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Design and Implementation of optical fiber sensor for Ammonia gas

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Abstract

The sensing probe was fixed in ammonia gas test cell. the Laser diode light is used as source and the fiber sensor was tested by exposing it to ammonia gas at different concentrations (1.25% - 25%) and the output light intensity spectrum is recorded by a spectrometer (Ocean Optics -HR 2000) at different exposure time periods. The intensity spectrum peak of the new cladding (PVA nano Cu) changes with different concentrations of ammonia gas.

The absorption peak intensity alters with the concentration of the ammonia gas. The absorption peak intensity increase with the increase of the concentrations of ammonia gas. By exposing the test cell to a wide range of wavelengths (200nm- 1110nm) demonstrates that the (650 nm) is significantly sensing for different ammonia concentrations. The output intensity spectrum results are recorded as a function of the concentration.

Keyword: ammonia gas, fiber sensor, absorption peak intensity, spectrometer.

تم تحديد مجس الاستشعار في خلية اختبار غاز الأمونيا باستخدام ضوء الصمام الثنائي الليزري كمصدر وتم اختبار مستشعر الألياف من خلال تعريضه لغاز الأمونيا بتركيزات مختلفة (1.25٪ - 25٪). وتم تسجيل طيف شدة الضوء الناتج بواسطة مطياف (Ocean Optics -HR 2000) عند مختلف فترات زمنية التعرض. تتغير ذروة كثافة الطيف للتكسية الجديدة (PVA nano Cu) بتركيزات مختلفة من غاز الأمونيا.

تتقاطع شدة ذروة الامتصاص مع تركيز غاز الأمونيا. زيادة كثافة ذروة الامتصاص مع زيادة تركيزات غاز الأمونيا. من خلال تعريض خلية الاختبار لمجموعة واسعة من الأطوال الموجية (200 نانومتر - 1110 نانومتر) يدل على أن (650 نانومتر) يستشعر بشكل ملحوظ لتراكيز الأمونيا المختلفة. يتم تسجيل نتائج الطيف كثافة الإخراج كدالة للتركيز.

1. Introduction

With the invention of the laser in 1960's, a great interest in optical systems for data communications began. The invention of laser, motivated researchers to study the potential of fiber optics for data communications, sensing, and other applications. Laser systems could send a much larger amount of data than microwave, and other electrical systems. The first experiment with the laser involved the free transmission of the laser beam in the air [1]. Researchers also conducted experiments by transmitting the laser beam through different types of waveguides. Glass fibers soon became the preferred medium for transmission of light. Initially, the existence of large losses in optical fibers prevented coaxial cables from being replaced by optical fibers. Early fibers had losses around 1000 dB/km making them impractical for communications use [2].

In 1969, several scientists concluded that impurities in the fiber material caused the signal loss in optical fibers. By removing these impurities, construction of low-loss optical fibers was possible. In 1970, Corning Glass Works made a multimode fiber with losses under 20 dB/km. The same company, in 1972, made a high silica-core multimode optical fiber with a 4 dB/km loss [3].

Recent advances in fiber optic technology have significantly changed the telecommunications industry. The ability to carry gigabits of information at the speed of light increased the research potential in optical fibers. Simultaneous improvements and cost reductions in optoelectronic components led to similar emergence of new product areas [4]. Last revolution emerged as designers to combine the product outgrowths of fiber optic telecommunications with optoelectronic devices to create fiber optic sensors. Soon it was discovered that, with material loss almost disappearing, and the sensitivity for detection of the losses increasing, one could sense changes in phase, intensity, and wavelength from outside perturbations on the fiber itself. Hence fiber optic sensing was born [5,6].

