Electronic Supplementary Material (ESI) for RSC Advances.

Electronic Supplementary Information

NiCoP-CeO_2 Composites for Efficient Electrochemical Oxygen Evolution

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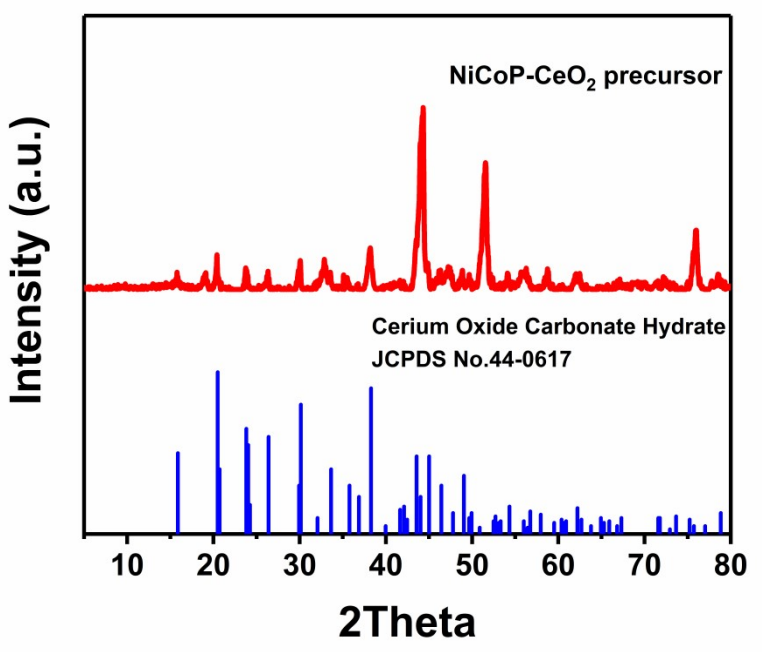

Fig. S1 XRD patterns of NiCoP-CeO_2 precursors.

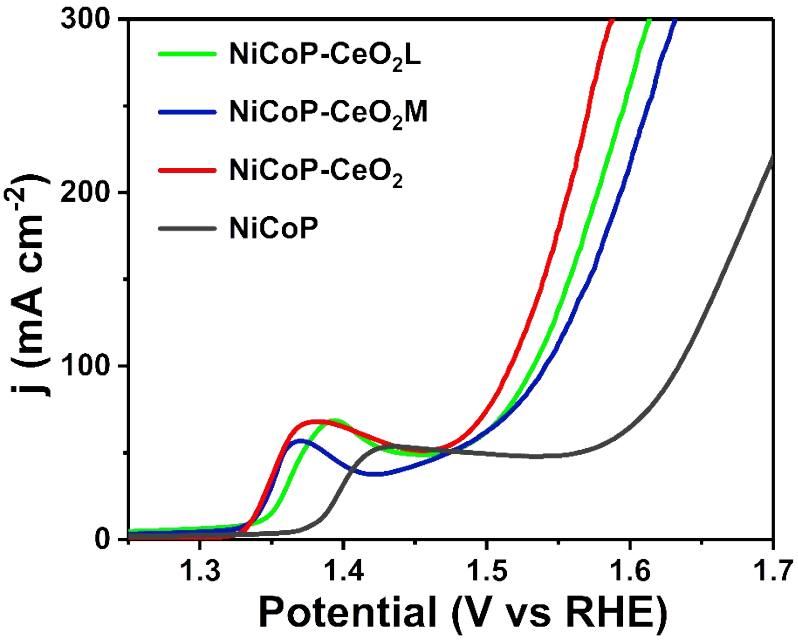

Fig. S2 LSV curves of NiCoP-CeO_2 electrodes with different amount loading on NiCoP in 1M KOH solution.

