Green Fiber Optic Sensor For Ammonia

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Abstract

Ammonia classified as one of the hazardous chemical to environment as well as human being. Therefore, monitoring the ammonia in air is a matter of concern. There are several methods to detect the ammonia gas including Nessler's reagent photo ionisation detector etc. Because of the carcinogenic property of Nessler's reagent it is not advisable to sense ammonia gas. Photo ionization detector and other electronic sensors have high sensitivity but because of the corrosive nature of ammonia gas they are of short life span. In this work we fabricated a nano particle coated tapered plastic optical fiber (POF) for sensing ammonia gas. Here we prepared nano particle from leaf extract and characterized it by UV and PL diffraction spectroscopy and the function ability of the fabricated sensor is tested by calculating its limit of detection (LOD) and Sensitivity.

Keywords — *Green synthesis, Nano-particles, SPR POF sensor, Ammonia.*

I. INTRODUCTION

Exposures to high concentration of ammonia cause irritation in eye, skin, lungs or even death some times. It affects equally to animal husbandry also. At the same time ammonia does high rate damage to industrial sector due to its corrosive nature. Hence its detection and controlled emission is shouted at times. For this reason a number of methods are employed and many electronic sensors are developed, but their longevity is a question mark due to corrosive nature of ammonia. Fiber optic ammonia sensor is also developed by others like Adlof et.al.[1] devised an ammonia sensor based of ph indicator but here the sensing area is developed following chemical method. Different chemicals again themselves are not safe enough. In [2] the author has proposed to use ethanol/chloroform solution dye in the unclad region but chloroform is not safe for fabrication point because excess inhalation of chloroform causes senseless. Taking this fact in to consideration here we tried to develop a fiber optic green sensor with SPR technique. In our proposed work we have extracted some nano particles from medicinal plant *Desmodium gangeticum*, After preparing the sample, it is characterized by uv-vis spectroscopy and photo luminosity. Then a dip coated POF is prepared and its functionability is tasted in terms of limit of detection (LOD) and Sensitivity. Generally *Desmodium gangeticum* used in Dashmoolarishta [3]. Taking its variety of advantages in large number of disease cure, it is thought to be containing some nano particles with miraculous medicinal benefits. So we went for preparing a sample which may contain the expected nano particles. The prepared sample when tested by uv-vis spectroscopy, to our surprise we got a UV peak at 672nm which comes under the range of silver nano particle wavelength absorption peak [4]. Then the pl of the sample further gave a red shift which is not possible for any chemical/ chlorophyll but for nano particle. Further characterization needs to be done for confirmation.

II. WORK PROCEEDINGS

The work is done basically in four steps as preparation of sample of nanoparticles and its characterization, fabrication of fiber sensor, experimental observation and finally result analysis.

Preparation of Sample:

Desmodium gangeticum leaves were cut down into tiny pieces (1-2 cm) then they are soaked in double distilled water. The sample of leaf extract is prepared by crushing down the soaked pieces with the help of Mortar, then it is filtered to get a pure solution without any coarse particle by using Whatman filter paper. The UV-VIS spectroscopy of the solution is taken. It is found that the UV peak is stable up to 15 day and then dissolves. Also the peak dissolves when heated above 60^0c. Figure: 1, shows the uv-vis absorbtion spectra of the sample.

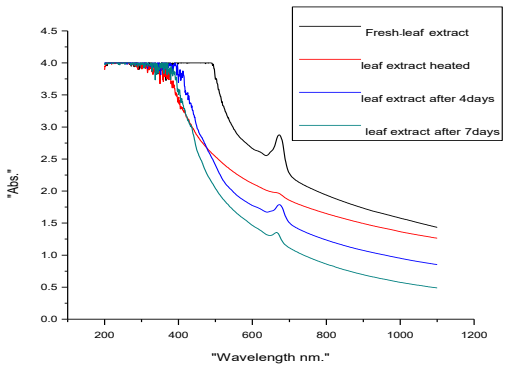

Figure 1: UV-VIS of desmodium leaf axtract

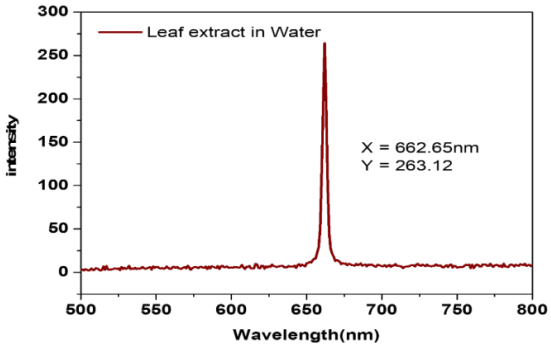

Figure.2 : Photoluminescence Spectrum of Aqueous Leaf Extract

Fabrication of fiber optic sensor:

The solution is taken on a watch glass and a tapered POF is dipped in it for 15 minutes. Then the fiber is allowed to dry for 1hour under sunlight. This left a coating of suspected nano particles on the tapered portion. This fabricated probe is then tasted by experiment for sensitization of ammonia gas.

Experimental Observation:

The dip-coated fiber is attached between laser emitterand photo current detector on a honey-comb tabletop. The photo current change for different concentration of ammonia gas is observed and put into a graph. The table below shows these observations. The current response for uncoated tapered fiber was 10A .

