Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

CeO_2 Sprinkled Graphitic Novel Packed Bed Anode-Based Single-Chamber MFC for Treatment of High Organic-Loaded Industrial Effluent in Upflow Continuous Mode

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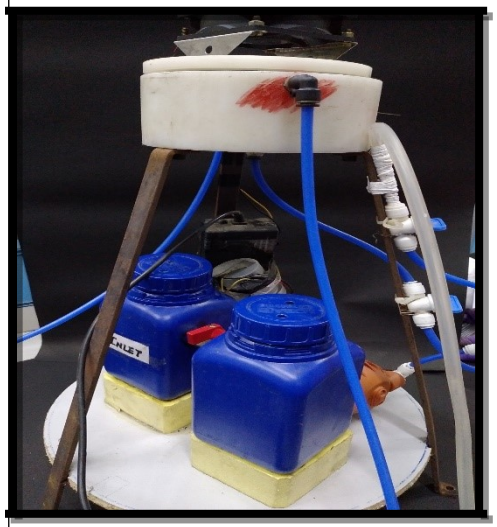
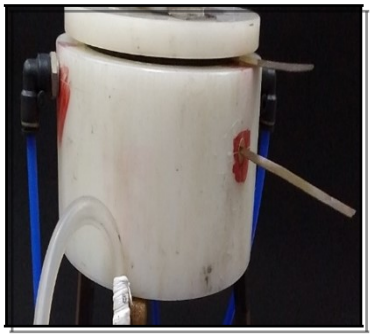
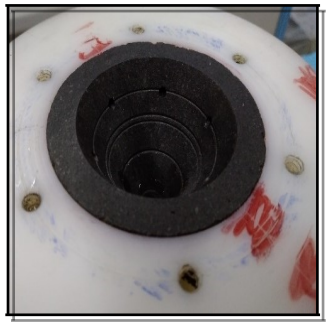
Conical SCMFC front side view



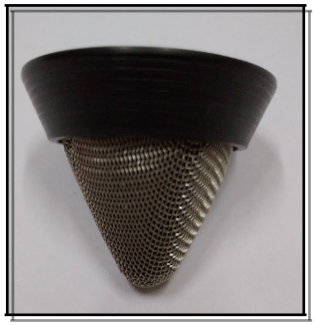
Conical SCMFC back side view



Teflon case which consists anode chamber

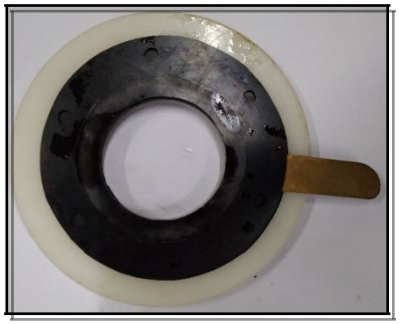


Top view of anode chamber with SS



SS basket for holding CeO_2-CNF/ACB

Connector for P-CeO_2-CNF/ACF air cathode



Connector with gasket for holding P-CeO_2-CNF/ACF air cathode along with Teflon lid

Pump for water circulation

Fig. S1. Photograph of real set-up and components of conical SCMFC.