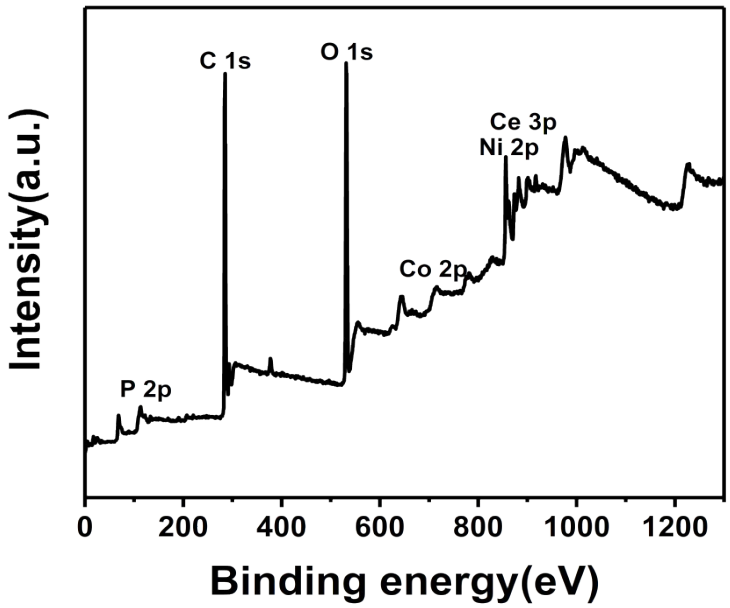

Fig. S3 XPS survey spectra of NiCoP-CeO_2.

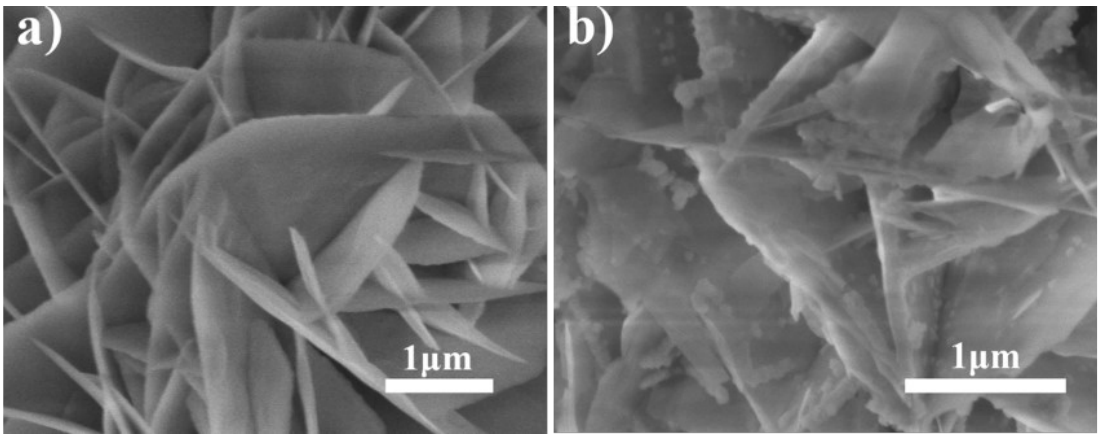

Fig. S4 SEM images of NiCo-LDHs (a) and NiCoP-CeO_2 precursors (b).

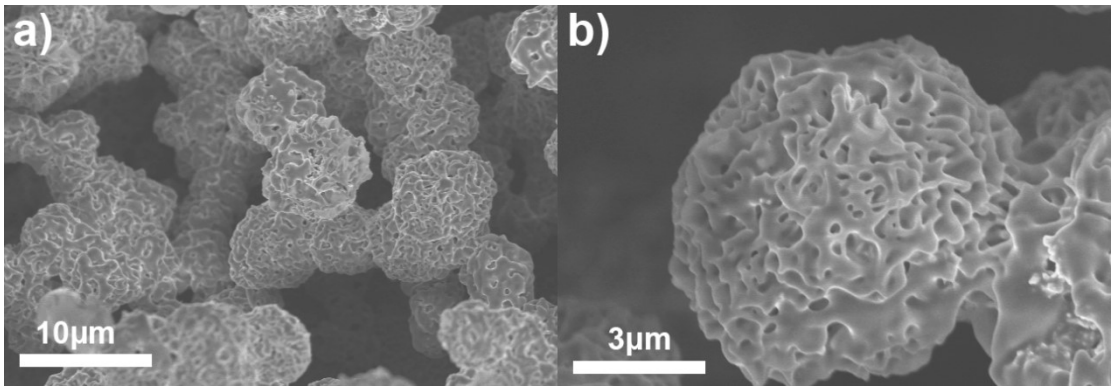

Fig. S5 SEM images of low (a) and high (b) magnification of NiCoP.

