Supplementary Information File for

Uniaxial Thermal Expansion Induced Successively Reversible Thermochromism in Zircon-Type $CaCrO_4$

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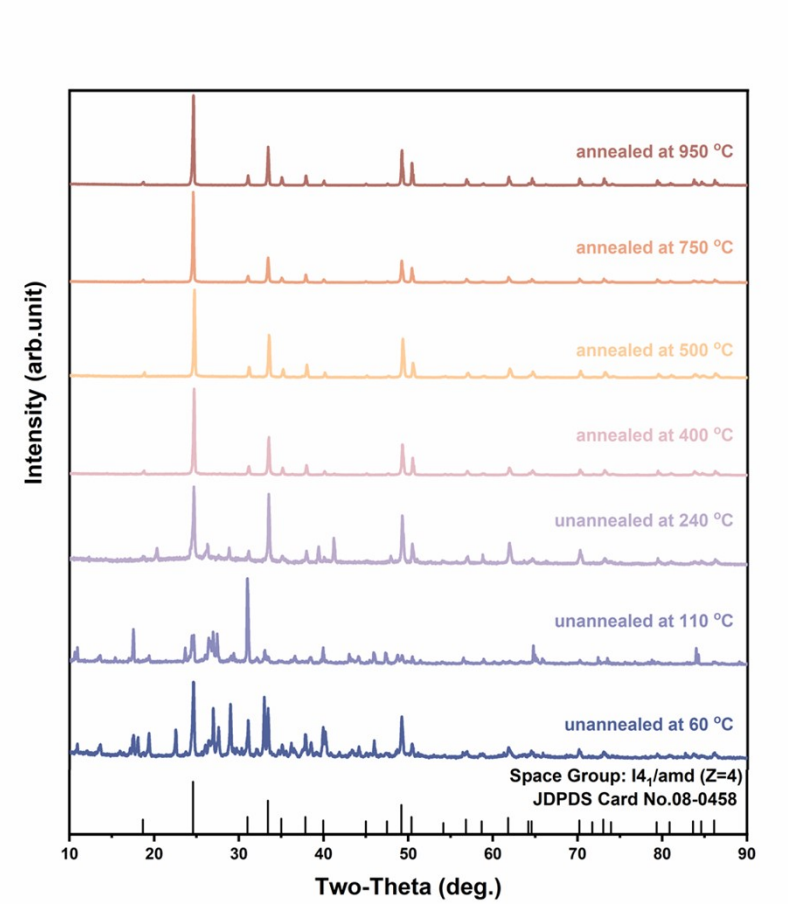


Figure S1. Powder X-ray diffraction results of $CaCrO_4$ crystalized at different temperature.

