Antibacterial activity and stability of silver nanoparticles in gelatin matrix papered through a rapid room temperature chemical route

Mostafa Yazdi Mamaghani 1, Masoud Mozafari 1, Vahid Shabafrooz 1, Daryoosh Vashaee 2, Lobat Tayehe 1,3

1 Helmerich Advanced Technology Research Center, School of Material Science and Engineering, Oklahoma State University, OK 74106, USA
2 Helmerich Advanced Technology Research Center, School of Electrical and Computer Engineering, Oklahoma State University, OK 74106, USA
3 School of Chemical Engineering, Oklahoma State University, Stillwater, OK 74078, USA

Abstract:
In this study, silver nanoparticles (Ag-NPs) have been successfully prepared through a simple and green method by reducing Ag+ ions in aqueous gelatin media with different concentrations. For this purpose, biology grade gelatin was used as a reducing and stabilizing agent. The effect of gelatin concentration on the particle size and the antibacterial activity of Ag-NPs have been investigated. Surprisingly, it has been found out that with increasing the gelatin concentration the antibacterial activity is also increased. However, the size of particles varied with the increase of concentration. Even though no chemical reducing or stabilizing agent has been used, after three months not only any reduction in intensity of peaks has been observed, but also the reduction of some remained silver salts with the time has been occurred.

1. Preparation of the Ag-NPs:
For synthesis of Ag-NPs, different concentrations of gelatin have been added to distilled water in a flask, and the solutions have been stirred to obtain a clear solution. To obtain the silver/gelatin solutions, the silver solutions (10 mL, 1 M) have been added to the gelatin solution with continuous stirring. The obtained solutions have been stirred and maintained for 48 hours at room temperatures. All the solutions have been kept in dark to avoid any photochemical reactions during the experiment. We named the samples as Gelatin (GA0), Gelatin/Ag 5mMolar (GA5), Gelatin/Ag 10mMolar (GA10), Gelatin/Ag 20mMolar (GA20) and Gelatin/Ag 40mMolar (GA40) suspensions.

Fig. 1. Optical images of GA0, GA5, GA10, GA20 and GA40 suspensions.

As can be clearly seen in Fig. 1, the sample GA0 was colorless. Right after addition of silver even in small amounts an obvious color change has been observed. This color change (dark brown) has been observed for all the silver contained samples, which is due to the formation of Ag nanoparticles in the gelatin media [1,2].

2. Ultraviolet-visible absorption spectra of Ag-NPs:
The color of the solutions which underwent the reduction process changed from colorless to dark brown [3]. These color changes indicated the formation of Ag nanoparticles formed in the gelatin solution which is further proven by UV-visible spectrum in Fig. 2.

Fig. 2. Ultraviolet-visible absorption spectra of Gelatin (GA0), Gelatin/Ag 5mMolar (GA5), Gelatin/Ag 10mMolar (GA10), Gelatin/Ag 20mMolar (GA20) and Gelatin/Ag 40mMolar (GA40) suspensions.

As can be seen in this figure, around 430 nm an obvious peak was detected due to the existence of the synthesized nanoparticles. It is known that silver has a surface plasmon resonance (SPR) which causes this peak. With increase of concentration of silver, we observed a slight shift of the peak toward higher wavelength because of the particle size increase of the particles. Since the concentration of GA20 has smaller particle size silver in comparison with the sample GA40, it shows higher intensity. It can be also concluded that in the concentration of 40 there will be some agglomerations of silver nanoparticles [4].

In addition, after three month not only any reduction in the intensity of the peaks has been seen, which shows that our prepared suspension is stable, but also a minute increase related to reduction of some remained silver salts with the time has been seen [5].

3. Summary:
In this study, a green method to synthesize Ag nanoparticles has been developed using a using gelatin as a green agent without special physical conditions. The Ag nanoparticles obtained in the presence of gelatin were in the range of nano, which can be related to the rate of the reduction process. The most advantage of this work is using a renewable material like gelatin, which are eco-friendly agent.