EXECUTIVE SUMMARY

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MINOR RESEARCH PROJECT REPORT
ON

"SYNTHESIS AND CHARACTERIZATION OF POLYCRYSTALLINE NANO FERRITES BASED GAS SENSORS"

submitted by
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SUBMITTED TO,

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Executive Summary

The behavior of $Mg_{1-x} Zn_x Fe_2O_4$ polycrystalline nano ferrites is studied for for gas sensing applications. The $Mg_{1-x} Zn_x Fe_2O_4$(with x = 0.0, 0.2, 0.4, 0.6, 0.8and 1.0) nanoferrites are prepared by co-precipitation method.This method is used to prepare the ferrites because this method has several advantages such as high production rate, small particle size, lower synthesis temperature, lower cost of production, homogeneity ,high purity and small particle size.

These ferrites are characterized by XRD and SEM techniques.The x-ray diffraction pattern shows well defined peaks which proves the formation of crystalline solid. The appearance of (311) peak at two theta value of about 35 degree confirms the formation of single phase cubic spinel structure of ferrites .

The SEM microphotographs of $Mg_{1-X} Zn_X Fe_2O_4$ mixed ferrite powder surface are obtained. All the samples have grain size much smaller than those for ferrite prepared by ceramic method .The grain size of these ferrites initially decreases with increase in zinc concentration from x=0 to x= 0.6 and then increases for x= 0.8 and x= 1.0. The average grain size of these samples varies from 71 nm to 300nm. Smaller the grain size, more is the surface area exposed to test gas and hence higher is the sensitivity. Because sensing mechanism of the reducing gases consists of the change of the electrical resistivity which results from chemical reaction between the gas molecules and adsorbed oxygen on the ferrite sensor surface. The adsorption of the gas on the surface depends on type of the test gas, and the sensor materials which again decides the sensitivity and response time.

It is observed that, the sensitivity of ferrite material increases with increase in temperature ,reaches maximum at optimum temperature and then decreases at higher temperature . This type of variation is observed for all the three test gases LPG, chlorine and ethanol and for all the samples of Mg1-xZnxFe2O4 with x= 0 ,.2,.4,.6,.8,1.0 .This variation is attributed to the cause that at lower temperature values, the gas response is limited by the low rate of chemical reaction, but at higher temperature values the higher rate of diffusion of gas molecules reduce the gas response. There is temperature called optimum temperature at which the rate of chemical reaction and rate of diffusion of gas molecules becomes equal. Hence the equilibrium is reached at that temperature due to which the sensor shows maximum sensitivity response. In the present investigation, for every gas there is specific temperature at which sensor sensitivity attains its peak value. All the samples are found to show maximum sensitivity at about 300^0C.

The response and recovery characteristics of Mg1-xZnxFe2O4 (with x= 0, 0.2 , 0.4 , 0.6, 0.8 and 1.0) are observed at operating temperature of 300^0C to LPG, chlorine and ethanol . The response and recovery time for this sensor is almost same for LPG and chlorine while it is higher for ethanol. The shorter response of this sensor to these gases is probably due to its higher porosity and lower grain saze .

Due to this short response and recovery times, Mg1-xZn x Fe2O4 material should be potential candidate for the fabrication of LPG , chlorine and to some extent ethenol gas sensors.