Oxygen-Vacancy Engineering of Cerium Oxide Nanoparticles for Antioxidant Activity

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Supporting Information

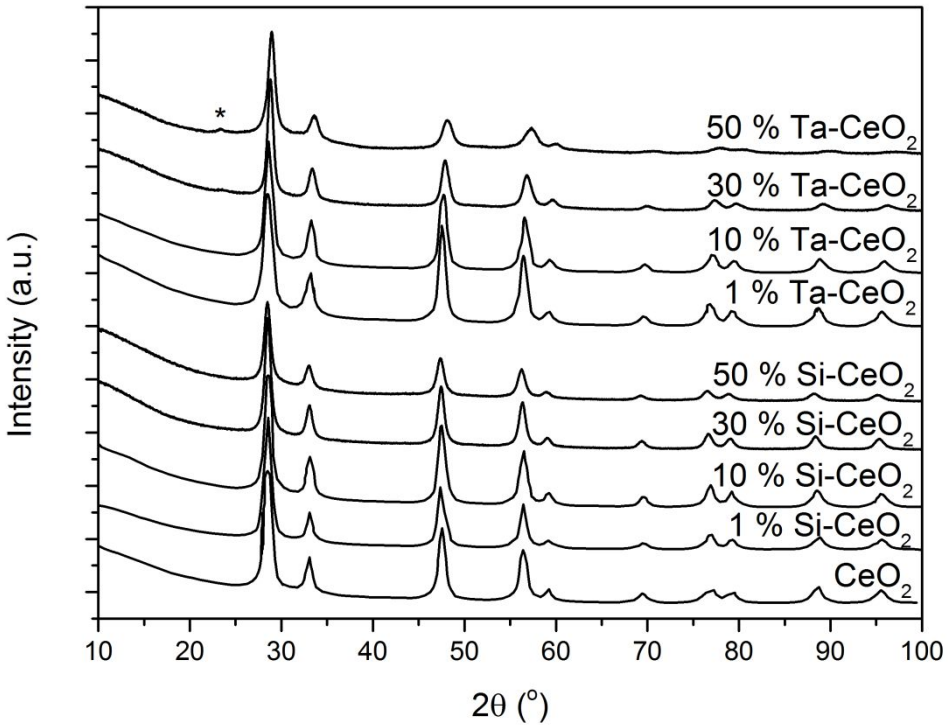


Figure S1. XRD spectra of FSP-synthesized nanoceria with 10, 30 and 50 at% Si and Ta doping. (*) denotes the presence of Ta_2O_5.

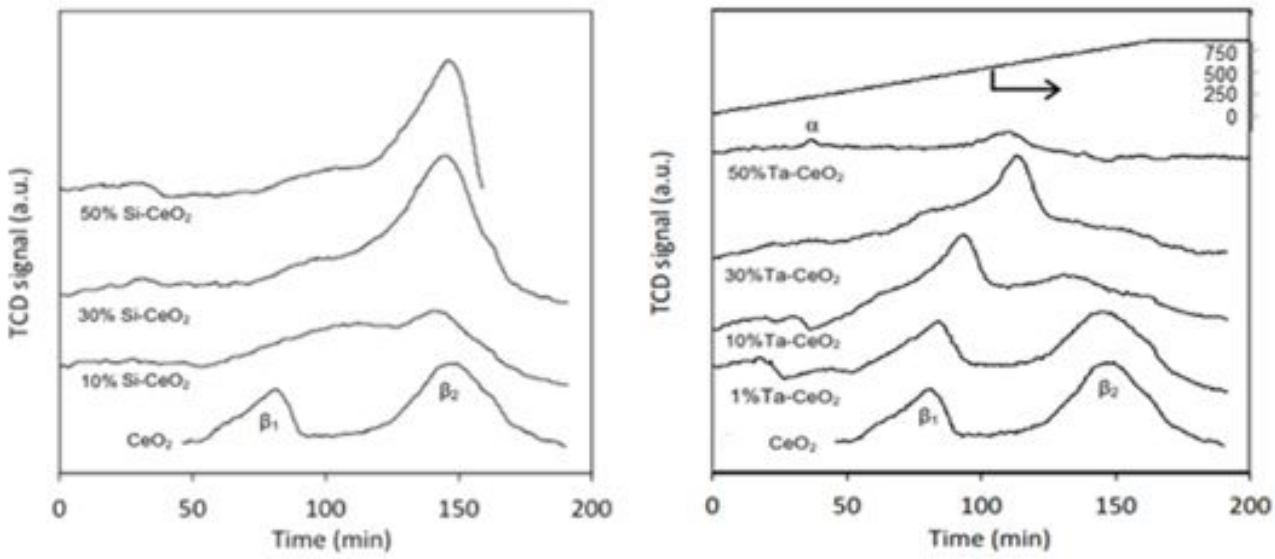
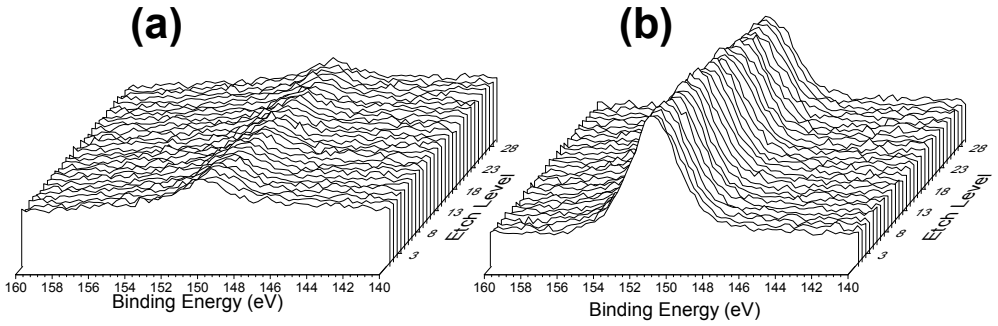


