Effects of Varying Silver Concentrations

Rahul Ajmera, CRESH student, Houston High School
Mentor: Dr. Sanjay Mishra, Ph.D. Department of Physics, University of Memphis, Memphis, TN

Introduction

Silver Nanoparticles have gained interest in recent years along with other polymer and nanometric metal particles. Known for its antibacterial uses, silver is used for dental operations and for burn wounds. The small size of the particles allows for antibacterial targeting in the body. The nanoparticles can be created using a variety of methods: spark discharging, electrochemical reduction, solution irradiating and cryochemical method. Solution chemistry provides ample control over size and shape. The particle shape and size are particularly important in the synthesis of the silver nanoparticles, as a differently sized and shaped particle offers different capabilities and uses. A reducing agent is used when creating the particles; in this case, polyvinylpyrrolidone (PVP). Since PVP is water-soluble, it is used in many pharmaceutical drugs to bind and coat the substance. It is also used similarly for silver nanoparticles. In this study, we are investigating the effect of PVP on varying silver concentrations.

Materials and Methods

- Silver Nitrate(AgNO3)
- PVP
- Acetone
- Scale(grams)
- Beakers
- Magnetic Stirrers
- Graduated cylinder
- Water

METHOD: 4 different amounts of AgNO3 were measured (50mg, 100mg, 150mg, 200mg) and mixed into water. 40 mL of acetone was added to all the solutions and then magnetically stirred for 15 min. Once mixed, 2.0 grams of PVP were added to each sample, and then allowed to mix for 35 minutes. All 4 of the samples (50mg, 100mg, 150mg, 200mg) were dried at room temperature for almost 2 days; turning into an orange-black color. The 100mg and 150mg samples did not dry as well as the 50mg and 200mg samples. For UV-Vis, the samples were dissolved into ethanol; for XRD, the samples were crushed into a powder. For both TGA and TEM, very small samples were taken.

Results and Discussion

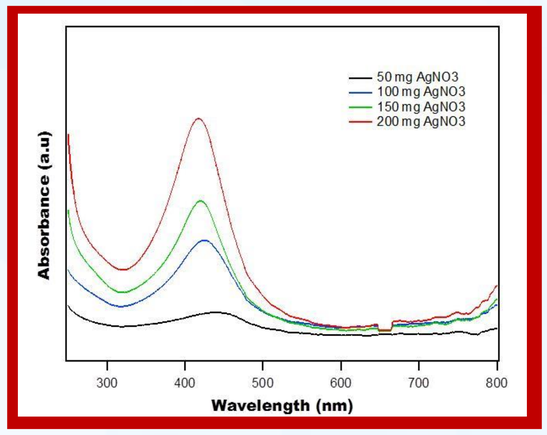

Fig.1: UV- vis absorption spectra for different concentrations of AgNO3 in Ag/PVP nanoparticles

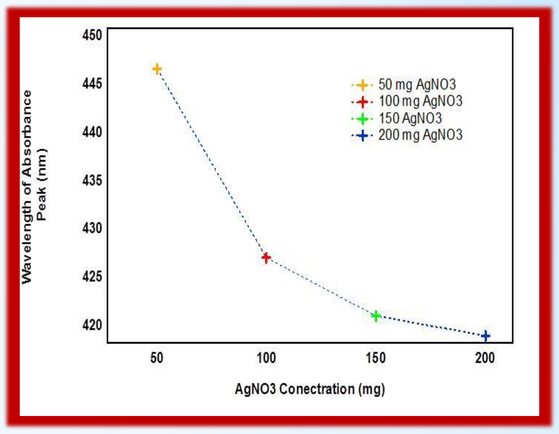

Fig. 2: UV-vis absorption peaks for each sample

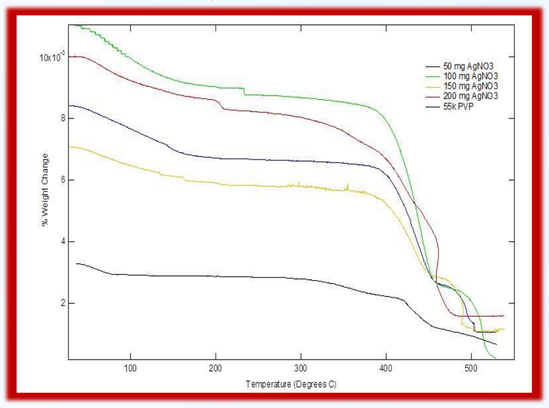

Fig. 3: Curve of the TGA thermogram of Ag/PVP nanoparticles and 55k PVP showing weight loss

