Characterization Techniques for Silver/ Gold Nanoparticles for its applications against *Staphylococcus aureus*

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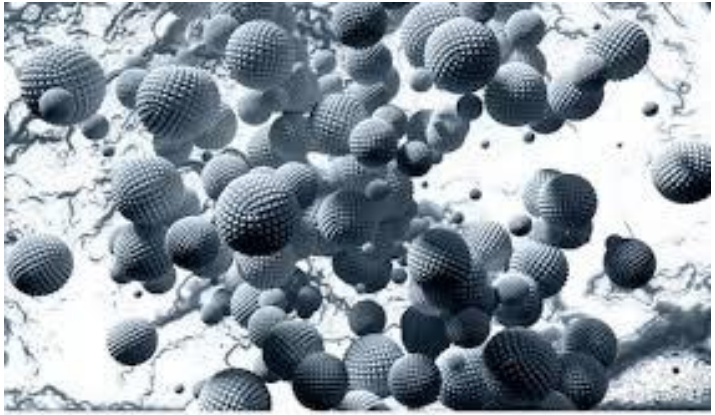
Introduction

Characterization is necessary, since the properties of Silver/ Gold nanoparticles tend to vary, since said properties are affected by the surface area, size, morphology, agglomeration, surface charge, coating, Zeta potential, dissolution rate and purity of the particle.



Main Objective

- Describe in the depth some characterization techniques that could be used to produce an accurate characterization of Ag/Au NP’s which antibacterial against *Staphylococcus aureus* will be tested.

- Select the most ideal characterization techniques to use on the thesis project

Characterization techniques

UV-vis

Purpose: It is used to visualize the reproducibility of the synthesis, as well as the stability of the colloids over time by comparing the absorption spectra measured through time. It can also be used to give an estimation of concentration, degree of agglomeration and size of the particles.

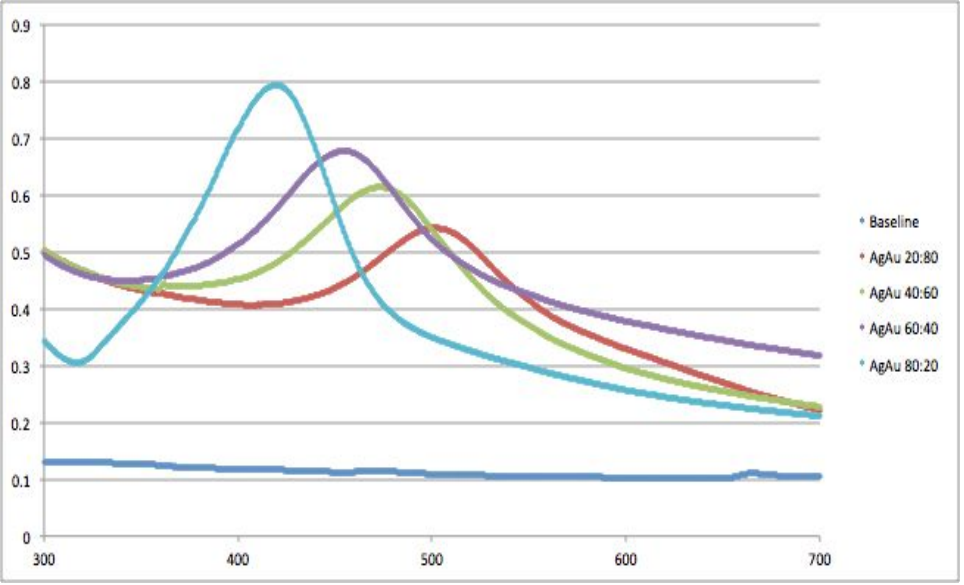
Preparation: Absorption spectra of the colloidal Ag/Au NPs needs to be measured in the range between 300 and 700 nm.

The samples should be diluted in water

XRD

Purpose: Used to confirm the crystalline nature of the bimetallic NP's and to study the structural properties of the NP's.

Preparation: 6-8 mL of colloidal sample are evaporated dropwise on a microscope slide. Patterns are obtained using a Rigaku Miniflex 600 diffractometer operating with a voltage of 40 kV, current of 15 mA, and Cu-Kα radiation (λ = 1.542 A) at room temperature, using a step width of 0.05◦(2θ) and scan speed of 1◦/min.