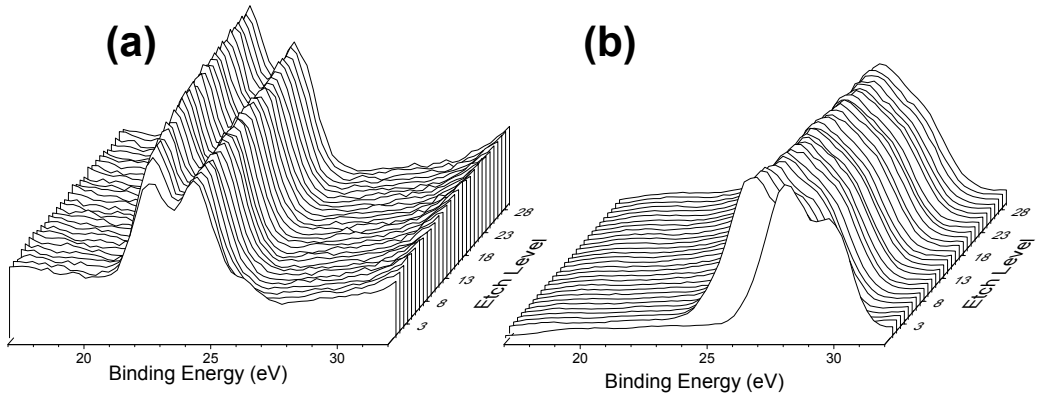
Figure S2. H_2-TPR results of FSP-synthesized nanoceria with 10, 30 and 50 at% Si and Ta doping (top line shows the temperature ramp profile at 10ºC/min followed by hold at 850ºC). For Si-CeO_2 particles, note the shifting of β_1 peak (surface lattice oxygen) towards higher reduction temperature with increasing Si doping, inferring to less accessible oxygen sites. The reduction temperature of β_2 peak (bulk lattice oxygen) remains unchanged by the presence of Si doping. For Ta-CeO_2 particles, the merging of β_1 and β_2 peaks with increasing Ta doping indicates lowering of activation energy for the reduction of lattice oxygen sites on CeO_2. The emergence of α peak at 50 at% Ta doping is most likely the characteristic reduction of tantalum oxide clusters.

Table S1. Ce^{3+}/Ce^{4+} surface composition of nanoceria and the dopant variants (XPS analysis).