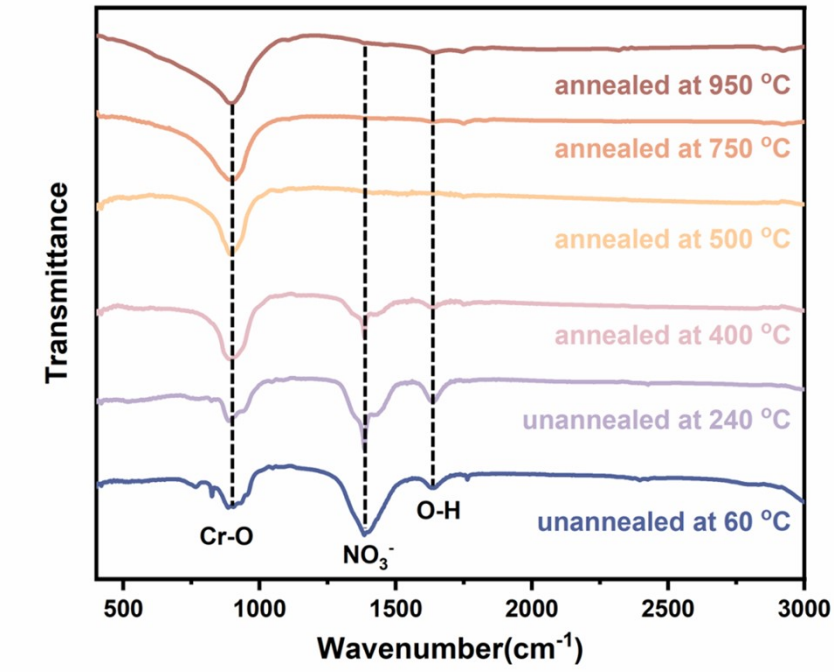


Figure S2. FT-IR spectra of $CaCrO_4$ synthesized in different conditions.

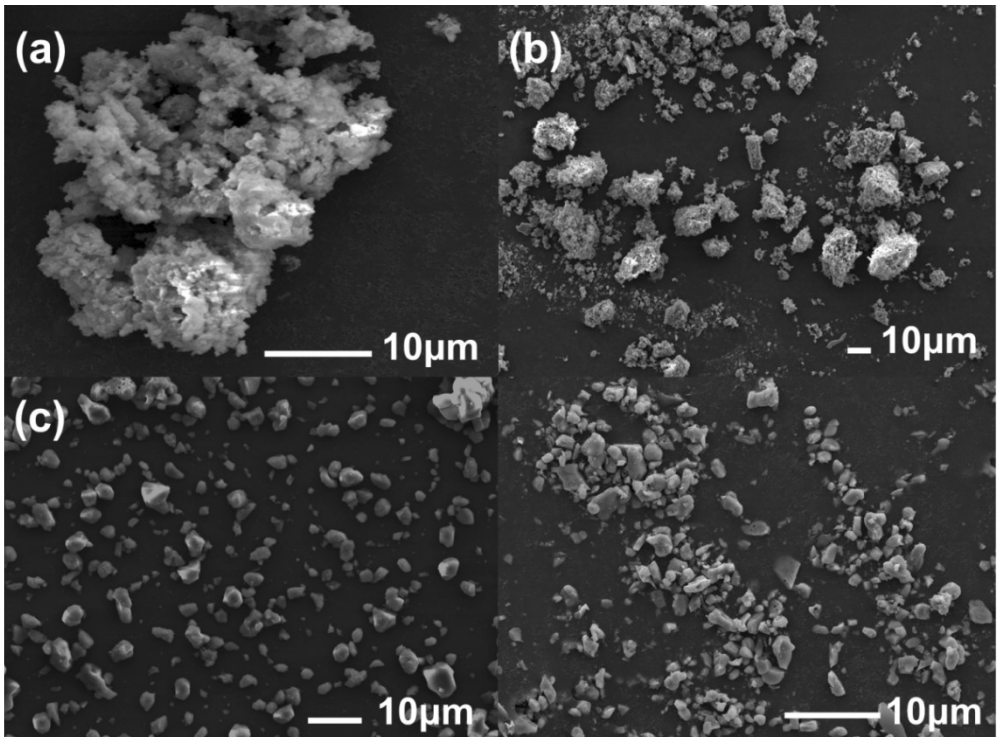


Figure S3. SEM graphs of $CaCrO_4$ synthesized in different conditions: (a) as precipitated and dried at 60 °C, (b) dried at 110 °C, (c) dried at 240 °C, and (d) calcined at 500 °C.

