



PMMA Optical Fiber As Chemical Concentration Meter

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ABSTRACT

Cladding of Poly-methyl-methacrylate optical fiber of 1 mm diameter is cleaved and optical signal with sine, square and] triangular wave is passed through fiber. Cleaved region is immersed in the solution of potassium dichromate, potassium permanganate and copper sulphate solution of different concentration. Peak to peak voltage of the signal at output is found to vary with frequency of the signal. Integrated area of the curves shows variation with the concentration. Concentration of the solution can be calculated directly using the analysis of the signal.

KEYWORDS : Optical sensor, Poly-methyl-methacrylate, Chemical concentration meter, Plastic Optical fiber

1 Introduction

Large bandwidth and low signal attenuation make optical fibers, one of the important modern day technological devices not only for data transmission but for effective sensors for chemicals, mechanical strains etc. [1-5]. Light transmitting through optical fiber suffer multiple reflections from the core-cladding boundary. A fiber with no cladding or modified cladding affects the signal propagating through it. The modifications so produced are dependent on the medium surrounding the core. These modifications effectively give information for the nature of the medium. There are certain high sensitive techniques like surface plasmon resonance which are now a days in use as base technology for making such sensors. This technique is not only highly sensitive but also is non-destructive and helps in real time detection.[6-8]. Apart from standard silica fibers, plastic optical fibers are also used for such applications. They offer fairly high numerical aperture and large diameter for greater light carrying capacity[9-10].

2 Experimental (Results and Discussions)

In present study PMMA optical fiber (core diameter 1mm) is used. Cladding is carefully removed for about one cm region using chloroform. Due care is exercised in maintaining the circular cross-section of the fiber. Cleaved region is housed in a small container for holding the liquid under experimentation. Light is obtained from white LED (1W). Electrical signal is provided by a function generator for sine, square and triangular waves with frequency in audio range. Signal obtained from other end has been converted to electrical signal using Fairchild L14G2 photodiode. Electrical signal is then analyzed using data storage oscilloscope. The parameters like amplitude and peak to peak voltage is measured with the variation of signal frequency. Variation these parameters were recorded at different concentration of aqueous solution of potassium dichromate, potassium permanganate and copper sulphate. Fig. 1(a-c) represents peak to peak voltage Vs. frequency for sine, square and triangular wave for potassium dichromate solution. Similar curves were obtained for It is noticed that peak to peak voltage decreases with increase in frequency. At higher frequency signal voltage saturates. However the concentration variation is prominent in the higher frequency region in all the three waves. Integrated areas under the curves are also obtained and plotted against concentration. It is found to show increasing trend with increase in concentration. At higher concentration, however the variation stabilizes.

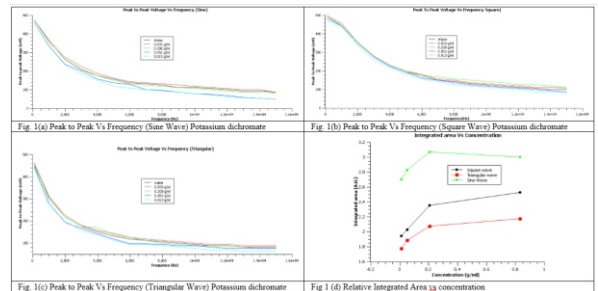
Chemical	Refractive index
PMMA(Core)	1.49
Potassium dichromate	1.70
Potassium permanganate	1.59
Copper sulfate	1.51

Table 1 Refractive indices of materials

Refractive indices of various materials are listed in table 1. Refractive index of various solutions decreases with reducing concentration.

This increases the chances for total internal reflections for various Fourier components of the signal passing through it. This increases the peak to peak voltage of the signal at low concentration.

For copper sulphate and potassium permanganate similar trends were observed.



4 Conclusions

PMMA optical fiber is an effective concentration meter for solutions. We have used three different chemical solution copper sulfate, potassium dichromate and potassium permanganate. Amplitude variation is obtained significantly for various concentration of solution with square, sine and triangular optical wave at different frequencies in audio region.

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