Table S1 Summary of electrocatalytic OER activities of LDHs-CeO_2 composites electrocatalysts[a]

Catalyst	Overpotential (mV)	Tafel slope (mV dec^{-1})	References
NiFe-LDH/CeO_2@CeNC	235	128.8	1
CeO_2/NiFe-LDH	243	65	2
CeO_{2-x}@CoFe LDH	204[b]	23.7	3
CeO_2-FeCo LDH	260	40	4
ceria/Ni-TMO	350	38	5
NF@NiFe LDH/CeO_X	280[c]	--	6
$Ni_{80}Fe_{20}$/50wt%CeO_2	289	40	7
NiCoP-CeO_2	**217**	**45**	**this work**

[a] except for special instructions, the value of catalyst overpotential in the table is at 10 mA cm^{-2} of current density; [b]: the overpotential at 100mA cm^{-2} of current density; [c] the overpotential of overall water splitting.

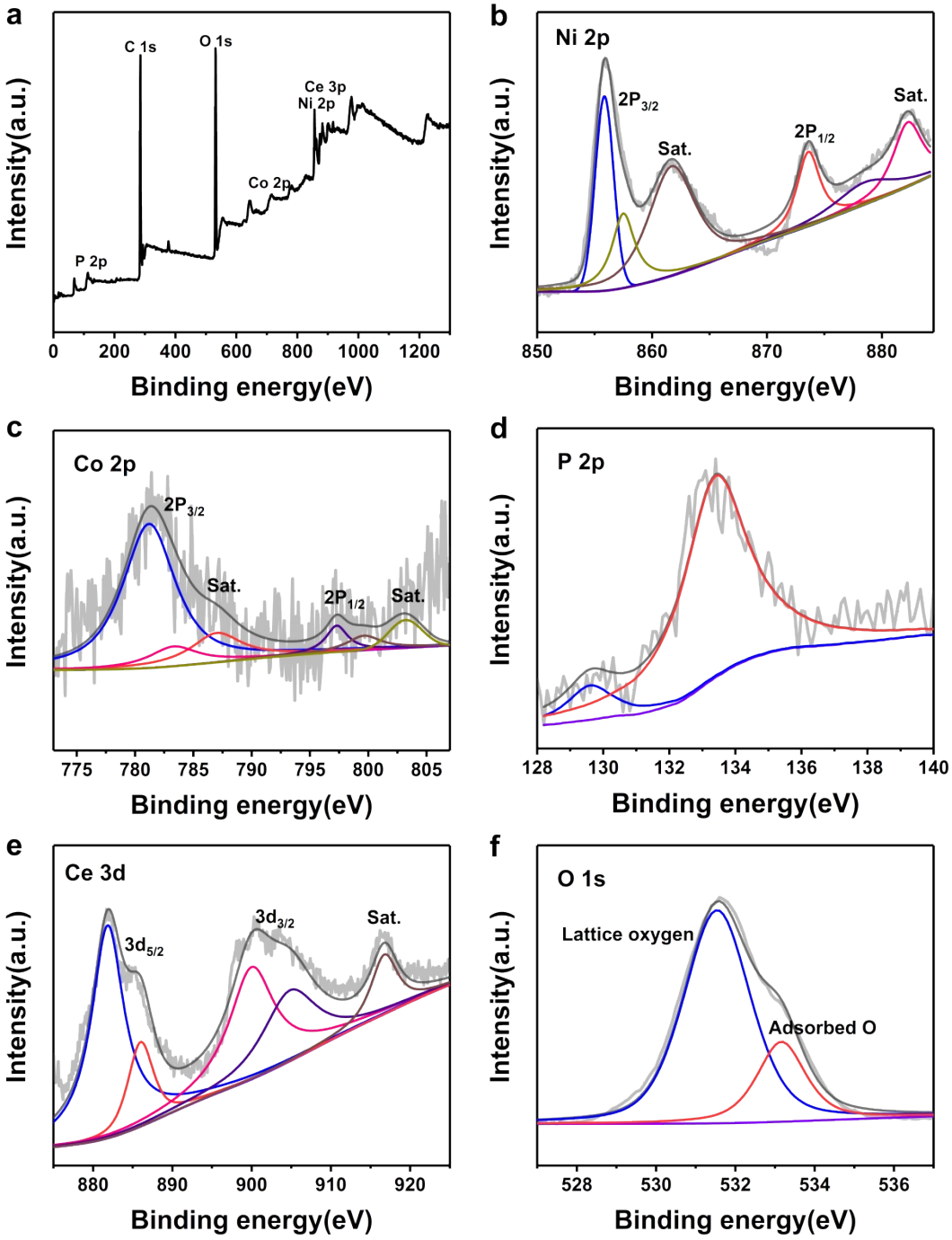

Fig. S6 XPS survey(a), Ni 2p(b), Co 2p(c), P 2p(d), Ce 3d(e) and O 1s(f) spectra of NiCoP-CeO_2 after stability test.

