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Tailoring Oxygen Vacancies and Active Surface Oxygen Species in CrOx Hierarchical Strawberry-Type Three-Dimensional (3D) Micro-Spindles Catalysts for Total Catalytic Oxidation of VOCs

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Table S1. Earlier Reports of total oxidation of VOC's over Cr-based catalysts

Entry	Catalyst	Substrate	Catalytic Performance	Ref
1	MCM-48 supported Chromium (Cr/MCM-48)	Trichloroethylene	$T_{100:}$ 350 ºC	1
2	3D Mesoporous Chromium oxide, prepared by Neutral Templating Route	Toluene	T_{100}: 280–300ºC	2
3	0.5% Pt/CrOOH	1,2-Dichloroethane (Flow rate: 46,000 h^{-1})	$T_{90:}$ 317 ºC	3
4	3D Mesoporous chromium oxide prepared by a Neutral Templating Route	Toluene (GHSV = 30,000 h^{-1})	$T_{90:}$ 300 ºC	4
5	Mesoporous Cr_2O_3 prepared using 3D cubic mesoporous silica: KIT-6 (Hard Template)	Toluene	T_{50}: 205 ºC	5
6	Mesoporous Cr_2O_3 with ordered 3D hexagonal polycrystalline structures using KIT-6 (Hard Template)	Toluene (Space vel. = 20000 h^{-1})	T_{90}: 300 ºC	6
7	Chromium-and Copper-modified SBA-15 (Cr_3Cu_7/SBA-15)	Toluene (WHSV = 1.2 h^{-1})	T_{100}: 360 ºC	7
8	Chromium & Cerium modified USY Zeolite catalysts (Cr_2O_3-CeO_2-USY) prepared by Impregnation Method	Dichloromethane	T_{90}: 281 °C	8
9	Cake-like Cr_2O_3 prepared in Microemulsion Methods	Toluene	T_{90}: 240 °C	9
10	γ-Alumina supported Chromium oxide catalysts by Impregnation Method	Benzene	T_{100}: 350 ºC	10
11	CeO_2–CrO_x oxide prepared using $(NH_4)_2CO_3$ as Precipitant.	Cl-VOC (CH_2Cl_2 + C_6H_5Cl + $C_2H_4Cl_2$ + C_2HCl_3) GHSV: 9000mLg^{-1} h^{-1})	T_{90}: 295 °C	11
12	Cr/TiO_2 porous microspheres prepared by hydrothermal method	Chlorobenzene (GHSV 15,000 h^{-1})	T_{90}: 265.73 °C	12
13	MnOx/Cr_2O_3 composites prepared by Pyrolysis of Cr-MOF precursors (MIL-101-Cr)	Toluene (60,000 mL/gh)	T_{90}: 259 °C	13
14	Cr modified ZSM-5 zeolite	Trichloroethylene	T_{90}: 495 °C	14
15	Hierarchical Strawberry-Type Three-Dimensional (3D) CrOx Micro-Spindles	Toluene	T_{90}: 270 °C	This Work

