Supplementary Information (SI) for Journal of Materials Chemistry A.

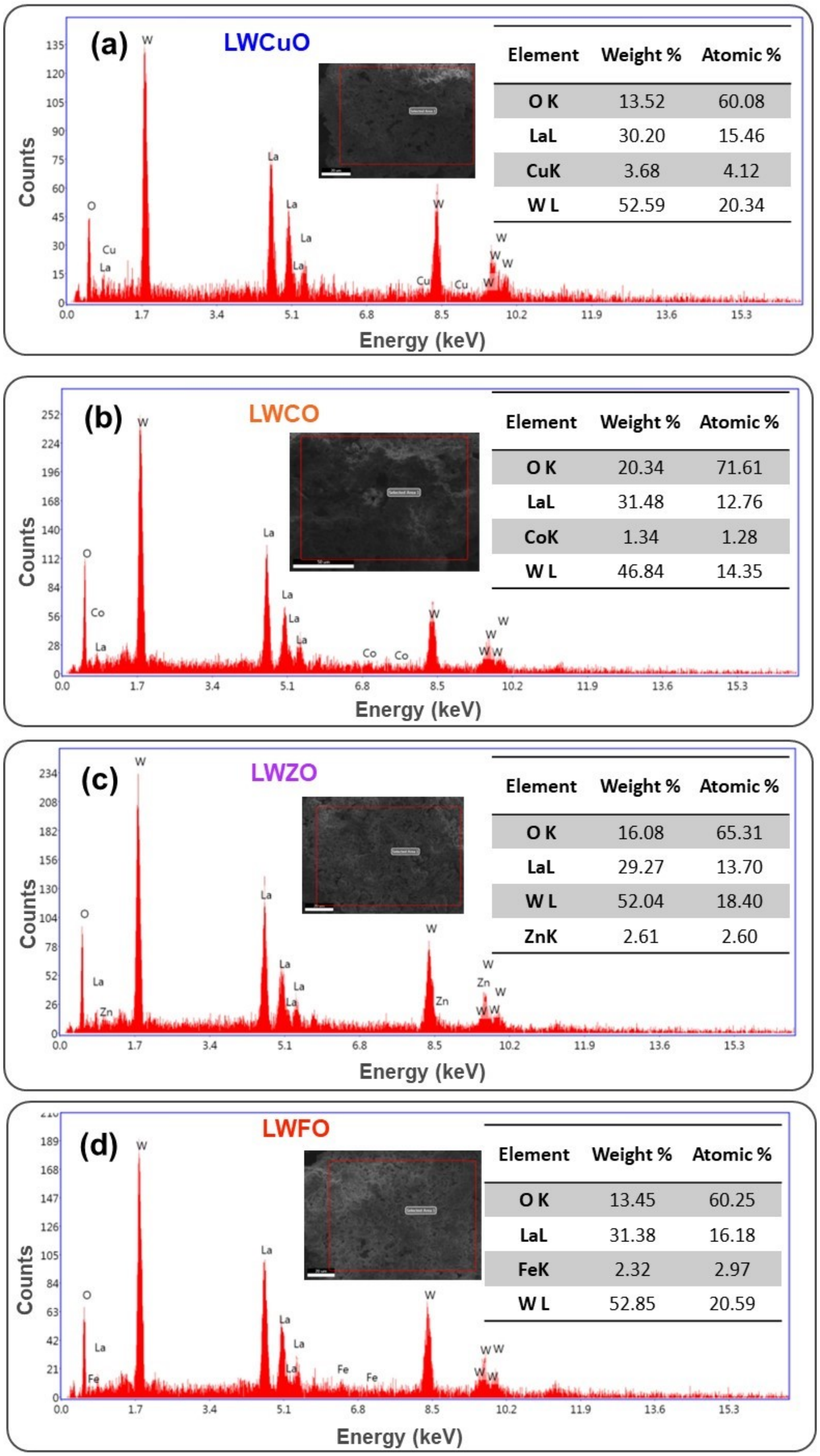
Supporting Information

Composite Oxide Cooling Pigments Mitigate the Impact of Urban Heat Islands

G.P. Darshan[1, 2 *], Akshay Arjun[2], H.B. Premkumar[2], Elisa Moretti[3], Alberto Vomiero[3, 4 *]

