Surfactant free one pot synthesis of CeO_2, TiO_2 and Ti@Ce oxide nanoparticles for ultra fast removal of Cr(VI) from aqueous media

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Caption for Supplementary Data

Fig. S1. BET-BJH pore size distribution of (a) CeO_2 (b) $Ti_{0.1}$-$Ce_{0.9}$ oxide nanoparticles (c) $Ti_{0.3}$-$Ce_{0.7}$ oxide nanoparticles (d) TiO_2.

Fig. S2. Zeta potential at variable pH.

Fig. S3. EDAX mapping image of CeO_2 adsorbed Cr(VI).

Fig. S4. EDAX mapping image of $Ti_{0.3}$@ Ce0.7 oxide nanoparticles adsorbed Cr(VI).

Fig. S5. EDAX mapping image of TiO_2 adsorbed Cr(VI).

Fig. S6. The reusability study for removal of Cr(VI) using $Ti_{0.3}$@$Ce_{0.7}$ oxide nanoparticles. (b) Surface area of $Ti_{0.3}$@$Ce_{0.7}$ after adsorption of Cr(VI).

Fig. S7. (a) Langmuir Isotherm plot (b) Freundlich Isotherm plot (c) Redlich-Peterson Isotherm plot (d) D-R Isotherm plot.

Fig. S8. Pseudo Second Order Reaction.

Fig. S9. FTIR spectra of $Ti_{0.3}$@$Ce_{0.7}$ oxide nanoparticles before and after adsorption of Cr(VI).

Table 1. Standard Error for Langmuir Isotherm.

Table 2. Standard Error for Freundlich Isotherm.

Table 3. Standard Error for R-P Isotherm.

Table 4. Standard Error for D-R Isotherm.

