

# SILVER NANOPARTICLES: CORRELATION BETWEEN STRUCTURAL AND ANTIMICROBIAL PROPERTIES

Maine South High School

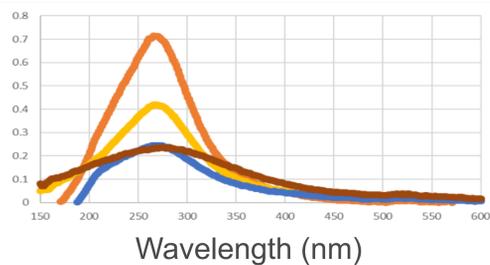
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## ABSTRACT

- In this project, we studied the structural properties of Silver nanoparticles in solution by X-ray Absorption Spectroscopy, Scanning Electron Microscopy and Spectrophotometric Analysis with the goal of obtaining information on the physical and chemical characteristics of these particles and their antimicrobial properties.

## SPECTROPHOTOMETRIC ANALYSIS

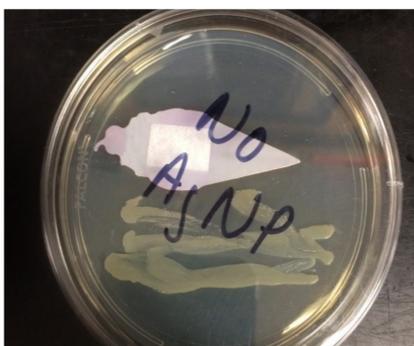
Spectrophotometric Analysis was performed at the Learning Center in the Argonne National Laboratory. The Ag standard solutions were diluted with water to achieve an absorbance compatible with the equipment range. The cuvette blank was recorded. A second cuvette with one of the standard solutions was inserted in the equipment and the absorbance recorded. The goal was to correlate the absorbance of each standard solution with its concentration. After measuring the standard solutions, a new blank was recorded using the starch solution used for the synthesis. After that, the synthesized silver nanoparticle solution was measured. Considering the nanoparticles size for each standard solution was known it would be possible to find the nanoparticles size comparing it with the synthesized solution. Spectrophotometric results comparing the 40nm standard (orange, yellow and blue) with synthesized sample (blue).



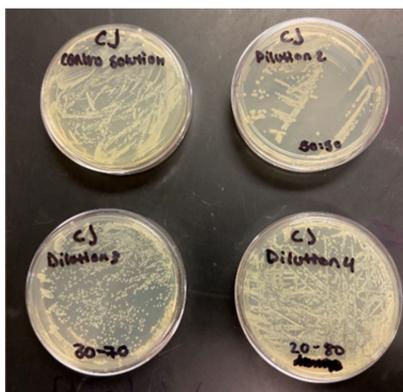
Standard 1 ———  
 Standard 2 ———  
 Standard 3 ———  
 Sample ———

## BACTERIA GROWTH

- The bacteria were spread over the entire surface of the agar.
- Using sterilized scissors and forceps, a pad of an untreated Band-Aid was cut and also a piece of one commercial silver Band-Aid. 2.0 mL of silver colloid solution was placed on one untreated pad.
- In addition, three dilutions of silver colloid solutions were spread directly on the plates for comparison. The petri dishes were incubated for 24 hours in either a 37°C oven or other warm place. After 24 hours, visual and photographic analysis were collected of bacterial growth.



Bacteria growth on dilution plates (left) and bandages (above)

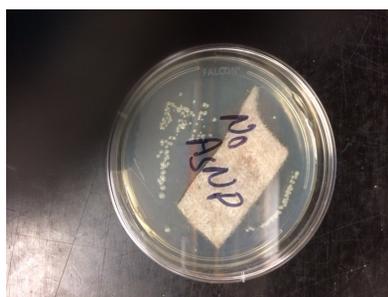


## CONCLUSIONS

- The Ag nanoparticles synthesis was successful as observed in the microscopy and spectrophotometric results. The particles could be observed and the absorption band corresponded to the same wavelength as the Ag nanoparticles standards. However, from the X-ray absorption results it was not possible to conclude its formation due to the excess of the precursor AgNO<sub>3</sub> in the solution. In addition, the presence of the starch also harmed the microscopy images.
- The dilution results look promising as antimicrobial.
- The growth on the bandages was not definitive
- Bacteria growth on commercial silver bandages (right)

## NEXT STEPS

- Thus, the synthesis protocol should be reevaluated and probably an additional precipitation step should be included to isolate the nanoparticles.
- Further research is indicated to determine the antibiotic properties of Ag nanoparticles
- Next time, additional bacterial growth tests would be completed for comparison, perhaps using pGlo bacteria for easier assessment



