UNIVERSITI TEKNOLOGI MARA

OXYGEN SENSING BEHAVIORS OF $Eu(Ba_{1-x}Pr_x)_2Cu_3O_{7-\delta}$ AND $Eu_{1-y}Pr_yBa_2Cu_3O_{7-\delta}$ CERAMIC RODS WITH HOT-SPOT

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MSc

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of the requirements for the degree of
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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 24th December 2014 to conduct the final examination of Mohd Ikhwan Bin Adzam on his Master of Science thesis entitled "Oxygen sensing behaviors of $Eu(Ba_{1-x}Pr_x)_2Cu_3O_{7-\delta}$ and $Eu_{1-y}Pr_yBa_2Cu_3O_{7-\delta}$ ceramic rods with hot-spot." in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The panel of Examiners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

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I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This research has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research

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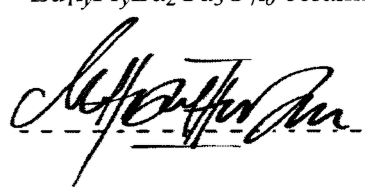
Signature of Student	:	
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ABSTRACT

Oxygen sensing properties of Pr doped $EuBa_2Cu_3O_{7-\delta}$ short ceramic rods were investigated. The $Eu(Ba_{1-x}Pr_x)_2Cu_3O_{7-\delta}$ (x=0, 0.05, 0.25 and x=0.40) and $Eu_{1-y}Pr_yBa_2Cu_3O_{7-\delta}$ (y=0, 0.05, 0.10, 0.15 and y=0.20) rods with dimensions of around 13mm x 0.65mm x 0.65mm and 13mm x 1.48mm x 1.48mm, respectively were prepared by standard solid state reaction method. For the first series of this study, $Eu(Ba_{1-x}Pr_x)_2Cu_3O_{7-\delta}$ rods were prepared to investigate the influences of changes in structure and the expected decrease in average Cu valence on oxygen sensing properties. X-ray powder diffraction analysis showed that orthorhombicity of the structure reduces with increasing Pr concentration. After the hot-spot became visible, samples x=0 and x=0.05 showed a sudden drop in current before remaining constant with increasing voltage. This is suggested to be due to steep increase in resistivity caused by the sudden increase in temperature of the hot-spot together with the structural changes that lead to reduction in oxygen content. However, for the x=0.25 and x=0.4 rods the output current shows no sudden drop. The results also showed that the reduced magnitude of the output current with increasing Pr could be attributed to the reduction in intrinsic hole concentration. The output current for all samples showed strong dependence on pO_2. Although the sensitivity of the output current to pO_2 between 50% pO_2 and 100% pO_2 reduces with increasing x, the stability and repeatability of the output current seems to improve. Also, while Pr doped $Eu(Ba_{1-x}Pr_x)_2Cu_3O_{7-\delta}$ reduces the magnitude of the output current, it produces better response time towards different pO_2. On the other hand, $Eu_{1-y}Pr_yBa_2Cu_3O_{7-\delta}$ rods were prepared and X-Ray powder diffraction analysis showed that, Pr doped $Eu_{1-y}Pr_yBa_2Cu_3O_{7-\delta}$ were all orthorhombic in unit cell structure with reduction in orthorhombicity upon doping. The *I-V* curve showed a relatively constant output current after the appearance of hot-spot. Meanwhile, the magnitude of the constant output current was observed to be decreasing with increasing Pr doping which indicates possible reduction in intrinsic hole concentration. In addition, the output current for rods with y=0.0, 0.05 and 0.10 showed a sudden drop upon the appearance of hot-spot, due to the sudden increase in hot-spot temperature, before becoming slightly constant. However, the sudden drop of output current upon appearance of hot-spot was not observed when Pr was increased to y=0.15 and 0.20 but instead a stable output current was observed. Interestingly, the output current after appearance of hot-spot for all rods showed strong dependency on ambient oxygen concentration. The sensitivity for each rod however, reduces with increasing ambient oxygen concentration. Pr doped $Eu_{1-y}Pr_yBa_2Cu_3O_{7-\delta}$ seems to prevent the sensitivity from dropping to almost zero as was the case of $Eu(Ba_{1-y}Pr_y)_2Cu_3O_{7-\delta}$ rods due to existence of Cu-O chains in the orthorhombic structure. Pr doping (for y=0.10) has also resulted in better oxygen absorption response time and better output current stability compared to other rods.