

## Supporting Information

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2 **Research Article**

3 **Enhancing the electrocatalytic potential of trimetallic CeSmGd-MOFs for oxygen evolution**  
4 **reaction, supercapacitor, and dye degradation applications**

5 **Muhammad Zia Ur Rehman Farooqi<sup>a</sup>, Khalid Mahmood<sup>\*a</sup>, Muhammad Tariq<sup>a</sup> Ajaz**  
6 **Hussain<sup>a</sup>, Muhammad Asif<sup>a</sup>, Muhammad Ali<sup>a</sup>, Muhammad Hanif<sup>\*c</sup>, Muhammad Awais<sup>a</sup>,**  
7 **Aysha Arshad<sup>a</sup>, Muhammad Rafiq<sup>\*b</sup>**

8 <sup>a</sup> *Institute of Chemical Sciences, Bahauddin Zakariya University, Multan 60800, Pakistan*

9 <sup>b</sup> *School of Materials Science and Engineering, Qingdao University, China*

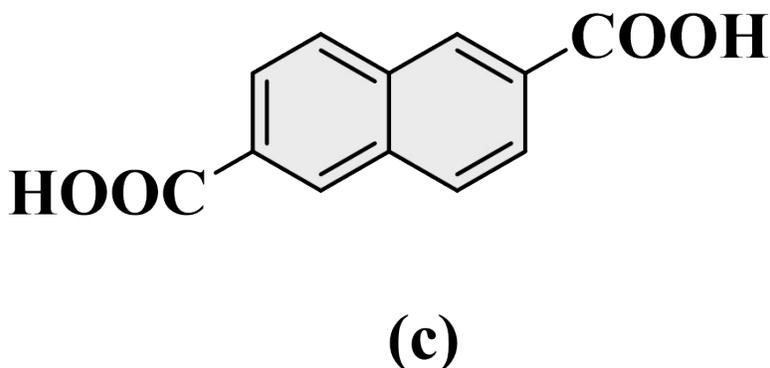
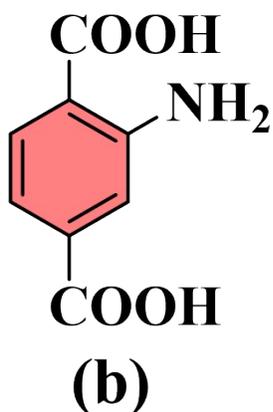
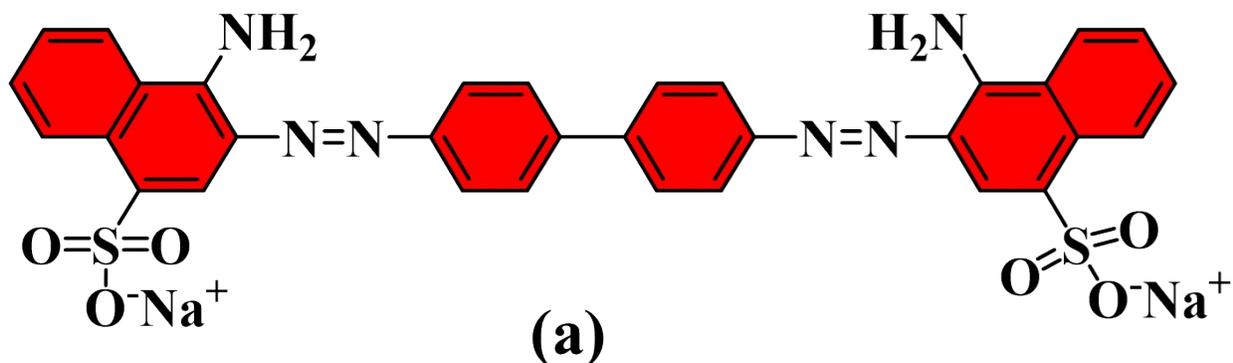
10 <sup>c</sup> *Department of Pharmaceutics, Faculty of Pharmacy, Bahauddin Zakariya University, Multan,*  
11 *60800, Pakistan*

12 Correspondence: (KM); [khalidmahmood@bzu.edu.pk](mailto:khalidmahmood@bzu.edu.pk)

13 (MH); [muhammad.hanif@bzu.edu.pk](mailto:muhammad.hanif@bzu.edu.pk)

14 (MR); [rafiqqaisrani92@gmail.com](mailto:rafiqqaisrani92@gmail.com)

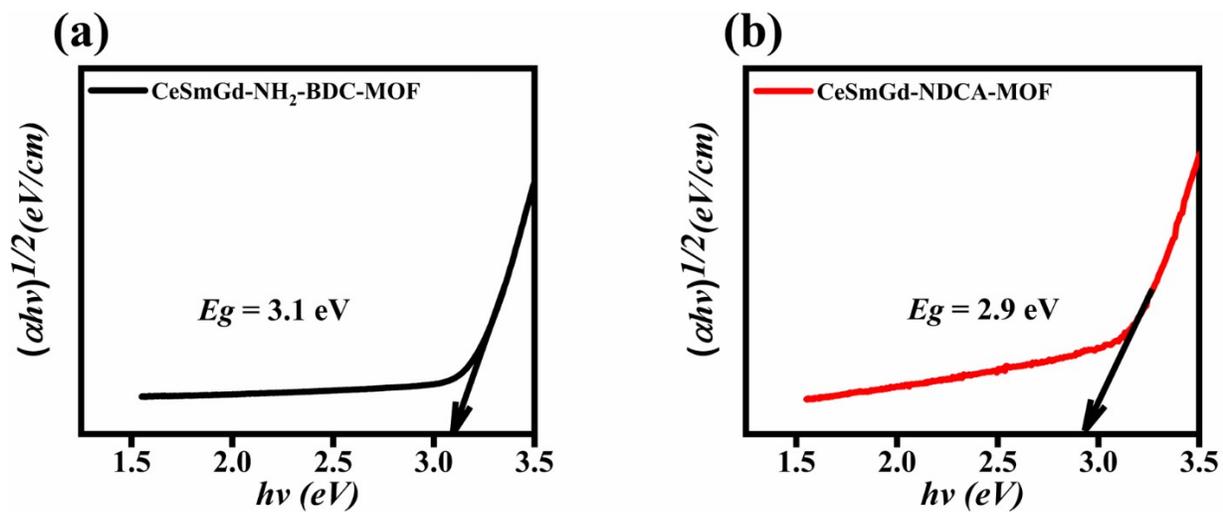
### 15 1. Molecular structure



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17 **Fig.S1** Molecular structures of (a) Congo Red dye, (b) 2-aminobenzene-1,4-dicarboxylic acid, and (d) 2,6-  
18 naphthalene dicarboxylic acid.