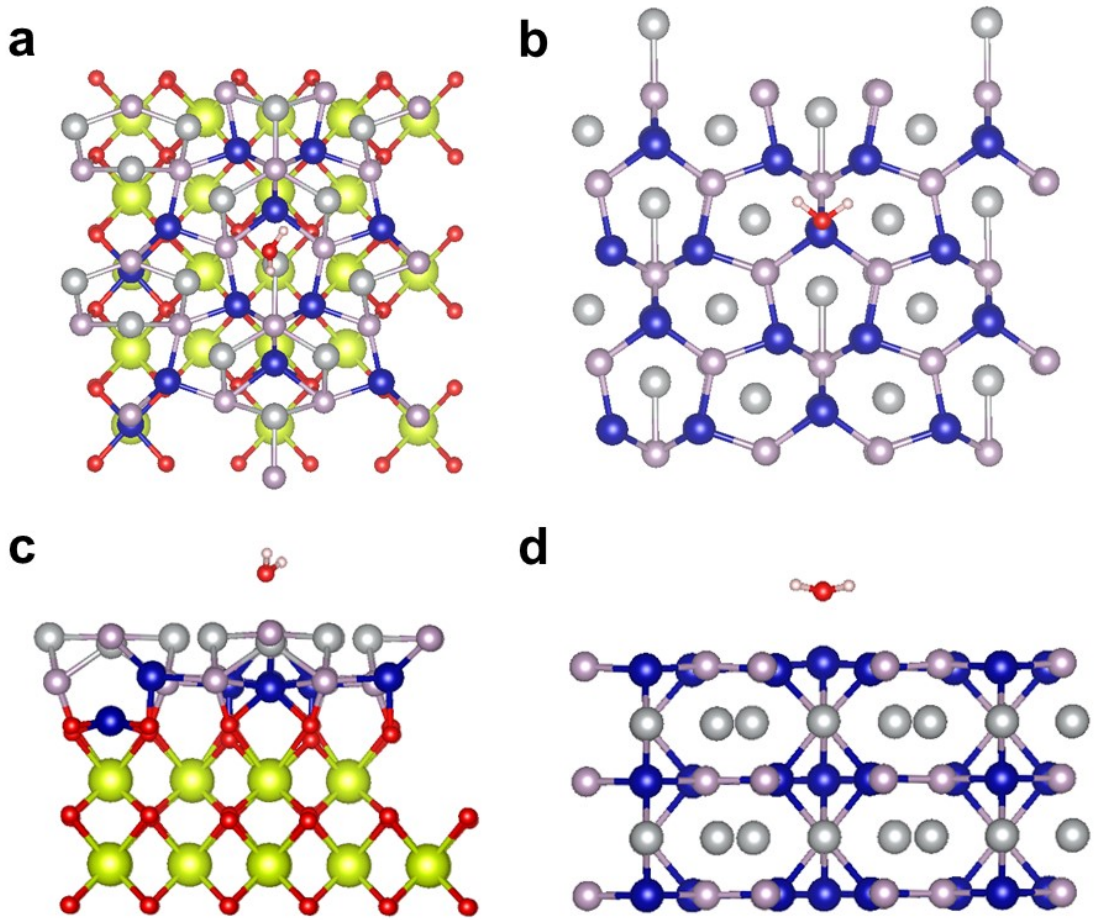

Fig. S7 Optimized adsorption structures of NiCoP-CeO_2 (a) and NiCoP (b).