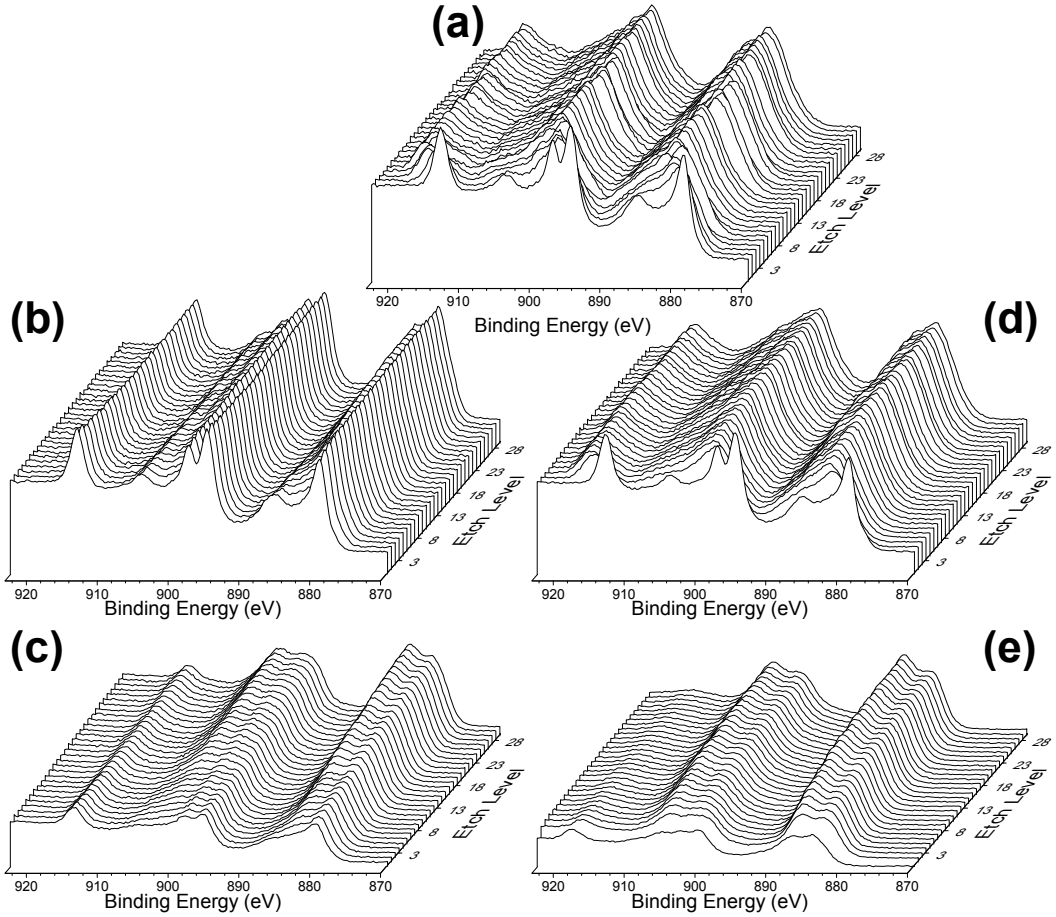
	Ce^{3+} (%)	**Ce^{4+} (%)**	**Ce^{3+}/Ce^{4+} surface ratio**	**% surface Ce^{3+} per unit catalyst**
CeO_2	18.2	81.8	0.22	18.2
10 at% Si-CeO_2	18.2	81.8	0.22	16.4
50 at% Si-CeO_2	24.1	75.9	0.32	12.0
10 at% Ta-CeO_2	18.5	81.5	0.23	16.7
50 at% Ta-CeO_2	27.0	73.0	0.37	13.5



Figures S3. Si2p XPS depth spectra of FSP synthesised Si-CeO_2 at (a) 10 and (b) 50 at% Si doping.



Figures S4. Ta4f XPS depth spectra of FSP synthesised Ta-CeO_2 at (a) 10 and (b) 50 at% Ta doping.



Figures S5. Ce3d XPS depth spectra of FSP-synthesized (a) neat nanoceria, (b) 10 and (c) 50 at% Si-CeO_2, (d) 10 and (e) 50 at% Ta-CeO_2.

Table S2. Aggregate size of nanoceria and the doped variants in the cell culture medium (measured by dynamic light scattering)

	Average hydrodynamic size (nm ± SEM)[a]
CeO_2	220 ± 6
10 at% Si-CeO_2	163 ± 1
30 at% Si-CeO_2	286 ± 2
50 at% Si-CeO_2	204 ± 12
10 at% Ta-CeO_2	177 ± 16
30 at% Ta-CeO_2	175 ± 6
50 at% Ta-CeO_2	164 ± 3

[a]Standard error of mean