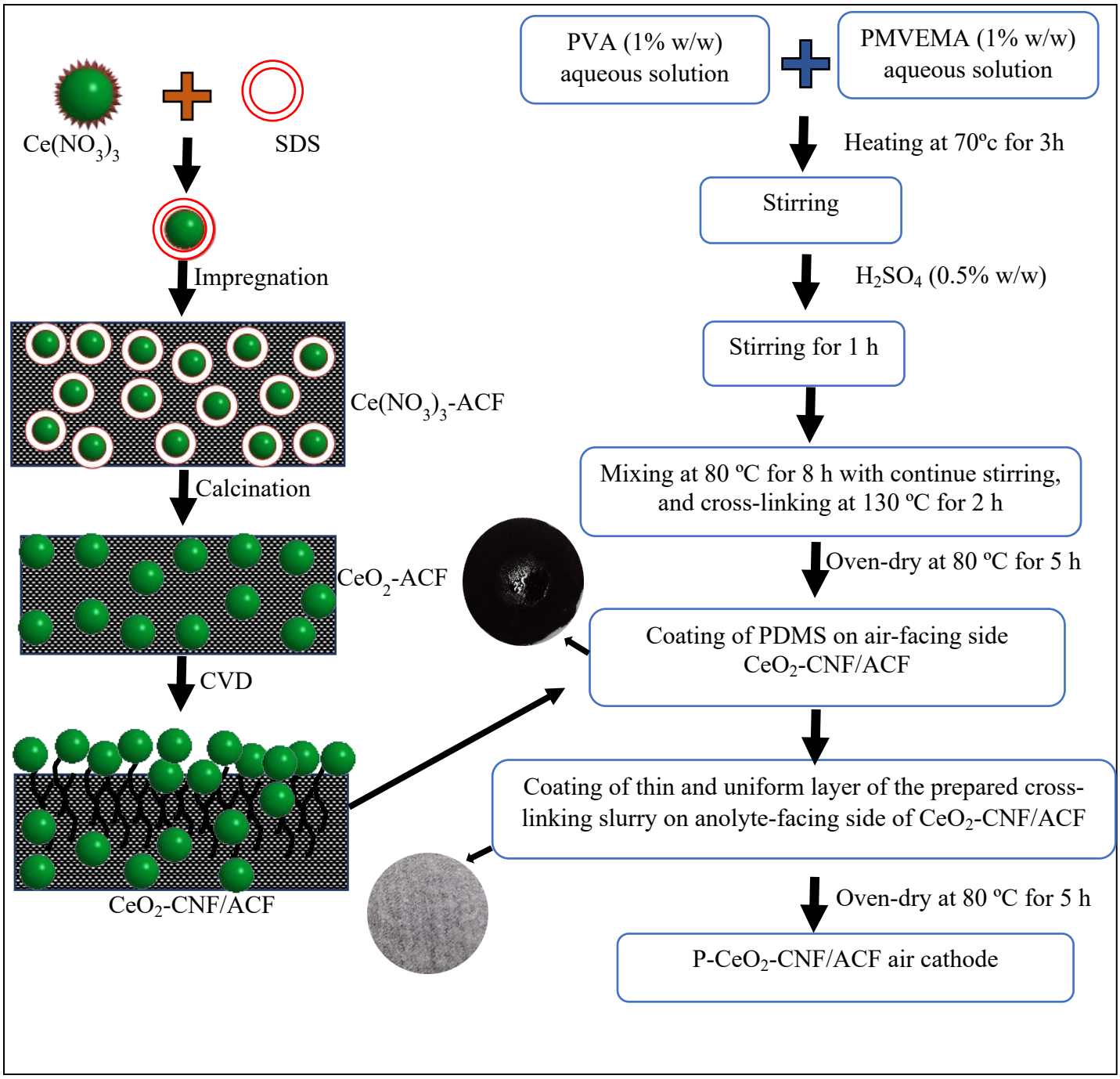


Fig. S2. Flow chart for the synthesis of CeO_2-CNF/ACF and P-CeO_2-CNF/ACF air cathode.