Supplementary Data

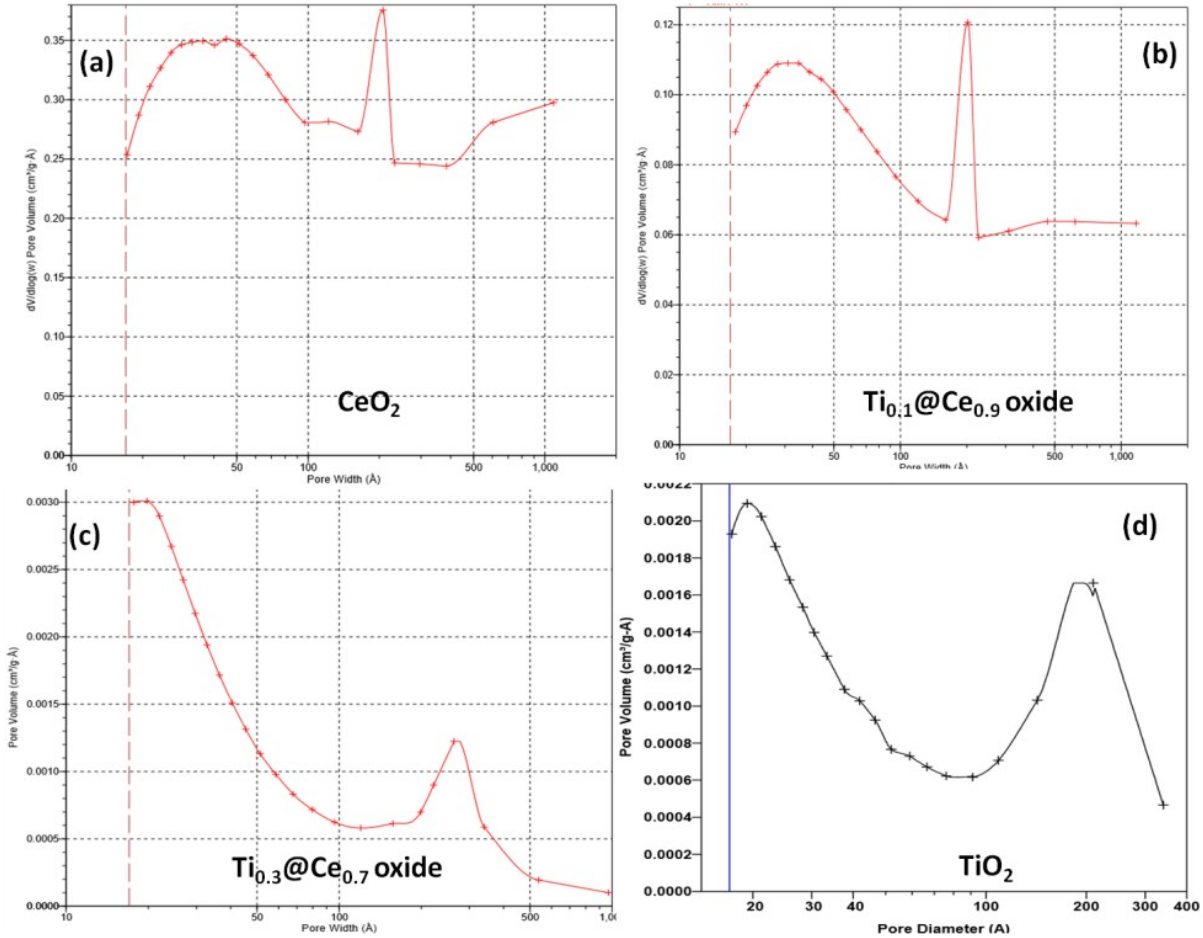


Fig. S1 BET-BJH pore size distribution of (a) CeO_2; (b) $Ti_{0.1}@Ce_{0.9}$ oxide nanoparticles; (c) $Ti_{0.3}@Ce_{0.7}$ oxide nanoparticles and (d) TiO_2.

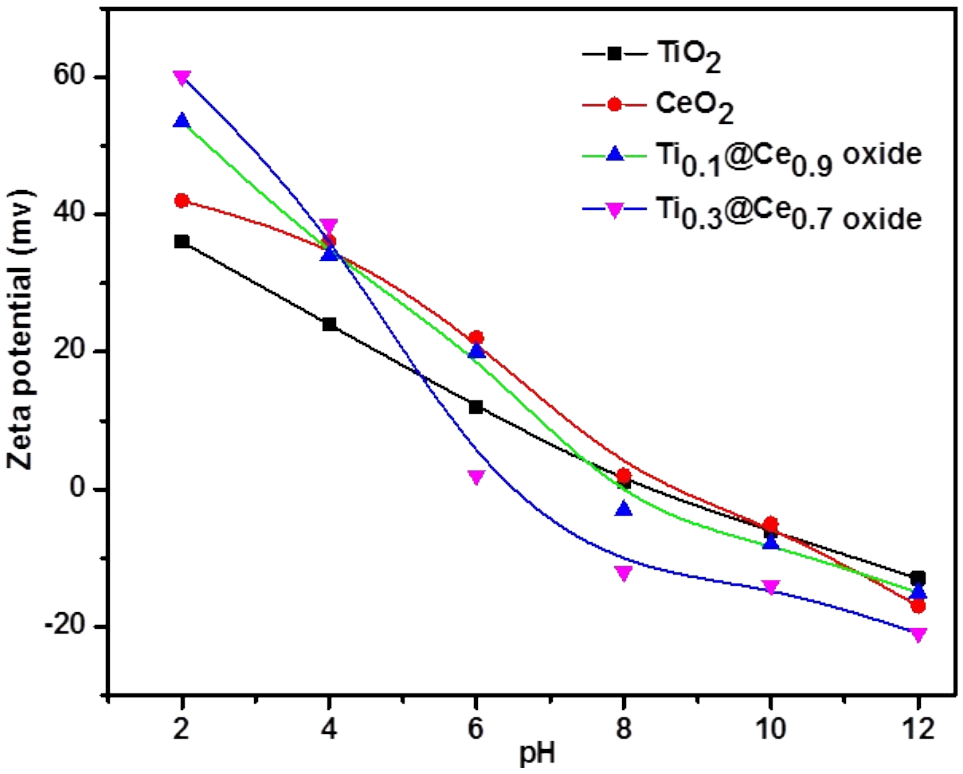


Fig. S2 Zeta potential at variable pH.

