Microfluidics Based Air Pollutants Detection Device by Using Solvent Cast Method

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***Abstract*: In this work, we have mentioned the use of various types of polymer (i.e. conducting and nonconducting) in the area of pollutant detection. Through the innovative idea and design, one may able to detect the pollutants, and then after other follow up to be implemented for removal of the detected pollutants. Solvent cast method is chosen for the implementing the idea to make a fabricated and thin films on various substrate such as Mica, Glass, ITO and other conducting components. We actually combined the two technologies for the overall work. The first method was use of solvent cast method for well mixing of all components while second method was use of Microfluidics technology for creating micron level channel for sensing application of maximum types of hazardous gases. By using microscopic images and other characterization tools, we reached at the position where we may say with concrete results the innovation of such devices.**

***Keywords:* Conductiong polymer, ITO, non conducting polymer.**

I. INTRODUCTION

As in the age of technological reforms, a lot of incorporation (inc) is added in the world for making sensor. As per the guide lines of world health organization, every inc are to be implemented pollution control mechanism in all type of waste such as liquid, solid and gas pollution. Through this work, we are trying to fabricate composite structure which may use for detecting such pollutant at early stage. Semi conducting materials are best suited for such kind of work [1]. For this work, we have used solvent cast method. In which, various polymers are being used with varying weight percentage of metal/non-metal oxides. Electronics nose is best example of such air quality kit [1]. In spite of these polymers and oxides compound, we also used varying dielectric, Ferro materials and others (bio molecule) [2].

II. MATERIALS AND METHODS

A. PDMS and SU8

Under the influence of temperature and environmental condition, lithographic method was used. Poly Di Methyl Siloxane was used as base materials for making detection channel. SU8 acts as photo resist which create binding of PDMS with the glass and other base substrate. Artificial neural network and artificial instruments are of such types [5].

B. PDMS

PDMS is the abbreviation of poly di methyl Siloxane. PDMS was purchased from Sigma Aldrich India. It is best fabricating chemical compound for making micron channel in Microfluidics research area. With the help of gold spin coater, gold coating of several microns are being done on glass substrate. Fig.1 shows the overview for such design. Digital connections are used for the design [6].

Fig. 1 Glass reservoir made up from Gold spin coating

C. SU8

SU8 was purchased from Sigma Aldrich India. It is the code of positive resist which act as combinational platform for PDMS. There are two types of resist: positive and negative resist. Fig. 2 is the outcome from this fabrication tools and conceptual design. Graphite shows good results for this kind of work [7].

Fig. 2. Channel fabricated channel by using PDMS and SU8

Research Methodology – Experimental Set ups

This includes microfluidic based electrical circuit design clubbed with solvent cast method etc.

D. Electrical Circuit Design

Electrical circuit is demonstrated in Fig 3. In the electrical circuitry, we had applied varying range of frequency over variable voltages. The breadboard has been taken for the completion of the complete microfluidic electrical circuit. In the solvent cast method, we mixed and continued the formulation of composites by using various compounds (Fig 4). In the same follow ups, under various parameters change, we got various layer of composites structure.

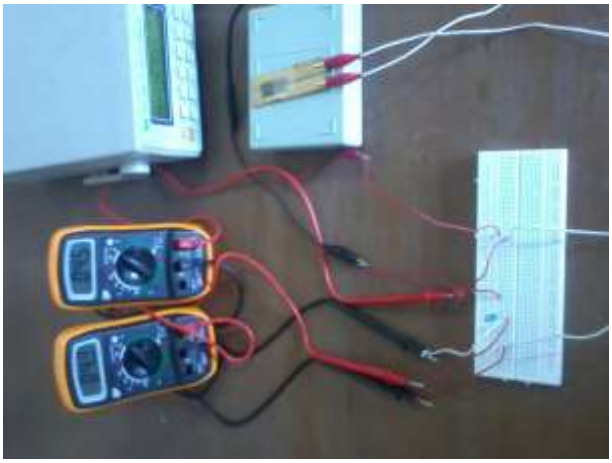

Fig.3 Electrical Circuit system for Microfluidics design

E. Solvent Cast Method

At 800-1200 rpm, 8-120 deg C and for approx. 40-70 minutes, all the chemical compositions were treated. Colloidal system has been used for the work [3]. Then drying of the thin films was done in hot air oven for 2-6 hours. This sensor design is best catalyst for air quality [4].