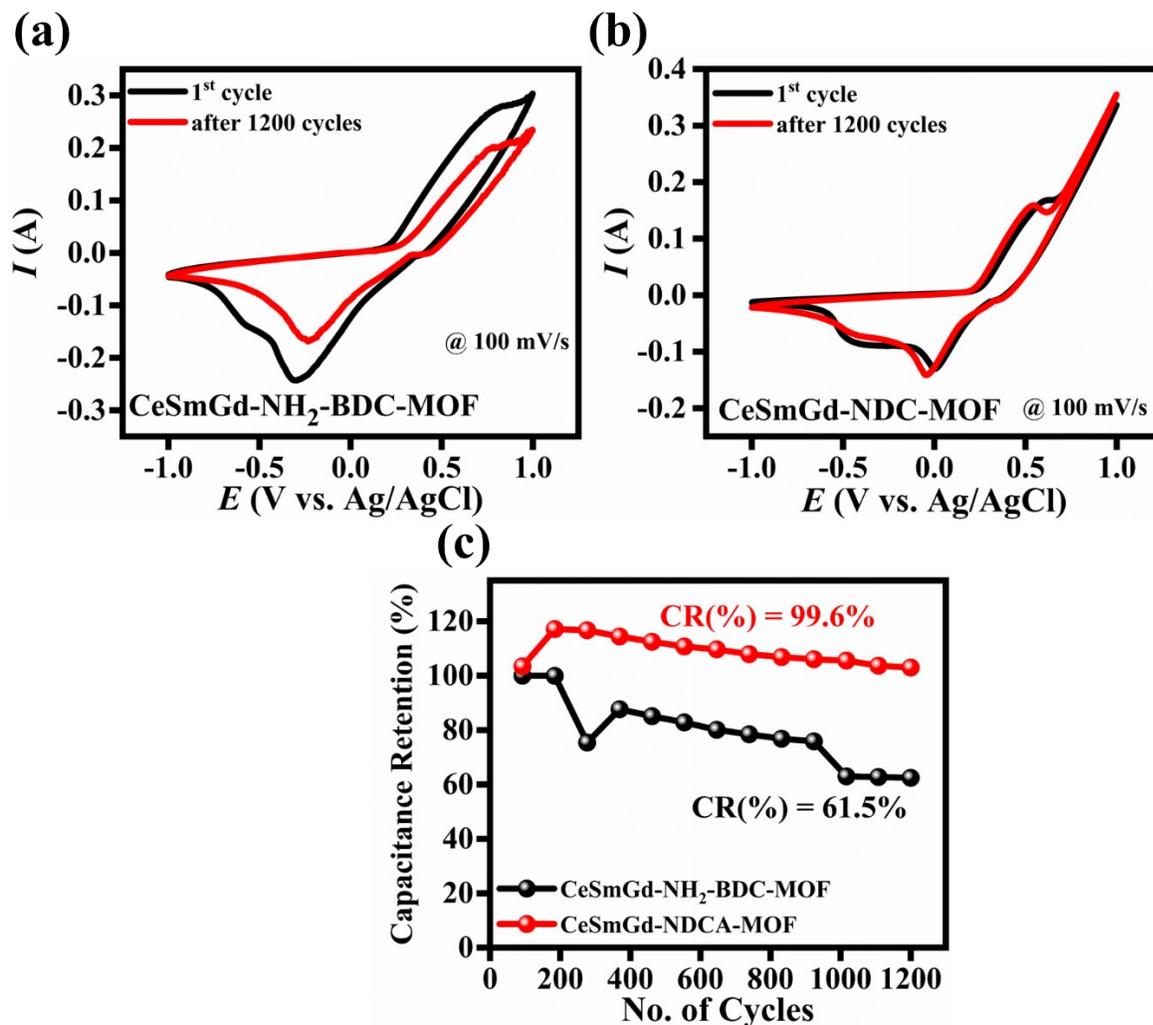
19 2. Optical Band Gap



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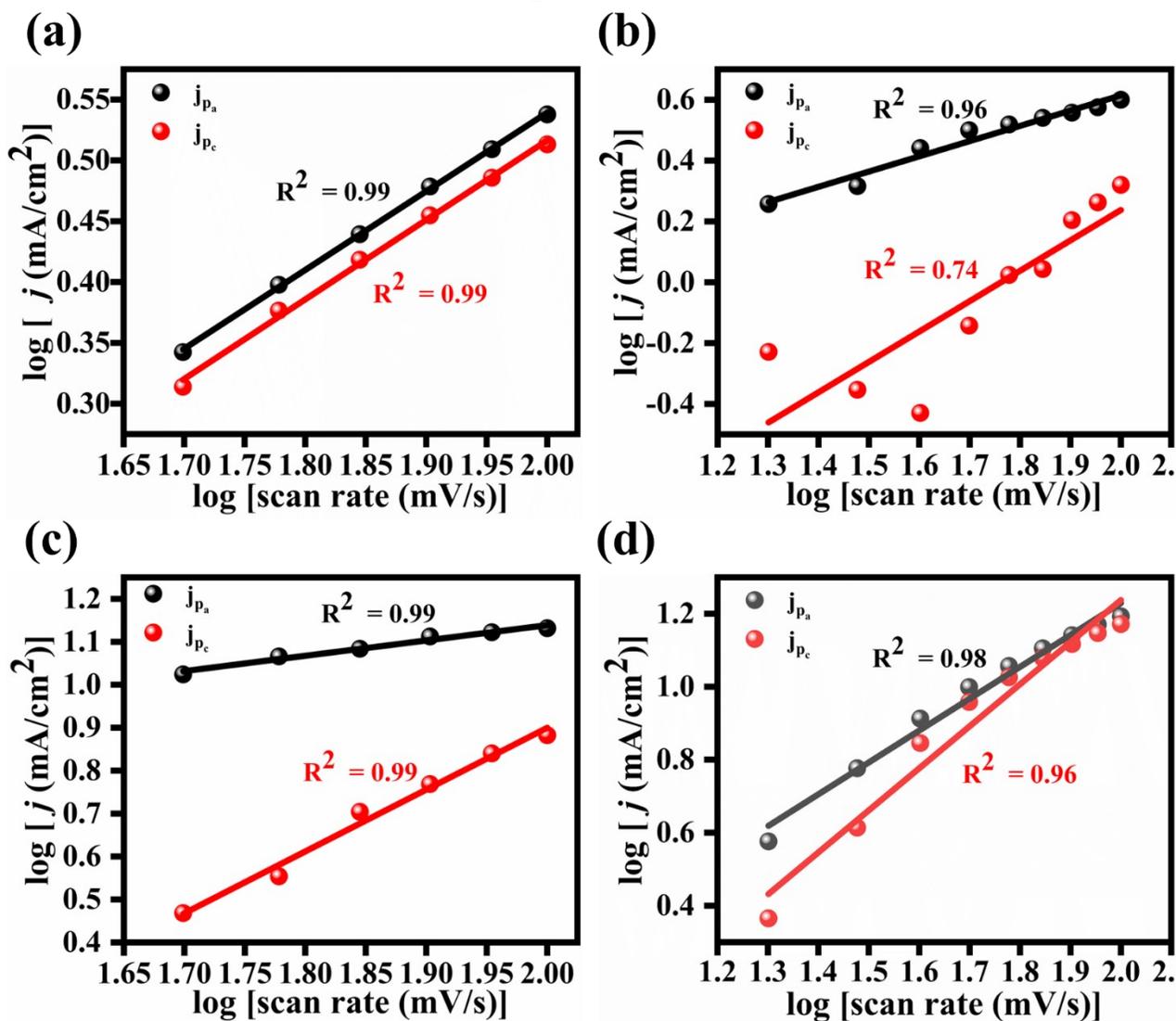
21 Fig.S2 showed (a, b) Energy band gap values of CeSmGd-NH<sub>2</sub>-BDC-MOF and CeSmGd-NDCA-MOF,  
22 respectively.

