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Synthesis of pure $BiFeO_3$ and doped $BiFeO_3$ powder samples using glycine fuel through solution combustion method (SCM)

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Abstract: The present article describes the preparation of pure $BiFeO_3$ and doped $BiFeO_3$ samples such as $Bi_{0.95}Ca_{0.05}FeO_3$, $Bi_{0.9}Ca_{0.1}FeO_3$, $Bi_{0.9}Ba_{0.1}FeO_3$, $Bi_{0.8}Ba_{0.2}FeO_3$, $BiFe_{0.95}Co_{0.05}O_3$ and $BiFe_{0.9}Co_{0.1}O_3$ powder samples through solution combustion method. The produced powder samples were grinded in an acetone media and calcined at different temperatures.

Keywords: $BiFeO_3$, Ca, Ba, Co substituted $BiFeO_3$ powders, SCM, Applications

I. INTRODUCTION

As the ferroelectric and ferromagnetic phases combined in a multiferroic materials, so these materials have gained popularity in recent years [1]. The $BiFeO_3$ multiferroic materials have Curie temperature T_C = 1103 K and a Neel temperature T_N = 643 K [2]. The multiferroic materials have number of applications such as spintronics, sensors [3], FeRAM, photovoltaics [4], phototransducer devices [5], electrooptic [6], high frequency filter [7], actuators [8], nano-electronics [9], spintronics [10] and microwave devices [11].

The present article describes the formulation of undoped $BiFeO_3$ and doped samples such as $Bi_{0.95}Ca_{0.05}FeO_3$, $Bi_{0.9}Ca_{0.1}FeO_3$, $Bi_{0.9}Ba_{0.1}FeO_3$, $Bi_{0.8}Ba_{0.2}FeO_3$, $BiFe_{0.95}Co_{0.05}O_3$ and $BiFe_{0.9}Co_{0.1}O_3$ powder samples using solution combustion method.

II. EXPERIMENTAL PROCEDURE:

1. *SYNTHESIS OF PURE $BiFeO_3$:*

The preparation of $BiFeO_3$ ceramics was carried out using the precursors such as $Bi(NO_3)_3.5H_2O$, $Fe(NO_3)_3.9H_2O$ acts as an oxidizers while glycine (NH_2CH_2COOH) was used as a fuel. In order to prepare the mixture of samples, the oxidizer (O) to fuel (F) ratio was properly calculated using the oxidizing and reducing valences of the metal nitrates and fuel [12].

The bismuth nitrate, ferric nitrate and glycine taken in a stoichiometric quantity were dissolved in a distilled water in a separate beaker after that, these solution were mixed together and placed in a pyrex dish for heating on a gas burner. After continuous heating the water gets evaporated and finally a combustion takes place with formation of $BiFeO_3$ powder. The experimental procedure was reported by Chaudhari et.al. [13]. The powder was grinded in an acetone medium and finally calcined at 350°C for 3 hours in a furnace. The following flowchart indicates the entire experimental procedure.