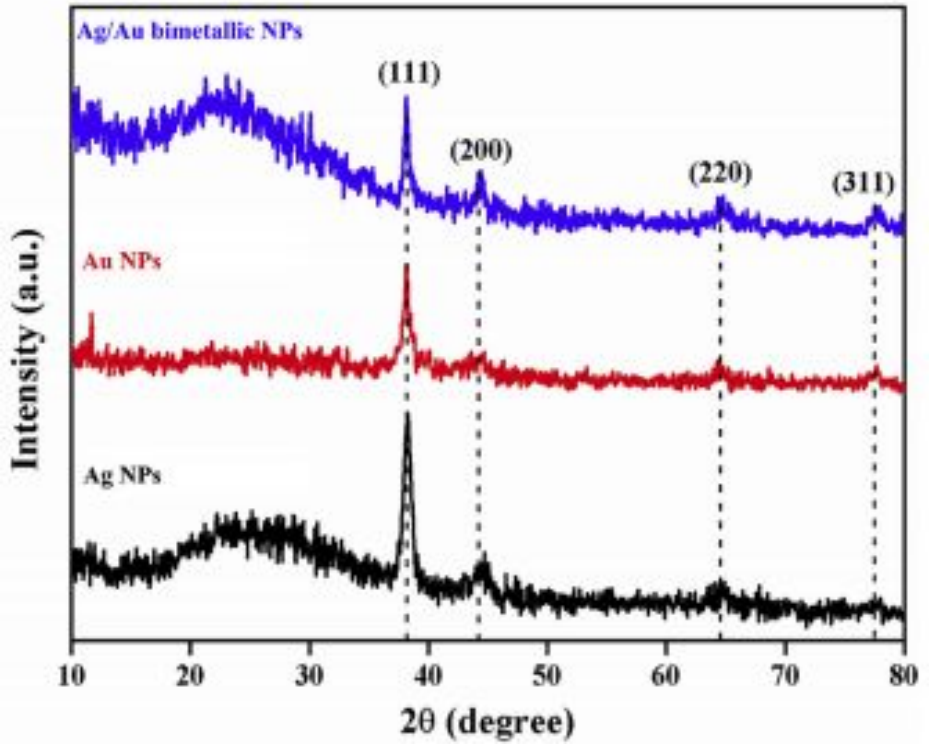


UV-vis

Expected bands of Ag/Au NP's for different concentrations (Red: 20:80, green: 40:60, purple 60:40 and light blue 80:20). Corresponds to absolute absorbance. Axis X corresponds to the wavelength, while Axis Y corresponds to the absorbance.

XRD

Expected patterns of the Ag/Au NP's. Because of its composition, the bimetallic NP's peaks are similar (or should be very similar) to the ones of Ag and Au.



SEM:

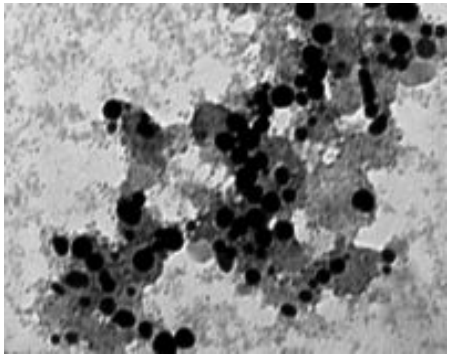
Purpose: It is used to reveal the exact size, shape, morphologies and dispersion of the nanoparticles focusing on the sample's surface. Images are in 3D with high resolution.

Preparation: The NP are prepared placing a drop of this suspension on a carbon-coated SEM grid.

TEM:

Purpose: It is used to reveal the exact size, shape, morphologies and dispersion of the nanoparticles, as well as crystallization, stress and magnetic domains. Images are in 2D with high resolution.

Preparation: The NP are prepared by drop-coating onto carbon-coated copper grids



TEM image of bimetallic NP's extracted synthetized from *Swietenia mahogani.* Most of the NP's are spherical with uniform size distribution.

FT-IR:

Purpose: Used to identify the possible biomolecules responsible for capping and efficient stabilization of the bimetallic NPs synthesized. In this case, it is simply used to confirm the presence of starch as the stabilizing agent of the noble metal NP's.