23 3. Electrochemical Cyclic Stability Test



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25 **Fig.S3** (a, b) Cyclic stability of both MOFs for 1200 cycles, (c) Corresponding plot of capacitance retention  
26 (%) vs. No. of cycles.

27 4. Electrochemical Results for CR degradation

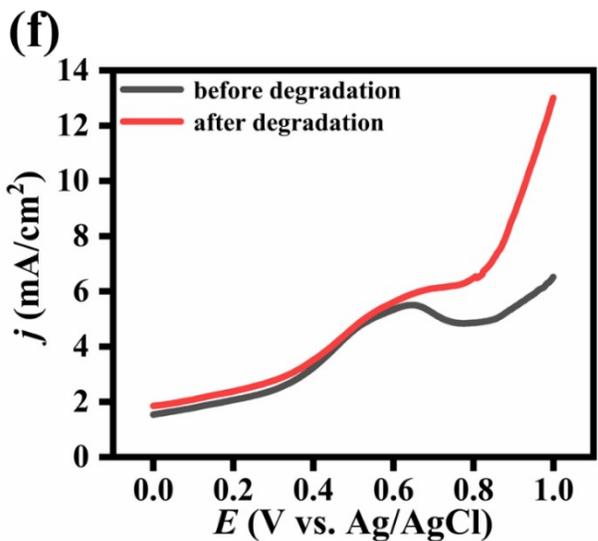
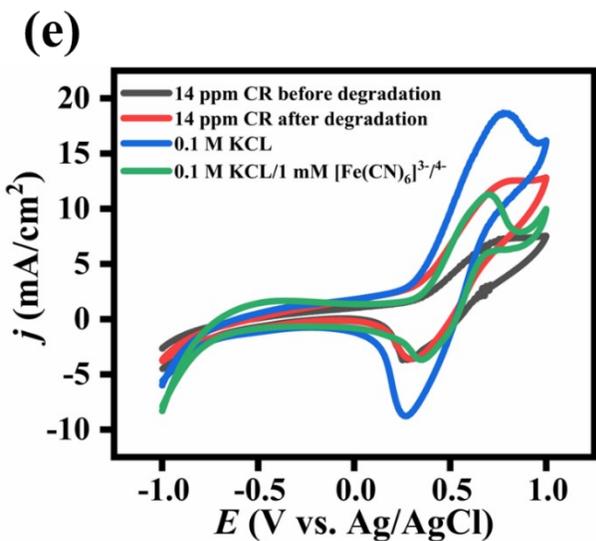
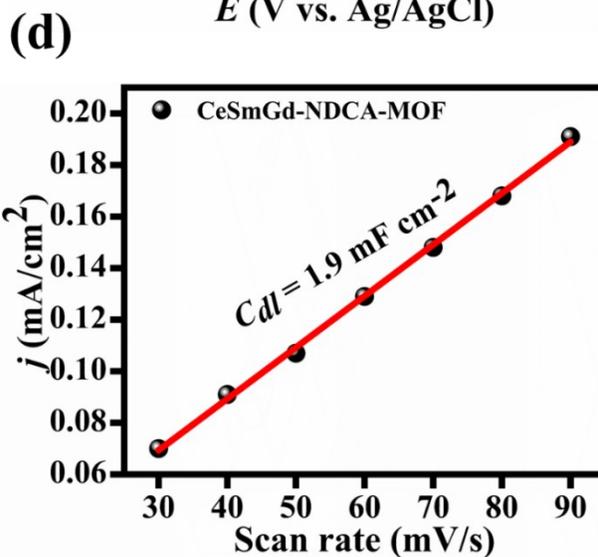
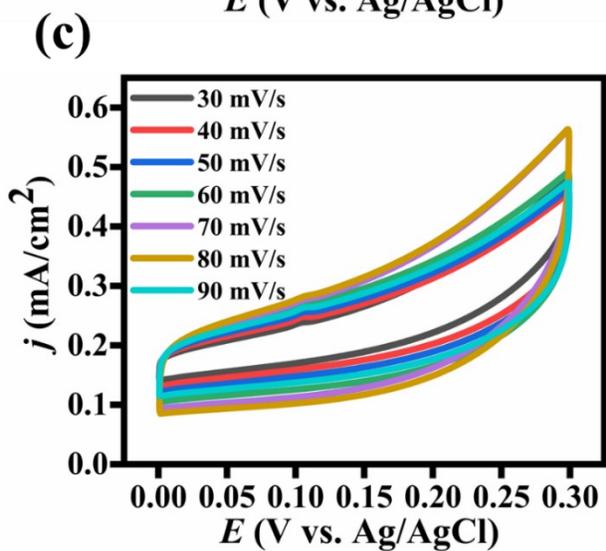
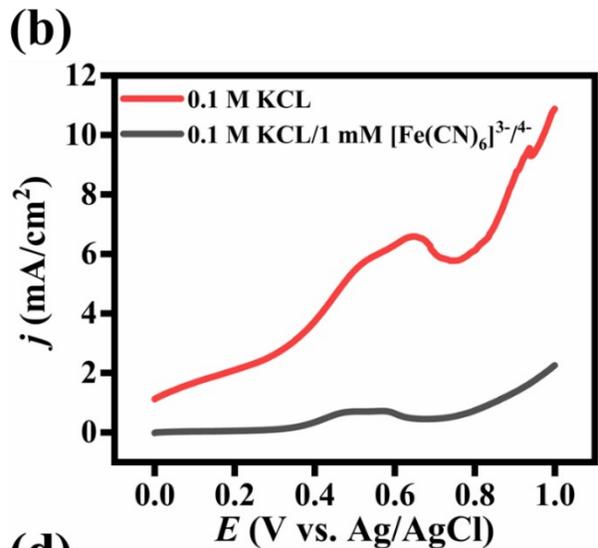
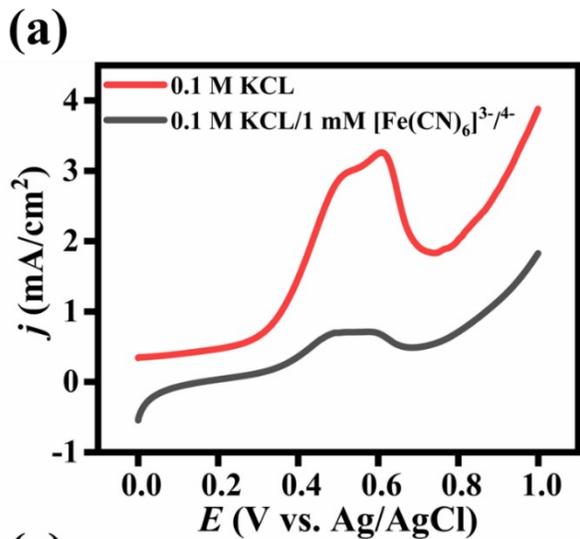