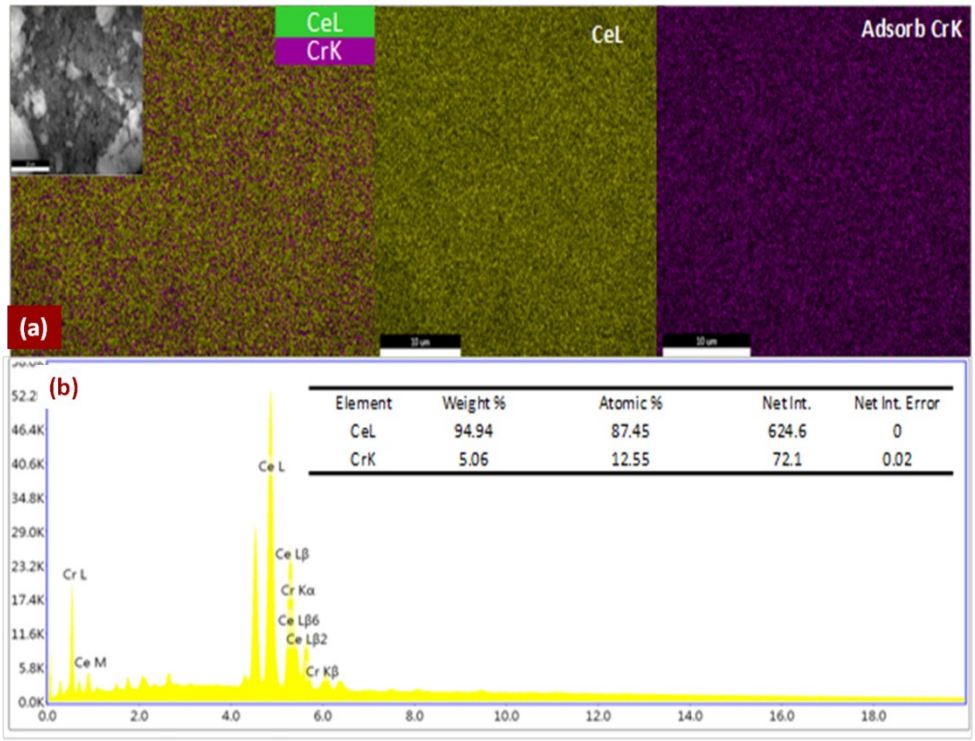
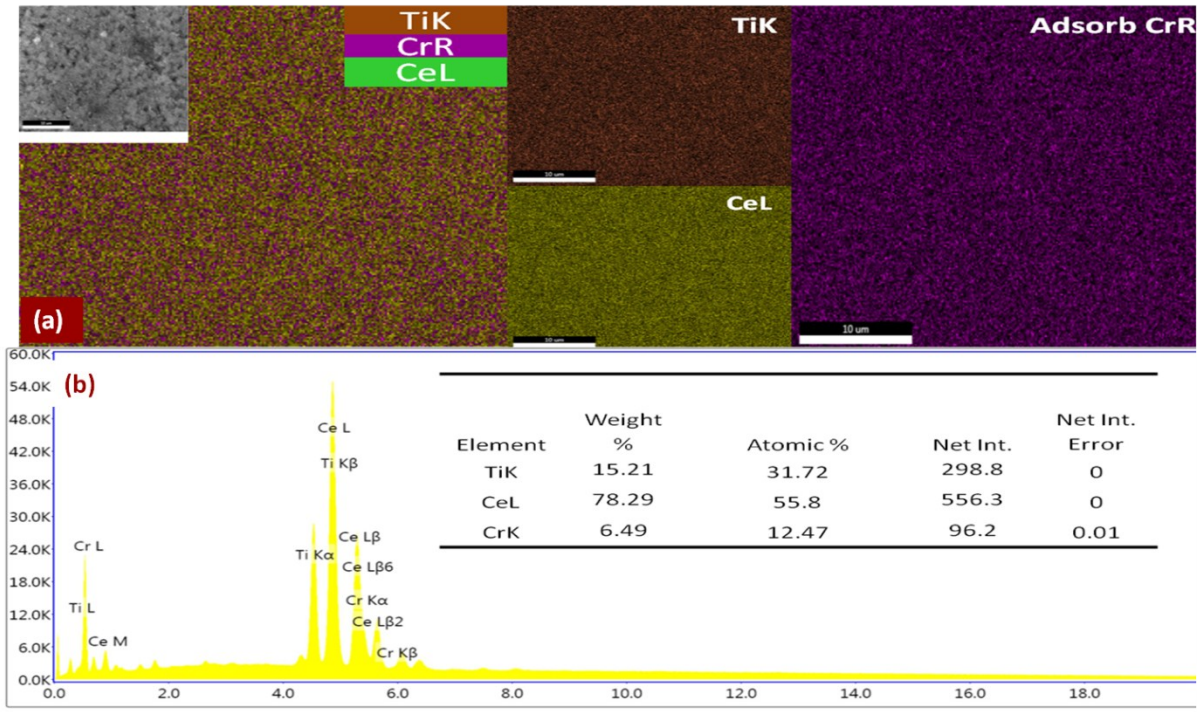
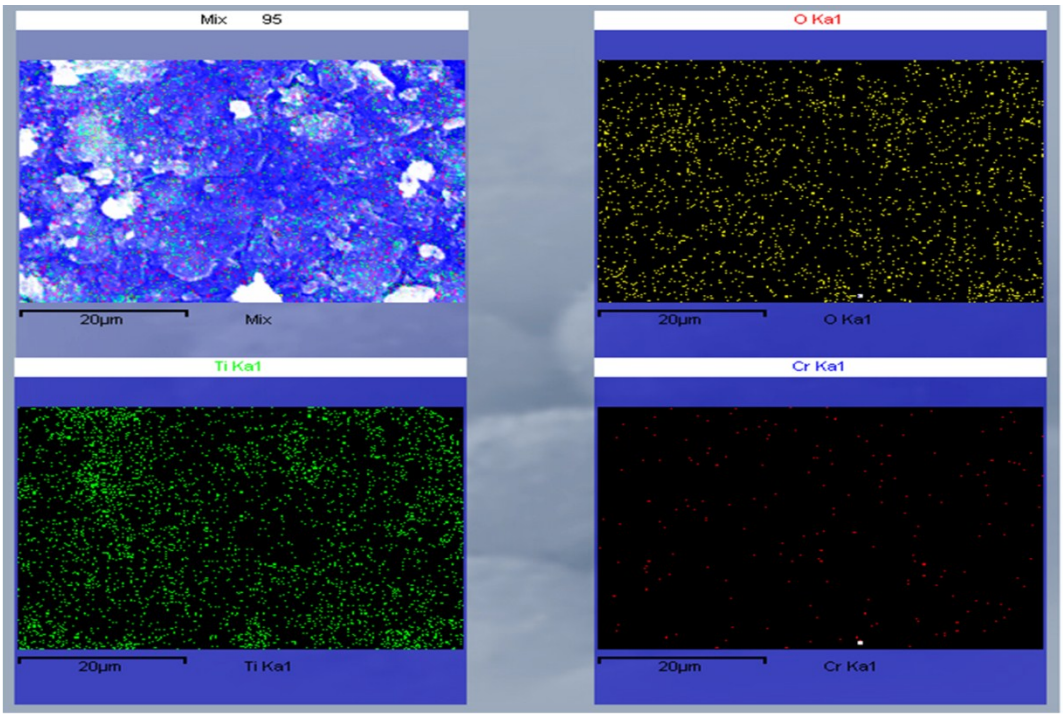