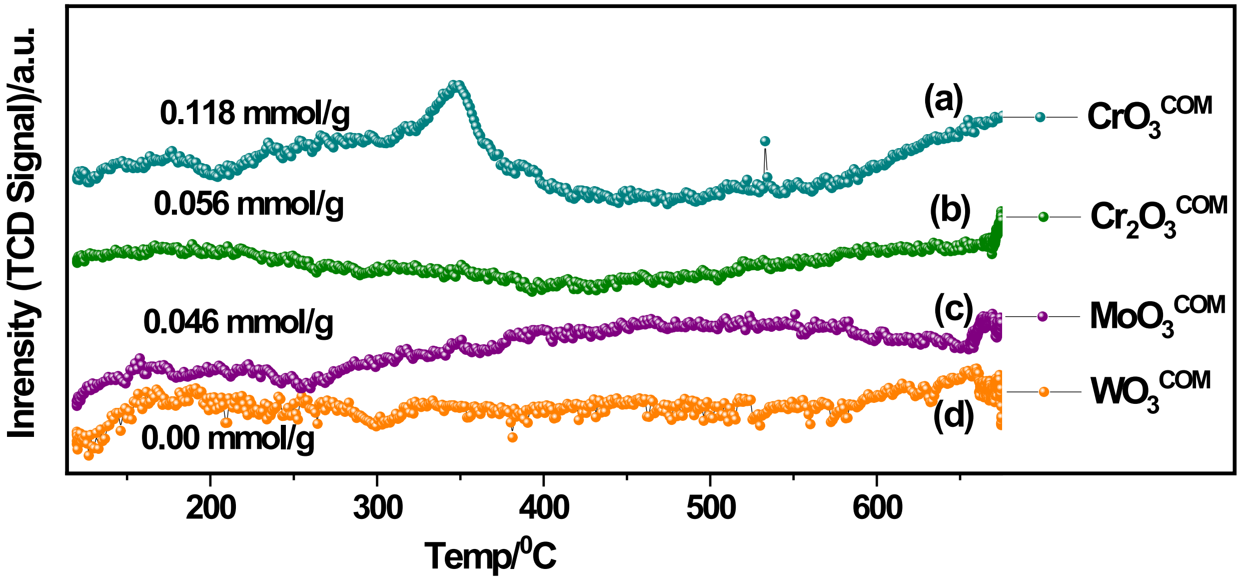

Fig S1. NH_3-TPD profiles of commercial (a) chromium (VI) oxide, (b) chromium (III) oxide, (c) molybdenum (VI) oxide and (d) tungsten (VI) oxide.

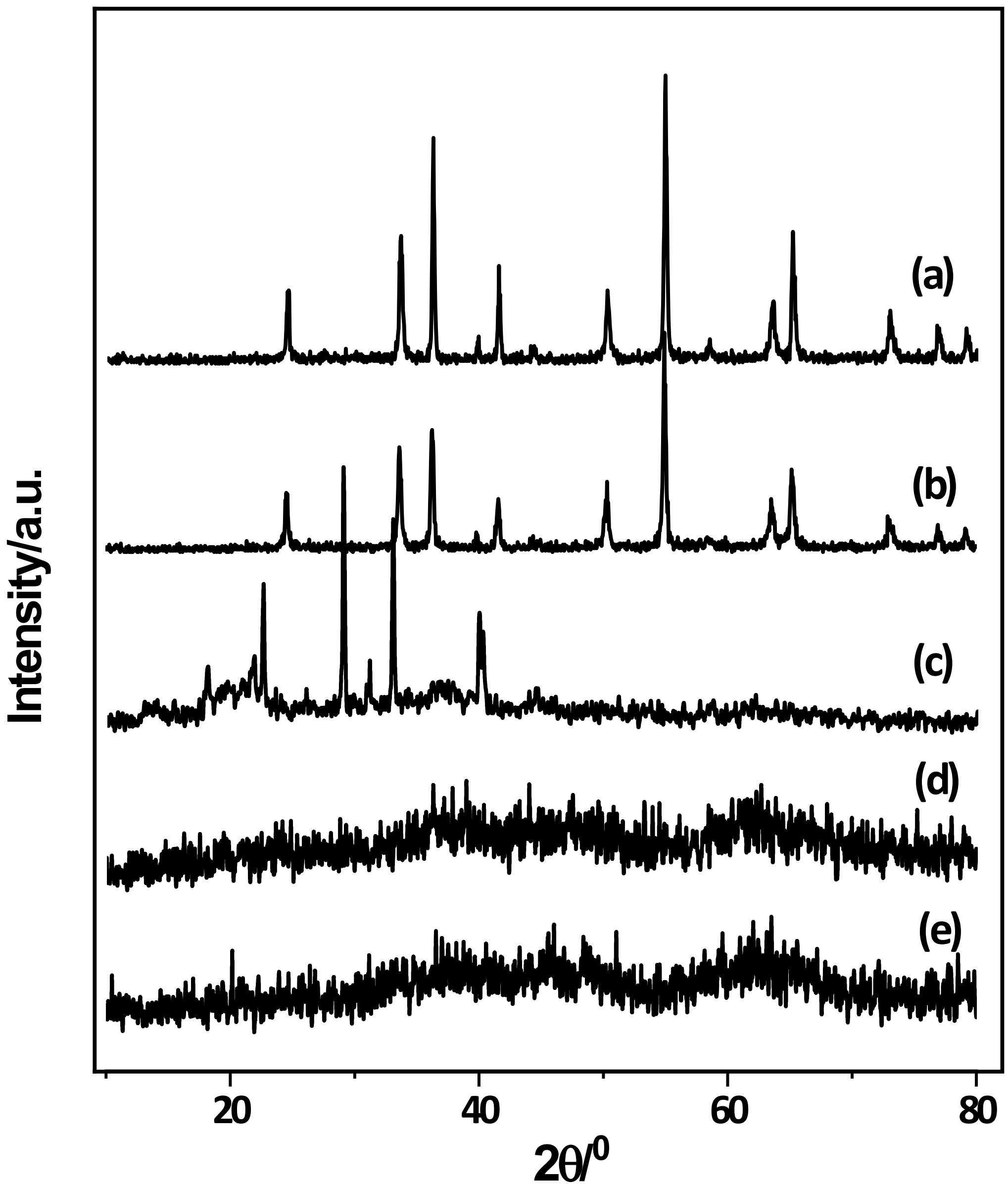

Fig. S2. XRD diffractogram of products (chromium oxide) calcined at (a) 750 ºC; (b) 550 ºC; (c) 450 ºC; (d) 350 ºC and (e) 150 ºC.