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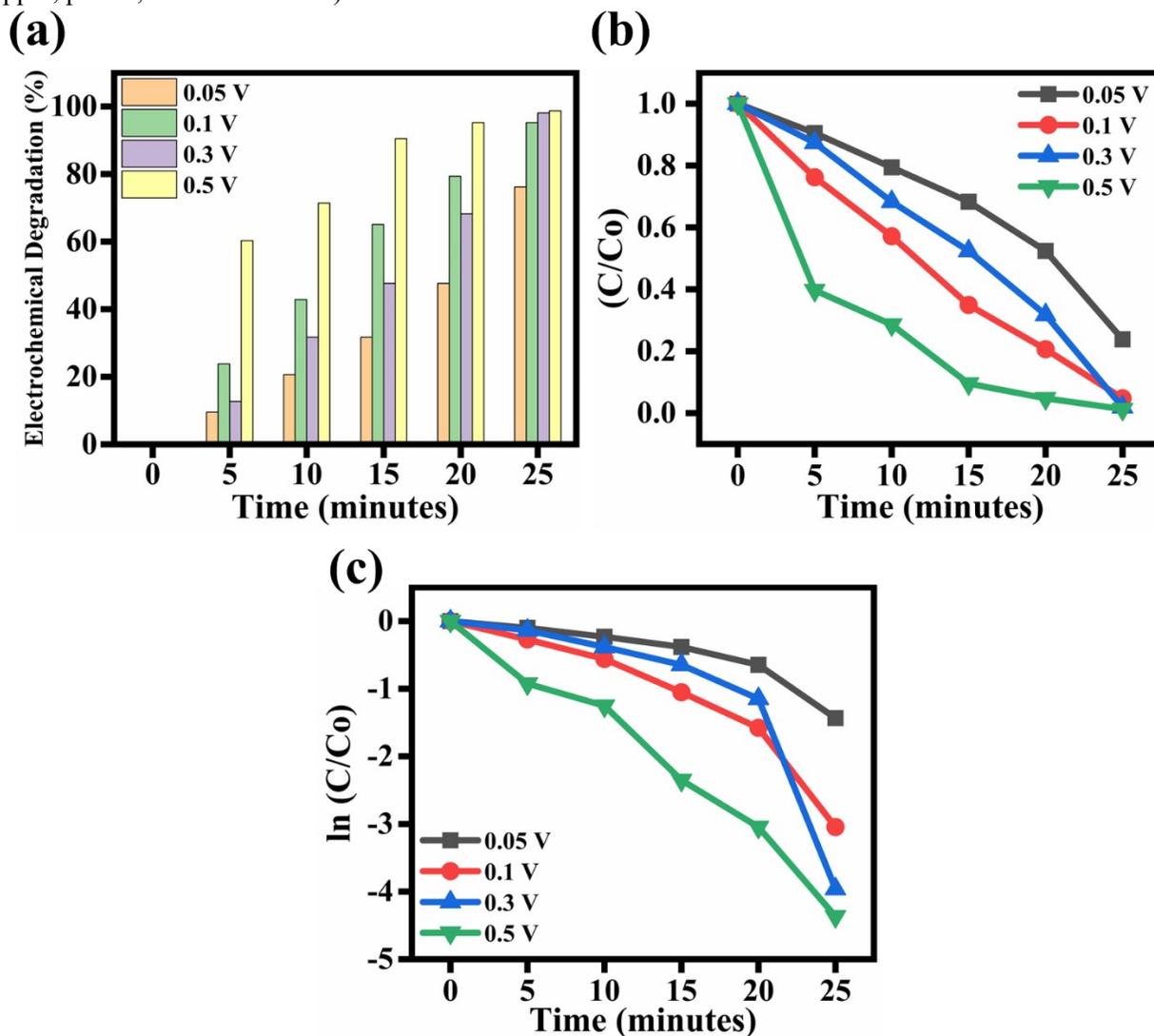
29 **Fig.S4** Plot of peak currents ( $I_{pa}$ ,  $I_{pc}$ ) vs.  $\log [\text{scan rate (mV/s)}]$  of CeSmGd-NH<sub>2</sub>-BDC-MOF, (a) in 0.1

30 M KCl, (b) 1mM [Fe (CN)<sub>6</sub>]<sup>3-/4-</sup>, (c) in 0.1 M KCl, (d) 1mM [Fe (CN)<sub>6</sub>]<sup>3-/4-</sup>-solution of CeSmGd-NDCA-

