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A Study on pH sensing Property of Carboxymethyl Guar Gum /Silver Nanocomposites

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ABSTRACT

Some metal nanoparticles have been used as the colorimetric gauges for estimating solution pH and other sensing properties. This application of thesemetal 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-visspectrophotometer. An optical and visual change in the CMGG/Ag NC solutionwas 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 roomtemperature.

Keywords: *pH Sensors; Silver Nanocomposites; Carboxymethyl Guar Gum.*

1.0 Introduction

Metal nanoparticles (NPs) have been considered a lotattention due to their optical properties that originate fromcharge-density oscillations, which are referred to asLocalized Surface Plasmons (LSP) in the UV-Visibleregion. Gold, silver and copper have been used mostly forthe synthesis of stable dispersions of their nanoparticles.

Such nanoparticles have been also used in areas such asphotography, catalysis, biological labelling, photonics, optoelectronics and sensors [1-3].

SPR is the collectiveoscillations of electrons in a solid or liquid excited byincident light. Because these oscillations becomes on theboundary of the metal and the external medium, so theseoscillations are very sensitive to any change to thisboundary.

Thus how much will be the change in themedium there will be similar change in the SPR shift. Thisis the fundamental principal behind many colour basedbiosensors [4].

On this basis in this paper a pH sensing property of the Carboxymethyl guar gum/Silvernanocomposites has been studied. For this CMGG/Ag NC was prepared by using green synthesis method as shown inour previous paper [5]. Then its pH sensing properties wereanalysed by using UV-Vis spectrophotometer. pH measurement has very importance in everyday life of ahuman being.

The pH of the rain water could also bemeasured and it is experimentally found that most of therain fall for the first 10-15 minutes is acidic in nature. If thevalue of the pH is found to be less than the value 5.6 thenthe rain is thought to be acidic.

Therefore pH sensing isconsidered an important application. A quick pH sensor isalways desirable.

So the aim of this work was to find out the pH sensingproperty of the carboxymethyl guar gum/silvernanocomposite in the room temperature by UV-visiblespectrophotometer.

2.0 Experimental

a. Synthesis of carboxymethyl guar gum/silver nanocomposites

CMGG/Ag NC was synthesized by using greensynthesis 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 mldouble-distilled water (DDW) with constant stirring. Now 10ml of silver nitrate solution was added to this solution andthe temperature was increased up to 70oC.

The colour of themedium converts from colourless to a clear yellowishbrown colour solution after a short time. This confirms thereduction of silver nitrate to silver nanoparticles.

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b. Preparation of different pH solutions

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

c. pH sensing property of the carboxymethylguar gum/Ag nanocomposites

The pH sensing property of carboxymethyl guargum/Ag nanocomposites was studied by using UV-visiblespectrophotometer. For this different solution of thedifferent pH were prepared freshly in range from 1-14 in afixed volume of 50 ml.

Then a fixed volume of 1ml Carboxymethyl guar gum/Ag nanocomposites was mixedwith this. We see that that within some seconds the colourof the different pH solutions start to change figure 1.1 (aand b). The UV-vis spectrum of the all the samples weretaken immediately shown in the figure 1.2.

Fig 1: (a and b). Visual Changes in Carboxymethyl Guargum/Ag Nanocomposites Solution on Increasing pH Rangefrom 1-13

Fig: 1(a).

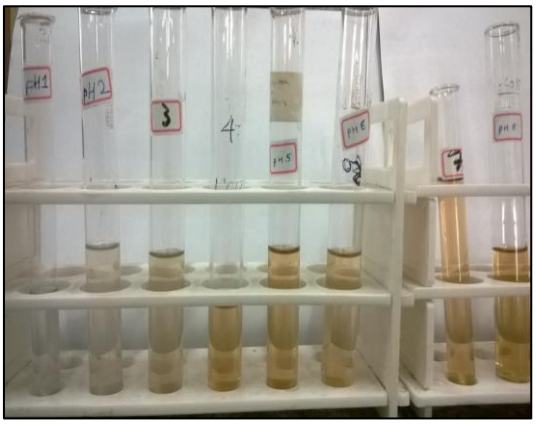


Fig: 1(b).