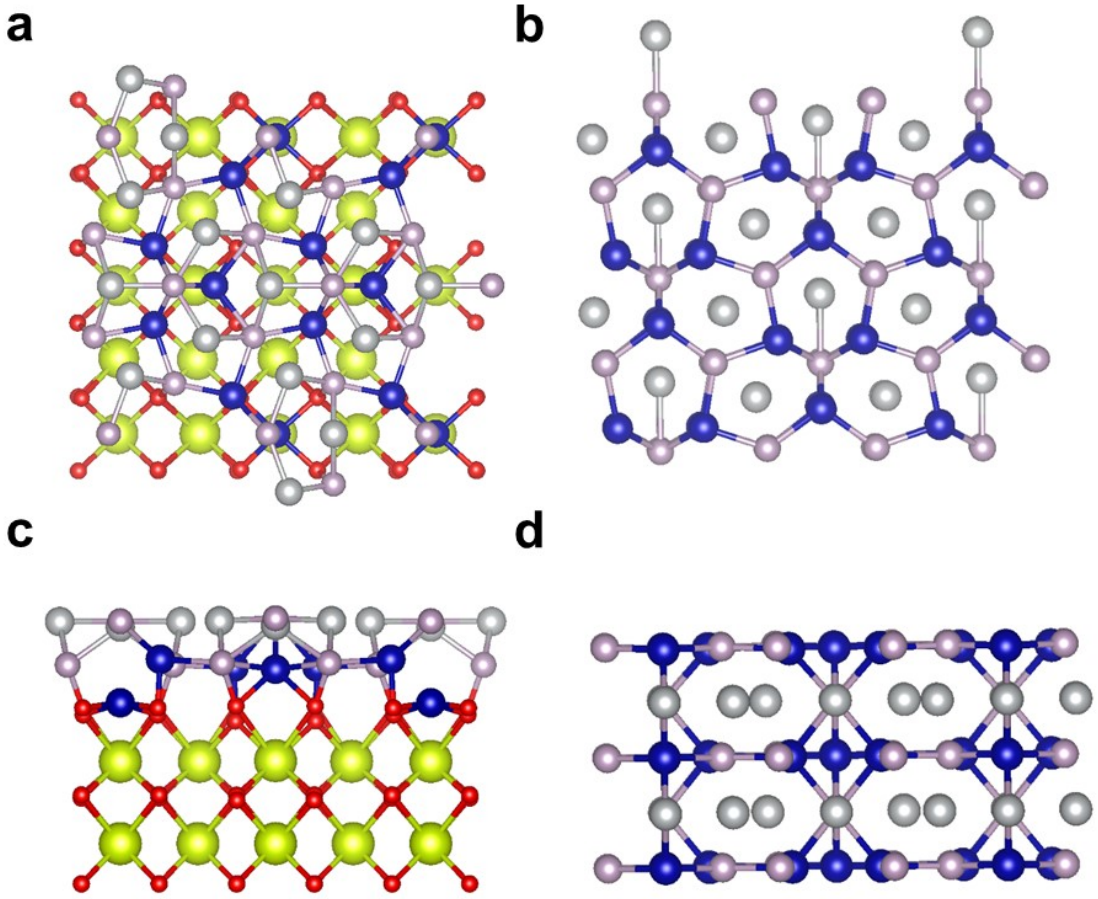

Fig. S8 The original structures of NiCoP-CeO_2 (a) and NiCoP (b).