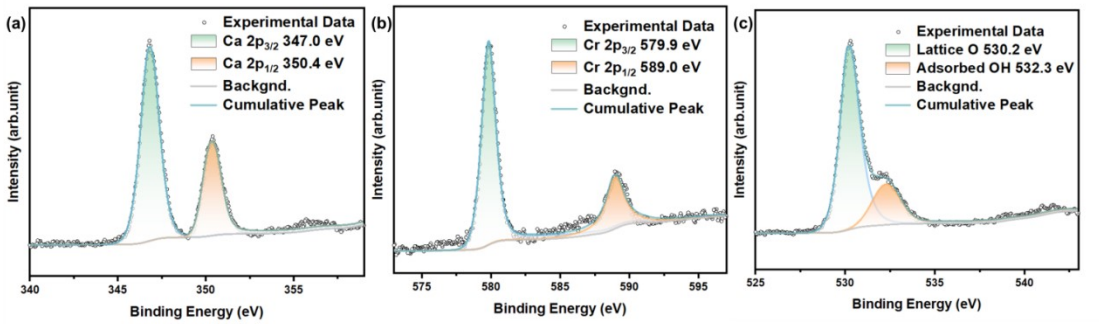


Figure S4. XPS core level binding energy spectra of Ca, O, Cr elements in $CaCrO_4$ sample that was calcined at 750 °C.

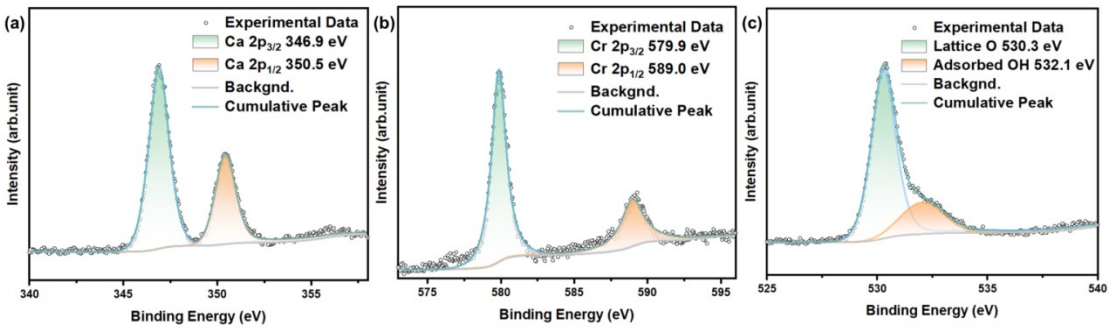


Figure S5. XPS core level binding energy spectra of Ca, O, Cr elements in $CaCrO_4$ sample that was calcined at 500 °C.

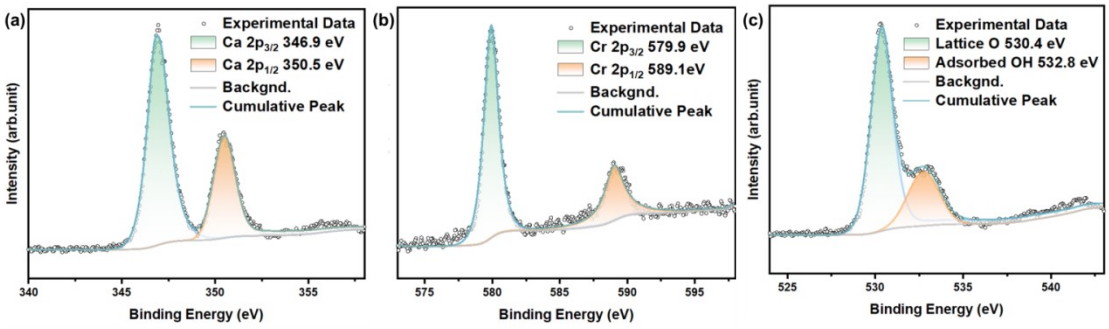


Figure S6. XPS core level binding energy spectra of Ca, O, Cr elements in $CaCrO_4$ sample that was calcined at 400 °C.

Table S1 CIE-$L^*a^*b^*$ parameters of zircon-type $CaCrO_4$ at different temperature.