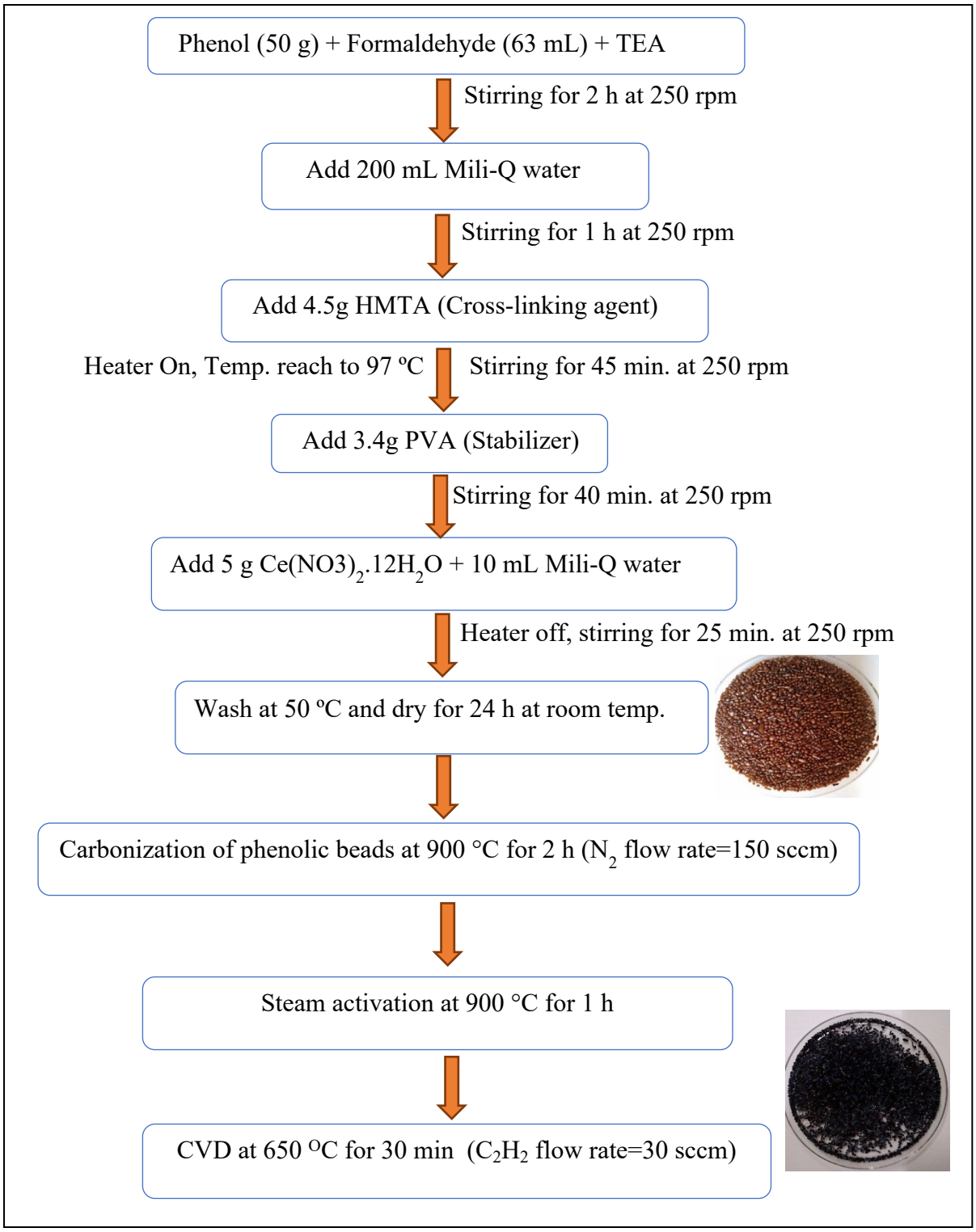


Fig. S3. Flow chart for the synthesis of CeO_2-CNF/ACB.

Table S1. Thermal power plant effluent water quality parameters

Parameters	**Quantity**
pH	9.60
TOC (Total Organic Carbon, mg/L)	15140
TC (Total Carbon, mg/L)	15660
IC (Inorganic carbon, mg/L)	5177
TN (Total Nitrogen, mg/L)	5071
Electric Conductivity (EC, mS/cm)	5.70
COD (mg/L)	20700
Colour	Dark brown
CFU/mL	50.00
Na content (mg/L)	1500.00
Phosphate (mg/L)	0.63
Fluoride (mg/L)	5.32
Cadmium (mg/L)	0.64
Copper (mg/L)	0.16
Lead (mg/L)	0.42
Zinc (mg/L)	3.46

Table S2. S_{BET}, V_T and PSD of the prepared materials

Sample	**S_{BET} (m^2/g)**	**V_T (cc/g)**	**V_{micro} (%)**	**$V_{meso-macro}$ (%)**
ACF	1050	0.67	82.91	17.09
CeO_2-CNF/ACF	545	0.33	83.13	16.87
CeO_2-PhB	0	0.00	0.00	0.00
CeO_2-CNF/ACB	371	0.25	72.02	27.98