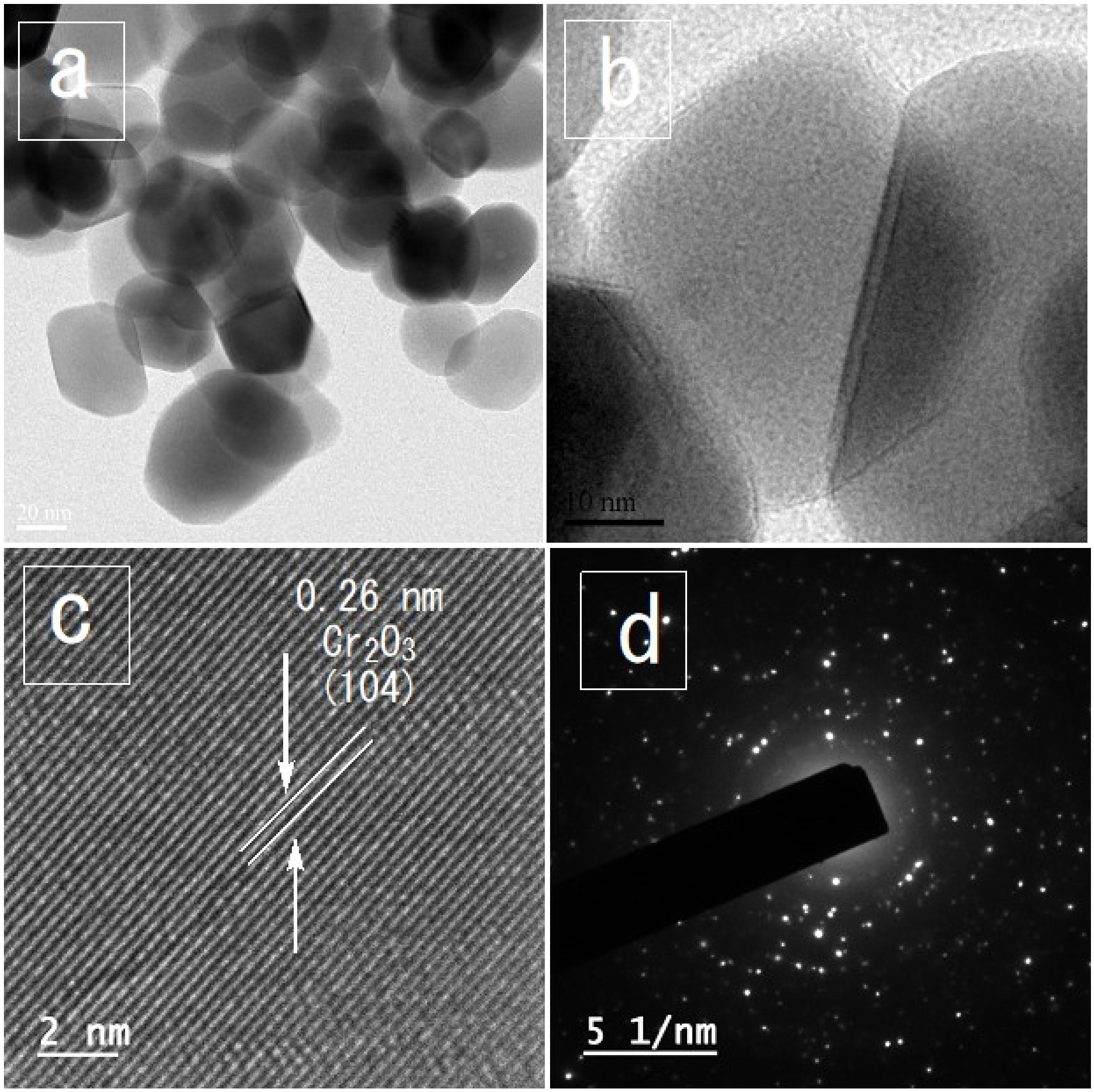

Fig. S3 TEM image of fresh chromium oxide nanoparticles catalyst i.e. $Cr_2O_3^{NIT}$ (a)-(c) with successively higher magnifications and (d) the corresponding SAED diagram.