	Temperature	L^*	a^*	b^*
heating	25	68	-8	69
	50	68	-8	69
	75	65	-7	67
	100	65	-5	67
	125	65	-4	67
	150	63	0	66
	175	64	0	67
	200	61	6	65
	225	60	7	64
	250	61	11	65
	275	59	14	63
	300	58	17	63
	325	56	22	61
	350	54	25	59
	375	52	28	57
	400	52	31	57
	425	52	33	57
	450	49	35	53
	475	49	36	52
	500	47	37	51
	525	47	39	51
	550	45	41	48
	575	42	39	44
cooling	550	46	40	48
	525	45	40	49
	500	47	37	51
	475	50	36	54

	450	50	35	55
	425	51	33	56
	400	54	31	59
	375	54	29	59
	350	54	26	60
	325	58	21	62
	300	58	19	63
	275	59	15	64
	250	60	12	64
	225	61	8	64
	200	61	5	64
	175	62	2	65
	150	64	0	67
	125	65	-2	67
	100	65	-4	67
	75	67	-6	69
	50	69	-8	70
	25	68	-7	70

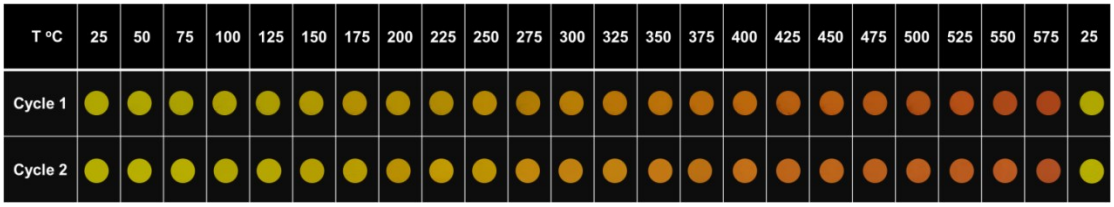


Figure S7. Digital photographs of the reversible thermochromism performance of $CaCrO_4$ pigments between 25 and 575 °C.

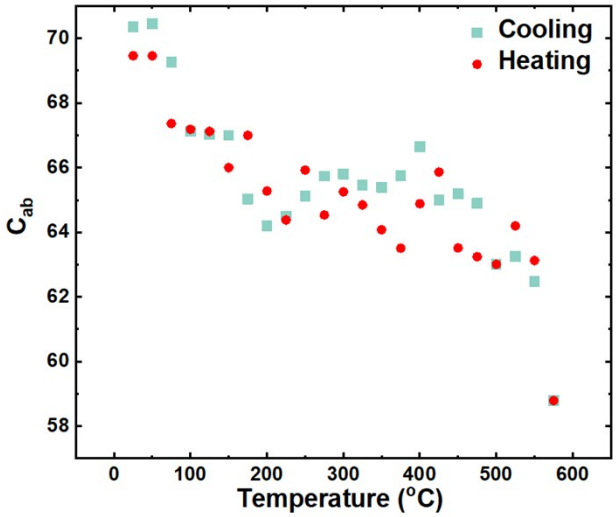


Figure S8. Chroma (C_{ab}) evolution as a function of temperature of the $CaCrO_4$ sample (calcined at 950 °C) in heating/cooling processes.

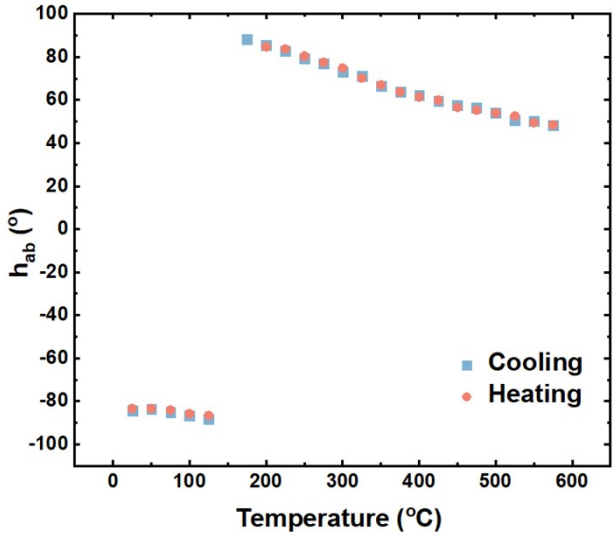


Figure S9. Hue angle evolution as a function of temperature of the $CaCrO_4$ sample (calcined at 950 °C) in heating/cooling processes.