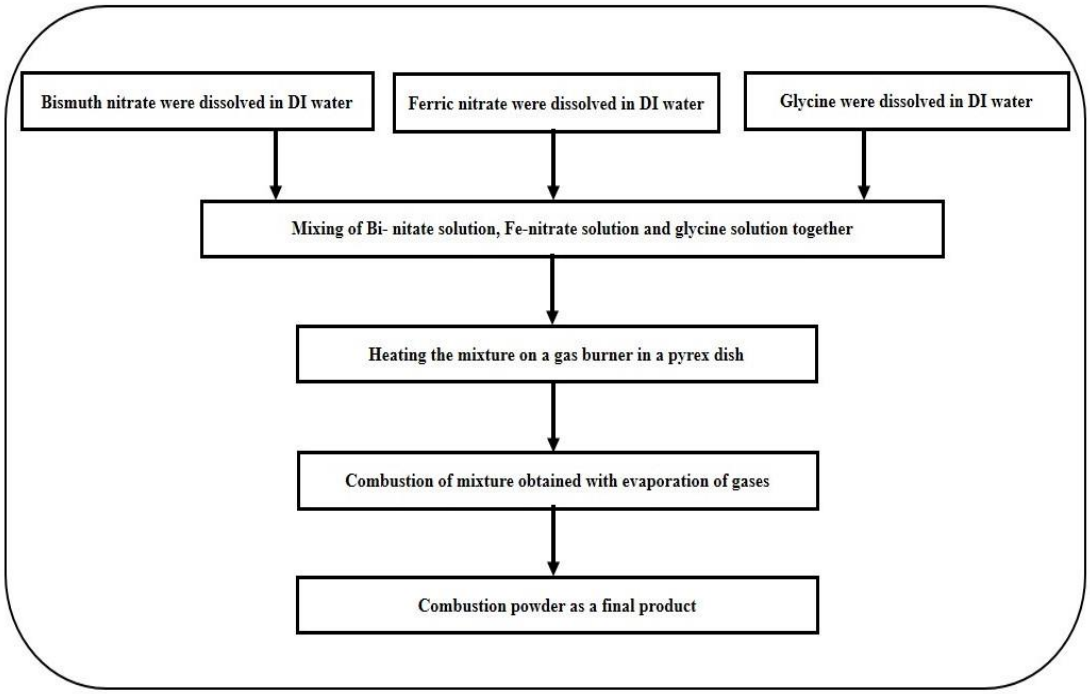

Fig.1. Flowchart of synthesis of $BiFeO_3$ powder samples by SCM

Fig. 2. Synthesized $BiFeO_3$ powder samples.

2. *SYNTHESIS OF $Bi_{1-x}Ca_xFeO_3$ (x = 0.05, 0.1):*

The formulation of $Bi_{0.95}Ca_{0.05}FeO_3$ and $Bi_{0.9}Ca_{0.1}FeO_3$ ceramic samples were carried out using the starting materials such as $Bi(NO_3)_3.5H_2O$, $Fe(NO_3)_3.9H_2O$, $Ca(NO_3)_2.6H_2O$ acts as an oxidizers while glycine (NH_2CH_2COOH) was used as a fuel. In order to prepare the mixture of samples, the oxidizer (O) to fuel (F) ratio was properly calculated using the oxidizing and reducing valences of the metal nitrates and fuel [12].

The bismuth nitrate, ferric nitrate, calcium nitrate and glycine taken in a stoichiometric quantity and were dissolved in a distilled water in a separate beaker after that, all these solutions were mixed together and placed in a pyrex dish for heating on a gas burner. After continuous heating the water gets evaporated and finally a combustion takes place with formation of $Bi_{0.95}Ca_{0.05}FeO_3$ and $Bi_{0.9}Ca_{0.1}FeO_3$ powder samples. These powders were grinded in an acetone medium and finally calcined at 375°C and 400°C for 3 hours in a furnace. The experimental procedure is reported by Chaudhari et.al. [13]. The following flowchart shows the complete experimental procedure.