Fig. S3 EDAX mapping image of CeO_2 adsorbed Cr(VI).



Element	Weight %	Atomic %	Net Int.	Net Int. Error
TiK	15.21	31.72	298.8	0
CeL	78.29	55.8	556.3	0
CrK	6.49	12.47	96.2	0.01

Fig. S4 EDAX mapping image of $Ti_{0.3}@Ce_{0.7}$ oxide nanoparticles adsorbed Cr(VI).



O K	77.74	91.28
Ti K	22.03	8.64
Cr K	0.23	0.08

Fig. S5 EDAX mapping image of TiO_2 adsorbed Cr(VI).

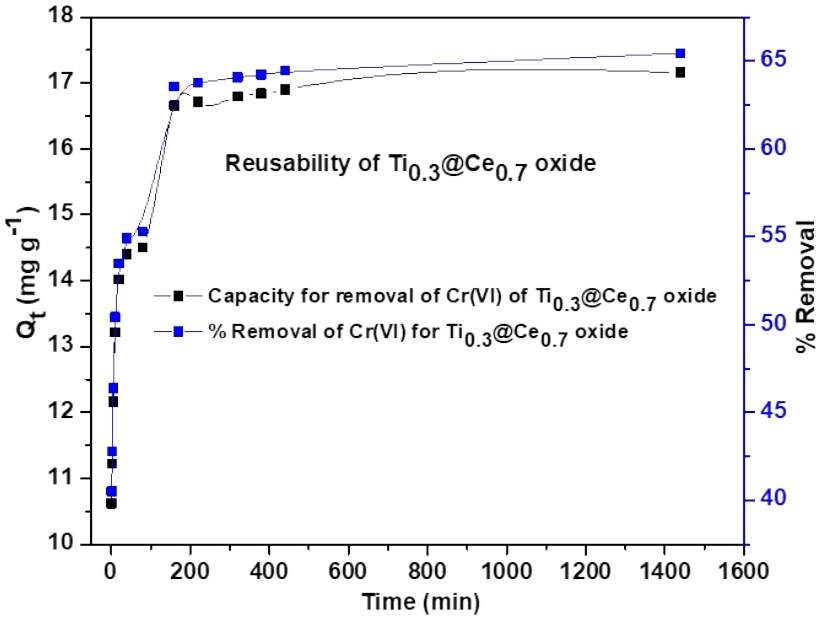


Fig. S6 (a) The reusability study for removal of Cr(VI) using $Ti_{0.3}@Ce_{0.7}$ oxide nanoparticles.