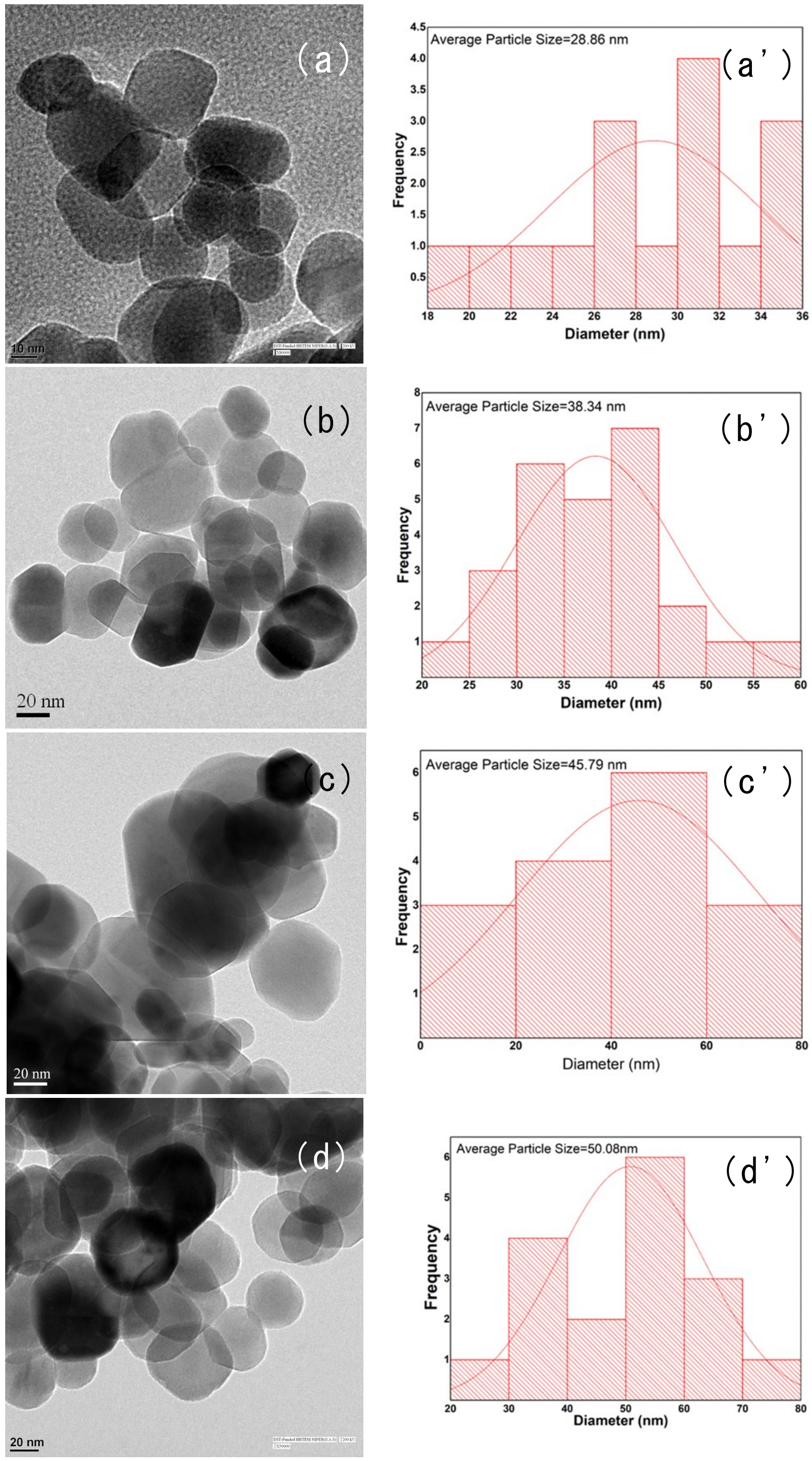

Fig. S4 HRTEM images and the respective particle size distribution (histogram) of (a) fresh and (b) spent $CrOx^{K-SB}$ and that of (c) fresh and (d) spent $Cr_2O_3^{NIT}$ catalysts.