Fig. 4 Schematic view of solvent cast method

Under the heading of solvent cast method, various polymers and oxides combination are used. Measuring instrument such FRET is best suited for this work [8]. With due affect, micron level thin films are made on the glass and other base substrate. While under the heading of Microfluidics technology, with the use of PDMS and SU8, micron level channel is fabricated. Minimum GS are found in this design [9]. Through the fabricated micron level channel, the flow of solid waste is made done.

F. Lithographic method

Lithographic method is best technique for making fabrication channel. The sophisticated method consists of various instrumentation used in this system. Dipole review are also being covered [10]. Fig 5 shows the SAED image for Cadmium doped CdSe quantum dots.

Fig. 5 SAED result of Cd doped CdSe quantum dots

Fig. 6 shows the transmission electron microscopy images of CdSe and Cd quantum dots. Tunable effects are available for this work in the LR part [11]. Proper scattering of quantum dots is well shown in the TEM photo.

Fig. 6 TEM result of scattered CdSe and Cd quantum dots

TEM and SEM results show the nano particles and quantum dots of CdSe and Cd. The overall systems are being crossed through the micron level channel. Vertically Aligned Carbon Nano Tubes are best suited for battery which mimics the same work [12]. Due to the very high sensitiveness, the channel shows the presence of pollutants molecules presents in the flowing media, which may be solid, liquid and/or gases.

With the help of Scherer formula, the dimensional relation with the frequency response can me sketched.

G. *UV Treatment*

In the lithographic method, after making the mask of PDMS-SU8, the exposure of Ultraviolet beams are done on this design for the removal of unwanted track of the channel. The main thing of UV implementation is the follow up the WHO and NIH rules of using UV i.e. under close chamber, to avoid extra, over and outer exposure of UV radiation in the environment i.e. human being and others. Fig 7 shows the fabricated channel. [13]

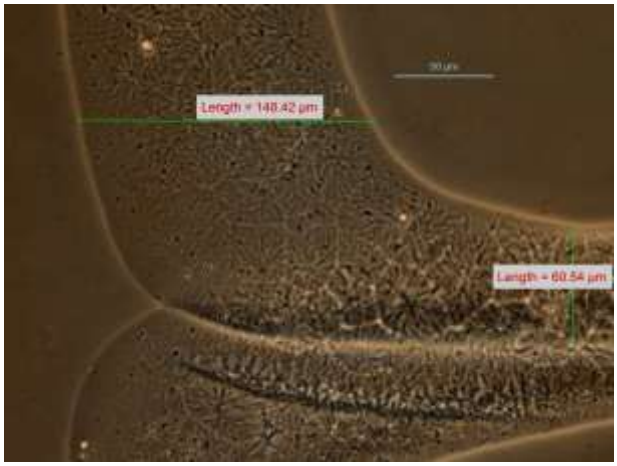

Fig. 7. Micro channel fabrication by using lithographic method

III. RESULTS AND DISCUSSION

A. *Structural outcomes*

With the help of solvent cast method, the thin films of composites have been made. The level of films is in between 2-10µm. With the help of XRD instruments, we got the 2Theta = 28-32 deg at around 40% au. The XRD data varies from 10wt% to 90wt% of $BaTiO_3$ with PMMA, incorporated with the TiO_2. Fig 8 shows quantum dots of CdSe and Cd.

Fig. 8. Quantum dots sample, by use of solvent cast method

We got various results by using instrumental techniques such as capacitance, inductance, FWHM, impedance, zeta, electrical potential vs. temperature [14-15]. We also checked frequency dependency. 1-100 KHz frequencies are used from 20-200 deg c.

B. *Micrographical data*

After using and incorporating Microfluidics and solvent cast method, we are in the level of fabrication of channel. Fig 9 shows the fabricated channel under micron domains. Fig 10 shows scattered TEM result of Cd [16-18].