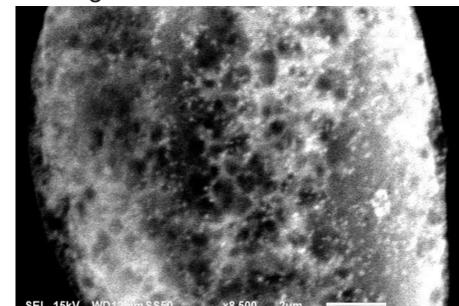
## SYNTHESIS METHOD

The silver nanoparticles synthesis was performed at Maine South High School. 10 mL of 0.1M AgNO<sub>3</sub> was mixed with 10 mL of 0.1M α-D-glucose. 10 mL of 0.2% wt. soluble starch solution was added into the silver solution. The final solution was heated on a hot plate until boiling vigorously. The solution was not stirred while boiling for 10 min.



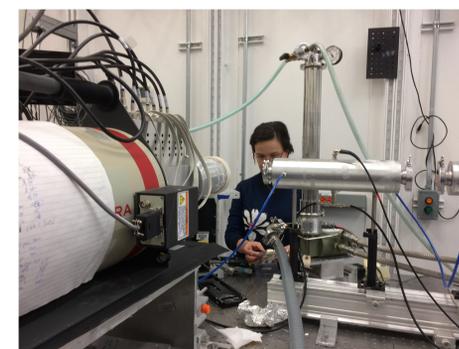
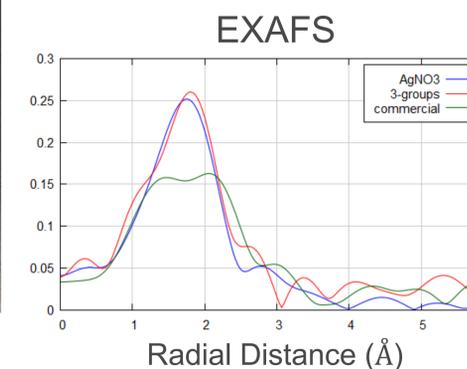
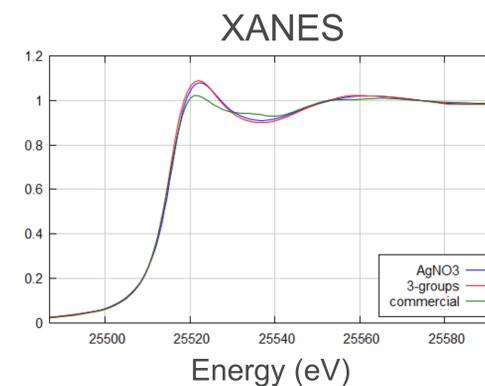
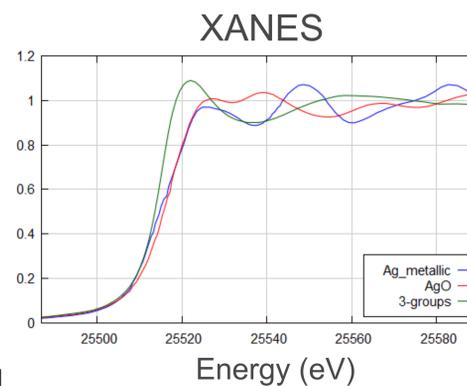
## SCANNING ELECTRON MICROSCOPE

- Scanning Electron Microscopy was performed at the Learning Center in the Argonne National Laboratory. A carbon tape was attached to the sample holder. A drop of the silver nanoparticles solution was placed on top of the tape. The solution was dried in an oven. Images were collected at 15kV and 8,500 magnification.



## X-RAY ABSORPTION METHODS AND RESULTS

- X-ray absorption near-edge structure (XANES) and extended X-ray absorption fine structure (EXAFS) at Ag K-edge (25514 eV) were measured at 20-BM of the Advanced Photon Source at Argonne National Laboratory. A Si (111) fixed-exit, double-crystal monochromator was used, and harmonic rejection was facilitated by a 15% detuning of the beam intensity at 500 eV above the edge. Data was collected in fluorescence mode using a 13-element Ge detector



## REFERENCES

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- Silver as an antimicrobial agent: [http://microbewiki.kenyon.edu/index.php/Silver\\_as\\_an\\_Antimicrobial\\_Agent#Current\\_uses](http://microbewiki.kenyon.edu/index.php/Silver_as_an_Antimicrobial_Agent#Current_uses)
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