[1]*Physics and Astronomy Department, University of Padova, Via Marzolo 8, Padova I-35131, Italy*
[2]*Department of Physics, Faculty of Natural Sciences, M S Ramaiah University of Applied Sciences, Ramaiah Technical Campus, Bengaluru 560058, India*
[3]*Department of Molecular Sciences and Nanosystems, Ca' Foscari University of Venice, Via Torino 155, Venezia, 30172, Italy*
[4]*Division of Materials Science, Department of Engineering Sciences and Mathematics, Luleå University of Technology, Luleå, 97187, Sweden*

Corresponding Authors: Dr. Darshan G.P. (Email Id.: darshubavimane@gmail.com) and Prof. Alberto Vomiero (Email Id.: alberto.vomiero@ltu.se).



Element	Weight %	Atomic %
O K	13.52	60.08
LaL	30.20	15.46
CuK	3.68	4.12
W L	52.59	20.34

Element	Weight %	Atomic %
O K	20.34	71.61
LaL	31.48	12.76
CoK	1.34	1.28
W L	46.84	14.35

Element	Weight %	Atomic %
O K	16.08	65.31
LaL	29.27	13.70
W L	52.04	18.40
ZnK	2.61	2.60

Element	Weight %	Atomic %
O K	13.45	60.25
LaL	31.38	16.18
FeK	2.32	2.97
W L	52.85	20.59

Fig.S1. EDX spectrum of the selected portions of the synthesized LWCuO, LWCO, LWZO, and LWFO nano pigments [Inset: The tables enclosed corresponding elemental compositions in both weight and atomic (in %)].

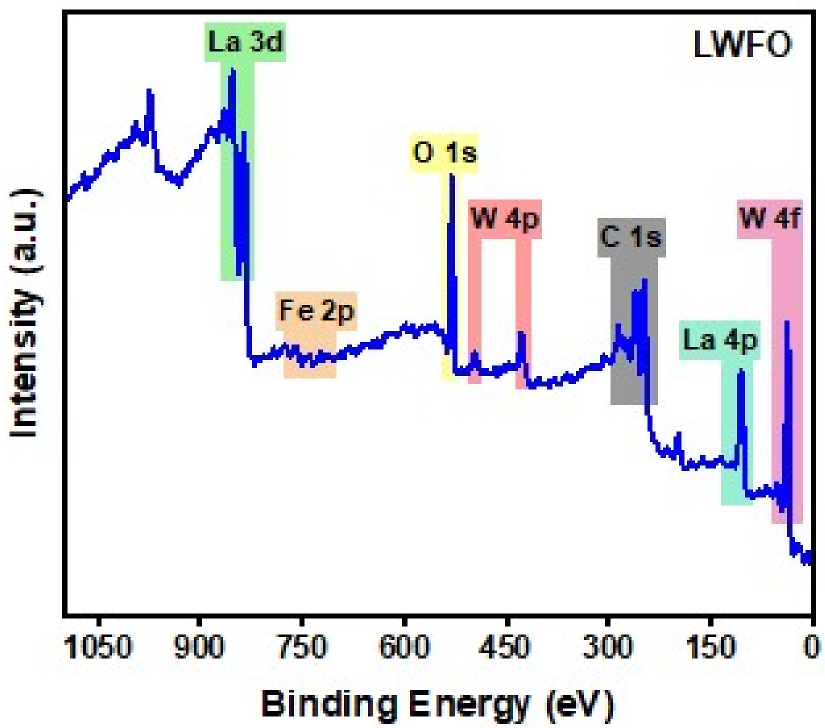


Fig.S2. XPS survey spectrum of the LWFO cooling nano pigment.

