

## Electronic Supplementary data

### Liquid-free alkaline gel filled reference electrode based on Cr<sub>2</sub>O<sub>3</sub> spheres

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## Preparation of Cr<sub>2</sub>O<sub>3</sub> spheres

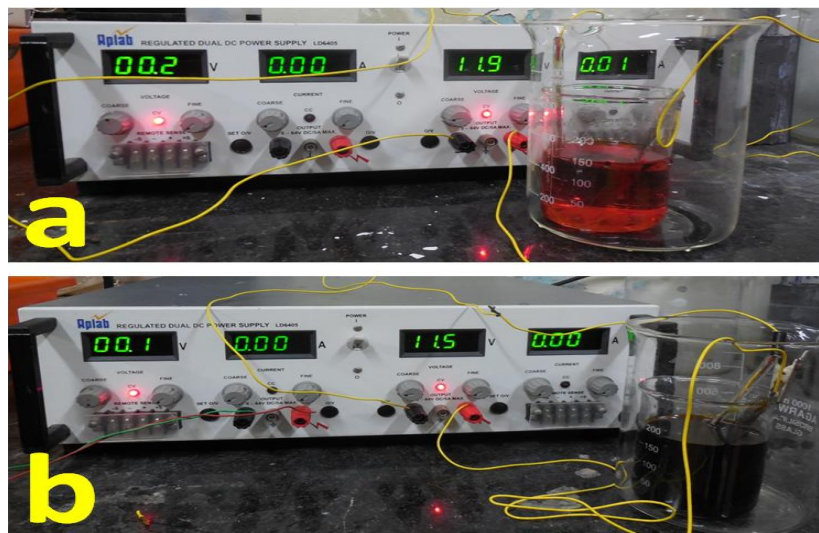


Fig. S1 – Electrochemical reduction of potassium chromate solution in the presence of concentrated sulphuric acid at (a) initial stage (b) final stage.

## Fabrication of PVA-KOH gel filled Cr<sub>2</sub>O<sub>3</sub> electrode

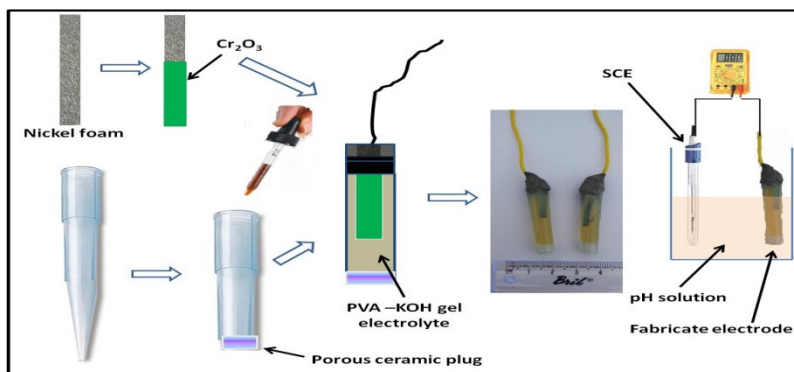


Fig. S2 – Schematic fabrication of Cr<sub>2</sub>O<sub>3</sub> PVA-KOH gel reference electrode and potential measurements.

Figure S2 shows the schematic fabrication of Cr<sub>2</sub>O<sub>3</sub> based PVA gel filled electrode. Nickel foam was used as substrate. Prior to coating of Cr<sub>2</sub>O<sub>3</sub>, the nickel foam was cleaned with plenty of water followed by ethanol and acetone. Finally foam was dried in hot air oven at 60 °C for 3 hours. Cr<sub>2</sub>O<sub>3</sub> and poly(vinylidene) fluoride binder were mixed in the ratio 90:10 wt/wt using *n*-Methyl pyrrolidine solvent and the slurry was coated on the nickel foam substrate and then foam was dried in oven at 60 °C. Sensing material was kept around 50 mg on both sides of the substrate. The PVA-KOH polymer electrolyte was prepared as follows: 5 g of PVA and KOH was mixed with 50 mL of water and the mixture was heated under constant stirring until a homogenous viscous solution was appeared. The resulting homogenous solution was filled in a porous bottom sealed micropipette followed with Cr<sub>2</sub>O<sub>3</sub> coated nickel foam was inserted in to a container. Finally, the top portion was sealed with epoxy resin and electrical wire lead was taken from the top end. The potential stability and performance of fabricated sensor were measured in various pH solutions in two electrode setup with respect to SCE.