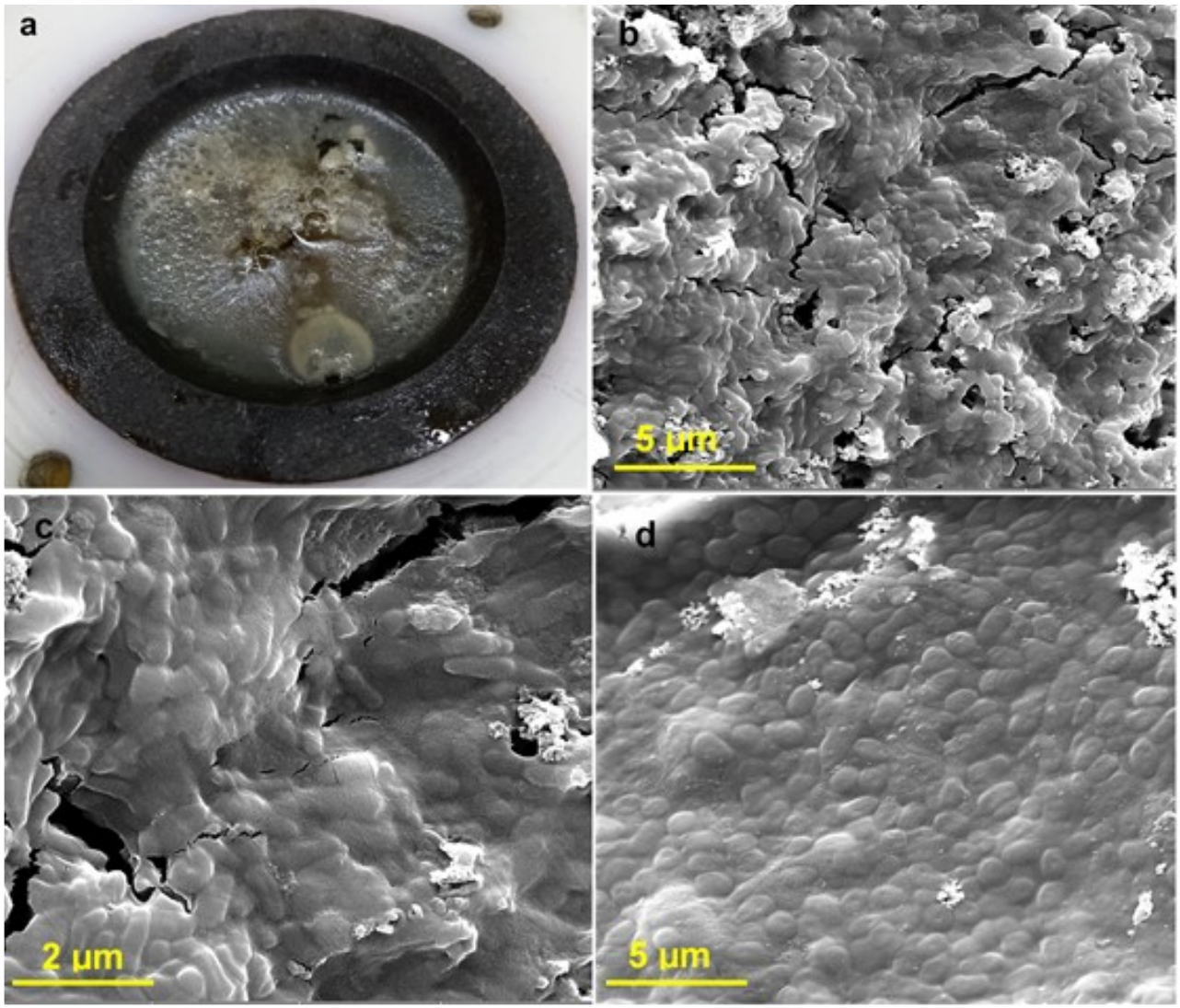


Fig. S4. (a) Digital image of the top view of biofilm in the anode chamber, (b-d) SEM images of biofilm grown in different regions over the packed beads.

