Volume 3, Issue 4 (2015) 739-740 ISSN 2347 - 3258
International Journal of Advance Research and Innovation

A Study on pH sensing property of Carboxymethyl guar gum /Silver Nanocomposites

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Article Info
Article history:
Received 8 January 2015
Received in revised form
15 January 2015
Accepted 28 November 2015
Available online 15 December 2015

Keywords
pH Sensors,
Silver Nanocomposites,
Carboxymethyl Guar Gum

Abstract
Some metal nanoparticles have been used as the colorimetric gauges for estimating solution pH and other sensing properties. This application of these metal nanoparticles is due to localized Surface Plasmon (LSP) or the Surface Plasmon Resonance. This study describes the pH sensing property of Carboxymethyl guar gum/silver nanocomposites (CMGG/Ag NC). For this CMGG/Ag NC was synthesized by the method mention in our previous paper. The pH sensing property of the NC was studied by using UV-vis spectrophotometer. An optical and visual change in the CMGG/Ag NC solution was analysed with the change in pH range from 1-14. The results show that CMGG/Ag NC have a nice ability for pH sensing applications at room temperature.

1. Introduction

Metal nanoparticles (NPs) have been considered a lot attention due to their optical properties that originate from charge-density oscillations, which are referred to as Localized Surface Plasmons (LSP) in the UV-Visible region. Gold, silver and copper have been used mostly for the synthesis of stable dispersions of their nanoparticles. Such nanoparticles have been also used in areas such as photography, catalysis, biological labelling, photonics, optoelectronics and sensors [1-3]. SPR is the collective oscillations of electrons in a solid or liquid excited by incident light. Because these oscillations becomes on the boundary of the metal and the external medium, so these oscillations are very sensitive to any change to this boundary. Thus how much will be the change in the medium there will be similar change in the SPR shift. This is the fundamental principal behind many colour based biosensors [4]. On this basis in this paper a pH sensing property of the Carboxymethyl guar gum/Silver nanocomposites has been studied. For this CMGG/Ag NC was prepared by using green synthesis method as shown in our previous paper [5]. Then its pH sensing properties were analysed by using UV-Vis spectrophotometer. pH measurement has very importance in everyday life of a human being. The pH of the rain water could also be measured and it is experimentally found that most of the rain fall for the first 10-15 minutes is acidic in nature. If the value of the pH is found to be less than the value 5.6 then the rain is thought to be acidic. Therefore pH sensing is considered an important application. A quick pH sensor is always desirable.

So the aim of this work was to find out the pH sensing property of the carboxymethyl guar gum/silver nanocomposite in the room temperature by UV-visible spectrophotometer.

2. Experimental

a. Synthesis of Carboxymethyl guar gum/silver Nanocomposites

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CMGG/Ag NC was synthesized by using green synthesis method as synthesized in our previous paper [5]. Shortly, for the synthesis of CMGG/Ag nanocomposite 2% (w/v) of CMGG [6-7] powder was dissolved in 10 ml double-distilled water (DDW) with constant stirring. Now 10ml of silver nitrate solution was added to this solution and the temperature was increased up to 70oC. The colour of the medium converts from colourless to a clear yellowish brown colour solution after a short time. This confirms the reduction of silver nitrate to silver nanoparticles.

b. Preparation of different pH Solutions

Concentrated Hydrochloric acid and Sodium hydroxide pellets were used for preparation of different pH solution range from 1 to 14 by using pH meter CL 54+ Toshcon Industry Pvt. Lit. Hardwar.

c. pH sensing property of the Carboxymethyl guar gum/Ag Nanocomposites

The pH sensing property of carboxymethyl guar gum/Ag nanocomposites was studied by using UV-visible spectrophotometer. For this different solution of the different pH were prepared freshly in range from 1-14 in a fixed volume of 50 ml. Then a fixed volume of 1ml Carboxymethyl guar gum/Ag nanocomposites was mixed with this. We see that that within some seconds the colour of the different pH solutions start to change figure 1.1 (a and b). The UV-vis spectrum of the all the samples were taken immediately shown in the figure 1.2.

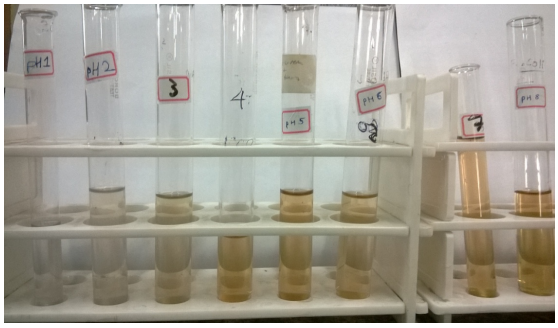

Fig: 1(a).

