

# Characterization, and toxicity results on silver and gold nanoparticle samples

Mikkel Leslie, Dylan Stankus, Dr. Jeff Nason, Kate Saili, Dr. Stacey Harper

## Introduction

Nanoparticles are particles with a diameter from 1 nanometer to 100 nanometers.

There properties differ from larger particles because of their larger surface area to volume ratio. Gold compounds have been used to treat rheumatoid arthritis and other autoimmune diseases for over 75 years. Currently, studies are currently being done to determine the mechanism that makes this treatment work.

### Zeta potential is used to measure the charge stability of a solution.

It indicates the degree of repulsion for adjacent similarly charged particles. A large zeta potential value indicates a stable colloidal solution that will resist aggregation, while a zeta potential closer to zero will tend to coagulate or flocculate.

Zeta Potential [mV]	Stability behavior of the colloid
from 0 to $\pm 5$ ,	Rapid coagulation or flocculation
from $\pm 10$ to $\pm 30$	Incipient instability
from $\pm 30$ to $\pm 40$	Moderate stability
from $\pm 40$ to $\pm 60$	Good stability
more than $\pm 61$	Excellent stability



## Causes for different measurements

1. Inflammation assays were done to measure the effect that different nanoparticles had on inflammation.
2. Toxicity results were obtained to determine whether the nanoparticles found that best helped inflammation could be used without killing or harming the subject.
3. Zeta potential was acquired for each sample to characterize the nanoparticles and find any correlations between zeta potential and inflammation or toxicity.

Samples were prepared by Dr. Koen Verduysee of Tennessee State University. The samples were then delivered to Dr. Stacey Harper and Kate Saili for the measurement of inflammation and toxicity to zebrafish. Afterward, samples were characterized through zeta potential measurements.

## Objectives

- > Characterize nanoparticle samples by measuring zeta potential.
- > Determine whether there are correlations between zeta potential, toxicology, and inflammation results.

## Methods

### Toxicity

Ions and nanoparticles of silver and gold were tested for toxicity by exposing 0-5 days post fertilization embryonic zebrafish to dilutions of sample solutions in buffered water. At five days, mortality was determined.

### Inflammation

Larvae, three days post fertilization were exposed overnight to 1  $\mu$ M silver and gold nanoparticle samples. Amputation then followed of just interior to the pigment-less region at the tail. Immediately after this they were placed in a solution of 1  $\mu$ M test compound and 20  $\mu$ g/mL lipopolysaccharide (LPS) in order to induce a greater response. The larvae next were incubated for eight hours. Afterward, the larvae were euthanized and the caudal fins were photographed with a 10x objective on Zeiss (FITC). Following this the cells were quantified within a pre-set AOI (a circle centered at the center of the amputation plane) using ImageProPlus. Inflammation results were not able to be obtained in time for presentation.

### Zeta Potential

Analysis was done by a Brookhaven Instruments Corporation Zeta Potential Analyzer. Samples were prepared for the analyzer by being thawed, diluted, and placed into a cuvette where a zeta potential electrode was added.

Results from the zeta potential measurements were assumed to be from only the gold or silver nanoparticles.



## Results

### Various ligand groups variance on zeta potential

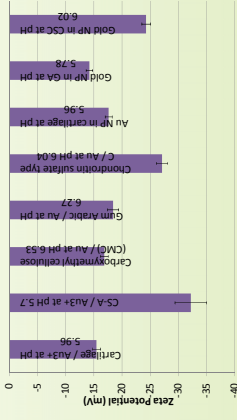


Figure 1: Gold nanoparticles with various ligand groups and given pH

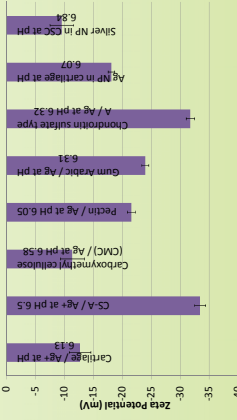


Figure 2: Silver nanoparticles with various ligand groups and given pH

### Zeta potential/toxicology results for varying ligand groups

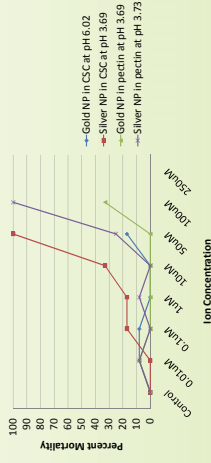


Figure 3: Toxicology results for various samples

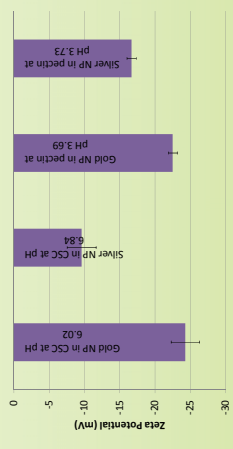


Figure 4: Zeta potential results for same samples that toxicology results were obtained for

## Results

### Old vs. New samples Zeta potential comparison

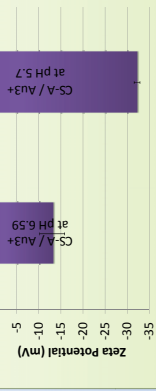


Figure 5: Samples of gold nanoparticles run at different times, CSA is Chondroitin sulfate type A, Au<sup>3+</sup> is gold ions

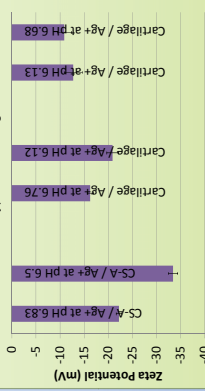


Figure 6: Samples of silver nanoparticles run at different times, CSA is Chondroitin sulfate type A, Ag<sup>+</sup> is silver ions

## Conclusions

- > Various ligand groups make a large difference on zeta potential as results show from figure's 1 and 2.
- > At lower zeta potentials toxicity to zebrafish increases. Also silver nanoparticles have smaller zeta potential and thus higher toxicity. Both of these can be seen from figure's 3 and 4.
- > Sample storage affects characterization results. Figure's 5 and 6 show different zeta potential results for samples with varying time's of measurement and various freezing and thawing procedure's.

## Acknowledgments

Subsurface Biosphere Initiative Undergraduate Internship

## References

- <http://medicinenetworld.org/cancer/lead/2-2006/how-gold-works-in-arthritis.html>
- [http://www.eorthopod.com/public/patient\\_education/6589/joint\\_injections\\_for\\_arthritis.html](http://www.eorthopod.com/public/patient_education/6589/joint_injections_for_arthritis.html)
- [http://en.wikipedia.org/wiki/Zeta\\_potential](http://en.wikipedia.org/wiki/Zeta_potential)
- [http://www.malvern.com/LabEng/technology/zeta\\_potential/zeta\\_potential\\_LDE.htm](http://www.malvern.com/LabEng/technology/zeta_potential/zeta_potential_LDE.htm)