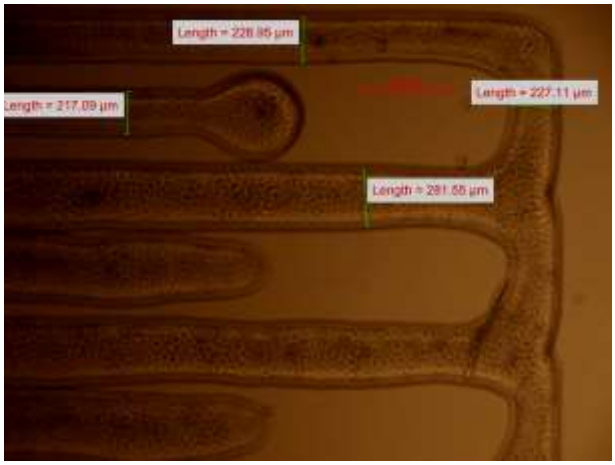

Fig. 9. Micro channel fabrication by using soft lithographic method

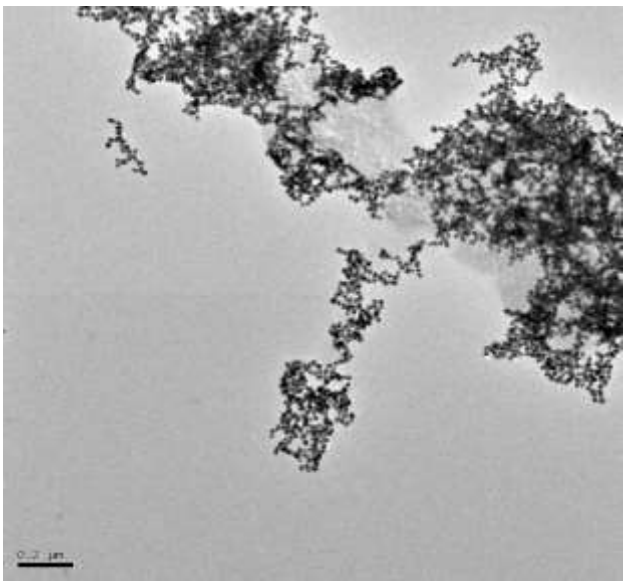

Fig. 10. TEM results of CdSe and Cd

C. *Fabrication results*

The fabricated results by using Microfluidics technology is mentioned in fig. 11, which may be best suitable for early level detection of air pollutants, by encapsulating compatible bio molecules and bio markers [19-20].

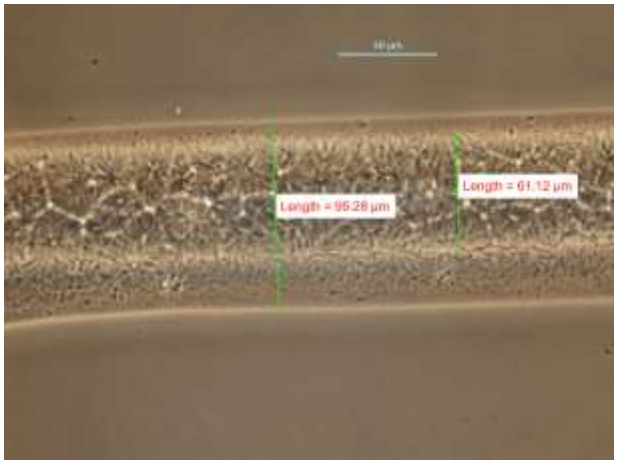

Fig. 11. Micro channel fabrication

IV. CONCLUSION

The main goal of making such air pollutant kit or device is to make it available for common media or society, which cannot bear so much expensive kit or device. PoC (The Point of Care), SoC (Ssystem on Chip), and LoC (Lab on Chip) are being developed by various companies. The price of such kit or device varies from 40-60 US dollar per kit[16-18], while by using this Microfluidics design, sandwiched with solvent cast method, these rate decreases. The rate of such detection kit will vary from 10-25 US Dollar. Apart from the price cut, the hand handling of such kit very easy to re calibrate and re used. Recycling, environmental friendly, user friendly and sustainability are also our prime concern for making such kits.

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