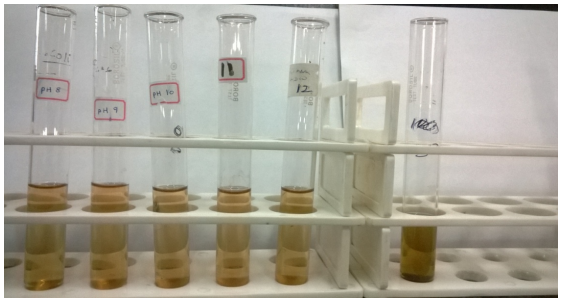

Fig: 1(b).

Fig: 1(a and b). Visual Changes in Carboxymethyl guar gum/Ag Nanocomposites Solution on Increasing pH Range from 1-13

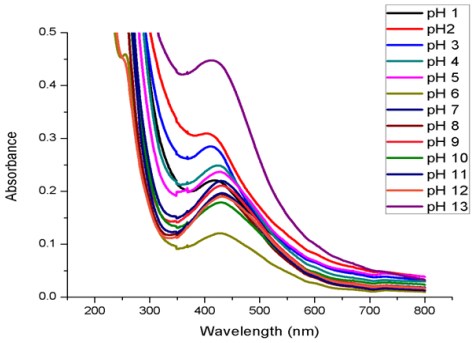

Fig: 2. Optical Changes in the UV-visible Spectrum of Carboxymethl Guar Gum/Ag Nanocomposite on Increasing pH Range from 1 to 13

3. Resluts and Discussion

a. pH Sensing property of CMGG/Ag NC

pH sensing property was tested by using the Surface Plasma Resonance(SPR) property of the Ag NPs in aqueous medium. For this, CMGG stabilized Ag nanocomposites was mixed with different pH solution and then were tested for absorbance spectrum by UV-vis spectrophotometer. A tremendous change in the λmax value was found from 403nm to 430nm for pH 1 to 7 and there was found approx no change in the λmax value for pH range 8 to 13. This pattern of change in λmax shift is shown in figure 1.3. Thus CMGG/Ag nanocomposites show a very good sensing property in pH range from 1 to 7.

b. pH Sensing mechanism of CMGG/Ag NC

This is well known from the literature that CMGG dissociates in small polymer chains and gets dissolve in water in acidic medium. In the synthesis process of CMGG/Ag nanocomposites CMGG works as a stabilizer as well as reducing agent. So this may be possible that when CMGG/Ag Nanocomposites comes in contact to acidic medium, then CMGG start to dissolve in acidic solution and thus the capping of the silver nanoparticles also losses. This causes the starting of agglomeration of the Ag nanoparticles. So λmax shift sharply from 430nm to 403nm. Thus this causes the sensing property of CMGG/Ag nanocomposites. But in basic medium (pH range from 8-13), there has been found no change in the λmax of the CMGG/Ag nanocomposites solution but almost constant figure 1.3. But in the extreme basic medium in pH range 13-14, a fast change in λmax value has been found. This change in λmax value may be due to neutralization process between acidic groups (carboxymethyl) of CMGG and base NaOH. Thus if we plot a graph between λmax value and the pH in the range 1-7. Then we may find out the pH of the unknown solution within seconds.

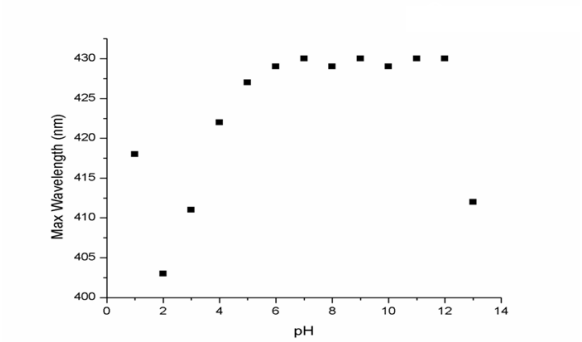

Fig: 3. Changes in λmax value with respect to pH Value

4. Conclusions

A deep study on the effect of change in pH in the CMGG/Ag nanocomposites was done for determining the pH sensing property of the nanocomposites. Very interesting results were found out. CMGG/Ag nanocomposites were found very pH sensitive in range 1-7 but almost insensitive in the basic medium (pH range 8-13). Thus such made CMGG/Ag nanocomposite may be useful as pH sensor in range (1-7). This may be a new tool in nanotechnology for pH sensors. By this process we may find out the pH of any unknown sample in range 1-7 very precisely in few seconds.

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