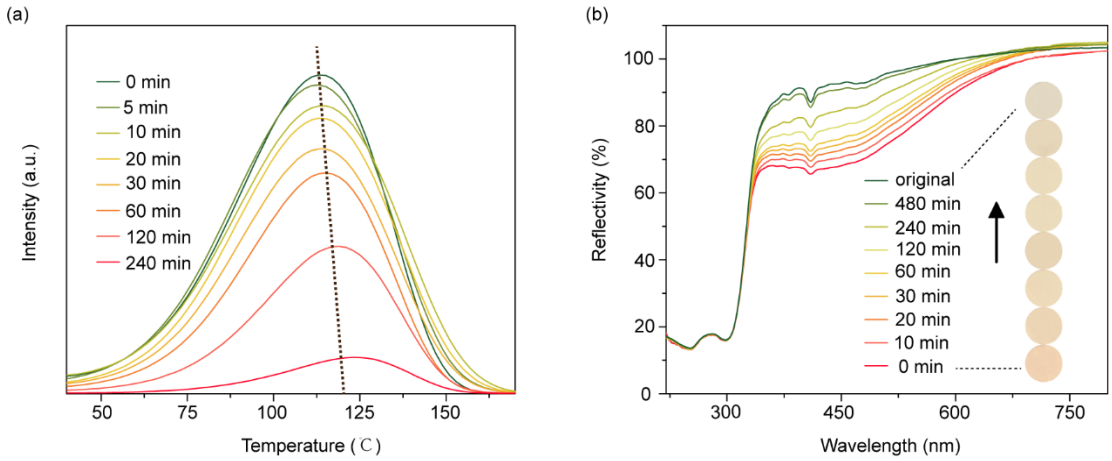

Figure S8. (a) TL spectra of $LiTaO_3$: 0.5 mol% Sm^{3+}/ 1 mol% Bi^{3+} after irradiation at 254 nm for 30 s with different delay times; **(b)** DRS of $LiTaO_3$: 0.5 mol% Sm^{3+}/ 1 mol% Bi^{3+} after irradiation at 254 nm for 30 s with different delay times. Insets: Sample photos at corresponding delay time.

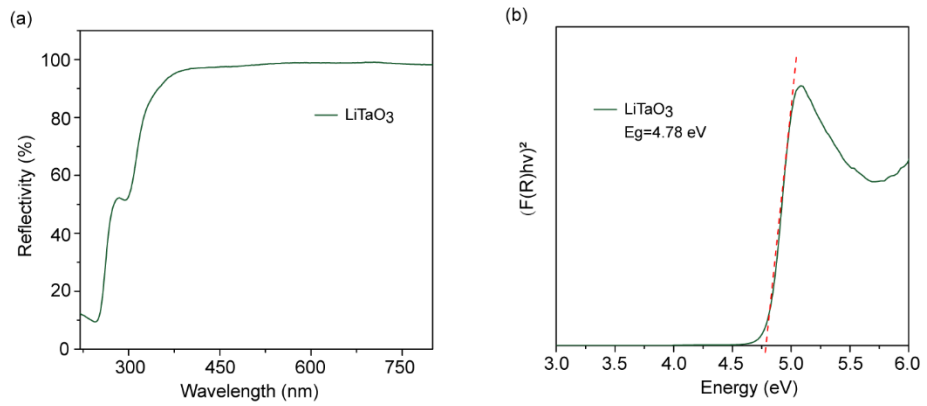

Figure S9. (a) DRS of $LiTaO_3$; **(b)** The relationship between the photon energy and the absorption coefficient of $LiTaO_3$.

The band gap (Eg) in $LiTaO_3$ was calculated by the following formula [25]: $(\alpha h\nu)^2 = A(h\nu - E_g)$, where h is the Planck constant, ν is the light frequency, A is the absorption constant, and α is the absorption coefficient that is proportional to F(R). According to the Kubelka-Munk formula [26], its expression is $F(R) = \frac{(1-R)^2}{2R}$, where R is the reflectivity of the material. Plot hν (photon energy) with $[F(R)h\nu]^2$ values, as shown in **Figure S5(b)**. By making a tangent to the resulting curve, the intercept between the tangent and the abscissa is Eg.

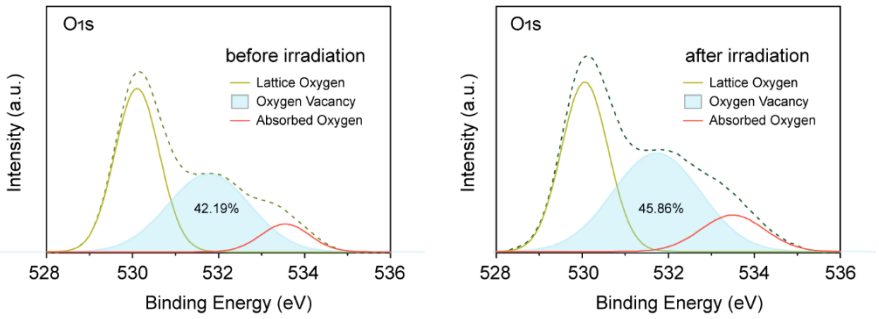

Figure S10. XPS spectra of $LiTaO_3$: 0.5 mol% Sm^{3+}/ 1 mol% Bi^{3+} in O_{1s} orbit before and after 254 nm light irradiation for 30 s.

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