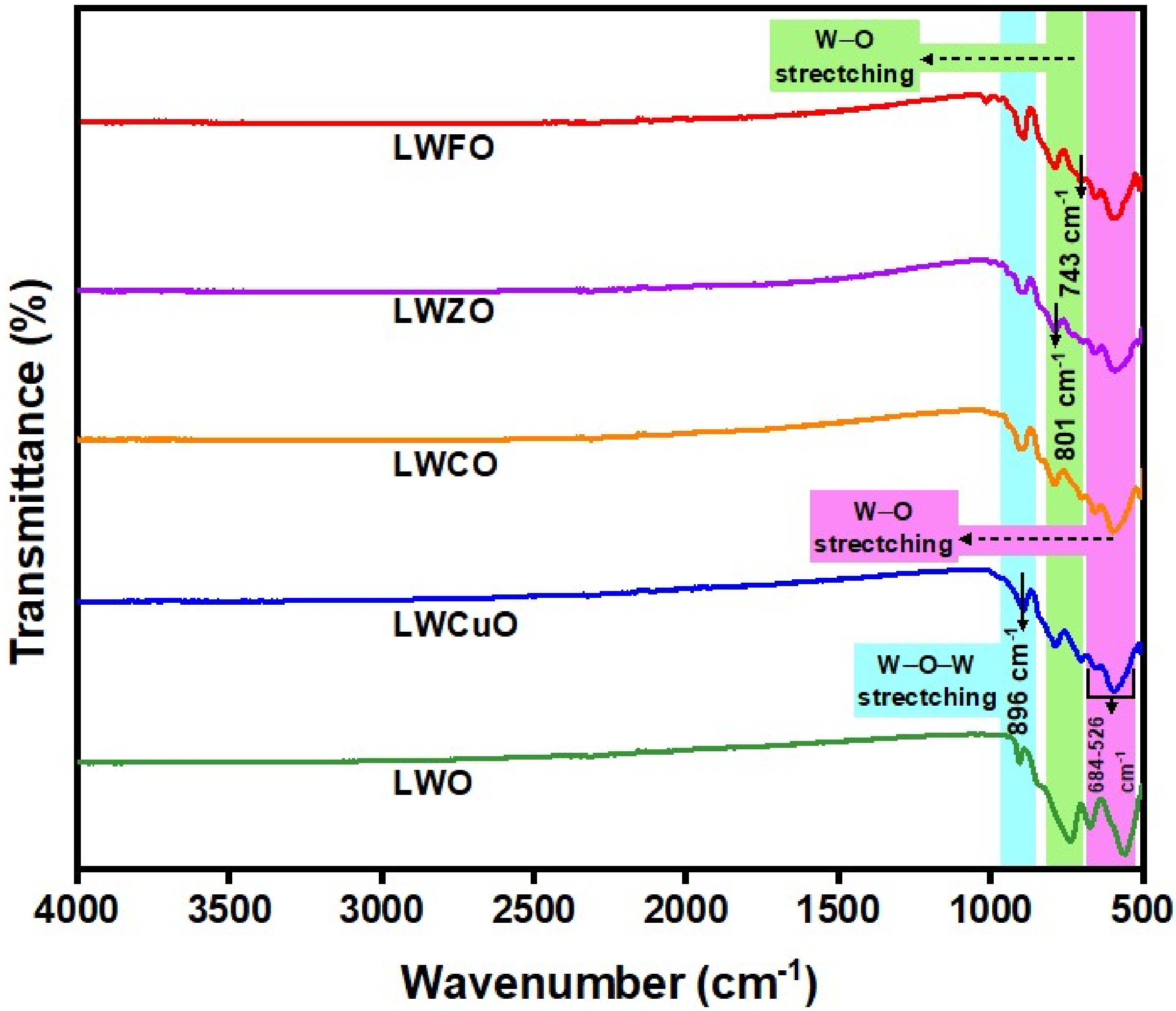


Fig.S3. FTIR spectra of the synthesized cooling nano pigments.