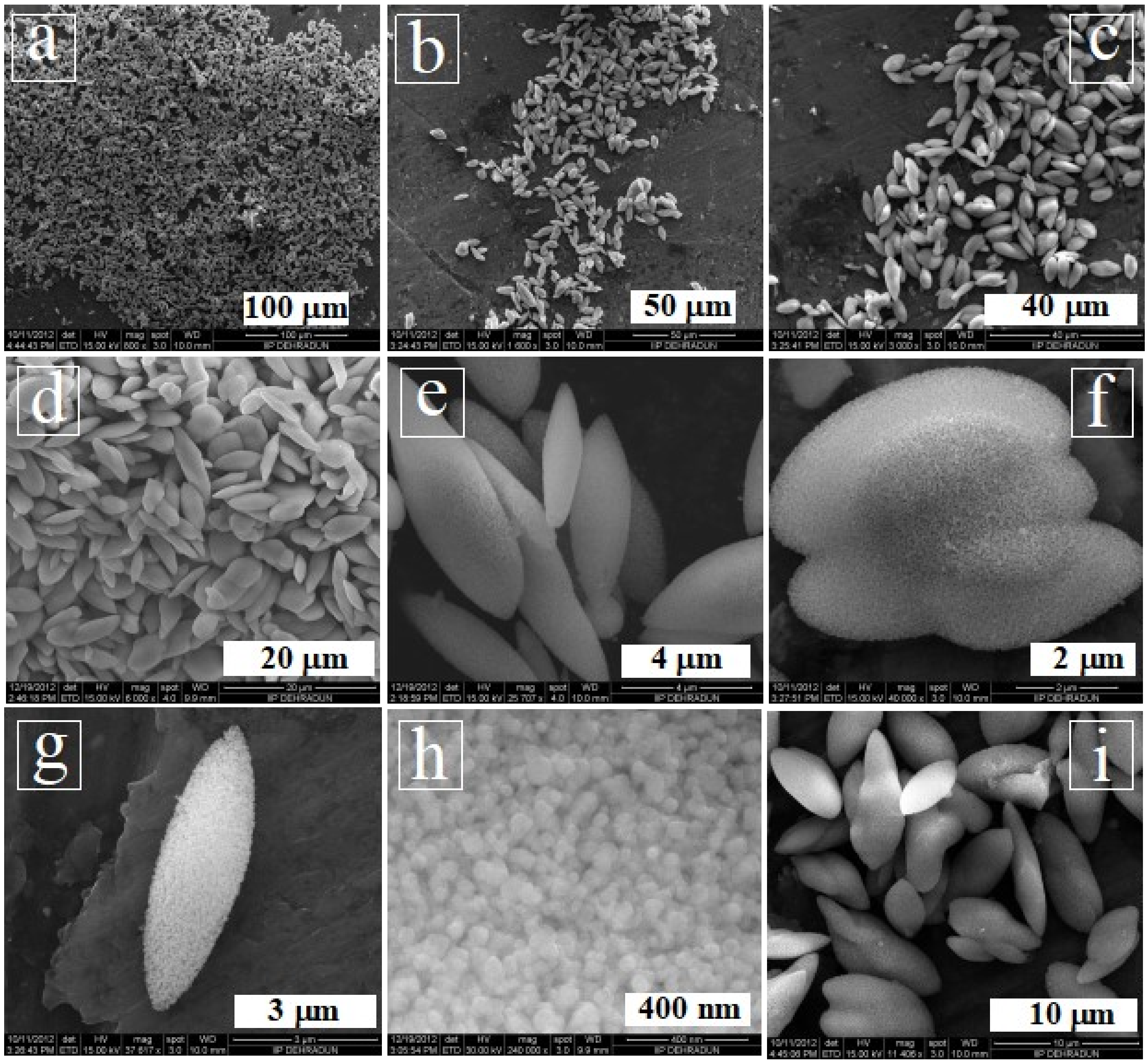

Fig. S5 SEM images of fresh (a)-(h) at ascending resolutions and (i) that of spent $CrOx^{K\text{-}SB}$ catalyst