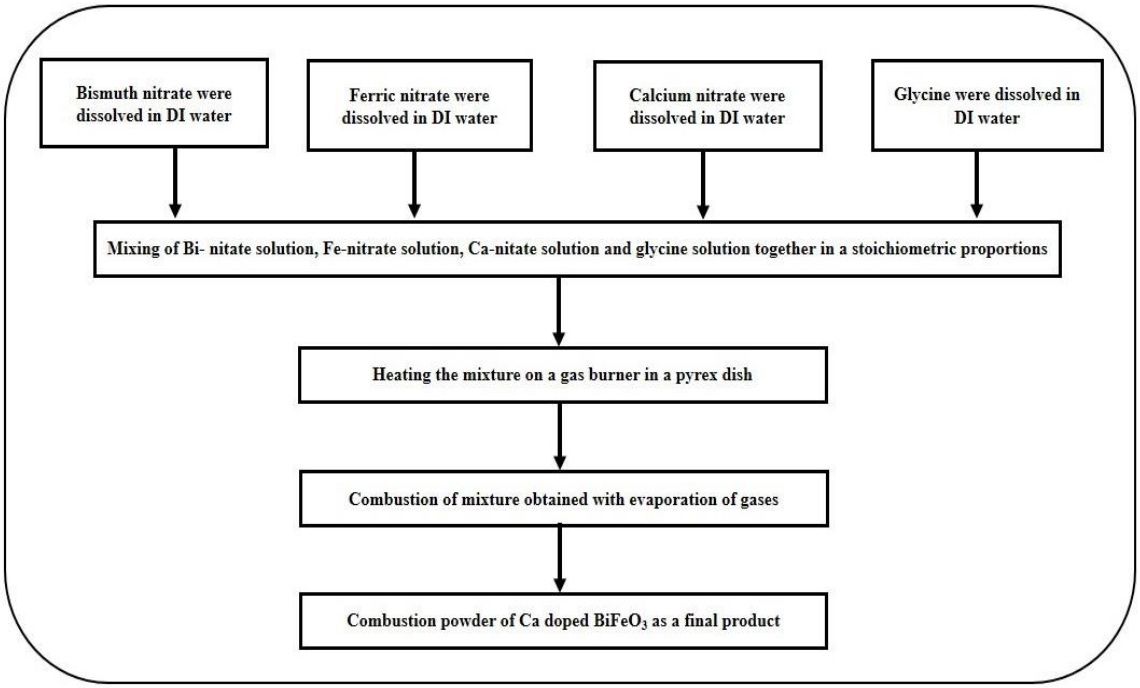

Fig.3. Flowchart of synthesis of Ca doped $BiFeO_3$ powder samples by SCM

Fig.4. Synthesized $Bi_{0.95}Ca_{0.05}FeO_3$ and $Bi_{0.9}Ca_{0.1}FeO_3$ powder samples by SCM

3. SYNTHESIS OF $Bi_{1-x}Ba_xFeO_3$ (x = 0.1, 0.2):

The preparation of $Bi_{0.9}Ba_{0.1}FeO_3$ and $Bi_{0.8}Ba_{0.2}FeO_3$ ceramics were carried out using the precursors such as $Bi(NO_3)_3.5H_2O$, $Fe(NO_3)_3.9H_2O$, $Ba(NO_3)_2$ acts as an oxidizers as well as glycine (NH_2CH_2COOH) was used as a fuel. In order to prepare the mixture of samples, the oxidizer (O) to fuel (F) ratio was properly calculated using the oxidizing and reducing valences of the metal nitrates and fuel [12].

The bismuth nitrate, ferric nitrate, barium nitrate and glycine taken in a stoichiometric extent and were dissolved in a distilled water in a separate beaker after that, these solutions were mixed together and placed in a pyrex dish for heating on a gas burner. After continuous heating the water gets evaporated and finally a combustion takes place with formation of $Bi_{0.9}Ba_{0.1}FeO_3$ and $Bi_{0.8}Ba_{0.2}FeO_3$ powders. The experimental procedure is reported by Chaudhari et.al. [13]. These powder were grinded in an acetone medium and calcined at 425°C and 450°C for 5 hours in a furnace. The following flowchart represents the full experimental procedure.