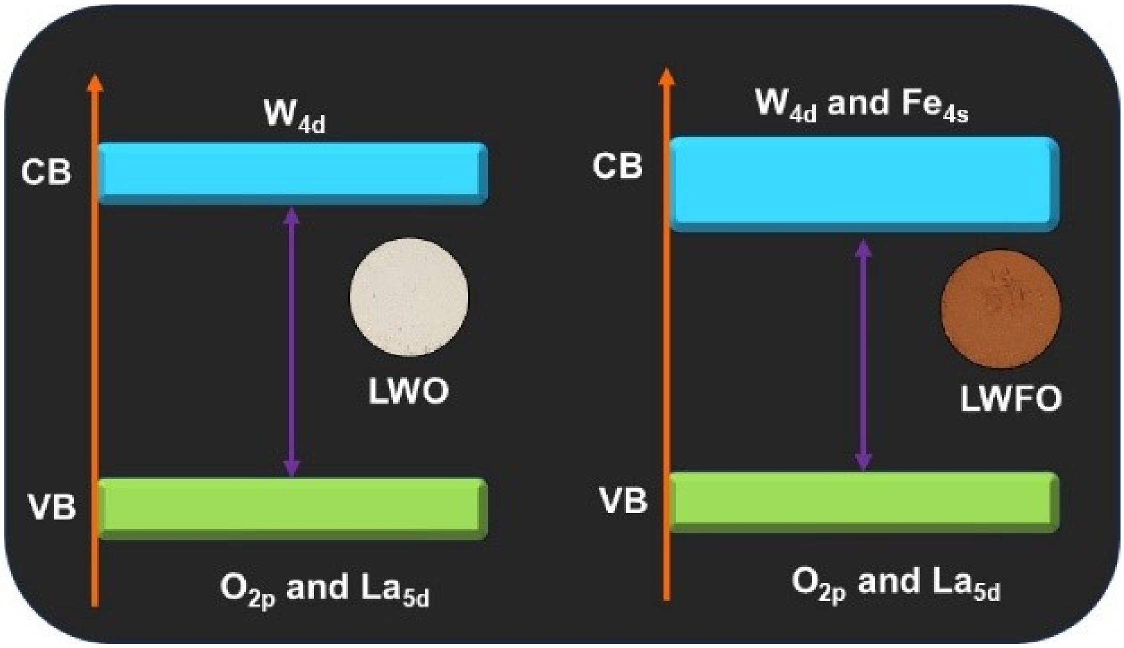


Fig.S4. Schematic illustration demonstrating band structures of LWO and LWFO pigments.

