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RESEARCH ARTICLE

Preparation of carboxymethyl guar gum/silver nanocomposites film and its optical and antimicrobial properties

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Abstract

Carboxymethyl guar gum/silver nanocomposites (CMGG/Ag NC) film was prepared by solution castings method. The aim of this paper was to study optical and antimicrobial activity of the film. The formation of nanocomposites film was confirmed by using SEM, TEM and XRD analysis. Optical properties of the film were tested by UV-Vis and Photoluminescence spectroscopy (PL) respectively. Antimicrobial activity of the CMGG/Ag NC film was studied against gram positive (*Bacillus subtilis*) and gram negative *(Escherichia coli*) bacteria by Kirby-Bauer method. It was found that a little amount of CMGG/Ag NC film was sufficient to inhibit pathogens. The result concludes that such prepared silver nanocomposites film may be effective in medical and clinical applications.

1. Introduction

Modern technologies continuously need new materials with special combination of properties [1]. We need such a material which could be environmental friendly, cost effective, easy forming and storing for long duration, less time consuming with desirable properties. Polymers and nanotechnology have increased the tremendous applications for obtaining these desirable materials. Nanocomposites are one of such material. Polymer nanocomposites are the materials, in which at least one of the components becomes less than 100 nm in one dimension. Due to the similarity in size between nanomaterial's and most biological molecules and structures, nanoparticles can be highly beneficial to use both in vivo and vitro biomedical research and applications [2]. Silver nanocomposites have been used in a lot of antimicrobial and wound healing applications [3-7]. Because of the very fine antibacterial activity of silver nanoparticles [8] many scientist have found that silver-containing materials can be used in medicine to reduce infections as well as to prevent bacteria colonization on prostheses [9], catheters [10-11], vascular grafts [12], dental materials [13], stainless steel materials [14] and human skin [15-16]. Beside from antibacterial abilities, research has revealed that silver ions can also destroy viruses, fungi, protozoa and even cancer cells [17].

This paper is the second part of my previous paper. CMGG/Ag NC were synthesized by my previous paper method [18]. In this paper CMGG/Ag nanocomposites film was prepared by solution casting method to test its antimicrobial and optical properties, so that it might be used in antimicrobial film in medical applications. CMGG is an anionic semi-synthetic guar gum derivative [19]. The polysaccharide backbone is similar to guar gum which is a galactomannan. Among the guar gum derivatives, CMGG is very important because it covers a wide range of industrial applications and has a good film forming property [20].

Although there are a lot of techniques for the synthesis of silver nanoparticles like reduction, thermal decomposition, radiation assisted, electrochemical, sonochemical, microwave assisted process and recently via green chemistry route [21]. But Green synthesis process have some extra benefits over conventional methods like low cost, ecofriendly, large scale synthesis and no need to use high temperature and pressure and toxic chemicals. Especially for medical applications Ag nanoparticles should be made by green synthesis process. So in this research article CMGG/Ag nanocomposite has been synthesized by the green synthesis process. Ultimately the aim of this research

article basically was to prepare CMGG/Ag NC film by solution casting method and to test it's optically property as well as antimicrobial activity against gram positive (*Bacillus subtilis*) and gram negative *(Escherichia coli*) bacterial.

2. Experimental

2.1 Materials

Silver nitrate ($AgNO_3$) was purchase from Merck Germany. Carboxymethyl guar gum was obtained from Hariom gum industry, Gujarat, India. All aqueous solutions were made using doubled distilled (DD) water. All the chemicals were used as they were received, without any purification.

2.2 Synthesis of CMGG/Ag NC

Silver nanoparticles have been synthesized by reduction process as shown in my previous paper [18]. For the synthesis of CMGG/Ag NC, CMGG was used as reducing and stabilizing agent. A fixed CMGG concentration solution was prepared in 10 ml DD water with constant stirring at room temperature. Then the temperature of this solution was raised from (70 to 90) ^oC. Then 10 ml of 15 mM silver nitrate solution was added drop wise, with continuous stirring. After addition of silver nitrate, colour of the solution start to change from colour less to a clear brownish solution within short period. This confirms the formation of silver nanoparticles. Solution was kept in same position for 100min for complete reduction of silver nitrate to silver nanoparticles.