Synthetic concrete pore solution: 0.1 M KOH, 0.1 M NaOH and 0.01 M of Ca(OH)<sub>2</sub> aqueous solution and its pH around 13.

### SEM morphological analysis

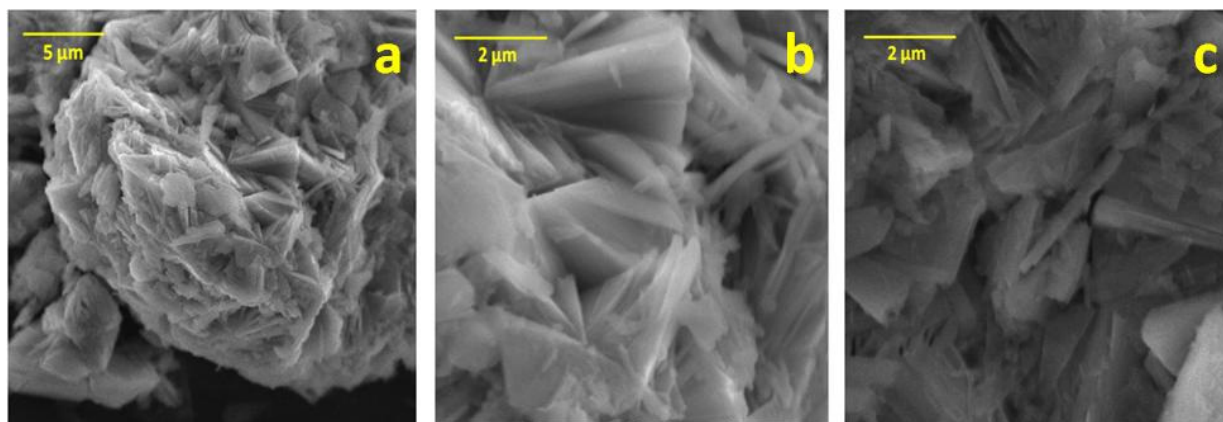


Fig. S3 – (a-c) SEM micrographs illustrating the morphology of  $\text{Cr}_2\text{O}_3$  precursor.