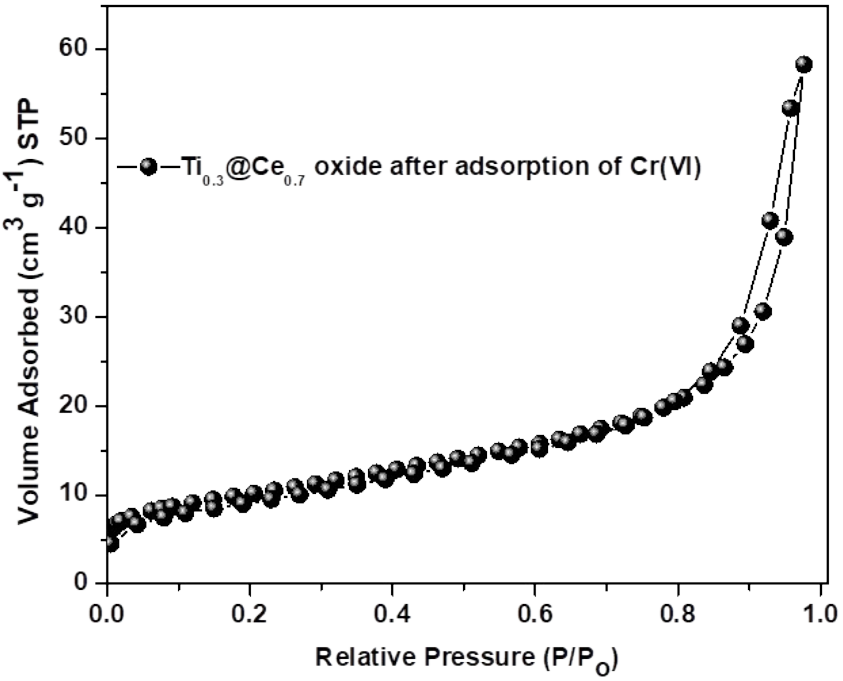


Fig. S6 (b) Surface area of $Ti_{0.3}@Ce_{0.7}$ oxide nanoparticles after adsorption of Cr(VI).

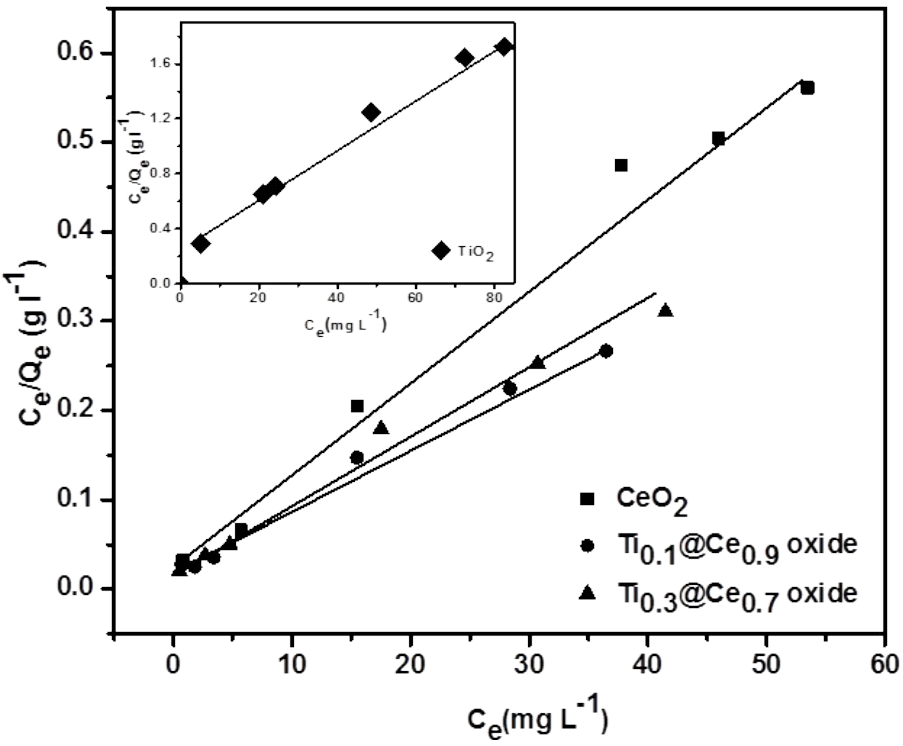


Fig. S7 (a) Langmuir Isotherm plot.

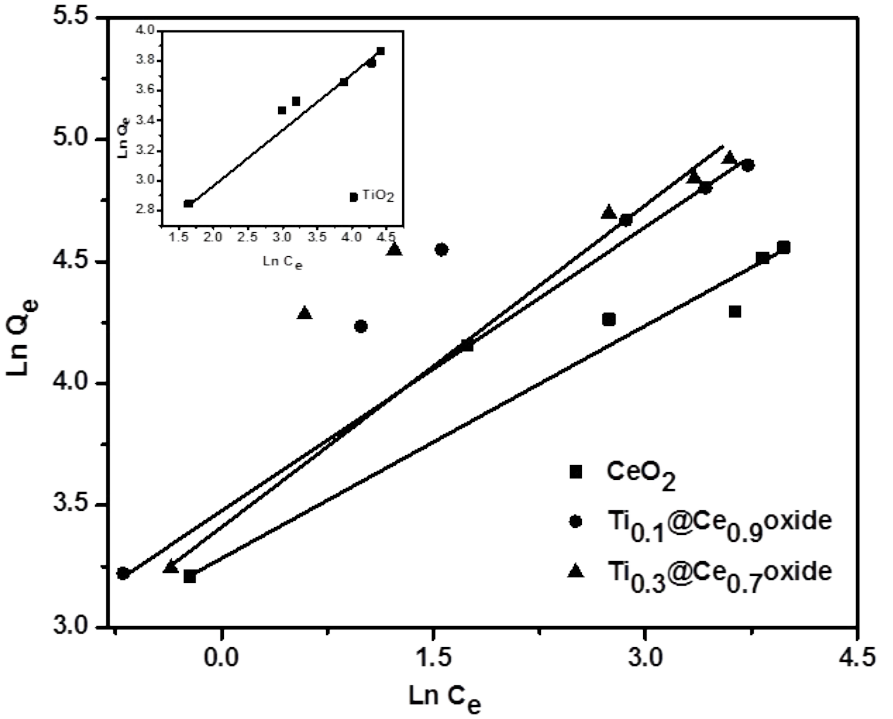


Fig. S7 (b) Freundlich Isotherm plot.