2.3 Preparation of CMGG/Ag NC film

CMGG/Ag NC film was prepared by solution casting method. The viscous CMGG/Ag NC solution was poured in Teflon plate. Then it was dried in oven at 30^OC for overnight. After 24 hours of drying, a fine thin CMGG/Ag NC film was obtained **Fig. 6.** Such obtained film was stored in the desiccators up to further testing.

2.4. Characterization of CMGG/Ag NC film.

CMGG/Ag NC film was characterized by using different techniques. Scanning Electron Microscope (SEM) (HITACHI-S-3700), Transmission electron microscopy (TEM) and XRD (BRUKER D8-ADVANCE) were used to find out the size and shape of silver nanoparticles in the CMGG matrix. UV (UV- Parkin Elmer Lambda -750), Photoluminiscence (PL-fluroLog–made by horiba-3, Horiba Jobin Yvon) testing were done for testing silver nanocomposites optical properties.

2.4.1 Antimicrobial testing

Antimicrobial activity of CMGG/AgNPs NC film was tested by using the disc diffusion or Kirby-Bauer method [22]. Luria Broth (LB) media was used for growth of the bacterial. The inhibition zones were measured after 24 hours of incubation at 37^oC. CMGG/Ag NC films synthesized by various concentration of silver nitrate solution (2.5mM, 5mM, 10mM and15mM) has been tested against gram positive (*Bacillus subtilis*) and gram negative (*Escherichia coli*) bacterial.

3. Results and discussion

3.1 Morphology and optical property of CMGG/Ag NC film.

Recorded UV-Vis spectrum of the CMGG/AgNC film formed by solution casting method agrees well with the result of Ref. [18]. An absorbance band was found between the Ag NPs Surface Plasmon Resonance (SPR) bands (350 to 450 nm). This confirms the presence of silver nanoparticles in the CMGG/Ag NC film. Further XRD analysis of the CMGG/Ag NC film was also tested **Fig. 1**. XRD spectrum was matched with JCPDS file no 01-1164. This confirms present of Ag metal in CMGG/Ag NC film in face central cubic lattice structure. Photoluminescence spectrum is shown in F**ig. 2**. The PL emission spectrum was obtained in visible region (400-600) nm with peak position 435nm. This PL emission in visible region may be due to excitation of electrons from occupied d bands into states above the Fermi level [22].

Morphology of the AgNPs in CMGG/Ag NC film was investigated by using SEM and TEM analysis **Fig. (3,4).** From the SEM image **Fig. 3**, it is clear that some particles are present in the film. Further the TEM image of the CMGG/Ag NC film confirms the formation of Ag nanoparticles in less than 20nm size with spherical shape **Fig. 4**. This also confirms the formation of CMGG/Ag NC film.

3.2 *Antimicrobial activity of CMGG/Ag NC film.*

The antimicrobial activity of CMGG/Ag NC film was tested against gram positive and gram negative bacteria, by using Kirby-Bauer method. This method has been found suitable for determining susceptibility and standard zones of inhibitions by many scientists [23]. According to this method, Luria Broth (LB) media was used for growing gram positive (*Bacillus subtilis*) and gram negative *(Escherichia coli*) bacterial. After this CMGG/Ag NC films prepared from different concentration of silver nitrate solutions (I = 2.5mM, II = 5mM, III = 10mM and IV = 15mM) were cut in a circular shape with same size. Then these films were put in the inoculated plates and stored for 24hours at 37^{o}C in incubator. Then zones of inhibition were measured by scale. Inhibition zone created by CMGG/Ag NC films against gram positive (*Bacillus subtilis*) and gram negative *(Escherichia coli*) bacterial are shown in **Fig. 5**. Inhibition zones diameter (in millimetres) around the different CMGG/Ag nanocomposites film was also found out **Table 1**. It was found that a CMGG/Ag NC film made from very little amount of $AgNO_3$ (2.5mM) was sufficient to inhibit both bacterial growth with 20mm of inhibition zone.