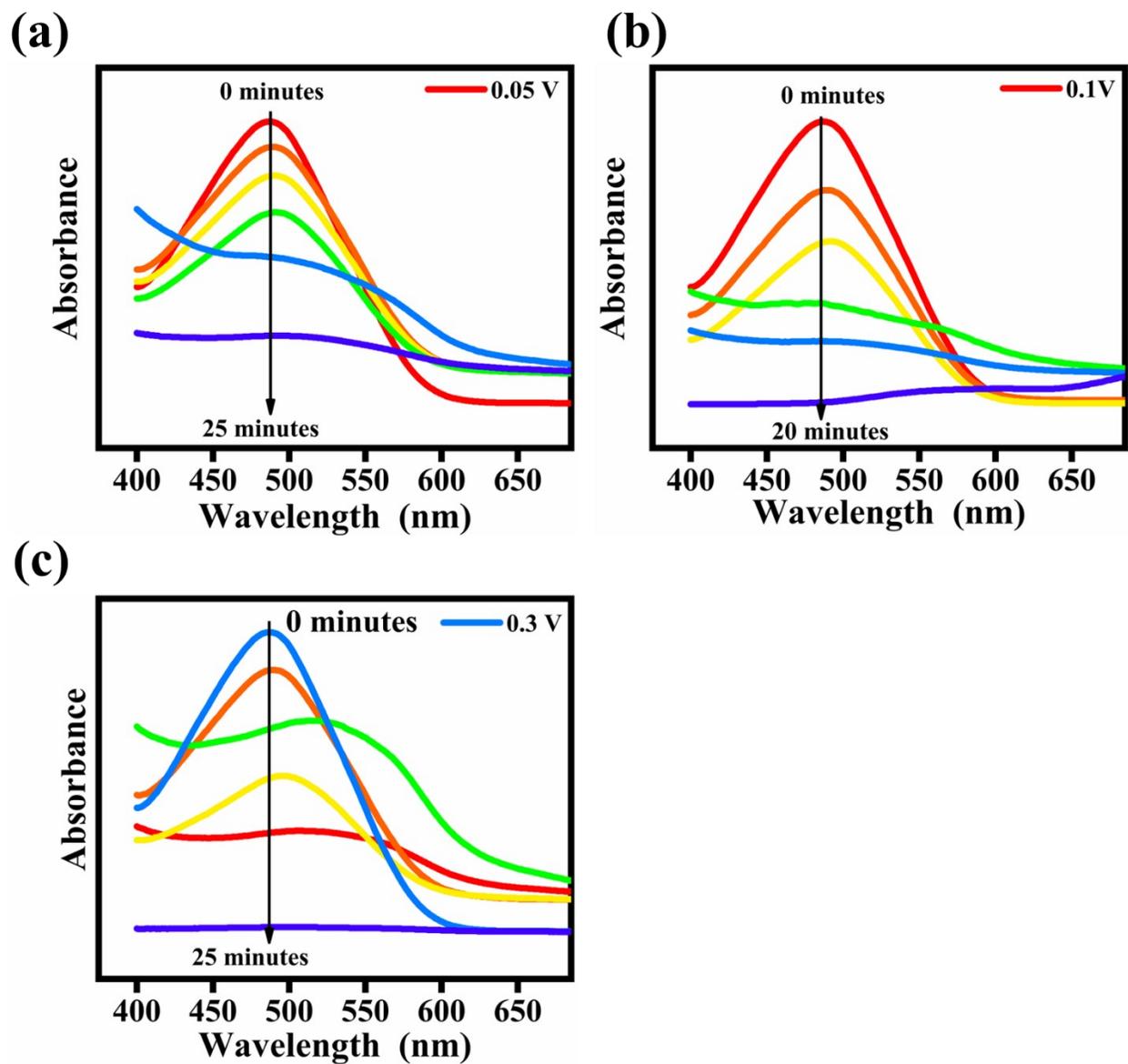
31 MOF



34 **Fig.S5** (a, b) Anodic oxidation curves of both MOFs in different electrolytes, (c) CV curves at various scan  
 35 rates in 0.1M KCL/14 ppm CR solutions, (d) Corresponding  $C_{dl}$  plots, (e) CV curve, (f) OER LSV curves  
 36 CeSmGd-NDCA-MOF before and after degradation of CR dye (Experimental conditions: CR conc. = 14  
 37 ppm, pH =7, t = 0-25 minutes).