### Elemental analysis by EDAX spectrum

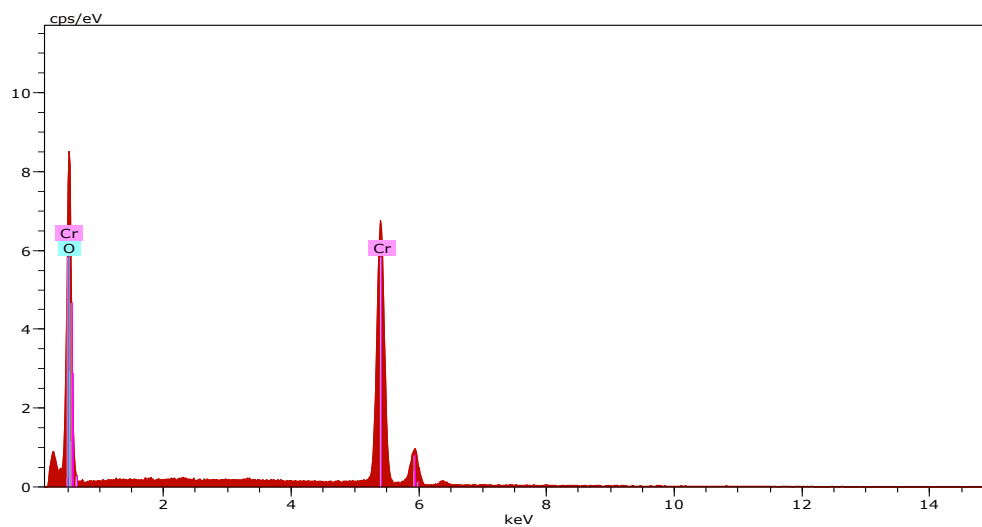


Fig. S4 – Energy dispersive spectrum of  $\text{Cr}_2\text{O}_3$

### Potential reversibility test by cyclic polarization method

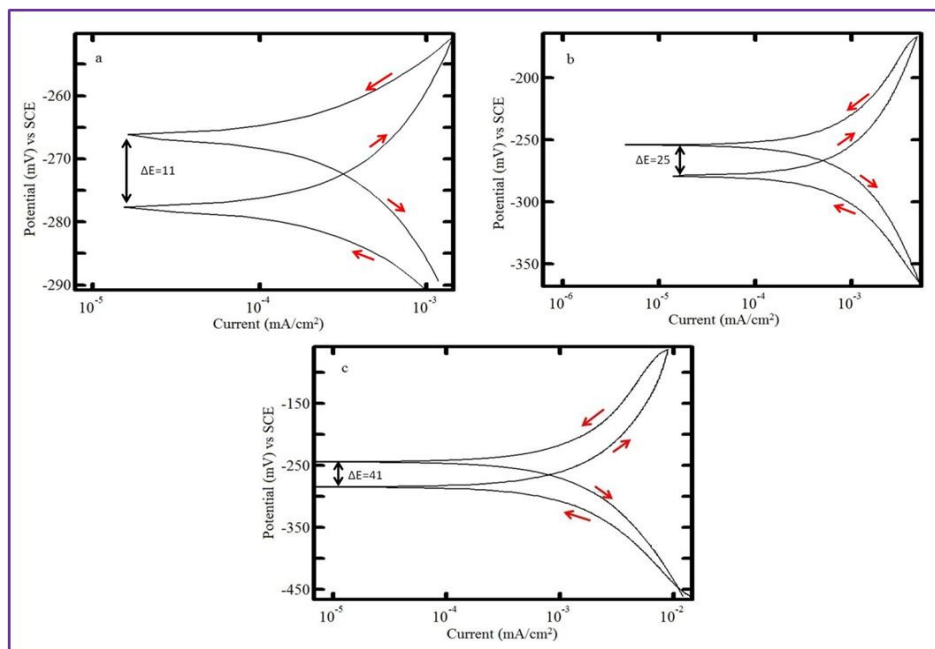


Fig. S5 – Reversibility characteristics of fabricated  $\text{Cr}_2\text{O}_3$  PVA-KOH electrode. [(a)  $\pm 20$  mV, b)  $\pm 100$  mV and c)  $\pm 200$  mV from the open circuit potential in synthetic concrete pore solution].

### Electrochemical impedance studies

Table. 1 shows the derived impedance parameters by circle fit method in synthetic concrete pore solution. It can be seen that; there is less difference when the electrode is stored in high alkaline synthetic concrete pore solution after exposure period of 75 days.

Table. S1 – Electrochemical impedance parameters

Electrode	$R_s$ (ohm.cm <sup>2</sup> )	$R_{ct}$ (ohm.cm <sup>2</sup> )	$C_{dl}$ (F)
Initial	$7.927 \times 10^2$	$2.401 \times 10^4$	$3.277 \times 10^{-4}$
After 75 days	$9.920 \times 10^2$	$2.939 \times 10^4$	$2.301 \times 10^{-4}$

### References

1. Buxbaum G, Pfaff G. Industrial Inorganic Pigments, *Weinheim: Wiley-Vch*, 3rd ed 2005.
2. Zhu JL, Wu SN. Pigment Technology, Beijing: *Chemical Industry Press 2nd ed*, 2002.
3. Li P, Xu HB, Zhang Y, Li ZH, Zheng SL and Bai YL. *Dyes Pigm*, 2009, 80, 287.