Figure S10. Digital photographs of the thermochromic $CaCrO_4$ pigments synthesized at different calcination conditions in either heating or cooling processes.

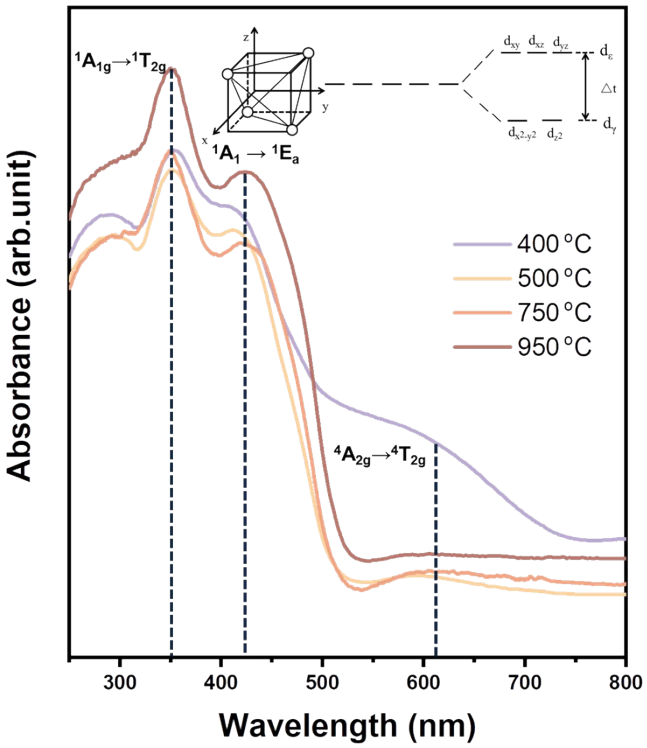


Figure S11. UV-vis absorption spectra of the $CaCrO_4$ samples calcined at 400 °C, 500 °C, 750 °C, and 900 °C. Inset of the figure show the splitting of 3d orbitals of Cr in tetrahedral crystal field.

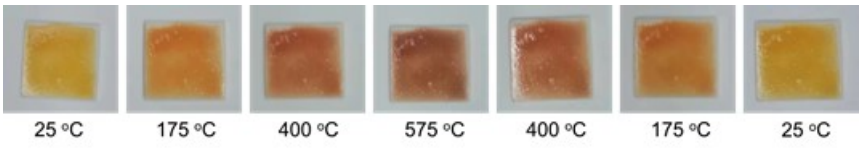


Figure S12. Thermochromic behavior of glazed $CaCrO_4$ pigments on ceramic plate.

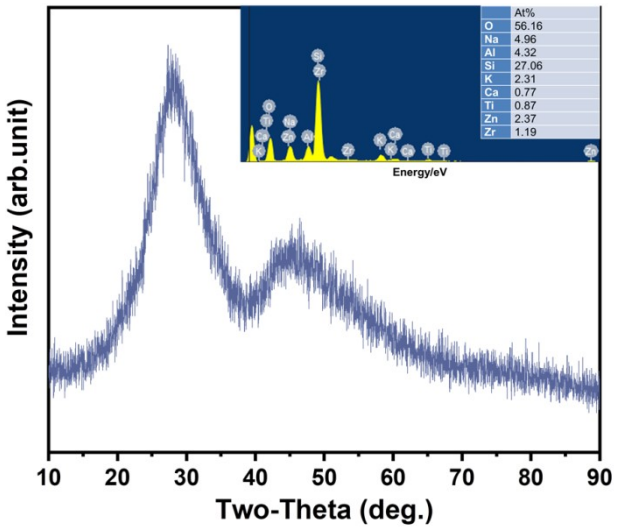


Figure S13. XRD and EDS of the low melting point glass powder.