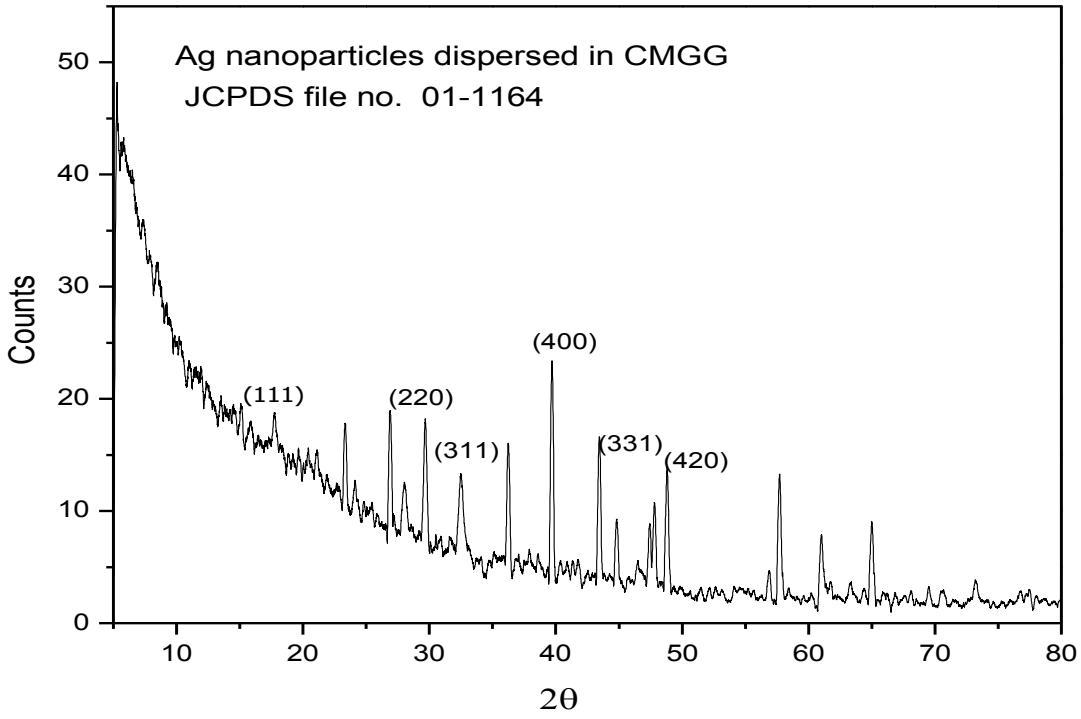

Fig. 1. XRD spectrum of CMGG/Ag nanocomposites film

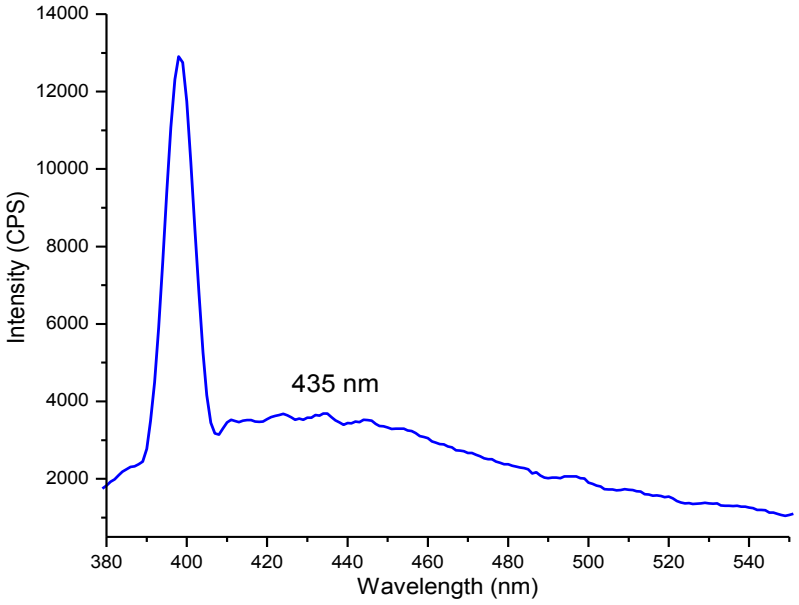

Fig. 2. Photoluminescence spectrum of CMGG/Ag NC film

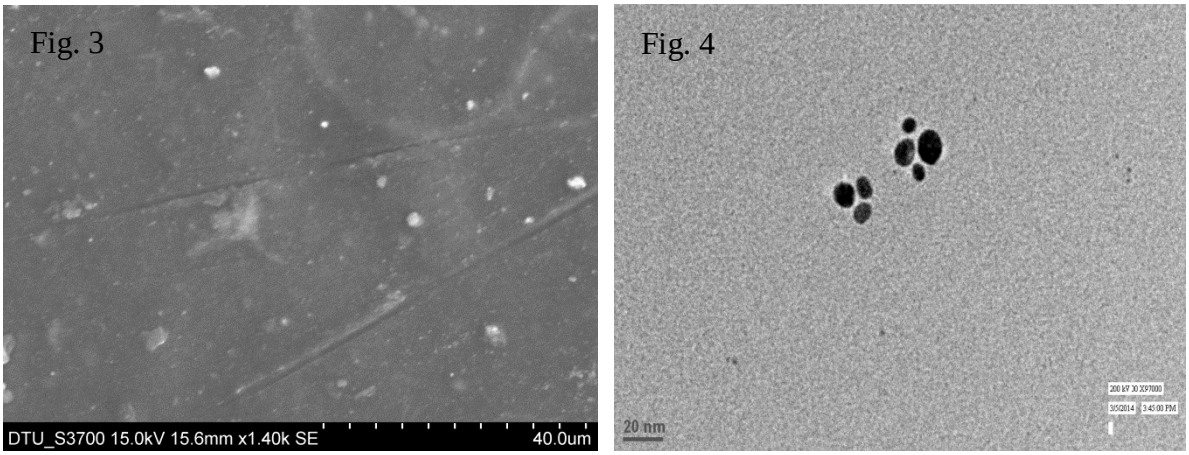

Fig. (3,4). SEM and TEM images of CMGG/Ag nanocomposites film.