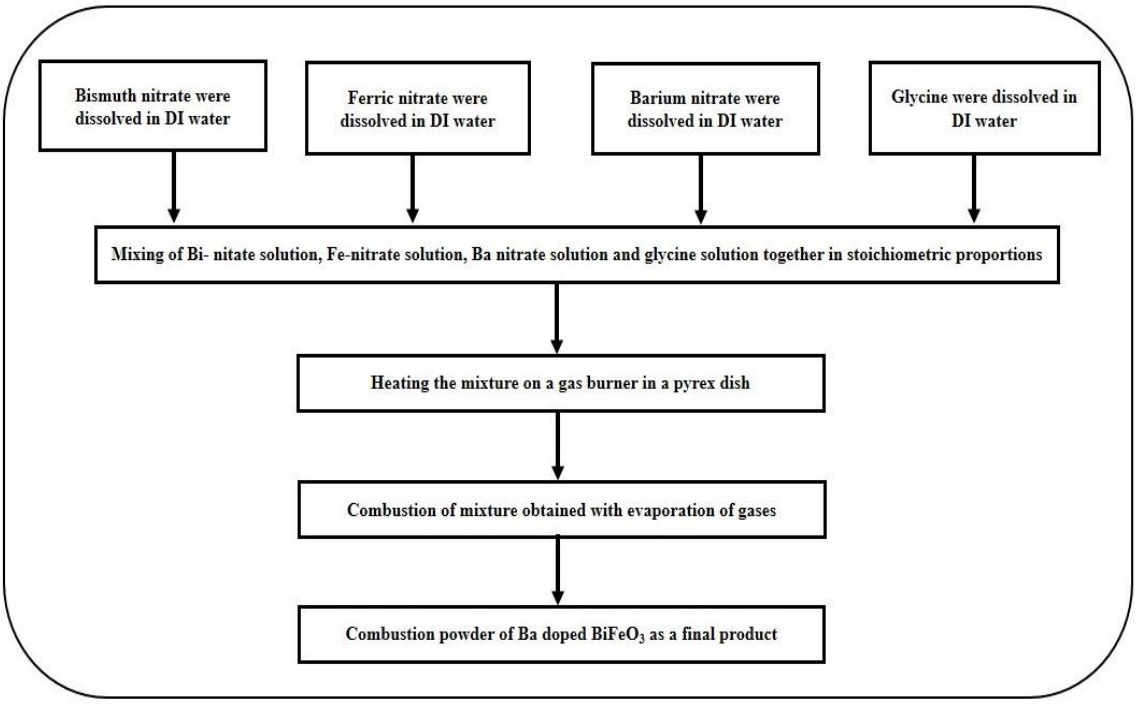

Fig.5. Flowchart of synthesis of Ba doped $BiFeO_3$ powder samples by SCM

Fig. 6. Synthesized $Bi_{0.9}Ba_{0.1}FeO_3$ and $Bi_{0.8}Ba_{0.2}FeO_3$ powder samples

4. *SYNTHESIS OF $BiFe_{1-x}Co_xO_3$ (x = 0.05, 0.1):*

The preparation of $BiFe_{0.95}Co_{0.05}O_3$ and $BiFe_{0.9}Co_{0.1}O_3$ ceramics was carried out using the precursors such as $Bi(NO_3)_3.5H_2O$, $Fe(NO_3)_3.9H_2O$, $Co(NO_3)_2.6H_2O$ acts as an oxidizers and glycine (NH_2CH_2COOH) was used as a fuel. . In order to prepare the mixture of samples, the oxidizer (O) to fuel (F) ratio was properly calculated using the oxidizing and reducing valences of the metal nitrates and fuel [12].

The bismuth nitrate, ferric nitrate, cobalt nitrate and glycine taken in a stoichiometric amount and were dissolved in a distilled water in a separate beaker after that, all these solutions were mixed together and placed in a pyrex dish for heating on a gas burner. After continuous heating the water gets evaporated and finally a combustion takes place with formation of $BiFe_{0.95}Co_{0.05}O_3$ and $BiFe_{0.9}Co_{0.1}O_3$ powders. The experimental procedure is reported by Chaudhari et.al. [13]. These powders were grinded in an acetone medium and finally calcined at 380°C and 330°C for 2 hours in a furnace. The following flowchart shows the entire experimental process carried out for the formulation of powder samples.