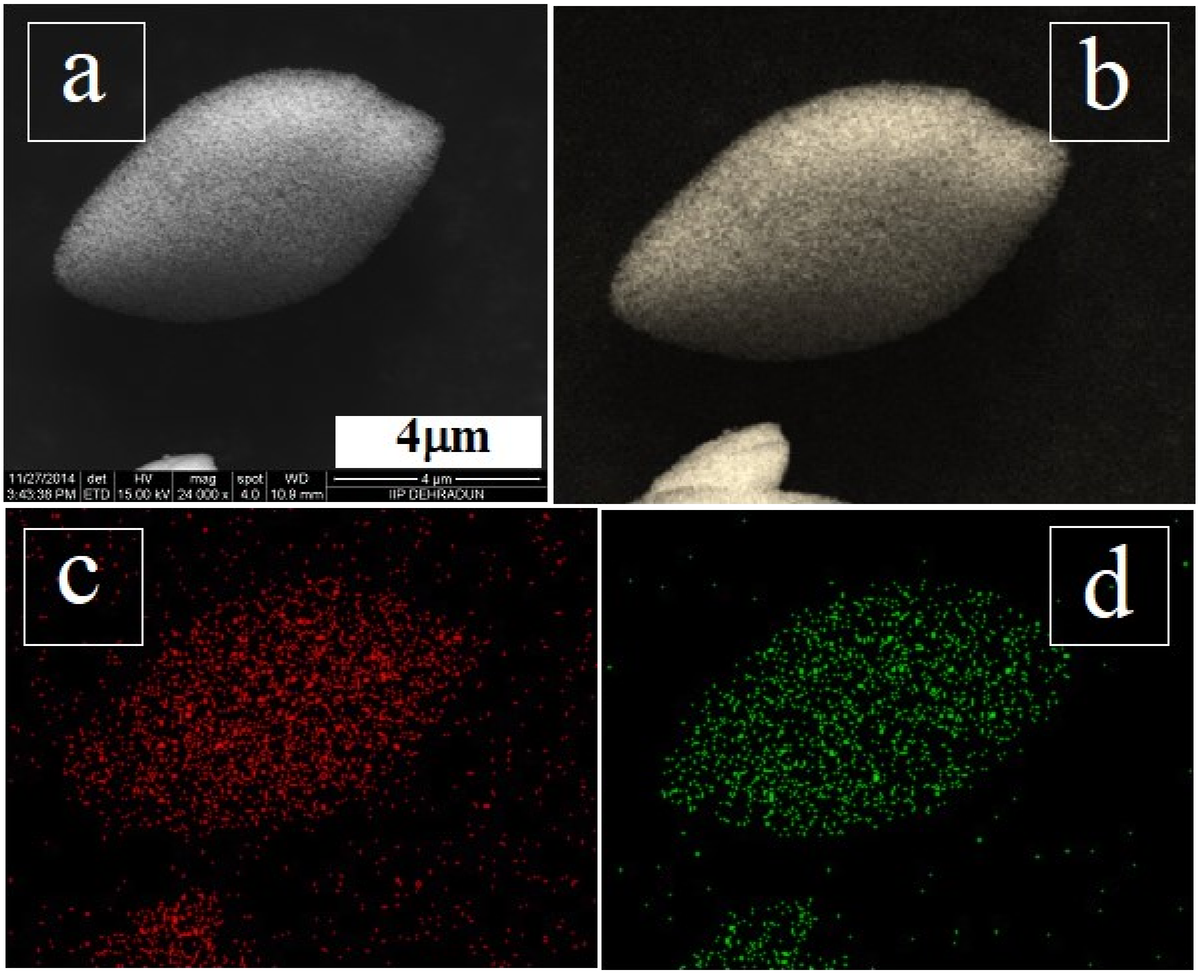

Fig. S6 SEM images (a,b) and SEM-EDX mapping of (c) chromium and (d) oxygen in $CrOx^{K\text{-}SB}$ catalyst

