Supplementary information

Gas sensing response analysis of p-type mesoporous Chromium Oxide thin films

Vinayak Kamble*, A. M. Umarji
Address: Materials Research Center,
Indian Institute of Science Bangalore,
India 560012
Email: vin.kamble01@gmail.com.
1. I-V characteristics

![I-V characteristics of Au electrodes on Cr$_2$O$_3$ films.](image)

Figure S1. I-V characteristics of Au electrodes on Cr$_2$O$_3$ films.

2. X-ray Diffraction

![Effect of (a) substrate temperature and (b) carrier flow rate on crystallinity in CM films.](image)

Figure S2. Effect of (a) substrate temperature and (b) carrier flow rate on crystallinity in CM films.
3. Raman Spectroscopy

The micro-raman spectroscopy of the as-deposited Cr$_2$O$_3$ films is done in order to characterize the crystallinity and to verify the presence/absence of other impurity phases or residual carbonaceous matter.

![Raman Spectrum](image)

**Fig. S3** The micro-raman spectrum of as-deposited film showing one $A_{1g}$ and three $E_g$ modes of rhombohedral Cr$_2$O$_3$.

The Raman spectrum is divided into two regions and enlarged. The first region (lower wave numbers) reveals 4 peaks ($A_{1g} + 3E_g$ modes) which are attributed to corundum structure of Cr$_2$O$_3$. No peaks were found pertaining to CrO$_2$ or CrO$_3$ which marks their absence. Further the 2$^{nd}$ region highlights the absence of carbonaceous matter.
Note:
Owing to the diverse nature of experimental setups (static or dynamic) it is difficult to compare the gas sensing properties of chromium oxide sensors developed by various research groups. However, following comparison has been made based on available literature.

Table S1. Comparison between the characteristics of state of the art Cr$_2$O$_3$ based sensors

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Microstructure</th>
<th>Type of sensing experiment</th>
<th>Test gas and concentration</th>
<th>Typical sensitivity value</th>
<th>Characteristics</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ordered Mesoporous Cr$_2$O$_3$ (Thick films)</td>
<td>Static measurement (Micro syringe injection)</td>
<td>Ethanol 1000 ppm</td>
<td>$R_g/R_a = ~13$ At T =150 °C</td>
<td>No selectivity</td>
<td>Chem. Commun., 2012, <strong>48</strong>, 865–867</td>
</tr>
<tr>
<td>2.</td>
<td>Porous Cr$_2$O$_3$ nanotubes (Thick films)</td>
<td>Static measurement (Micro syringe injection)</td>
<td>Ethanol 800 ppm</td>
<td>$\Delta R/R_a = ~2$</td>
<td>High operating temperature $&gt;400$ °C And slower response at temperature $&lt;400$ °C</td>
<td>Nanotechnology <strong>19</strong> (2008) 035504</td>
</tr>
<tr>
<td>3.</td>
<td>Cr$_2$O$_3$ thick films</td>
<td>Static measurement (Micro syringe injection)</td>
<td>Ethanol 700 ppm</td>
<td>$R_g/R_a = ~30$</td>
<td>Slower response times ($\sim 30$ s) and recovery time ($\sim 150$ s)</td>
<td>Sensors and Actuators B <strong>158</strong> (2011) 259–264</td>
</tr>
<tr>
<td>5.</td>
<td>Porous Cr$_2$O$_3$ thin films (This work)</td>
<td>Dynamic flow based method</td>
<td>Ethanol 1000 ppm</td>
<td>$\Delta R/R_a = ~15$</td>
<td>Fairly good response and selective to ethanol.</td>
<td>This work</td>
</tr>
</tbody>
</table>