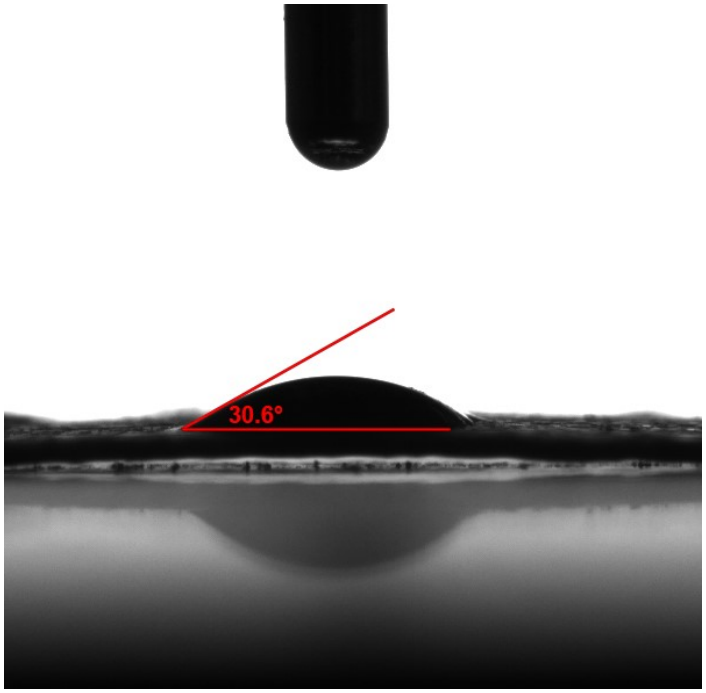

Fig. S9 Wetting-ability testing of CeO_2.

Table S2. The optimized cartesian coordinates of NiCoP-CeO_2 and NiCoP

NiCoP-CeO_2			NiCoP		
0	0	1.35277	0.49529	5.07893	1.67548
0.02303	2.66743	4.10991	3.30659	10.31073	1.67548
2.88952	0.00396	4.11684	0.47161	5.07885	5.08629
2.8113	2.6159	1.35277	3.31533	10.28331	5.03904
0	5.2318	1.35277	3.84608	3.00033	1.67548
0.0229	7.80346	4.10779	1.03478	8.23213	1.67548
2.70454	5.23515	4.1506	3.83469	2.96915	5.06936
2.8113	7.8477	1.35277	1.0232	8.21316	5.03776
5.6226	0	1.35277	1.03478	1.92572	1.67548
5.64656	2.66787	4.13337	3.84608	7.15752	1.67548
8.50666	0.00342	4.11198	1.0181	1.93826	5.04106
8.4339	2.6159	1.35277	3.84654	7.1773	5.07086
5.6226	5.2318	1.35277	4.18934	5.07893	0
5.64689	7.80236	4.12983	1.37804	10.31073	0
8.32137	5.23387	4.13564	4.19638	5.07621	3.36693
8.4339	7.8477	1.35277	1.39179	10.31077	3.35792
1.43936	1.30994	2.97536	4.24351	5.07085	6.82256
4.19188	3.92649	2.99711	1.44424	10.3079	6.63614
4.21695	1.30795	0	4.81036	1.20583	0
4.32257	1.26128	5.70197	1.99906	6.43762	0
1.40565	3.92385	0	4.7809	1.22486	3.36791
1.37954	3.8927	5.46921	1.97409	6.45061	3.38077
1.40565	1.30795	0	4.77331	1.21183	6.63074
1.39606	1.28222	5.89543	1.94581	6.47496	6.60677
4.21695	3.92385	0	1.99906	3.72023	0
4.16594	3.91233	6.04234	4.81036	8.95203	0
4.23963	1.31061	2.88846	1.96904	3.7029	3.38286
1.38719	3.93027	2.80884	4.78893	8.92288	3.35985
1.38494	6.53675	2.80691	1.93216	3.67373	6.61286
4.23884	9.15753	2.88691	4.78379	8.92613	6.6404
4.21695	6.53975	0	5.54045	3.33506	0
4.17373	6.55994	6.03274	2.72915	8.56686	0
1.40565	9.15565	0	5.47971	3.3314	3.3706
1.39705	9.20253	5.89234	2.67424	8.55772	3.3613
1.40565	6.53975	0	5.48084	3.25982	6.69606
1.3934	6.59375	5.46542	2.67939	8.51565	6.75704
4.21695	9.15565	0	2.72915	1.5911	0
4.32511	9.21423	5.69747	5.54045	6.8229	0
4.19111	6.54119	2.99495	2.67108	1.59653	3.36251
1.4394	9.15852	2.97404	5.4839	6.81753	3.36675
7.05788	1.31191	2.98255	2.67286	1.63479	6.75106
9.81354	3.9277	2.971	5.48962	6.87733	6.69424
9.83955	1.30795	0	2.72915	5.07893	1.67548

