

# Screen-printed copper oxide based films for pH sensing applications

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Screen printed pH electrodes are good alternative to the traditional glass pH electrodes which are bulky, fragile and require wet storage. Materials such as  $\text{RuO}_2$  and  $\text{IrO}_2$  are popular for their good pH sensing properties but they are also expensive and quite rarely available in the earth's crust. Therefore, it is vital to find materials which are abundant in the earth's environment and at the same time exhibit excellent pH sensing properties.

In this study, two copper oxides ( $\text{Cu}_2\text{O}$  and  $\text{CuO}$ ) were used to prepare thick film pastes, which were subsequently screen printed on alumina substrates and sintered at  $850^\circ\text{C}$  and  $900^\circ\text{C}$ . Potentiometric measurements revealed that the electrodes made of the  $\text{CuO}$ -based paste and sintered at both temperatures showed excellent sensitivity (electromotive force *emf* versus pH) towards pH change (Fig. 1a), fast response time, low drift and hysteresis, long term stability and low interference from other ions. The X-ray diffraction (Fig. 1b) analysis revealed that after sintering the oxidation state of copper in the  $\text{Cu}_2\text{O}$  screen printed film changes from  $1+$  to  $2+$ , thereby showing that even though the starting materials were different, the resultant phase composition of the sintered thick films was the same. However, the electrodes made of the  $\text{Cu}_2\text{O}$ -based paste had poorer sensing properties probably due to more amorphous structure of  $\text{Cu}_2\text{O}$  than  $\text{CuO}$  [1] which leads to restricted diffusion of the ions in the sensing layer.

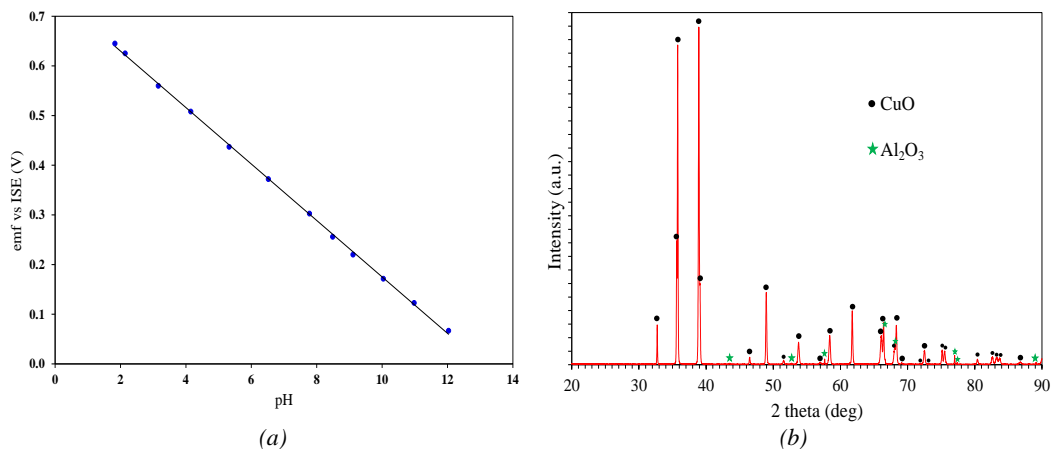


Fig 1. (a) *emf* vs pH for  $\text{CuO}$  electrode and (b) X-ray diffractogram of  $\text{Cu}_2\text{O}$  layer screen printed on alumina substrate sintered at  $850^\circ\text{C}$ .

Therefore,  $\text{CuO}$  as a starting material allows for relatively low sintering temperature, obtaining sensitivity comparable to the currently popular metal oxides as well as glass pH electrodes and is a good candidate for screen printed pH electrodes in water quality monitoring applications.

[1] K. Tang, X. Wang, W. Yan, J. Yu, R. Xu, *J. Membr. Sci.*, 286, 1-2, (2006).

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