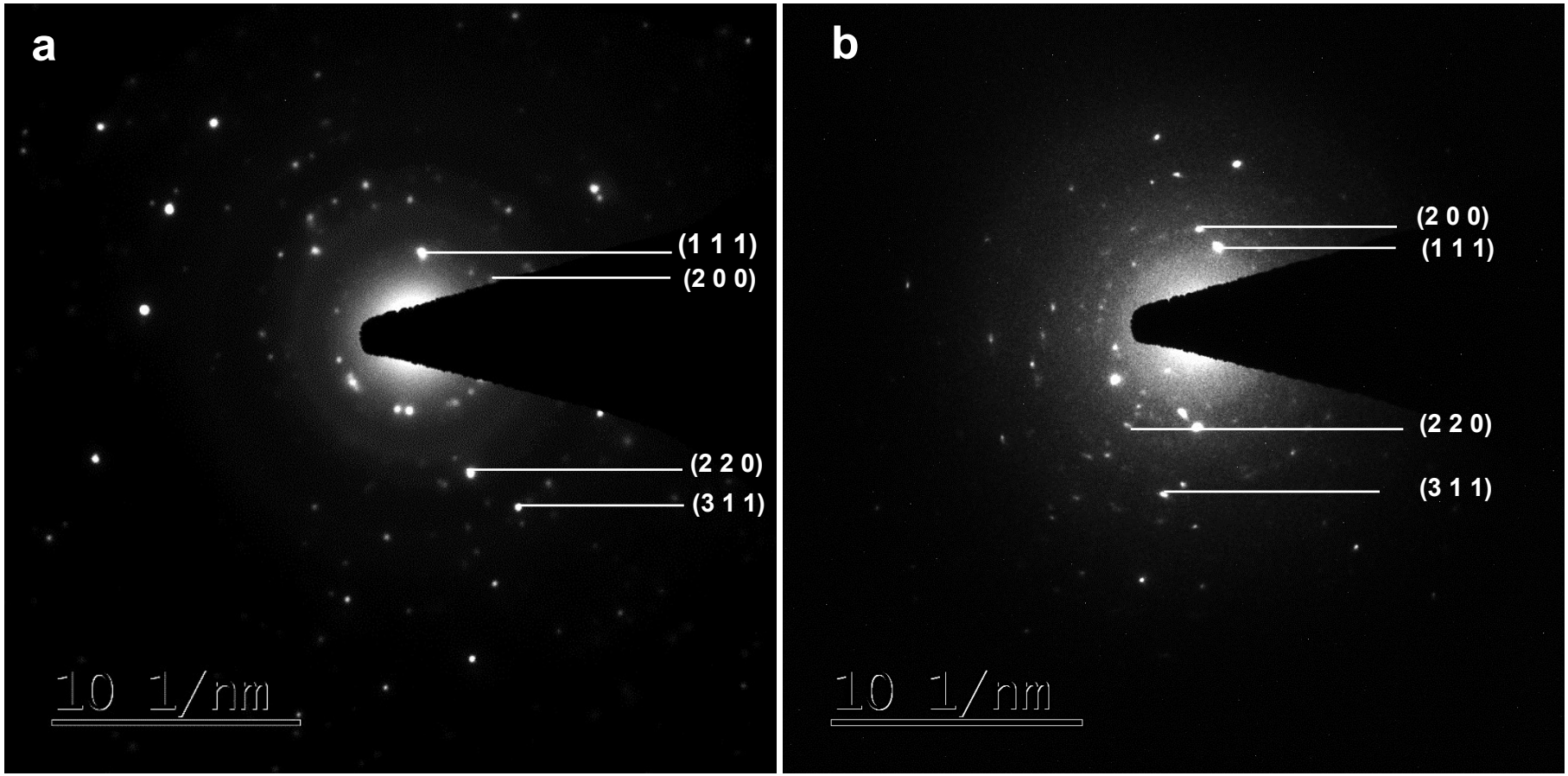


Fig. S5. SAED pattern of (a) CeO_2-CNF grown on ACB (anode) and (b) CeO_2-CNF grown on ACF (cathode) along with the corresponding (h k l) values determined from d-spacing.