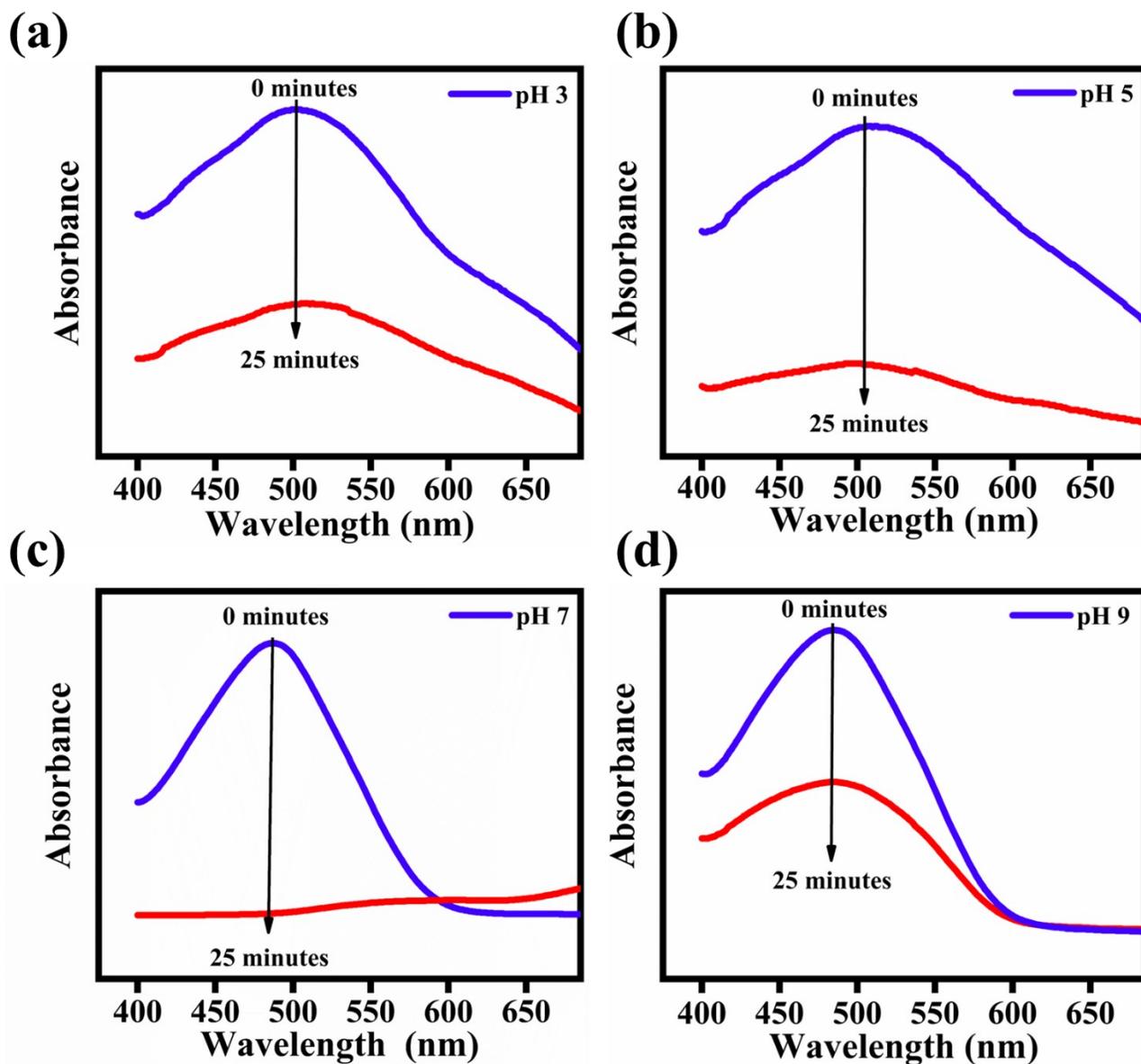


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 39 **Fig.S6** (a) Bar graph of % electrochemical degradation vs. time, (b)  $C/C_0$  plot, (c)  $\ln C/C_0$  plot of CeSmGd-  
 40 NDCA-MOF at different potentials (Experimental conditions: CR conc. = 14 ppm, V = 0.05, 0.1, 0.3, 0.5V,  
 41 pH =7, t = 0-25 minutes).  
 42



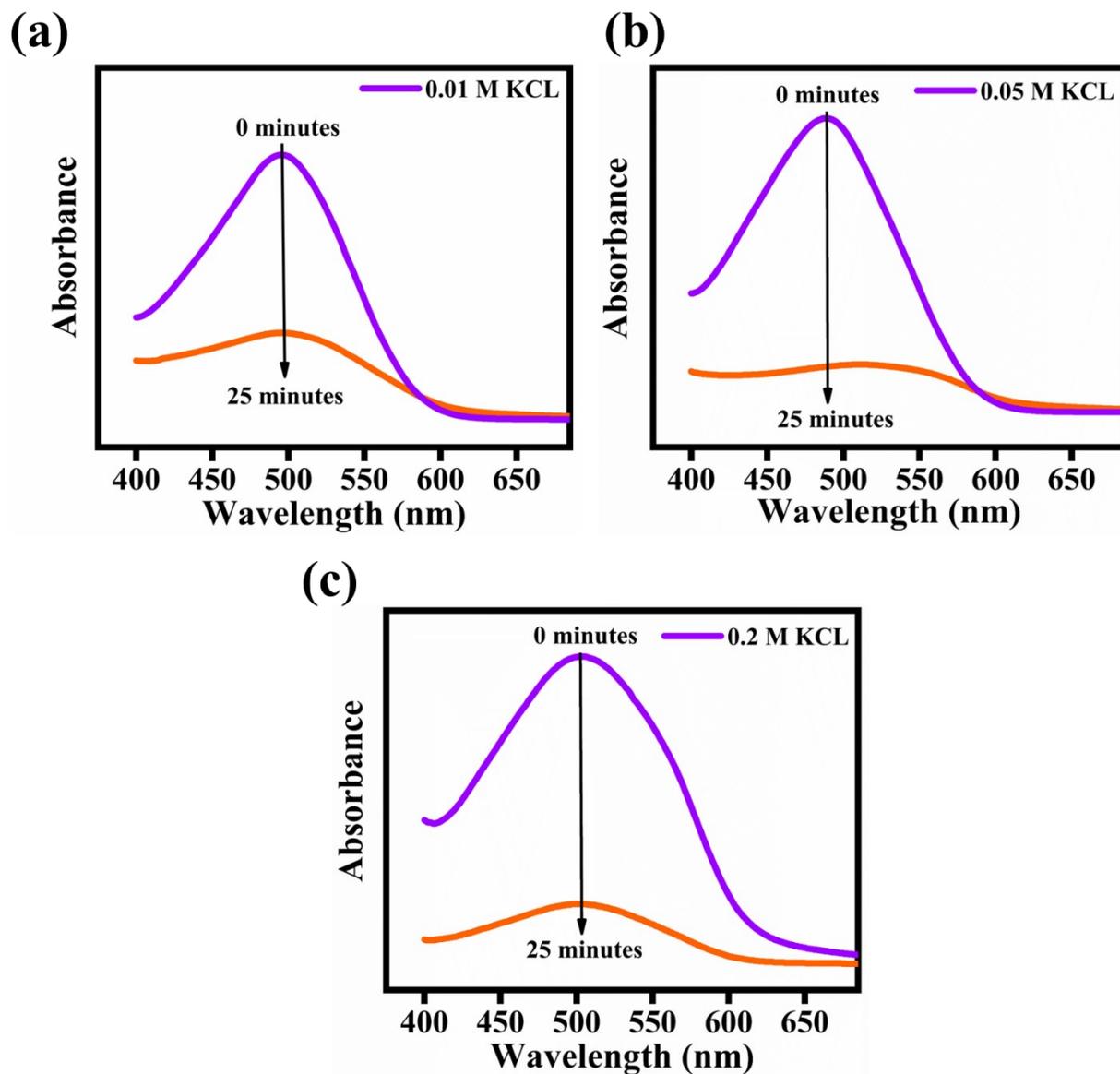
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44 **Fig.S7** (a, b, c) UV visible graph of CR dye in the presence of catalyst before and after degradation of CR  
 45 dye (Experimental conditions: CR conc. = 14 ppm, V = 0.05, 0.1, 0.3 V, pH =7, t = 0-25 minutes, KCL  
 46 Conc. = 0.1 M).