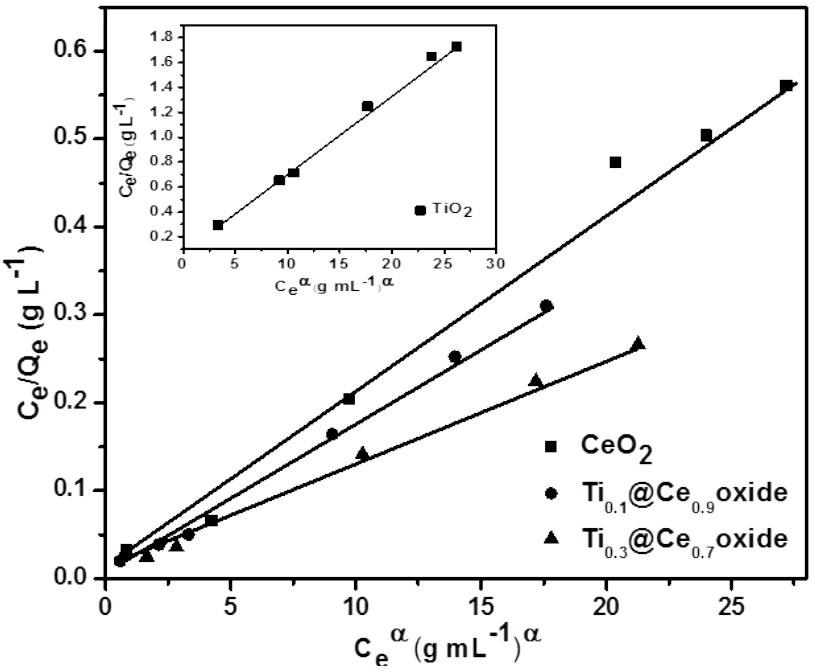


Fig. S7 (c) Redlich-Peterson Isotherm plot.

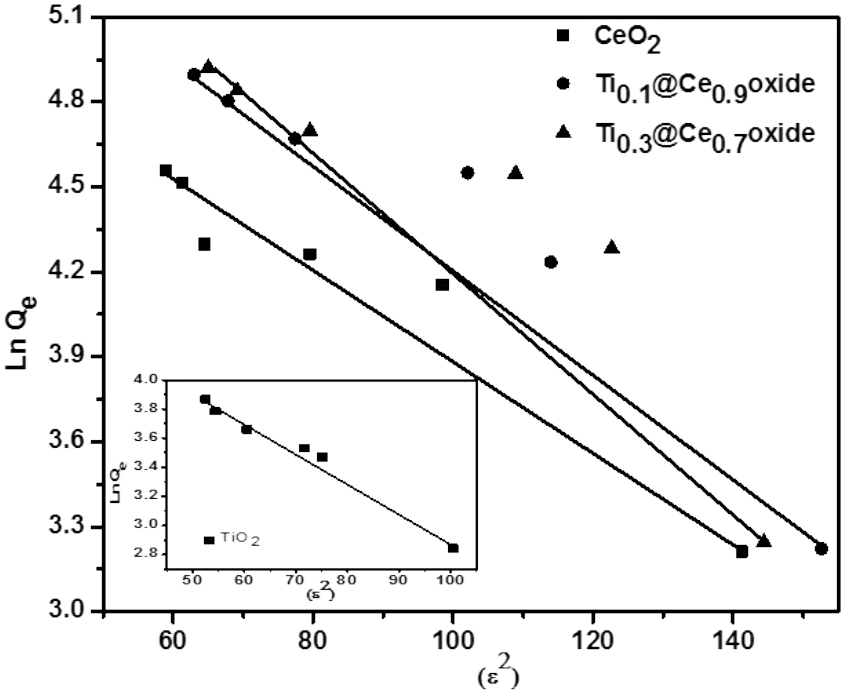


Fig. S7 (d) D-R Isotherm plot.