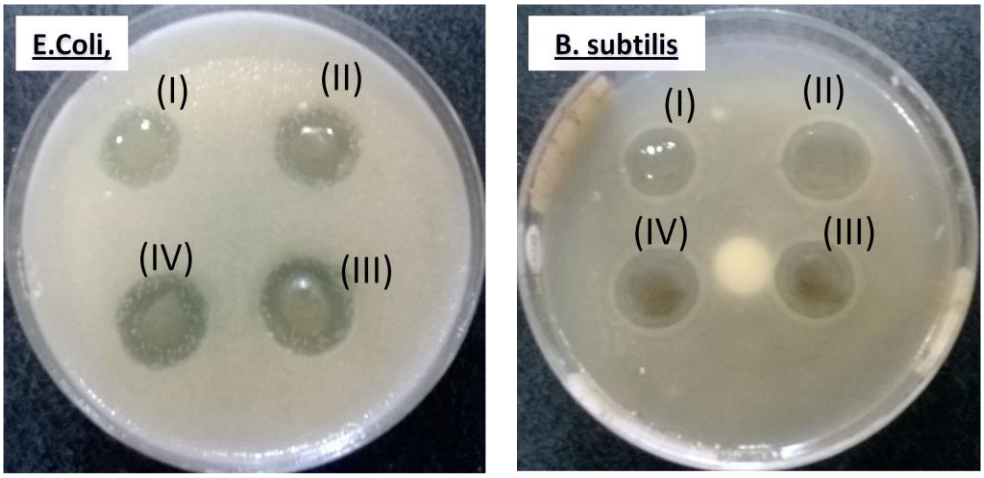

Fig. 5. Inhibition zones against various bacteria with different CMGG/Ag nanocomposites films synthesized by various concentrations of $AgNO_3$ solutions (I = 2.5 mM, II = 5 mM, III = 10 mM and IV = 15 mM).