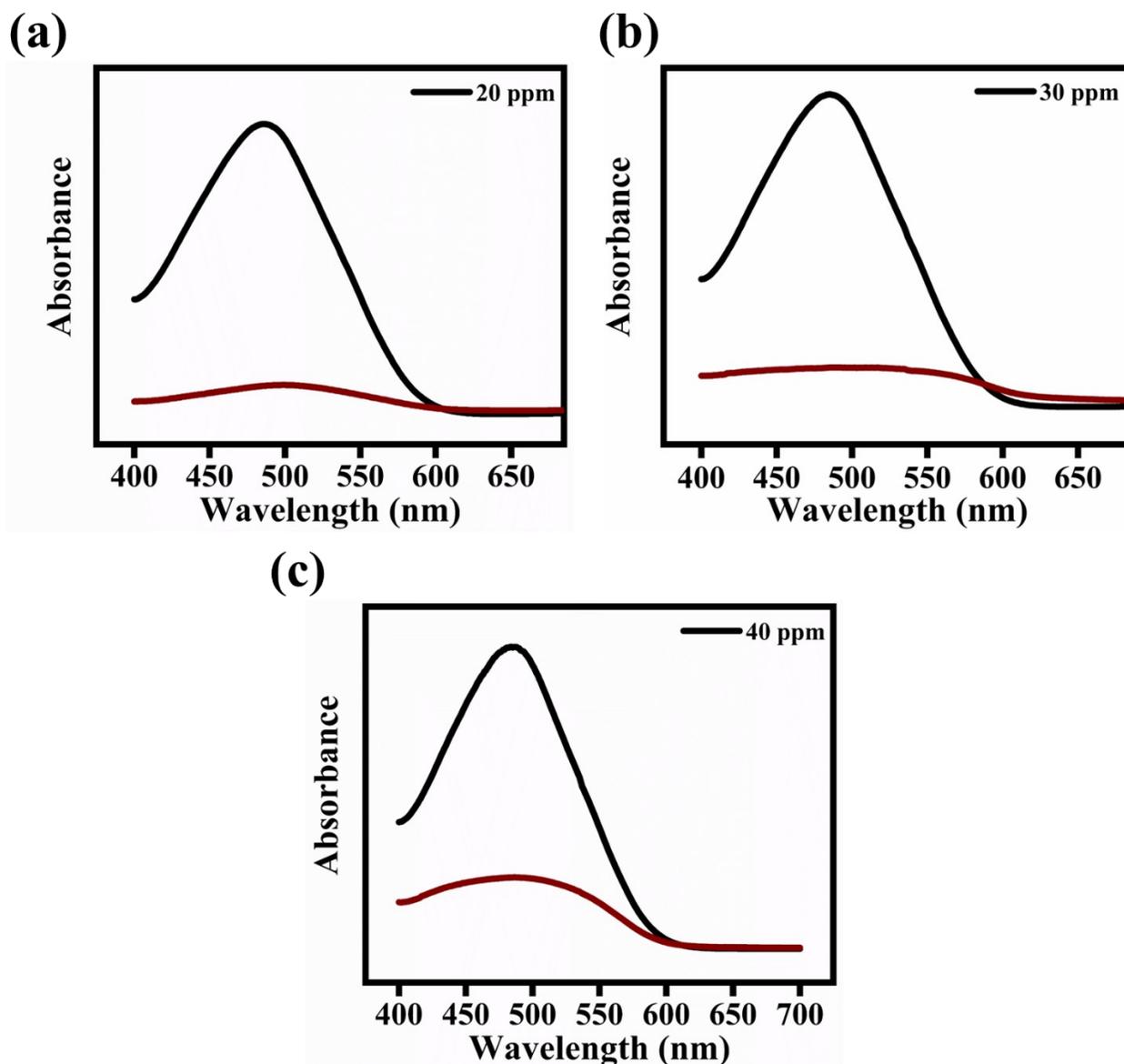


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48 **Fig.S8** (a, b, c, d) UV visible graph of CR dye in the presence of electrocatalyst before and after degradation  
 49 of CR dye (Experimental conditions: CR conc. = 14 ppm, V = 0.1 V, pH = 3, 5, 7, 9, t = 0-25 minutes, KCL  
 50 Conc. = 0.1 M).

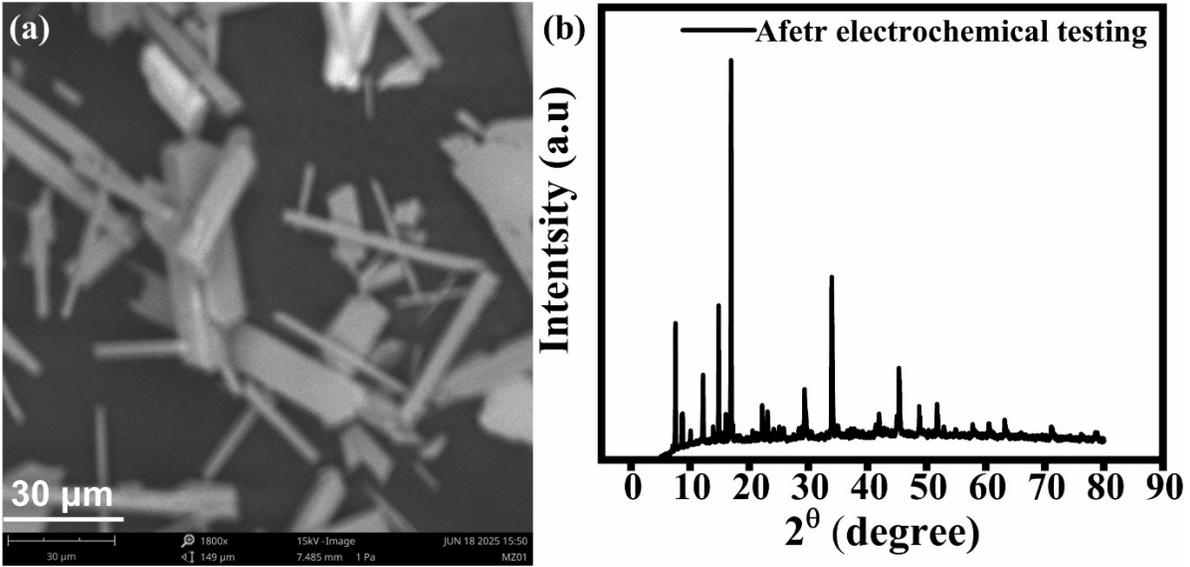


51  
 52 **Fig.S9** (a, b, c) UV visible graph of CR dye in the presence of electrocatalyst before and after degradation  
 53 of CR dye through electro (Experimental conditions: CR conc. = 14 ppm, V = 0.1 V, pH = 7, t = 0-25  
 54 minutes, KCL Conc. = 0.01,0.05,0.2 M).  
 55



