UNIVERSITI TEKNOLOGI MARA

EFFECT OF DIVALENT Ca^{2+} AND Mg^{2+} SUBSTITUTIONS ON OXYGEN SENSING PROPERTIES OF HOT-SPOT BASED $(Eu_{1-x}Ca_x)Ba_2Cu_3O_{7-\delta}$ AND $(Eu_{1-y}Mg_y)Ba_2Cu_3O_{7-\delta}$ CERAMIC RODS

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of the requirements for the degree of
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AUTHOR'S DECLARATION

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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ABSTRACT

This thesis describes the effects of Ca^{2+} and Mg^{2+} substitution on oxygen sensing properties of hot spot-based Eu123 rods. $Eu_{1-x}Ca_xBa_2Cu_3O_{7-\delta}$ (x=0-0.5) and $Eu_{1-y}Mg_yBa_2Cu_3O_{7-\delta}$ (y=0-0.5) ceramics were synthesized from oxide powders using the standard solid state method and fabricated into short rods. For unsubstituted x=0 rod the *I-V* behavior after formation of hot spot showed decreasing output current with increasing voltage under different pO_2 concentration. However, for Ca-substituted rods, after appearance of a visible hot spot, a constant current plateau in the *I-V* curve was formed. The output current response of the rod in periodically changing pO_2 between 20% and 100% showed improved stability and reproducibility for x=0.1, x=0.4 and x=0.5 compared to x=0.2 and x=0.3. Improved oxygen absorption and desorption time was observed for $Eu_{1-x}Ca_xBa_2Cu_3O_{7-\delta}$ (x=0.1, 0.4, 0.5) compared to the unsubstituted rod. Among the Ca-substituted samples, the x=0.4 rod produces oxygen absorption and desorption time of 64.5 s and 93.1 s, respectively. On the other hand, for Mg-substituted rods *I-V* behavior after formation of hot spot showed a negative slope. Faster absorption time of 3.0 s and desorption time of 6.9 s were observed for y=0.4 compared to other Mg-substituted rods. The improved output current stability, reproducibility and response time is suggested to be due to changes in oxygen activation energy and increased hole concentration as a result of Ca^{2+}/Mg^{2+}substitutions. The Mg-substituted rods showed better performance compared to Ca-substituted rods possibly due to higher porosity and vacancy concentration. However, the difference in PTCR behavior for the same substitution level between Ca-substituted and Mg-substituted rods is suggested to be due to the differences in ionic size of Ca^{2+} andMg^{2+} which caused differences in reduction of oxygen activation energy. For the unsubstituted and Mg-substituted series, the relation between output current and pO_2 shows a good agreement with the ideal case of oxygen excess material, derived from the mass action law.

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