9.95195	1.25816	5.6714	5.54045	10.31073	1.67548
7.02825	3.92385	0	2.77637	5.07218	5.09418
6.99383	3.89925	5.49056	5.56405	10.30184	5.05215
7.02825	1.30795	0	3.85531	5.06169	8.91448
7.01515	1.28136	5.89371	3.25541	4.30172	9.07331
9.83955	3.92385	0	3.31944	5.86151	9.10425
9.78452	3.90493	5.95578			
9.85916	1.30944	2.87771			
7.00423	3.927	2.8137			
7.00246	6.53882	2.81158			
9.85845	9.1581	2.87721			
9.83955	6.53975	0			
9.79058	6.5757	5.95274			
7.02825	9.15565	0			
7.015	9.19806	5.89494			
7.02825	6.53975	0			
7.00755	6.58306	5.48463			
9.83955	9.15565	0			
9.95457	9.2201	5.67129			
9.81292	6.53999	2.9704			
7.05851	9.15553	2.98083			
4.89192	5.06049	10.9447			
1.92742	0.00981	8.61797			
10.92348	5.25766	8.67953			
3.01019	3.31994	8.83502			
0.38039	8.41719	8.80759			
0.3809	2.07036	8.80809			
3.03003	7.16858	8.83196			
7.5936	0.00852	8.60129			
5.36187	5.274	8.86023			
8.72577	3.34305	8.82861			
6.02457	8.42635	8.80319			
6.0294	2.04678	8.79841			
8.72866	7.13126	8.82957			
11.21949	0.0087	6.05078			
3.37733	5.23954	7.276			
4.01392	1.35168	7.56515			
1.2307	6.62314	7.26885			
1.22699	3.8687	7.27464			
4.0168	9.12598	7.5596			
5.58773	0.00623	6.07427			
8.97638	5.24346	7.17657			
9.64897	1.35377	7.5303			
6.86323	6.61179	7.2981			

6.8567	3.87215	7.30716	
9.64621	9.13019	7.52972	
10.36712	3.44862	7.41042	
1.94795	8.69486	7.34877	
1.94645	1.79325	7.35101	
10.36906	7.04267	7.40529	
10.87765	0.01125	8.83688	
1.89288	5.25345	8.97673	
4.74549	3.46005	7.50141	
7.58383	8.67942	7.34024	
7.58401	1.80128	7.33733	
4.75034	7.02393	7.48714	
5.28314	0.0064	8.83368	
7.60187	5.23894	8.95171	
4.14623	5.57168	11.31531	
5.61206	5.10058	11.60368	