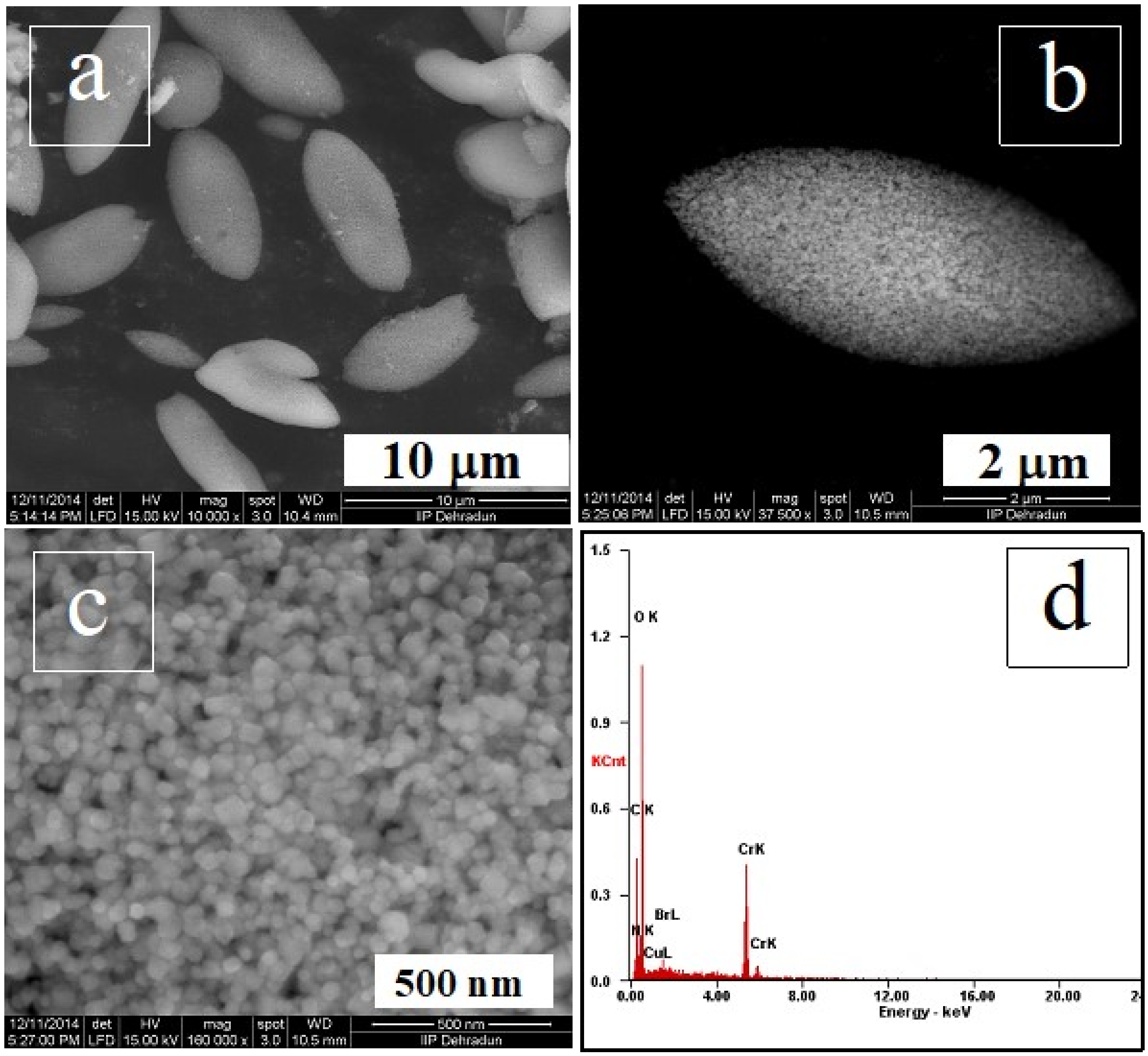

Fig. S7 SEM images (a-c) of uncalcined $CrOx^{K\text{-}SB}$ catalyst and (d) corresponding EDX diagram demonstrating the presence of C and Br as impurities during catalyst synthesis

