

**Endorsement from collaborating/Beneficiary Industry: iWave  
Systems Technologies Pvt. Ltd**

I have gone through the Project Proposal entitled "Synthesis, grain size optimization, stress analysis of BiFeO<sub>3</sub> films and development of high sensitive prototype alcohol sensors" submitted by Dr. Jayarama A., Associate Professor, Dept. of Physics, AIET, as the Principal Investigator; Prof. Dr. Richard Pinto (Ex. Professor TIFR and IIT Bombay), Research Director, AIET as the Co- Investigator-1 and Prof. Dr. Siddharth Duttgupta, Associate Professor, EE Department, IITB, Mumbai as the Co- Investigator-2 along with Kumar Bhagavath, Associate Director, iWave Systems Technologies Pvt. Ltd. Bengaluru as Industry Investigator for DST-SERB-IRRD and noted the obligations and responsibilities indicated as stated below:

Our role with the Principal Investigator will be in terms of:

1. Contribution in financial terms : Rs. 50 Lakhs
2. Contribution in kind (List of activities):
  - a) Packaging ,
  - b) Testing and
  - c) Applications

I hereby affirm that my Organization/Industry is committed to participate in the Project to the full extent as indicated in the Project Proposal including the financial liabilities accruing there-from as detailed above. A summary profile of my Organization is given below:

Name of Organization: iWave Systems Technologies Pvt. Ltd.

*Line of Business/ Major Products:* iWave focuses on Product Engineering Services involving Embedded Hardware, FPGA and Software. iWave's Hardware expertise spans complex board design up to 30 layers; Analog , Digital & RF Designs; FPGA Development up to 3+ million gates and VHDL / Verilog RTL Development & Verification.

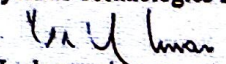
No. of employees: 156. Annual Turnover: 44 Crores


The project proposal titled 'Synthesis, grain size optimization, stress analysis of BiFeO<sub>3</sub> films and development of high sensitive prototype alcohol sensors' is an industrial R & D problem faced by our company and to be solved through the academic experts from AIET and IIT Bombay. This research will lead to the bulk production of room temperature alcohol sensor device which has high demand in various applications.

Date: 03-01-2018

Place: Bangalore

For iWave Systems Technologies Pvt. Ltd.,

  
(Head of the Industry/Agency)  
Seal/Stamp

  
PRINCIPAL  
Alva's Institute of Engg. & Technology,  
Hq. MOOREDR - 574 225, D.K





Synthesis, grain size optimization, stress analysis of  $\text{BiFeO}_3$  films and development of high sensitive prototype alcohol sensors

File No : IRR/2018/000003/PHY (Ver-1)

Submitted By : Jayarama A

Submission Date : 25-Jan-2018

## Proposal

File No : IRR/2018/000003/PHY (Ver-1)



### Proposal Details

**Project Title :** Synthesis, grain size optimization, stress analysis of BiFeO<sub>3</sub> films and development of high sensitive prototype alcohol sensors

**Scheme :** Industry Relevant R&D

**Broad Area :** Physical Sciences

**Sub Area :** Condensed Matter Physics and Materials Science (IRRD)

**Duration In Month :** 36

**Total Cost (in Rs.) :** 1,00,00,000

**Name of Principal Investigator :** Jayarama A

**Email ID :** jrmarasalike@gmail.com

**Date of Birth :** 21-Jan-1976

**Contact No :** +919611945201

**Category :** OBC

**Gender :** Male

**Nationality :** Indian

**Is differently abled :** No

**Designation :** Associate Professor

**Department :** Physics

**PI Institute :** Alva's Institute of Engineering and Technology

**PI Institute Address :** Shobhavana campus, mijar, moodbidri, Mangalore, Karnataka-574225

**Pin Code :** 574280

### CO PI Details :

| Name & Designation                                       | Date of Birth | Mobile No.   | Email                 | Institute Details   |
|--|---------------|--------------|-----------------------|---|
| Dr. Richard Pinto<br>(Research Director)                 | 16-Oct-1942   | 919892818760 | rpinto@ee.iitb.ac.in  | Alva's Institute of Engineering and Technology, Shobhavana Campus, Mijar, Moodbidri, KARNATAKA-574225 |
| Dr. Siddhartha P<br>Dutttagupta<br>(Associate Professor) | 01-Feb-1969   | 0            | sdgupta@ee.iitb.ac.in | Indian Institute of Technology Bombay, IIT PO Powai, Mumbai, MAHARASHTRA-400076                       |