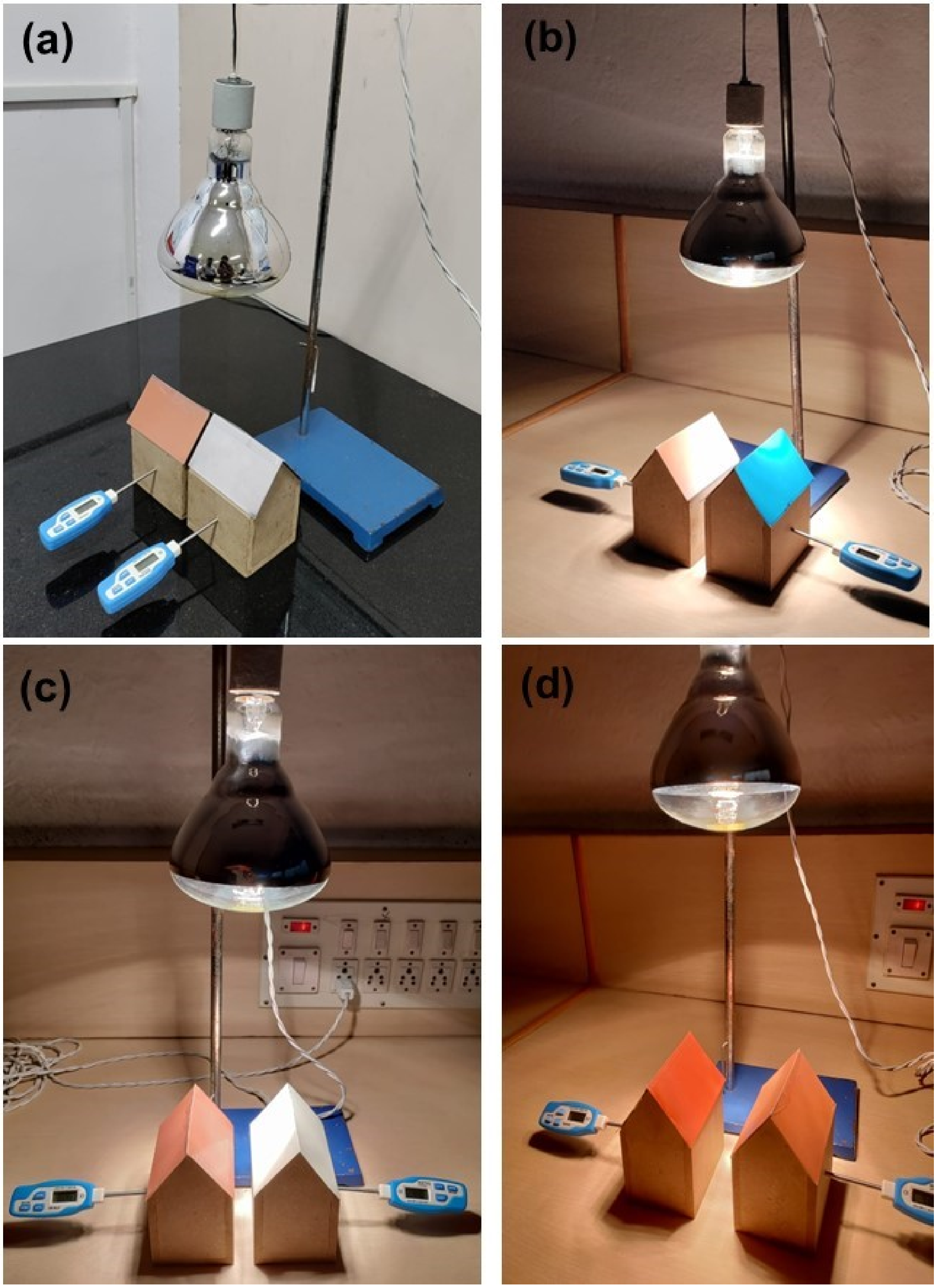


Fig.S5. Photographic images of the house models with different commercially available roofing materials to study passive daytime radiative cooling applications.