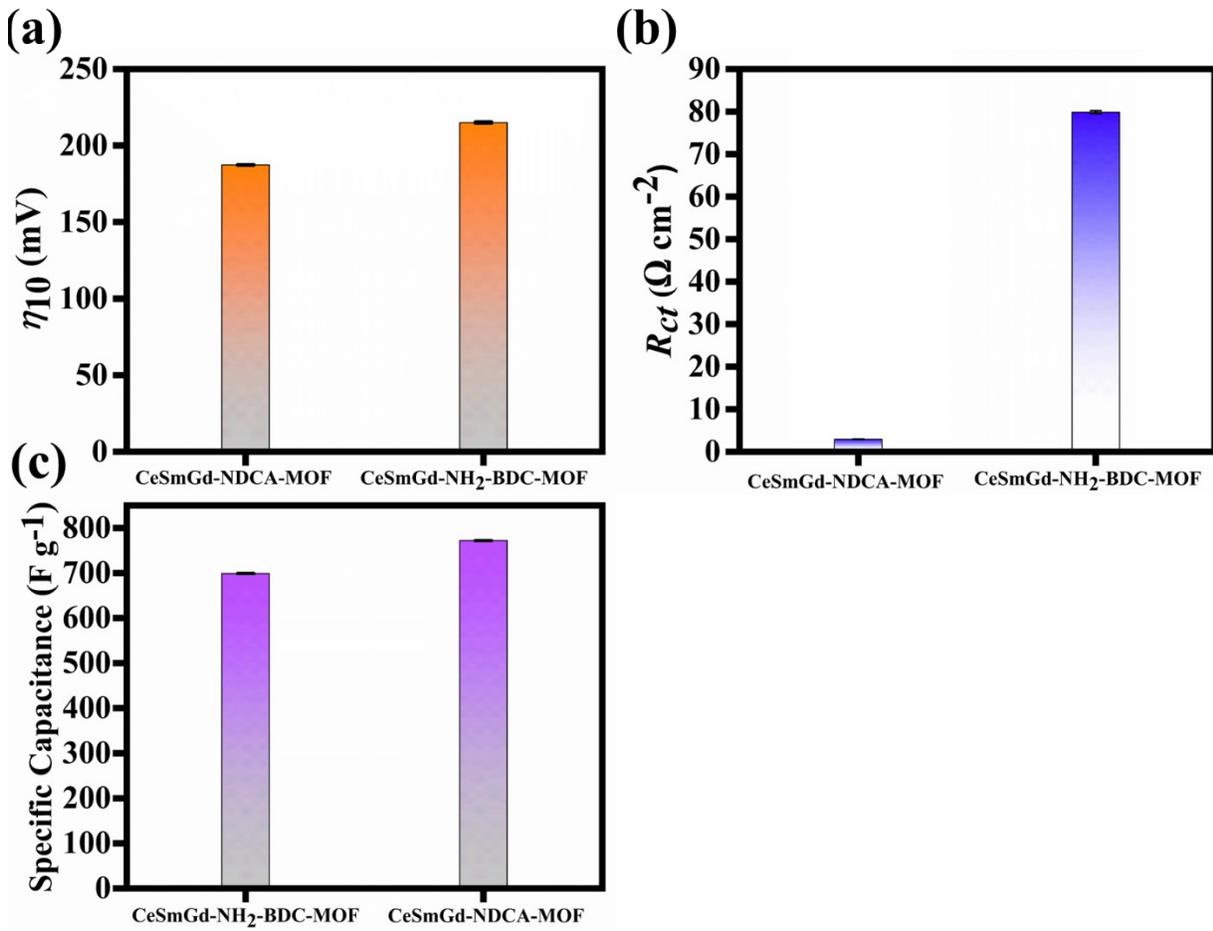
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57 **Fig.S10** (a, b, c) UV visible graph of CR dye in the presence of electrocatalyst before and after degradation  
 58 of CR dye through electro (Experimental conditions: CR conc. = 20, 30, 40 ppm, V = 0.1 V, pH = 7, t =  
 59 0-25 minutes, KCL Conc. = 0.01M).



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61 Fig.S11 (a) SEM images, (b) XRD pattern of CeSmGd-NDCA-MOF after electrochemical tests.



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63 **Fig.S12** Repeatability results bar graph of (a)  $\eta_{10}$  as derived from LSV curves, (b)  $R_{ct}$  as derived from EIS,  
64 and (c)  $C_{sp}$  of CeSmGd-NH<sub>2</sub>-BDC-MOF and CeSmGd-NDCA-MOF at 1 A/g as derived from GCD  
65 curves.



67 **Fig.S13** Proposed mechanism for CR degradation.

68 **TableS1.** Summary of the major intermediates of the degraded CR dye and their environmental  
69 performance.

Stages	Intermediates	Environmental performance
Initial	Benzidine derivatives Naphthalene derivatives	Toxic and carcinogenic Remain in H <sub>2</sub> O, desulfonation reduces toxicity
Intermediate	Aromatic/phenolic compounds	Moderate toxicity causes mutagenicity
Ring opening	Unsaturated dicarboxylic acid	Low toxicity and more biodegradable than aromatic compounds
Further Oxidation	Short-chain acid	Biodegradable and minimal environmental impact
Complete oxidation	CO <sub>2</sub> , H <sub>2</sub> O, NH <sup>4+</sup> , Cl <sup>-1</sup>	Complete mineralization, eco- friendly product

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71 **TableS2.** The calculated TOC rate constant (k) values at various potentials.

Potential (V)	K (min <sup>-1</sup> )
0.05	0.057
0.1	0.121
0.3	0.155
0.5	0.266

72

73 **TableS3.** TOC for different applied voltages, having fixed dye concentrations and KCl molarity.

Potential (V)	Dye Conc. (mg/L)	Volume (ml)	Reaction Time (t)	Electrochemical degradation (ED) (%)	TOC (mg C/L)	TOC removed after ED%	TOC remaining after ED%
0.05	14	150	25	76.19048	7.72	5.87	1.85
0.1	-	-	-	95.2381		7.35	0.37
0.3	-	-	-	98.09524		7.56	0.154
0.5	-	-	-	99.28571		7.71	0.05

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75 **TableS4.** TOC for different dye conc., having fixed potential and KCl molarity

Potential (V)	KC L (M)	Dye Conc. (mg/L)	Volume (ml)	Reaction Time (t)	Electrochemical degradation (ED) (%)	TOC (mg C/L)	TOC removed after ED%	TOC remaining after ED%
0.1	0.1	14	150	25	95.2381	7.72	5.87	1.85
-	-	20	-	-	91.56627	11.03	10.09	0.937
-	-	30	-	-	88.53503	16.55	14.65	1.90
-	-	40	-	-	67.51592	22.04	14.877	7.163

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77 **TableS5.** TOC for different KCl molarity, different dye conc., having fixed potential and dye conc.

Potential (V)	KCL (M)	Dye Conc. (mg/L)	Volume (ml)	Reaction Time (t)	Electrochemical degradation (ED) (%)	TOC (mg C/L)	TOC removed after ED%	TOC remaining after ED%
0.1	0.01	14	150	25	65	7.72	5.08	2.70
-	0.05	-	-	-	72	-	5.55	2.16
-	0.1	-	-	-	95.2381	-	5.87	1.85
-	0.2	-	-	-	48	-	3.70	4.014

78

79 **TableS6.** TOC for different pH, having fixed molarity and dye conc., and applied Voltages

Potential (V)	pH	Dye Conc. (mg/L)	Volume (ml)	Reaction Time (t)	Electrochemical degradation (ED) (%)	TOC (mg C/L)	TOC removed after ED%	TOC remaining after ED%
0.1	3	14	150	25	50.72464	7.72	3.86	3.86
-	5	-	-	-	70.74074	-	5.40	2.316
-	7	-	-	-	95.2381	-	5.87	1.85
-	9	-	-	-	50	-	3.86	3.86

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