S. No	Concentration (mM) of $AgNO_3$ used	Inhibition (mm) zones against various bacteria after 24 hours	
		E. Coli	B. subtilis
1.	2.5	20	20
2.	5.0	21	20
3.	10	22	22
4.	15	22	22

Table 1. Inhibition zones (mm) against E. coli and B. subtilis bacteria with CMGG/Ag NC films made by various concentrations of $AgNO_3$.

Fig.6. CMGG/Ag nanocomposites film

4. Conclusions

CMGG/Ag NC film has been prepared successfully by solution casting method. Size of the Ag nanoparticles in the film was found less than 20nm which was confirmed by TEM. Nanocomposite film was found very effective against gram positive (*Bacillus subtilis*) and gram negative *(Escherichia coli*) bacteria. Because this nanocomposites film has been synthesized by green method and no toxic material has been used, so this film may be very effective for medical and clinical applications. This film may also be used for the storage of Ag nanoparticle for long duration.

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References

[1] Tamboli M S, Kulkarni M V, Patil RH, Gade WN, Navala SC and Kale BB 2012 *Colloids and surfaces B Biointerfaces.* **92** 35.
[2] Singh M, Singh S, Prasad S and Gambhir I S 2008 *Digest Journal of Nanomaterials and Biostructures*, **3(3)** 115.
[3] Balogh L, Swanson D R, Tomalia D A, Hagnauer G L and McManus A T 2001 *Nano Letter,* **1(1)** 18.
[4] Schrand A M, Braydich-Stolle L K, Schlager J J, Dai L and Hussain S M 2008 *Nanotechnology*. **19** 235104.
[5] Ciobanu C, Gavriliu S, Lungu M, Gavriliu L and Ciobanu L C 2009 *The Open Chemical and Biomedical Methods Journal*. **2** 86.
[6] Hettiarachchi M A and Wickramarachchi PASR 2011 *J. Sci. Univ. Kelaniya.* **6** 65.
[7] Chellamani K P, Sundaramoorthy P, Sureshram T 2012 *International Journal of Emerging Technology and Advanced Engineering* **2(11)** 176.
[8] Panacek A, Kvitek L, Prucek R, Kolar M, Vecerova R, Pizurova N, Sharma V K, Nevecna Tand Zboril R 2006 *J. Phys. Chem. B.* 110 (33) 16248.
[9] Roldán M V, Frattini A L, Sanctis O A and Pellegrini N S 2005 *Anales AFA* **17** 212.
[10] Yin H, Yamamoto T, Wada Y and Yanagida S 2004 *Materials Chemistry and Physics* **83** 66.
[11] Zhu Z, Kai L and Wang Y 2006 *Materials Chemistry and Physics* **96** 447.
[12] Edelstein A S, Cammarata R C 1996 *Nanomaterials, synthesis, properties and applications*, (Bristol and Philadelphia Publishers, Bristol).
[13] Maillard M, Giorgo S and Pileni MP 2002 *Adv. Mater.* **14(15)** 1084.

[14] Mock J J, Barbic M, Smith D R, Schultz D A and Schultz S 2002 *J. Chem. Phys*. **16(15)** 6755.
[15] Duran N, Marcato P L, Alves O L and De Souza G I (2005) *J. Nanobiotechnology* **3(8)** 1.
[16] Guzmán M G, Dille J and Godet S 2009 *Int. J. Chemical and Biol. Eng.* **2(3)** 104.
[17] Sung H J, Yun H H and Sung C Y 2005 *J Material Sci.* **40(20)** 5413.
[18] Gupta A P and Verma D K 2014 *Adv. Nat. Sci.: Nanosci. Nanotechnol.* **5** 035018.
[19] Gong H, Liu M, Chen J, Han F, Gao C and Zhang B 2012 *Carbohydrate Polymers*, **88(3)**1015.
[20] Gupta A P and Verma D K 2014 *Int. J. Biol. Macromol.* **68** 247.
[21] Geethalakshmi R and Sarada D V L 2010 *Int. J. Eng. Sci. and Tech.* **2(5)** 970.
[22] Vasireddy R, Paul R and Mitra A K 2012 *Nanomaterials and Nanotechnology*. **2(8)**1.
[23] Lawrence W, Barry AL, O'toole R, Sherris J C (1972) *Applied Microbiology* **24(2)** 240.