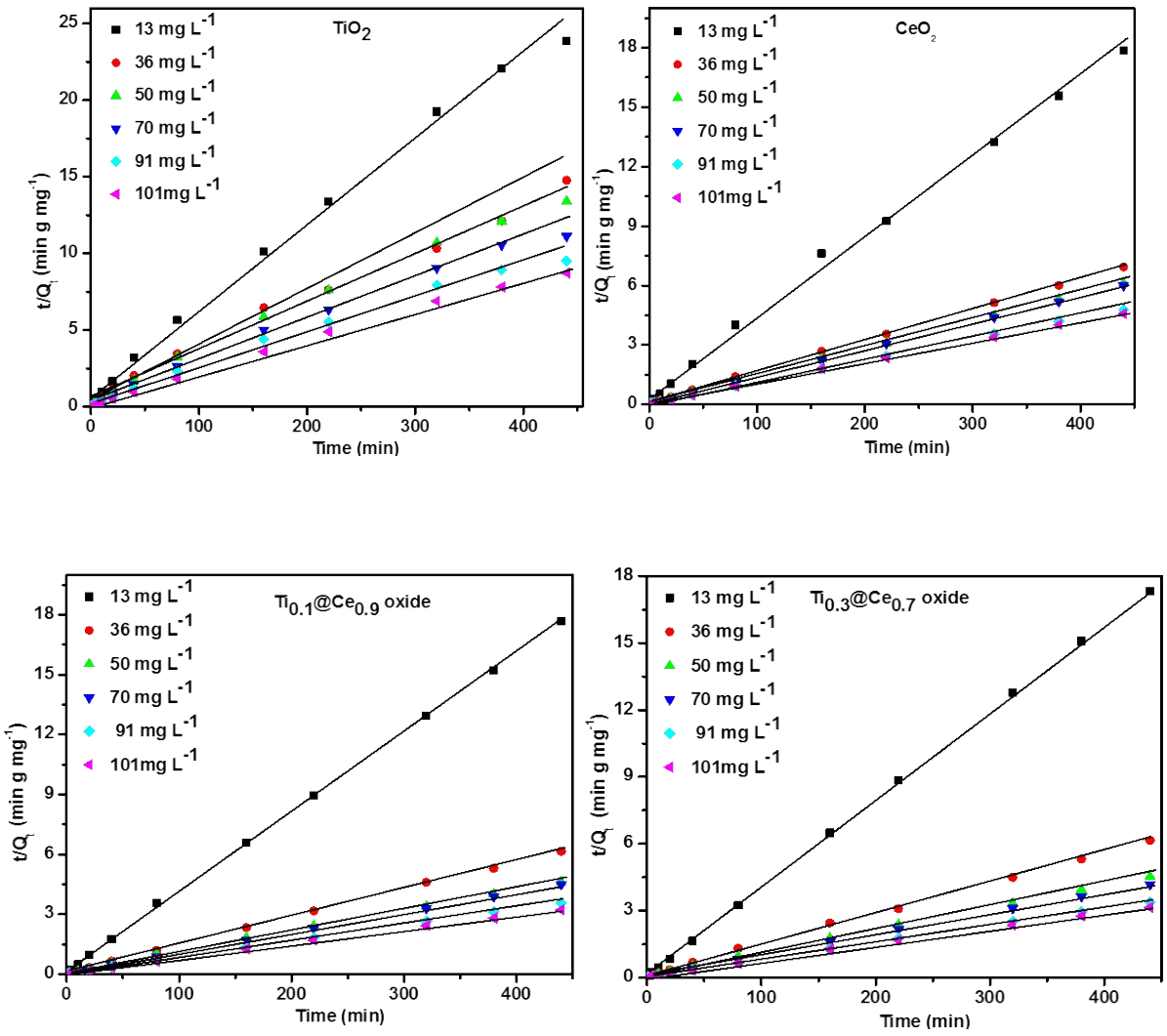


Fig. S8 Pseudo Second Order Reaction.