2. Experimental work.

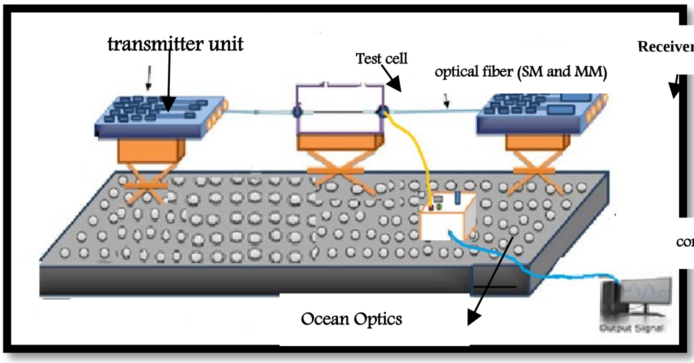

Fig. (1) setup of experimental work

It was connected the ammonia gas sensor to the light source (Red Laser Diode 650 nm).Then we connected the other party of it to the receiver unit to calculate the output power of each concentrations of ammonia gas (1.25 % , 2.5 %, 10 % , 25%), after that we sketched the spectrum intensity by Ocean device (Ocean Optics -HR 2000) for each type of optical fiber (SM,MM) . as shown in Fig. (2).

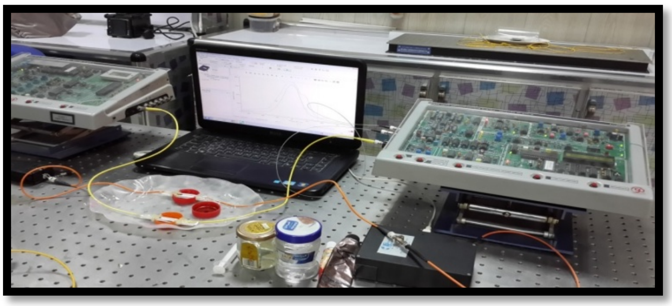

Fig. (2) Connected the optical fiber sensor into the Ocean device and the receiver unit.

3. Result and Discussion

1-Multimode Fiber Sensor at Different concentrations of ammonia gas.

Figure (3) shows the intensity spectra to a range of Ammonia concentrations at room temperature obtained with optical fiber (MM) coated with polymer (PVA Nano Cu) under two different environments; before and just after Ammonia gas exposure. It is observed from this figure that the intensity decreases due to the addition of different concentrations of Ammonia because polymer (PVA Nano Cu) shows a reversible change in their resistance when exposed to Ammonia vapors [7].

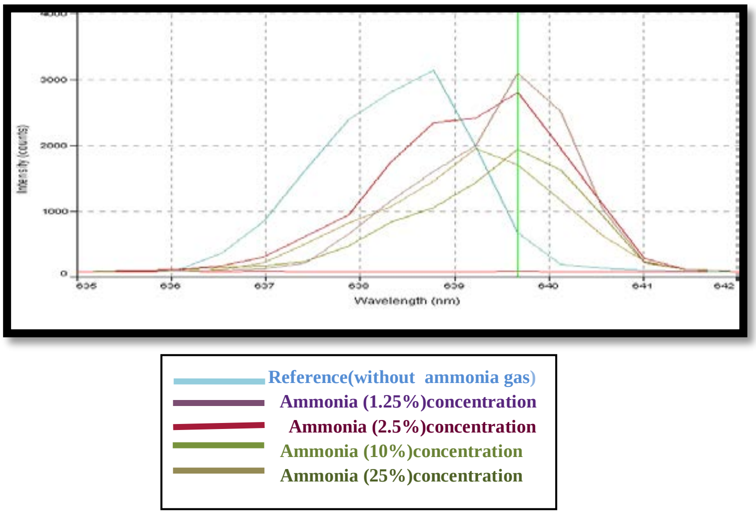

Fig. (3) The spectrum intensity of the optical sensor(MM) coated with a polymer (without ammonia gas) and various concentrations of ammonia gas.

Figure (4) shows the difference of change in power versus concentrations of NH_3 gas at a stable wavelength (650 nm) and room temperature. Clearly that the sensitivity of the sensor system at lower concentration of NH_3 gas is higher than that at higher concentrations.