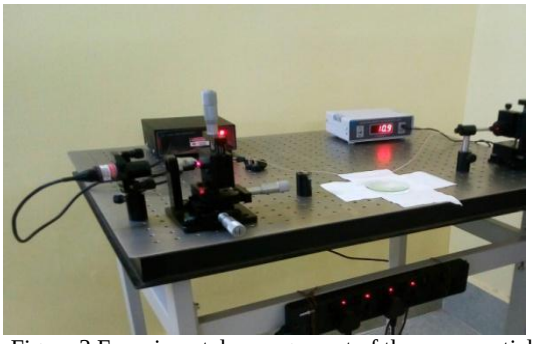

Figure.3 Experimental arrangement of the nano particles coated tapered POF

TABLE 1

Concentration (N)	**Intensity**
13.4	10.8
6.7	10.7
3.35	10.6
1.675	10.5
Slope (sensitivity)	0.023881 ppm/dbm
limit of detection	0.1966ppm

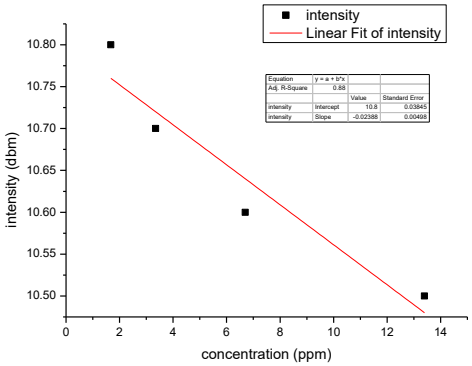

Figure: 4- intensity vs concentration

Result Analysis:

As the uv-vis graph of the leaf extract showed a peak at 672 nm figure [1] and it remains fixed in the photoluminescence of the solution, indicates there is a high emission of radiation from the solution. Secondly this uv absorption peak is coming equal to the absorption peak of silver nanoparticle[4]. The advantage of this is taken and supposing the nanoparticles to be silver, it is expected that it must be emitting surface Plasmon which can be used for sensing application, we went for experimental analysis. Our result gives a positive response to our expectation. Table:1, presents the experimental observation data which is the variation of transmitted intensity of incident red laser light through nano-particles coated tapered POF vs concentration of ammonia gas in open air. The sensitivity is generally measured between wavelength and dielectric constant of the medium at evanescent field [5] by the formula $Sn = \Delta\lambda res\ \Delta ns$, where $\Delta\lambda res$ is the change in resonance wavelength and Δns is the change in refractive index. The refractive index of a solution is directly proportional to the concentration of the solute in it [6]**.** when different concentration of ammonia is placed in the coating area of the sensor, the evanescent field of the incident laser is affected and the transmitted intensity showed a change which is noted down for different concentration of ammonia then a graph figure:[4] is plotted between transmitted intensity and concentration of ammonia in mg/ml [8] the graph shows the sensitivity of the prepared probe is 0.023881 this graph can be compared with [9 ,10] but the variation is almost linear. The prepared nano particle coated optical fiber having 5.618 µM of Limit

of detection i.e. The lowest detectable concentration of the analyte is 0.1966 ppm.

Jarzebinska et al [9] reported a fiber optic sensor for ammonia detection by using tapered optical fibers coated with nano assembled coating with a thickness of some 10 nm. The coating is composed of tetrakis (4-sulfophenyl) porphine (TSPP) and poly (allylamine hydrochloride) (PAH), which was deposited on the fiber via an electrostatic self-assembly process. The exposure of the sensor to NH3 induced changes in the transmission spectrum, and a linear response is found for the NH3 concentration range from 10 to 100 ppm (v/v). The limit of detection is as low as 2 ppm, and the response time is less than 100 s. J. Aubrecht et al [10] developed Ammonia Gas Sensor Using Optimized Organometallic Reagent, sensitivity and the Limit of detection of the sensor was 1.52×10-5 ppm and 31 ppm respectively. Compared to these two ammonia sensor, nanoparticle coated tapered fiber optic sensor can detect very small quantity of ammonia and the sensitivity of the senor is 0.02388.

The value of linear correlation coefficient is 0.9591 it is closer to one , which indicate that there is a high correlation between concentration and response. Again graph is showing limit of detection i.e. the lowest detectable concentration of the analyte is 9.95×10-3ppm. From the above comparison, if the linear correlation coefficient value of the concentration-response graph is close to 1, indicates that the sensor will detect even very small quantity of ammonia, and it can be considered as an effective sensor for ammonia sensing application.

III. CONCLUSION

In this work nano particle is procured using green synthesis of *Desmodium gangeticum* leaves and it is characterized by UV and PL methods. Leaf extract in water is showing a maximum absorption and emission at 672nm respectively and it's unstable at 60°C and 12 days, the size of the material is calculated from UV data is about 200nm indicates the prepared nano particle is metalic and we coated the nano particle on the tapered region of optical fiber for ammonia sensing application. Because of the high sensitivity and low LOD of the nano particle coated tapered optical fiber we can use it as ammonia sensor at a room temperature.

Future scope of the work is ammonia can be released in a controlled manner, which will give accurate concentration of it. The sensitivity can also be analyzed by taking various length of tapered region, different concentration of the coated solution, which will confirm the functionability of the low cost gree sensor for detecting ammonia gas.

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