### Industry Details :

| SNo. | Industry   | Share of Total Budget |
|------|--|-----------------------|
| 1    | iWave Systems Technologies Pvt. Ltd.<br>No. 7/B, 29th Main, BTM Layout 2nd Stage., Bengaluru, Karnataka 560076 | 50                    |



**Project Summary :** Alcohol sensors with high selectivity and sensitivity have tremendous application potential as a device in traffic management (drunken driving), food ferment, wine making and medical processes. Colorimetric indicators are commonly used for Alcohol detection. The indicators are generally composed of compounds of cobalt, nickel/iron and amino acids. Manufacturing process for colorimetric ethanol sensor is patented by De Castro et al. in 1995. However, it has been observed that though these indicators are simple to use the sensitivity is poor and unreliable. Semiconductor gas sensors offer the potential for developing portable, rugged and inexpensive detectors. However, these sensors based on materials like  $\text{SnO}_2$ ,  $\gamma\text{-Fe}_2\text{O}_3$  etc. though have higher sensitivity, they lack in selectivity.

However, all the sensors we came across function in the temperature range of  $120\text{-}400^\circ\text{C}$ . The only sensor operating at room temperature is reported by Palkar and R. Pinto et al. (one of the Investigators) who have demonstrated the performance of high-resistive thin films of  $\text{BiFeO}_3$  as an alcohol sensor at room temperature. The performance seems to be excellent as far as detection sensitivity and selectivity is concerned. The merit of any sensor, apart from sensitivity, is also judged by selectivity, response and recovery time, aging factor and simplicity in operation. It is therefore thought to be meaningful to design and fabricate prototype Alcohol sensor based on  $\text{BiFeO}_3$  thin films since it could be operated at room temperature. It is well known that the gas-sensing properties of oxide thin films are strongly dependent on its morphological features and grain size. Large surface area and smaller grain size of the material are known to favor the sensitivity. Since Palkar and R. Pinto et al. (one of the Investigators) have not studied the effect of morphology and grain size and also doping effect of  $\text{BiFeO}_3$  thin films on sensor properties we intend to take up this kind of detailed study before designing a prototype device. Also, aging effect needs to be studied. It will require time to time characterization of the grown films using different techniques. It will include structural phase determination, elemental analysis, grain size determination etc. The resistivity change occurring on exposure to alcohol vapors for thin films having different grain morphology needs to be studied. The objective of the proposal is to optimize grain size and morphological conditions of  $\text{BiFeO}_3$  thin films deposited by using pulsed laser deposition technique so as to get best possible ethanol sensing properties at room temperature. The study will include determination of aging effect and sensitivity level. We intend to design and fabricate a prototype ethanol sensing device that will be robust, handy and easy to operate and will operate at room temperature

**Objective :**

- BFO powder preparation through Sol-Gel route and preparation of BFO targets for the growth of BFO films using pulsed laser deposition
- Growth of BFO thin films and characterization of the films using SEM and X-Ray Diffraction techniques
- Work on the effect of growth conditions and dopants on the ethanol sensing properties of BFO thin films to be studied on lab scale using ethanol sensor measurement setup
- Stress analysis of BFO thin films, grain size/morphology studies and optimization of BFO thin film growth conditions so as to get best possible ethanol sensing properties in terms of sensitivity and selectivity
- Study of surface redox reactions and ethanol sensing mechanisms of BFO films both by using XRD and electrical measurements
- Fabrication of prototype alcohol sensor device with associated electronics. Once the device is fabricated and tested, it will be packaged and further tested in collaboration with iWave Systems Technologies Pvt. Ltd.

**Keywords :**

BFO thin film, Alcohol sensor, Grain size, Sensitivity, Selectivity

**Expected Output and Outcome of the proposal :**

The main outcome of this proposal is a room temperature alcohol sensor with high selectivity and sensitivity which have