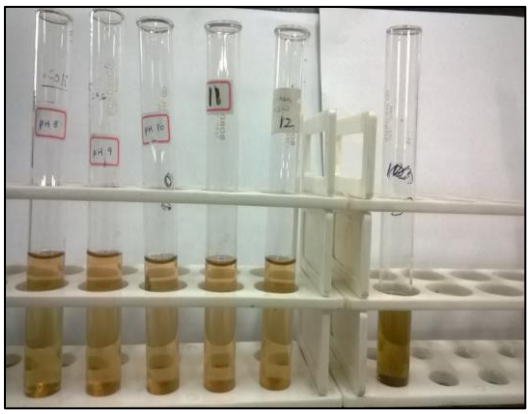
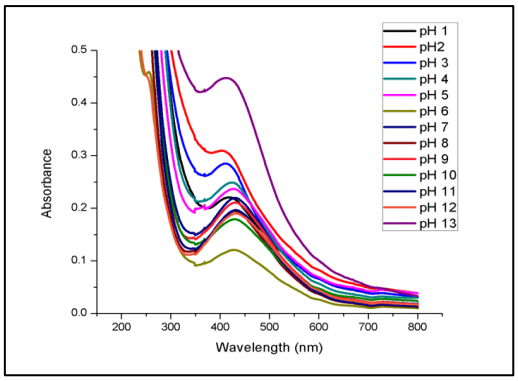


Fig 2: Optical Changes in the UV-visible Spectrum of Carboxymethl Guar Gum/Ag Nanocomposite on IncreasingpH Range from 1 to 13



3.0 Resluts and Discussiona. 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 aqueousmedium. For this, CMGG stabilized Ag nanocompositeswas mixed with different pH solution and then were testedfor 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 approxno change in the λmax value for pH range 8 to 13. Thispattern of change in λmax shift is shown in figure 1.3. Thus CMGG/Ag nanocomposites show a very good sensingproperty in pH range from 1 to 7.

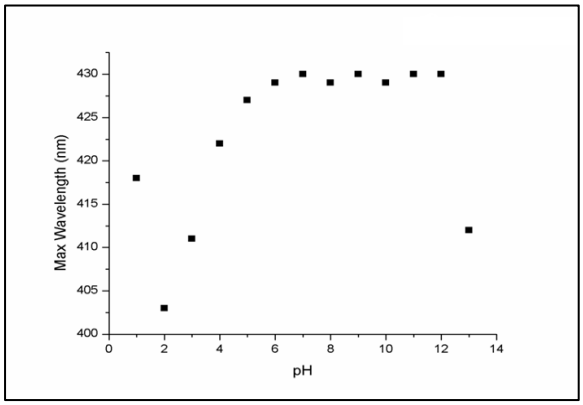
b. pH Sensing mechanism of CMGG/Ag NC

This is well known from the literature that CMGG dissociates in small polymer chains and gets dissolve inwater in acidic medium. In the synthesis process of CMGG/Ag nanocomposites CMGG works as a stabilizer aswell as reducing agent. So this may be possible that when CMGG/Ag Nanocomposites comes in contact to acidicmedium, then CMGG start to dissolve in acidic solution andthus the capping of the silver nanoparticles also losses. Thiscauses the starting of agglomeration of the Agnanoparticles. So λmax shift sharply from 430nm to 403nm. Thus this causes the sensing property of CMGG/Agnanocomposites.

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 constantfigure 1.3. But in the extreme basic medium in pH range 13- 14, a fast change in λmax value has been found. Thischange in λmax value may be due to neutralization processbetween acidic groups (carboxymethyl) of CMGG and base NaOH.

Thus if we plot a graph between λmax value and thepH in the range 1-7. Then we may find out the pH of theunknown solution within seconds.

Fig 3: Changes in λmax value with Respect to pH Value



4.0 Conclusions

A deep study on the effect of change in pH in the CMGG/Ag nanocomposites was done for determining thepH sensing property of the nanocomposites. Veryinteresting results were found out. CMGG/Agnanocomposites 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 usefulas pH sensor in range (1-7). This may be a new tool innanotechnology for pH sensors. By this process we mayfind out the pH of any unknown sample in range 1-7 verypreciselyin few seconds.

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