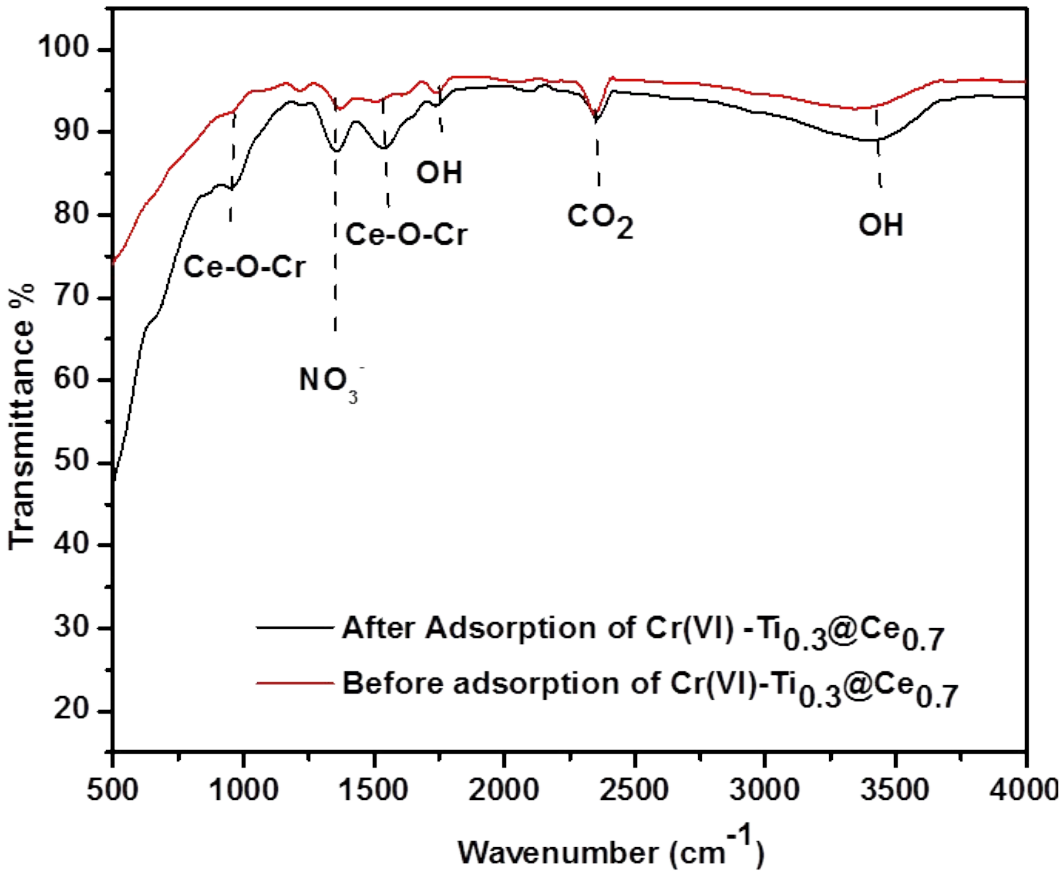


Fig. S9 FTIR spectra of Ti@Ce oxide Before and after adsorption of Cr(VI).

Table 1. Standard Error for Langmuir Isotherm

Parameters	Values (CeO_2)	Values (TiO_2)	Values $Ti_{0.1}@Ce_{0.9}$ oxide	Values $Ti_{0.3}@Ce_{0.7}$ oxide
Intercept error	0.0216	0.0216	0.00587	0.00675
Slope error	$6.34*10^{-4}$	$6.34*10^{-4}$	$2.93*10^{-4}$	$3.01*10^{-4}$
Adjacent R^2	0.982	0.982	0.991	0.991
Pearson R^2	0.9928	0.9928	0.996	0.996
Residual sum of squares	0.00394	0.01674	$3.98*10^{-4}$	$5.1*10^{-4}$
Sum of squares	0.02752	0.02752	0.057	0.0744
F values	275.248	275.248	572.34	578.22
Prob>F	$7.7*10^{-5}$	$7.7*10^{-5}$	$1.8*10^{-5}$	$1.7*10^{-4}$

Table 2. Standard Error for Freundlich Isotherm

Parameters	Values (CeO_2)	Values (TiO_2)	Values $Ti_{0.1}@Ce_{0.9}$ oxide	Values $Ti_{0.3}@Ce_{0.7}$ oxide
Intercept error	0.166	0.112	0.150	0.207
Slope error	0.050	0.0318	0.060	0.087
Adjacent R^2	0.69	0.983	0.865	0.740
Pearson R^2	0.89	0.959	0.944	0.890
Residual sum of squares	0.027	0.021	0.205	0.398
Sum of squares	0.091	0.648	1.713	1.52
F values	10.16	119.68	33.29	15.22
Prob>F	0.0498	$3.9*10^{-4}$	0.00448	0.0174

Table 3. Standard Error for R-P Isotherm

Parameters	Values (CeO_2)	Values (TiO_2)	Values $Ti_{0.1}@Ce_{0.9}$ oxide	Values $Ti_{0.3}@Ce_{0.7}$ oxide
Intercept error	0.0188	0.0331	0.00445	0.00469
Slope error	0.00107	0.001	$4.4*10^{-4}$	$3.9*10^{-4}$
Adjacent R^2	0.997	0.995	0.996	0.997
Pearson R^2	0.994	0.998	0.998	0.994
Residual sum of squares	0.0027	0.0059	$1.8*10^{-4}$	$2.3*10^{-4}$
Sum of squares	0.272	1.688	0.0747	0.0572
F values	394.43	1140.18	1583.3	985.5
Prob>F	$3.7*10^{-5}$	$4.5*10^{-6}$	$2.3*10^{-6}$	$6.1*10^{-6}$

Table 4. Standard Error for D-R Isotherm

Parameters	Values (CeO_2)	Values (TiO_2)	Values $Ti_{0.1}@Ce_{0.9}$ oxide	Values $Ti_{0.3}@Ce_{0.7}$ oxide
Intercept error	0.175	0.101	0.411	0.413
Slope error	0.00019	0.00143	0.0040	0.00403
Adjacent R^2	0.918	0.975	0.924	0.782
Pearson R^2	0.967	0.990	0.969	0.908
Residual sum of squares	0.0787	0.0129	0.383	0.334
Sum of squares	1.134	0.657	1.00	1.588
F values	57.62	202.3	62.008	19.01
Prob>F	0.0016	$1.4*10^{-4}$	0.00141	0.0120