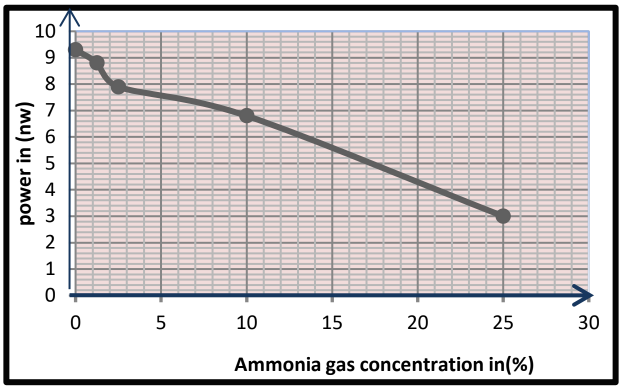

Fig. (4) the Relation between concentration of ammonia gas and the output power.

2-Single mode fiber Sensor at Different concentrations of ammonia gas.

Figure (5) shows the intensity spectra to a range of Ammonia concentrations at room temperature obtained with optical fiber (SM) coated with polymer (PVA Nano Cu) under two different environments; before and just after Ammonia gas exposure. It is observed from this figure that the intensity decreases due to the addition of different concentrations of Ammonia because polymer (PVA Nano Cu) shows a reversible change in their resistance when exposed to Ammonia vapors [8].

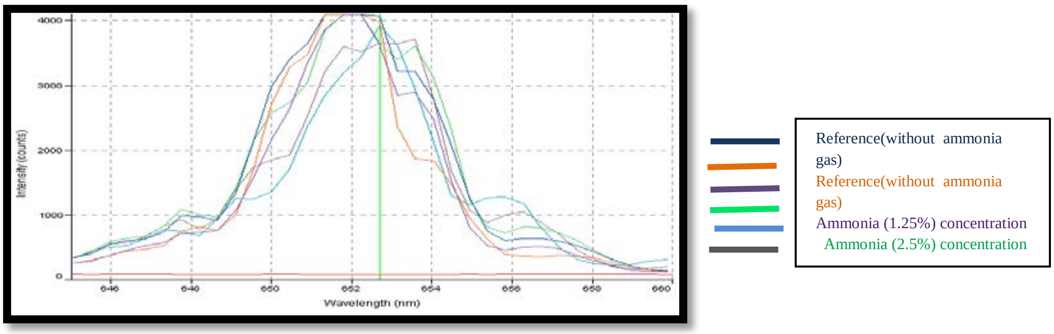

Fig. (5) The Intensity spectrum of the optical sensor(SM) coated with a polymer (without ammonia gas) and various concentrations of ammonia gas.

Figure (6) shows the difference of change in power versus concentrations of NH_3 gas at a stable wavelength (650 nm) and room temperature. Clearly, that the sensitivity of the sensor system at lower concentration of NH_3 gas is higher than that at higher concentrations.

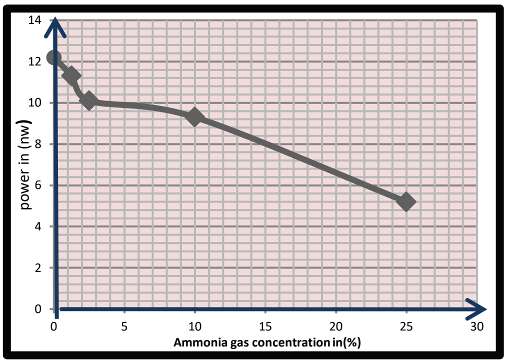

Fig. (6) The relation between concentration of ammonia gas and the output power.

4. Conclusions

By studying the chemical fiber optic sensor, we concluded the following:

1- Evanescent wave fiber optical sensors have been found to have many advantages in addition to the advantages of general optical fiber sensors.
2- Conducting polymers (PVA Nano Cu) was successfully tested for sensing toxic vapor, such as (NH_3).
3- The loss increases strongly depending on the different concentrations between (1.25% - 25%).
4- Greatest output power at lower concentration of ammonia gas (1.25%).
5- Increases the absorption of light with the increase in the concentration of ammonia.
6- The Red laser light (650 nm) was more sensitive for Ammonia gas with highly significant from concentration effects.

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