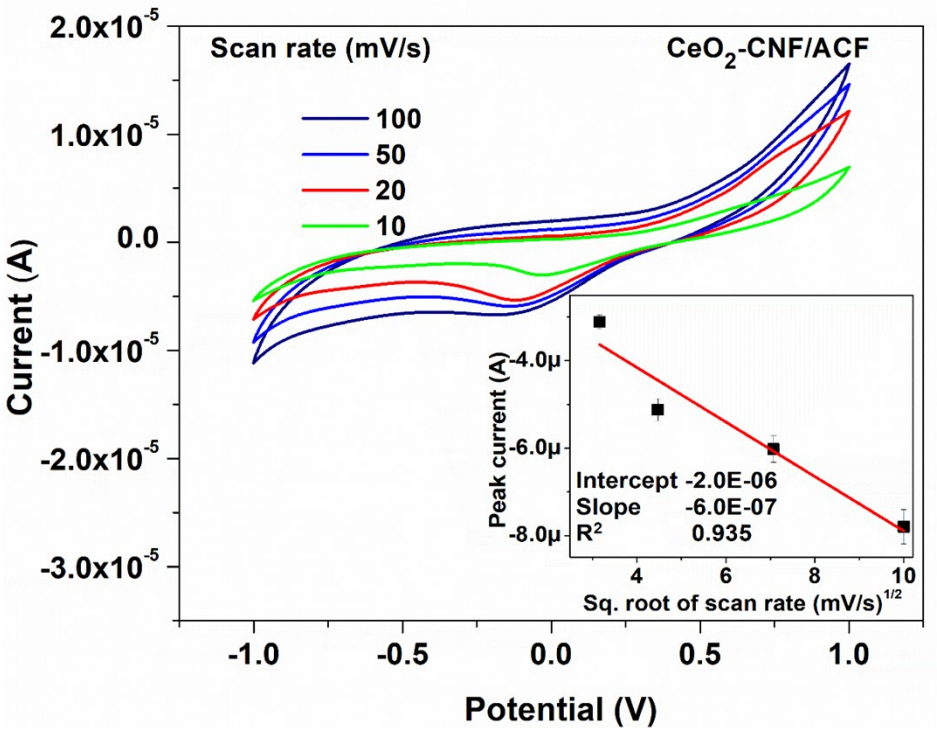


Fig. S6. The cyclic voltammogram for CeO_2-CNF/ACF at different scan rates, and the plot (inset) for cathodic peak current vs. square root of scan rate (Randles-Sevcik equation).

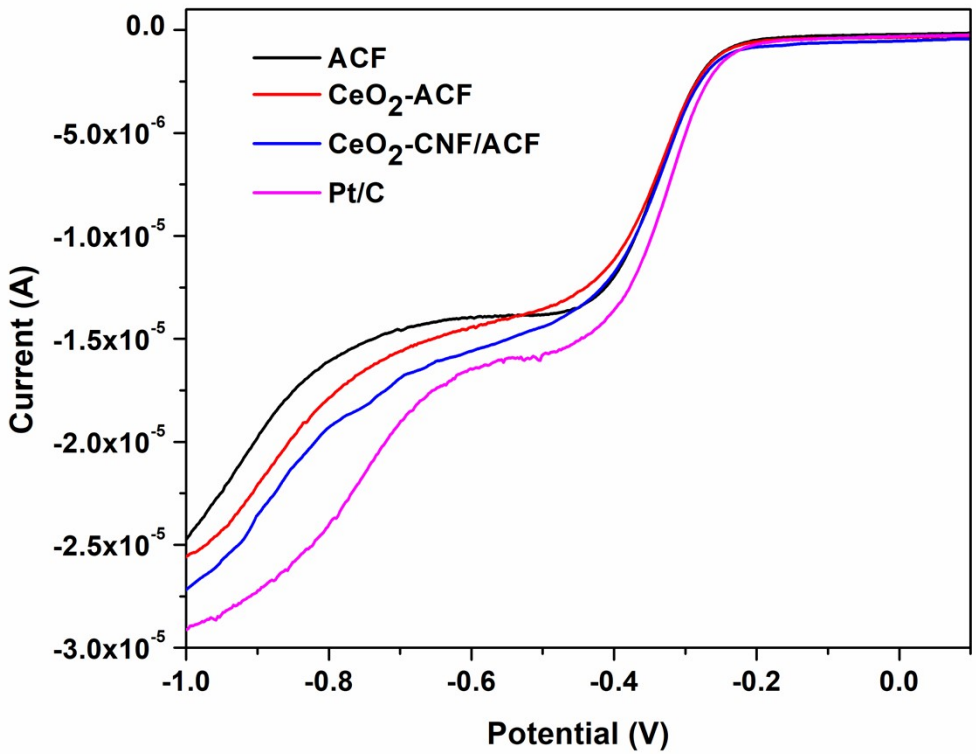


Fig. S7. ORR polarization curves for ACF, CeO_2-ACF, CeO_2-CNF/ACF and Pt/C (5 wt% Pt on activated carbon) in the oxygen saturated 1M KOH at RDE spped of 1000 rpm and scan rate of 10 mV/s.