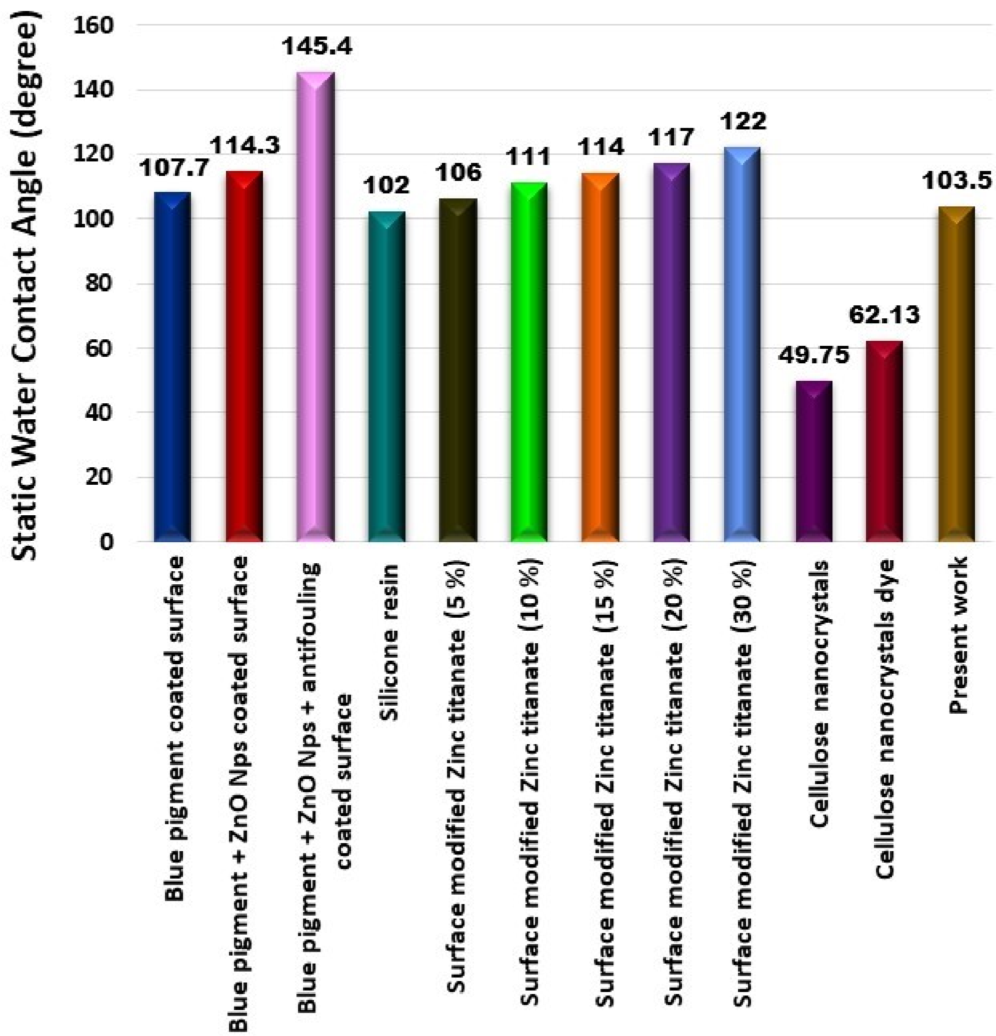


Fig.S6. Comparison of WCA of various pigment coatings with prepared LWFO pigment.

Table S1: List of previously reported NIR reflective pigments synthesized via various routes and corresponding NIR reflectance values.

SI. No.	Pigments	Synthesis method	NIR Reflectance (%)	External stimuli tests (Chemical/ Thermal/Photo)	References
01.	$TiO_2@NiTiO_3$	Precipitation-calcination	83.38	No	Zou et al. [22]
02.	$Y_3Fe_4AlO_{12}$	Solution combustion	87.66	Yes	Zhou et al. [23]
03.	$BaSn_{1-x}Fe_xO_{3-\delta}$	Sol–gel	79.81	Yes	Wang et al. [24]
04.	$TbFeO_3$	Coprecipitation	48	Yes	Maria et al. [25]
05.	$YFeO_3$	Solid-state reaction	45.8	No	Li et al. [26]
06.	$La_{1-x}Ce_xAlO_3$	Sol–gel	82.22	Yes	Cheng et al. [27]
07.	$LiCe(MoO_{4+\delta})_2$	Solid-state reaction	95.28	Yes	Xiao et al. [28]
08.	$BaTi_5O_{11}$: 5 % Ni	Solid-state reaction	76.19	Yes	Jian et al. [29]
09.	Fe_2Mn_6: $CuCr_2O_4$	Coprecipitation	24.7	No	Mingmin et al. [30]
10.	$YIn_{0.9x}Mn_{0.1}MxO_{3-\delta}$ (M = Li/Zn, x = 0–0.4)	Solid-state reaction	97.76	Yes	Zhang et al. [31]

Table S2: Estimated average crystallite size, and energy gap of the prepared cooling nano pigments.

Pigments	Average crystallite size (nm)	Energy gap (eV)
LWO	25	3.74 ± 0.0030
LWCuO	30	3.13 ± 0.0048
LWCO	27	2.83 ± 0.0088
LWZO	23	3.78 ± 0.0036
LWFO	28	3.06 ± 0.0048

Table S3: The CIE chroma coordinates (L*a*b*) and color difference (ΔE^*) values of the prepared pigments after IR light irradiation for 48 h.

Pigments	Treatment	CIE L*a*b*			ΔE*
		L*	a*	b*	
LWO	Bare	91.84	-3.6	6.9	1.14
	IR Irradiated	92.08	-3.48	7.02	
LWCuO	Bare	80.87	-3.29	24.39	3.85
	IR Irradiated	82.23	-3.59	23.32	
LWCO	Bare	62.01	-0.69	-2.57	2.21
	IR Irradiated	61.59	-0.72	-3.02	
LWZO	Bare	94.42	-2.57	7.39	3.28
	IR Irradiated	95.23	-2.2	6.58	
LWFO	Bare	62.77	19.34	19.79	0.399
	IR Irradiated	63.88	20.63	20.32	

Table S4: The NIR reflectance and simulated results of prepared LWFO pigment and conventional pigments.

Coatings	NIR Reflectance (%)	Area (m^2)	Electricity (kW-h/m^2)	Cost ($/month)
Construction Cement	30.12	268.42	49.99	249.95
Pearlescent pigment	80.35	268.42	35.22	176
LWFO	97.82	268.42	32.45	162.25