Table S3. The original cartesian coordinates of NiCoP-CeO_2 and NiCoP

NiCoP-CeO_2			NiCoP		
0	0	1.35277	0.49529	5.07893	1.67548
0.03431	2.66848	4.12059	3.30659	10.31073	1.67548
2.90239	2.93E-04	4.1163	0.51711	5.07893	5.07034
2.8113	2.6159	1.35277	3.32841	10.31073	5.07034
0	5.2318	1.35277	3.84608	3.00033	1.67548
0.03607	7.79476	4.12049	1.03478	8.23213	1.67548
2.71648	5.23215	4.14039	3.85081	2.9635	5.0495
2.8113	7.8477	1.35277	1.03951	8.1953	5.0495
5.6226	0	1.35277	1.03478	1.92572	1.67548
5.65684	2.66835	4.1204	3.84608	7.15752	1.67548
8.52526	4.19E-04	4.11556	1.03951	1.96255	5.0495
8.4339	2.6159	1.35277	3.85081	7.19435	5.0495
5.6226	5.2318	1.35277	4.18934	5.07893	0
5.65813	7.7947	4.11969	1.37804	10.31073	0
8.33865	5.23224	4.14052	4.21375	5.07893	3.36596
8.4339	7.8477	1.35277	1.40245	10.31073	3.36596
1.44418	1.30832	2.99617	4.24186	5.07893	6.65575
4.20013	3.92466	2.98001	1.43056	10.31073	6.65575
4.21695	1.30795	0	4.81036	1.20583	0
4.34271	1.24827	5.6815	1.99906	6.43762	0
1.40565	3.92385	0	4.79816	1.22414	3.36686
1.41549	3.88011	5.47558	1.98686	6.45583	3.36686
1.40565	1.30795	0	4.80198	1.24067	6.63827

1.41296	1.26502	5.91852	1.99068	6.47247	6.63827
4.21695	3.92385	0	1.99906	3.72023	0
4.19986	3.89717	5.98113	4.81036	8.95203	0
4.24584	1.31021	2.88857	1.98686	3.70192	3.36686
1.38916	3.92882	2.80896	4.79816	8.93372	3.36686
1.39029	6.53486	2.81443	1.99068	3.68538	6.63827
4.24668	9.15426	2.88184	4.80198	8.91718	6.63827
4.21695	6.53975	0	5.54045	3.33506	0
4.2003	6.56623	5.9817	2.72915	8.56686	0
1.40565	9.15565	0	5.49564	3.33255	3.3579
1.41295	9.19826	5.91724	2.68434	8.56435	3.3579
1.40565	6.53975	0	5.50245	3.30597	6.71691
1.41607	6.58348	5.47734	2.69115	8.53777	6.71691
4.21695	9.15565	0	2.72915	1.5911	0
4.34306	9.21506	5.67932	5.54045	6.8229	0
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1.44546	9.15492	2.98794	5.49564	6.82541	3.3579
7.06692	1.30849	2.99519	2.69115	1.62018	6.71691
9.82236	3.92471	2.98071	5.50245	6.85198	6.71691
9.83955	1.30795	0	2.72915	5.07893	1.67548
9.96534	1.24843	5.68037	5.54045	10.31073	1.67548
7.02825	3.92385	0	2.76452	5.07893	5.06071
7.03797	3.8802	5.47508	5.57582	10.31073	5.06071
7.02825	1.30795	0			
7.03554	1.26512	5.91814			
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9.82272	3.89711	5.98155			
9.86871	1.30997	2.88783			
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7.01303	6.53524	2.81412			
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9.82303	6.56632	5.9823			
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7.03551	9.19846	5.9172			
7.02825	6.53975	0			
7.03819	6.58364	5.4769			
9.83955	9.15565	0			
9.96549	9.21533	5.67942			
9.82402	6.53868	2.98781			
7.06761	9.1551	2.98798			
2.0062	10.46274	8.63497			
10.99854	5.2313	8.68815			
3.12567	3.34735	8.8416			

0.42986	8.42027	8.81849	
0.43058	2.04307	8.81939	
3.1253	7.11605	8.84164	
7.62889	2.72E-04	8.63513	
5.37644	5.23167	8.68815	
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6.05258	8.42031	8.81886	
6.05325	2.04364	8.81899	
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11.22993	5.23E-05	6.08561	
3.41231	5.23165	7.21577	
4.06001	1.34773	7.55126	
1.27942	6.62797	7.28344	
1.27965	3.83575	7.28188	
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5.60762	10.46344	6.08615	
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9.68297	1.34809	7.55015	
6.90201	6.62829	7.283	
6.90253	3.836	7.28178	
9.68235	9.1161	7.54933	
10.4118	3.43171	7.4306	
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5.30021	2.09E-05	8.82978	
7.59451	5.2314	8.92818	

References

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