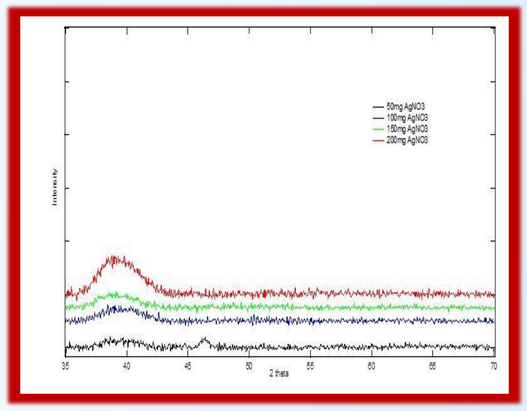

Fig.4: XRD data shows presence of silver in the synthesized sample

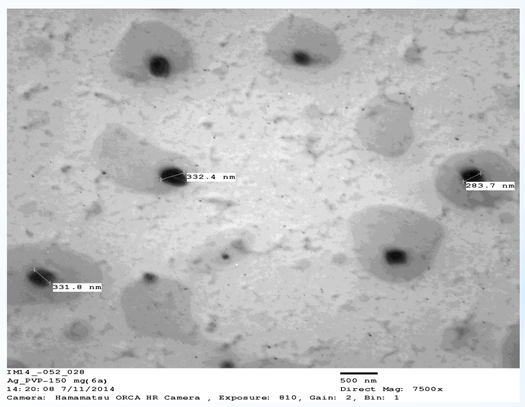

Fig. 5: Particle size of Ag particles; those labeled ranging from 283-333nm

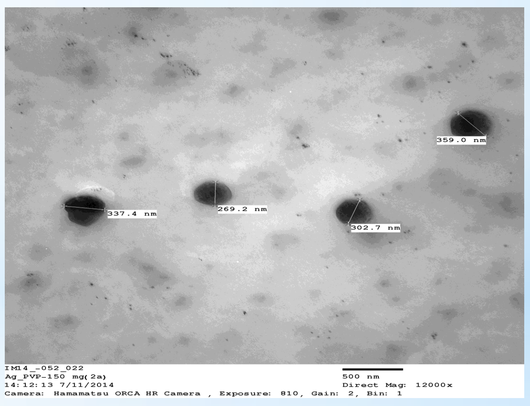

Fig.6: Particle size of Ag particles; those labeled ranging from 269-359nm

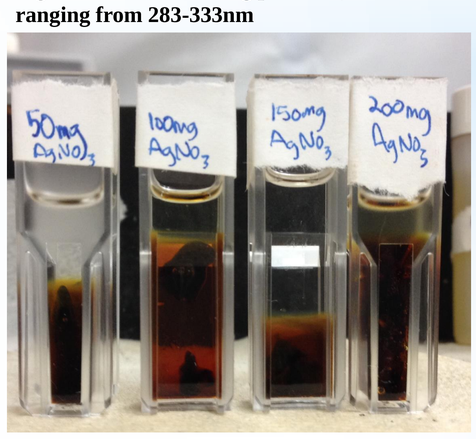

Fig.7: Colors of samples being dissolved in ethanol

Conclusion: As the silver concentration was increased, the particles absorbed light at a shorter wavelength according to the UV-vis graph. The broadness of the peaks of each sample indicates larger particle sizes. As the peak gets narrower, particle size gets larger. In addition, the temperature needed to induce weight loss was higher as the silver concentration rose; as evidenced by the TGA data. This is due to silver's higher resistance to heat; with a melting point of 961.8°C. With more silver, the percent weight loss at certain temperatures is expectedly less.

Conclusion

Our results, based on tests conducted by UV-vis, TGA, XRD, and TEM, coincide with the results of many others. By increasing the concentration of silver in the Ag/PVP compound, particle size is increased. Other effects of increasing silver concentrations include light absorption at shorter and shorter wavelengths as silver is added, and a display of increased heat resistance until around 480 °C. After this, silver becomes the main, if not only, particle in the sample.

References

[1] Lee, C. G. Comparative study of the Ag/PVP nanocomposites synthesized in water and in ethylene glycol. *Current Applied Physics*, S346-S349. Retrieved July 14, 2014, from http://www.sciencedirect.com/science/article/pii/S1567173910004074 [2] Du, R. Size-controlled preparation of silver nanoparticles by a modified polyol method.*Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 197-202. [3] Synthesis and Characterization of Silver/Polyvinilpirrolidone (Ag/PVP) Nanoparticles Using Gamma Irradiation Techniques. *American Journal of Applied Sciences*, 892-901.

Acknowledgments

Dr. Sanjay Mishra, Ph.D. Department of Physics, University of Memphis, Memphis, TN
William Armstong, Department of Physics, University of Memphis, Memphis, TN