# SYNTHESIS OF SMFEO$_3$ PEROVSKITE OXIDE BY SOL-GEL METHOD

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**ABSTRACT**
**$SmFeO_3$ perovskite oxide was prepared by sol-gel method using citric acid and calcined at $850^0$ C for 4 hours. The sample was characterized by X-ray diffractrometry, Scanning Electron microscopy and EDAX. The prepared sample had single phase perovskite structure. The lattice constant, unit cell volume and average grain size were calculated using XRD data. The surface morphology was studied from SEM images of the sample.**
**Keywords: $SmFeO_3$, perovskite, sol-gel method**

## I. INTRODUCTION

Presently environmental pollution has become a serious problem for human being. The hazardous gases emitting from auto and industrial exhaust are continuously contaminating the air quality. Therefore detection, measurement and control on these gases are strongly demanded all over the world. Variety of sensing techniques has been used to detect such harmful gases. Among them, scientists have shown a great practical interest in solid state metal oxide gas sensor. Different semiconducting gas sensing materials including complex materials have been investigated for ethanol, benzene, $NO_2$ and VOCs. However, their gas sensing properties such as sensitivity, selectivity and operating conditions are still unsatisfactory

Meanwhile, perovskite-type oxides were reported to have wide range of applications including gas sensors [1-4],solid oxide fuel cell[5], and catalysis[6].Among various perovskite oxides, $SmFeO_3$ has shown great technological versatility due to its variable physical properties for gas sensing applications. $SmFeO_3$ is perovskite type oxide with general formula $ABO_3$ (A: rare earth, B: transition metal) and has orthoferrite phase. Being p-type semiconducting material, its resistance decreases with the adsorption of oxidizing gases like $O_3$ ,$NO_2$ ,ethanol and increases with exposure to reducing gases like CO and $H_2$. So far, use of $SmFeO_3$ based semiconductor sensor is limited to only oxidizing gases due to its lower electrical conductivity and reduction stability for reducing gases [7-8]. Electrical conductivity and reduction stability is strongly affected by the nature of both the A-site cation and the B-site cation [9].A bigger A-site cation provides greater reduction stability whereas doping at B-site improves the electrical conductivity. It was reported that doping of Ce at Sm site in $SmFeO_3$ enhances the reduction stability and results in new n-type semiconducting material [10].Further doping at Fe site by Co, Ni and Mg has been reported for better conductivity and sensitivity [11-13]. Thus, $ABO_3$ type perovskite structure of $SmFeO_3$ makes it possible to obtain desirable sensitivity and selectivity by partial substitution at A-site and/or the B-site [14-19].

Various methods like sol-gel method, co-precipitation method, hydrothermal method have been studied for the synthesis of $SmFeO_3$ perovskite [20-23]. Many reports showed that $SmFeO_3$ perovskite powder prepared through a sol-gel method in citric system presented high sensitivity and selectivity [].In present paper, SmFeO3 perovskite oxide was prepared by sol-gel method and its structure and morphology have been investigated.

## II. METHODS AND MATERIAL

The fine powder of $SmFeO_3$ perovskite oxide was prepared by a sol-gel method. Chemicals used in the synthesis are samarium nitrate $Sm(NO_3)_3.6H_2O$, iron nitrate $Fe(NO_3)_3.9H_2O$ and citric acid monohydrate. Initially stoichiometric amounts of samarium nitrate, iron nitrate and citric acid monohydrate were mixed in the ratio 1:1:1 and grounded in Agate mortar for 30 minutes. Then ethylene glycol was added to the mixture under constant stirring at $75^0$C for 2 hours to obtain a sole which was then dried into a gel. The gel was dried in oven at $110^0$C for 12 hours and allowed to cool naturally. Finally, sample was calcined at $800^0$C for 4 hours.

## III. RESULTS AND DISCUSSION

Fig. 1 depicts X-ray diffraction pattern of $SmFeO_3$ powder. The comparison of these X-ray diffraction pattern with the standard JCPDS card number 39-1490 conforms that the prepared powder has perovskite phase with orthorhombic symmetry and belong to space group Pnma(62). Importantly single phase perovskite structure was observed without presence of secondary phases.

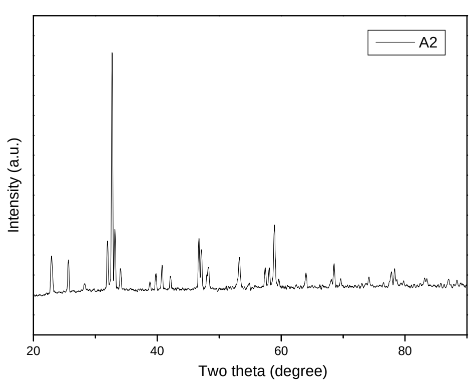


**Figure 1 XRD pattern of $SmFeO_3$ powder prepared by sol-gel method**

The lattice parameters of the sample were calculated from XRD pattern based on the formula d= $(h^2/a^2+k^2/b^2+l^2/c^2)^{-1/2}$ , where (h, k, l) are indices of crystallographic planes, d is the interplanar distance and (a, b, c) are lattice parameters. For SmFeO3 powder prepared by sol-gel method, lattice constants a, b and c is 5.604 $A^0$, 7.704 $A^0$ and 5.397 $A^0$ respectively. By means of Scherer's formula, D= $0.89\lambda/\beta\cos\theta$ where $\lambda$ is wavelength of X-ray, $\theta$ is diffraction angle and $\beta$ is true half-peak width, the crystalline particle size was estimated and is found to be 50.08 nm. The volume of unit cell of prepared sample is 233.05 $A^{03}$

Fig 2 represents the SEM images of the sample to study its surface morphology. The micrography indicates that the morphology of the particle is irregular because sintered material being crushed until powder form is obtained. The average size of particle is 100 nm.

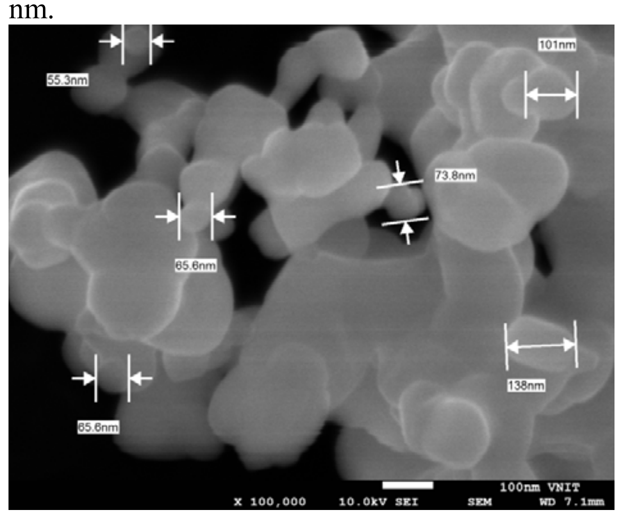


**Figure 2: SEM of $SmFeO_3$ powder prepared by sol-gel method**

## IV. CONCLUSIONS

The results demonstrated here depict the possibility of synthesis of fine powder of $SmFeO_3$ perovskite oxide by sol-gel method in citrate system. XRD pattern confirms the presence of single phase orthorhombic perovskite structure.SEM analysis showed that material in powder form presented irregular morphology and different particle sizes.

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