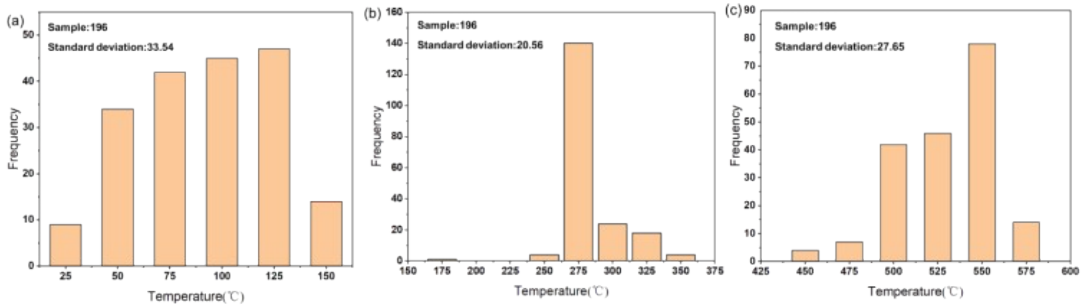
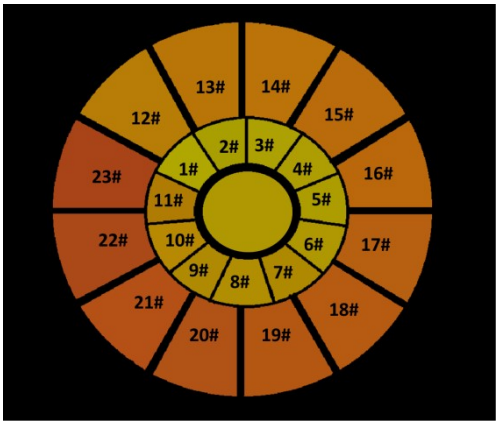


Figure S14. Readable accuracy of thermochromic markers in colorimetric questionnaire card of the thermochromic $CaCrO_4$ pigment in different temperature range by the naked eye. (a) target temperature 125 °C, (b) target temperature 275 °C, (c) target temperature 550 °C.

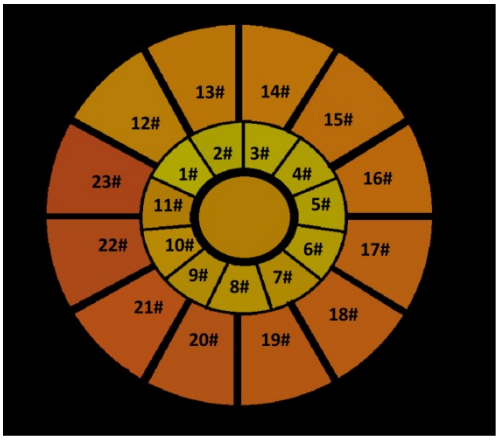
Colorimetric card questionnaire

Hello, everyone! We come from smart chromic material and device group, Jilin Normal University. We adhere to the innovative concept of technology serving life, aiming to develop highly sensitive color changing materials to serve people's production and life. The following image is a continuous reversible thermochromic color chart designed by us to help people recognize the oil temperature of a frying pan with their naked eyes. This color chart can help us master the "heat" of stir frying, avoid the "oily taste" caused by low-temperature stir frying and the carcinogenic substances such as benzo[a]pyrene caused by high-temperature heating, and help you and your family cook healthier and more delicious dishes. Please help us identify the color block corresponding to the following target colors and fill in the corresponding number in the blank. Your help is of great significance for the research of high-sensitivity oil temperature indicator color card materials and the daily dietary health of millions of households. Thank you everyone!

1. Please indicate the color block that is closest to the target color and fill in the number of that color block in the blank box. (Note: Only fill in the color block number that you think is closest to the target color) _____



2. Please indicate the color block that is closest to the target color and fill in the number of that color block in the blank box. (Note: Only fill in the color block number that you think is closest to the target color) _____



3. Please indicate the color block that is closest to the target color and fill in the number of that color block in the blank box. (Note: Only fill in the color block number that you think is closest to the target color) _____