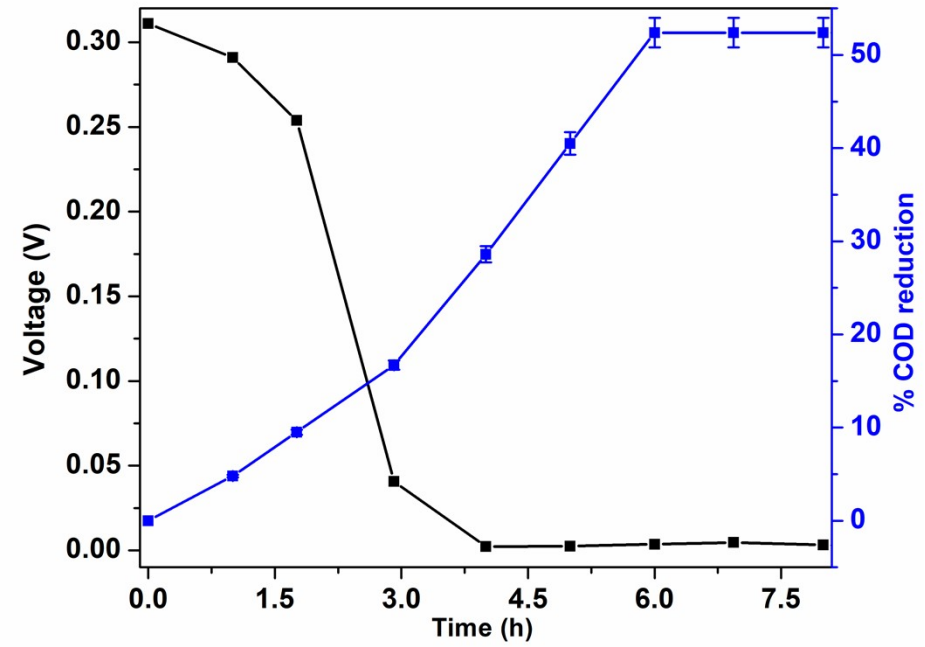


Fig. S8 Generated voltages and percentage COD reductions using ACB (viz. substrate without CeO_2) as the packed bed anode and CeO_2-CNF/ACF as the cathode at 51 min of HRT.

Table S3: Evaluation of the performance of the present study with literature

S. No.	Type of MFC	Type of effluent	COD (mg/L)	Chamber volume (mL)	Anode // Cathode	External resistance	Flow rate (mL/min)	HRT (h)	% COD reduction	Voltage (mV)	Power density (mW/m^2)	Ref
1	SCMFC	Refinery wastewater	4500 - 5000	500	Stainless steel mesh 300 // Carbon cloth	100		15	44	785	113	[19]
2	DCMFC	Synthetic swine wastewater containing antibiotics	3000	350	Cylindrical graphite felt // carbon-fiber brush	1000		24	90.9-93.5	630 - 720		[20]
3	Three-chamber MFC	Synthetic wastewater	705	anode (1100), cathode (1600), and a clarifier (900)	Carbon felt // iron(II) phthalocyanine (FePc)-carbon felt	1000	0.83	72	87	547	9.3	[21]
4	SCMFC	Meat wastewater samples	1357.6 ± 78.6	930	Carbon brush // Plain carbon cloth	27		77, 25 and 15	28.2, 38.6, 69.0	520	3000 mW/m^3	[22]
5	DCMFC	Artificial municipal wastewater	300 ± 15	350	Cylinder-shaped graphite felt // carbon-fiber brush	1000	0.35, 0.47, 0.59 and 0.70	16.56, 12.48, 9.84 and 8.4	92.4 – 94.4	599	253.84	[23]

6	DCMFC	Synthetic wastewater	1500	296	Graphite rods covered with carbon cloth	100	0.05	0.41	55-60	600	188	[24]
7	DCMFC	Chocolaterie wastewater	3800 ± 150	Cathode (600) and (500)	Carbon veil		0.2375 - 0.833	15	70	540	98	[25]
8	DCMFC	Synthetic wastewater	6500	Anode (10.66 L) and cathode (9.96 L).	Plain porous carbon paper	100		22.78 – 24.57	88.53	816.8	62.94 mW/m^3	[26]
9	DCMFC	Synthetic wastewater	30000	800	Graphite plate	1000		6.7		440	283	[27]
10	DCMFC	Brewery wastewater	3197 ± 979	Anode (10 L) and cathode (30 L)	Carbon fiber cloth	10000	1, 2 and 3	313	94.6 ± 1.0		1.61	[28]
11	SCMFC	Thermal power plant	~21000	51	CeO2-CNF/ACB // CeO2-CNF/ACF	100	1, 3 and 5	0.85	76	341	424 mW/m^3	This study