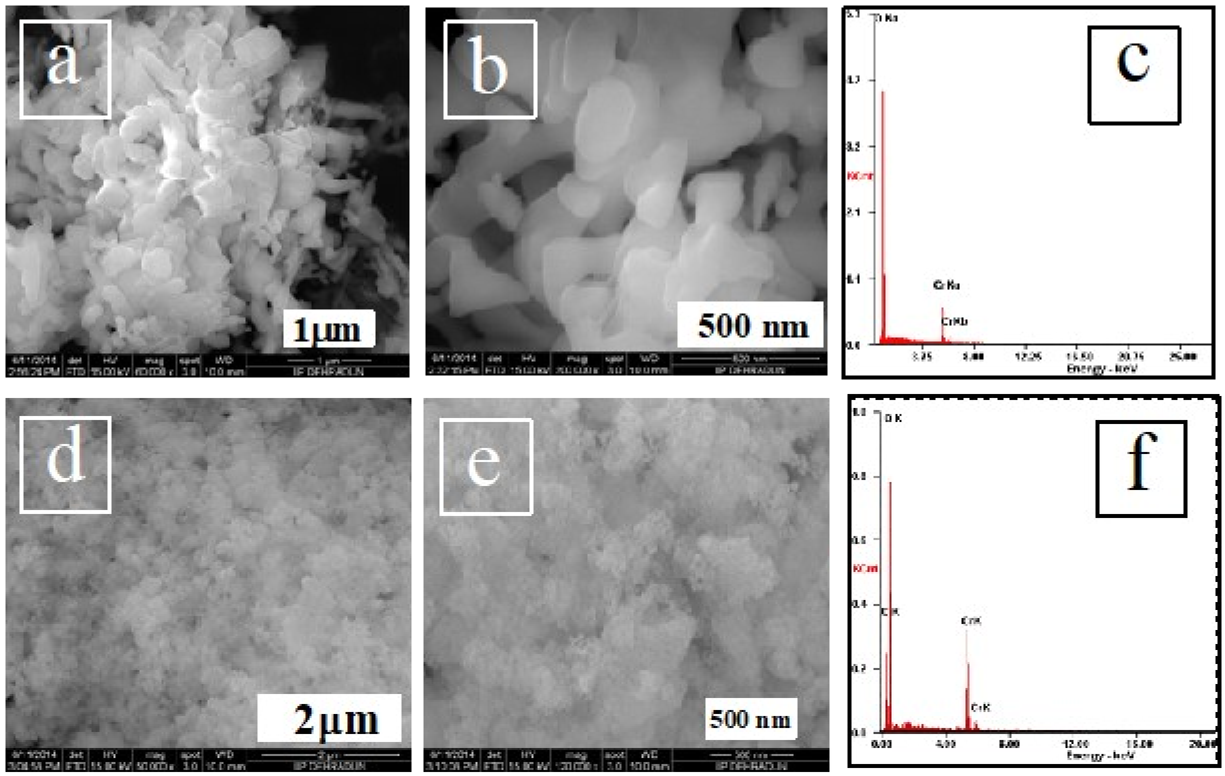

Fig. S8 (a), (b) SEM and (c) SEM-EDAX image of Cr(III) oxide prepared by heating $(NH_4)_2Cr_2O_7$ and (d), (e) SEM and (f) SEM-EDAX image of CTAB-promoted Cr(III) oxide nanoparticles i.e. $Cr_2O_3^{NIT}$ prepared by using Cr $(NO_3)_3$. $9H_2O$.

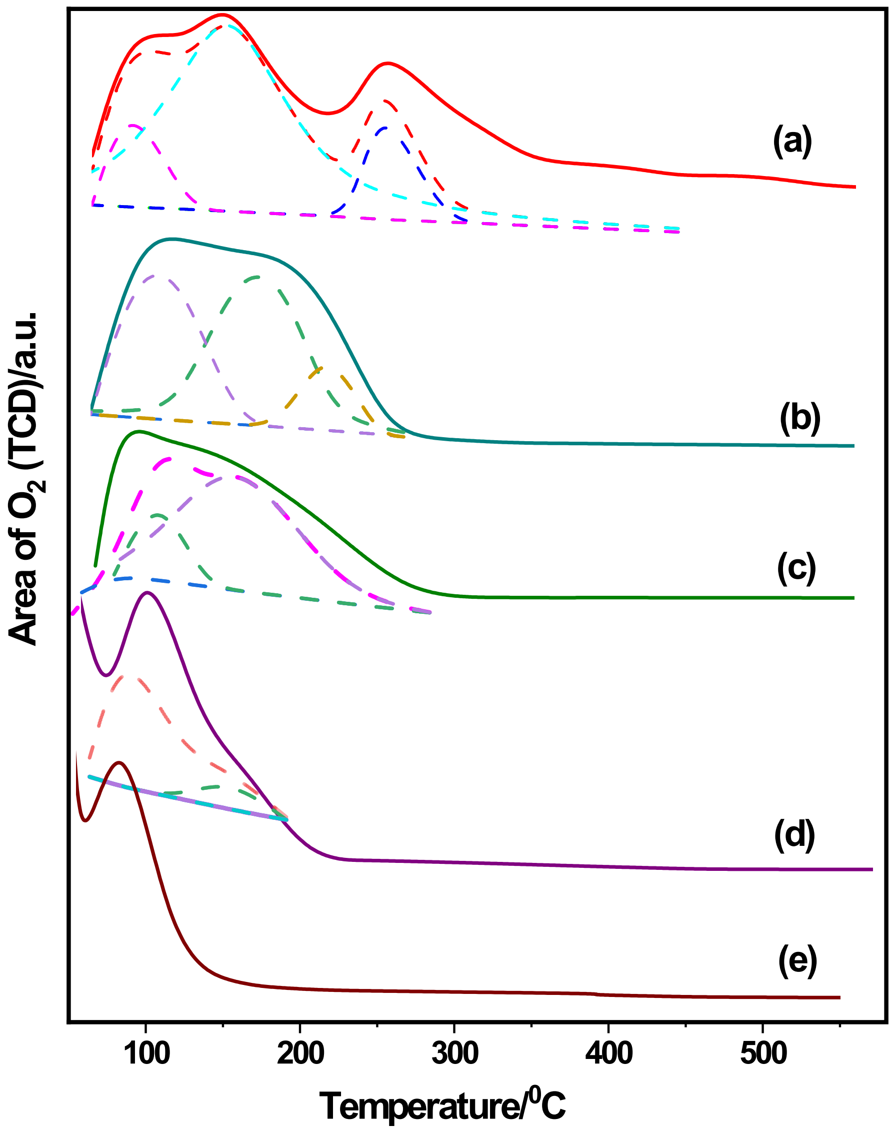

Fig. S9 O_2-TPD plots of (a) $CrO_x^{K\text{-}SB}$, (b) Chromium oxide prepared using (chromic acid + NH_4OH) mixture, followed by drying (CrO_x^{AH}) (c) chromium oxide generated heating ammonium dichromate, (d) commercial Cr(VI) oxide, (d) $Cr_2O_3^{NIT}$ and (e) commercial Cr_2O_3

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