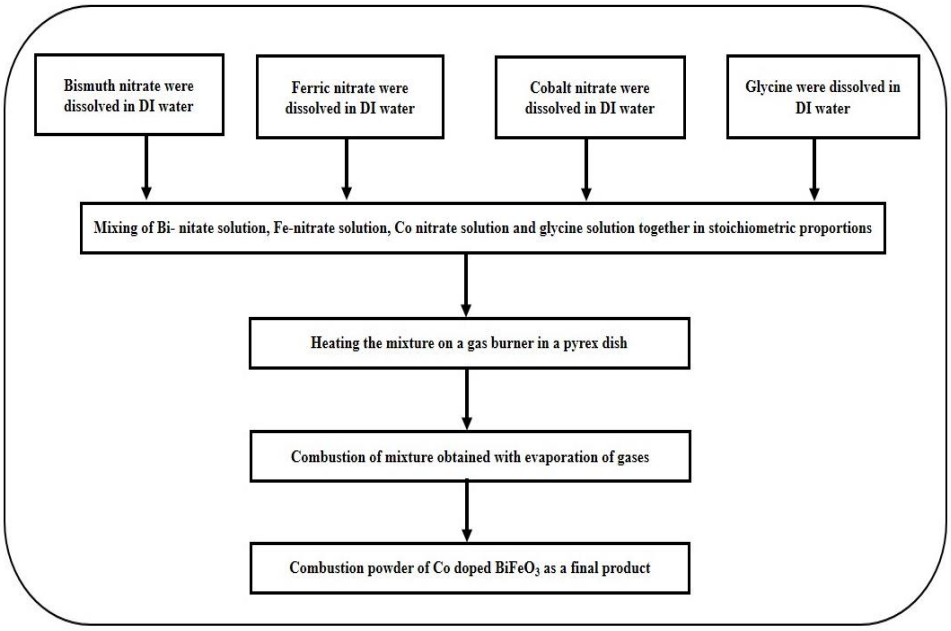

Fig.7. Flowchart of synthesis of Co doped $BiFeO_3$ powder samples by SCM

Fig.8. Synthesized $BiFe_{0.95}Co_{0.05}O_3$ and $BiFe_{0.9}Co_{0.1}O_3$ powder samples by SCM

III. RESULTS AND DISCUSSION:

Fig.1. shows the preparative flowchart of $BiFeO_3$ powder sample and Fig.2. shows the synthesized $BiFeO_3$ sample in the powder form. Fig. 3. shows the preparative flowchart of Ca substituted $BiFeO_3$ powder samples and Fig.4. shows the synthesized $Bi_{0.95}Ca_{0.05}FeO_3$ and $Bi_{0.9}Ca_{0.1}FeO_3$ powder samples. Fig. 5. shows the flowchart of synthesized Ba substituted $BiFeO_3$ powder samples and Fig.6. shows the synthesized $Bi_{0.9}Ba_{0.1}FeO_3$ and $Bi_{0.8}Ba_{0.2}FeO_3$ powder samples. Fig.7. shows the flowchart of synthesis of Cobalt substituted $BiFeO_3$ powder samples and Fig.8. shows the synthesized $BiFe_{0.95}Co_{0.05}O_3$ and $BiFe_{0.9}Co_{0.1}O_3$ powder samples. These formulated powder samples were grinded in an acetone medium and calcined in a furnace.

IV. CONCLUSION:

In the present paper were have successfully synthesized the pure $BiFeO_3$, doped samples such as $Bi_{0.95}Ca_{0.05}FeO_3$, $Bi_{0.9}Ca_{0.1}FeO_3$, $Bi_{0.9}Ba_{0.1}FeO_3$, $Bi_{0.8}Ba_{0.2}FeO_3$, $BiFe_{0.95}Co_{0.05}O_3$ and $BiFe_{0.9}Co_{0.1}O_3$ through solution combustion method. These prepared powder samples were calcined at different temperatures.

V. ACKNOWLEDGMENT:

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