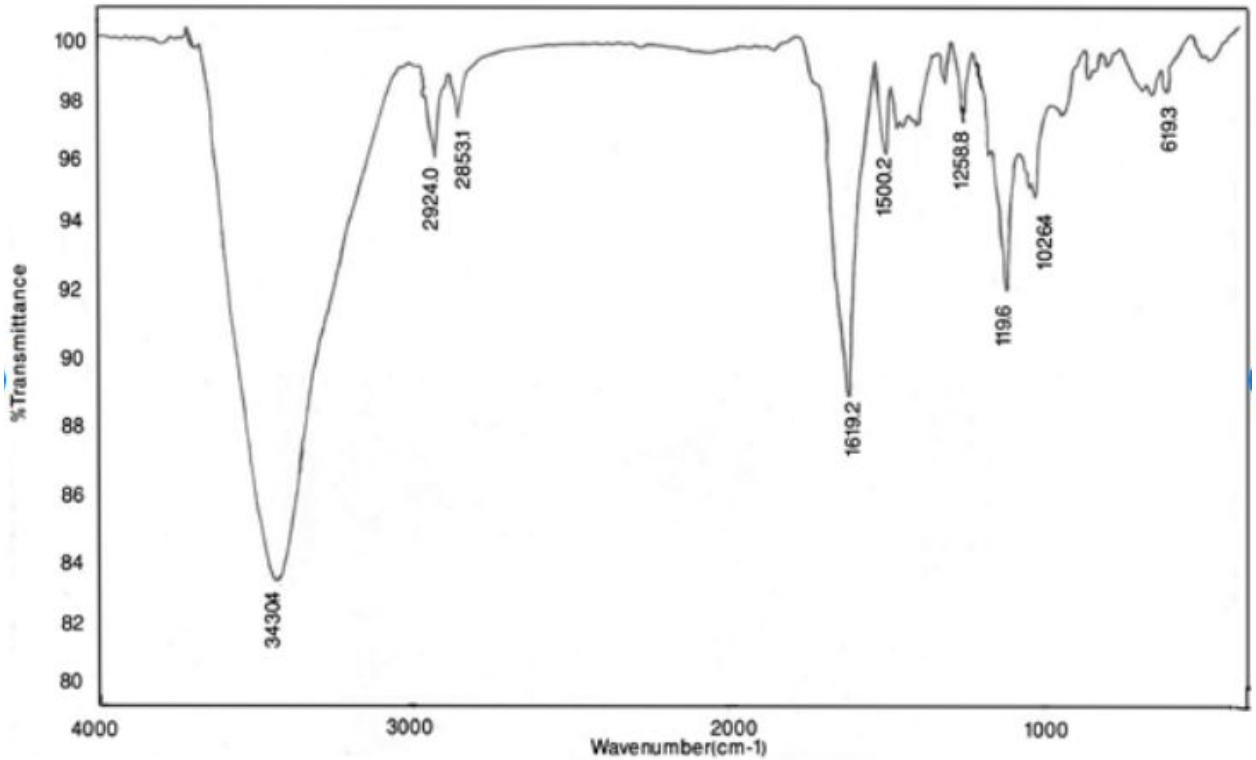
Preparation: Dry powders prepared after centrifugation of the NP solutions at 13000 g for 20 min followed by drying of the formed pellets.

The spectra were collected in range of 4000–400 cm^{-1} using transmission mode (T%), resolution of 4 cm^{-1} with 1 cm^{-1} interval scanning and scanning speed of 2 mm/sec.

Dynamic Light Scattering (DLS):

Purpose: This technique helps to determine the distribution of particle sizes in suspension (hydrodynamic size) and even the diffusion coefficient of these.

Preparation: The Ag/AuNPs samples are prepared by being diluted in a ratio 1:10 with deionized (DI) water For all the samples, the refractive index to be used is 0.135 with an absorptivity value of 3.39.

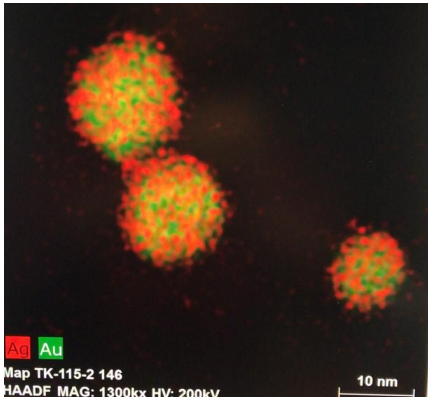


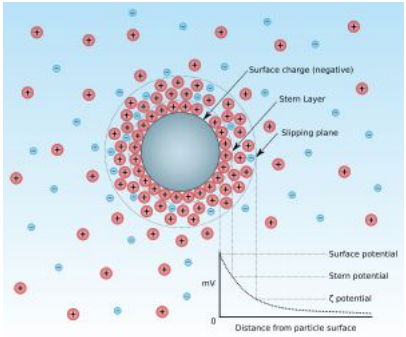
FT-IR

Expected bands of, Ag/Au NP's, which shows peaks that corresponds to OH/NH and C=O groups. Although bands may vary depending on the synthesis process or source of the metals, this serves a reference.

Alternative Techniques

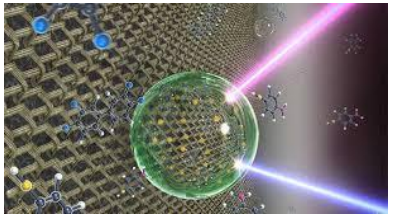
1. **EDX:** It is a technique that can provide the composition and the percentage of each element. Although the composition of the bimetallic alloy is known, this study could help to verify if the composition matches the one that we are assuming.





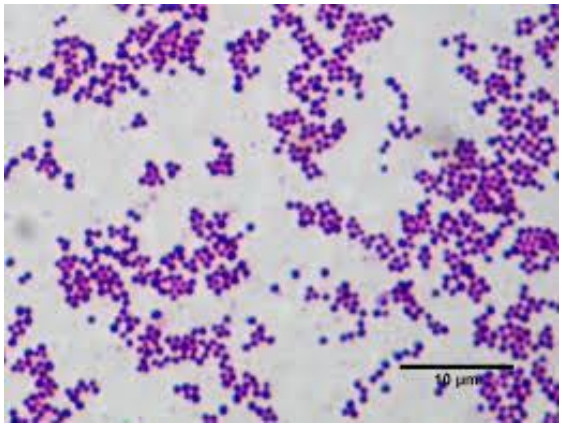
2. **Zeta Potential:** It can tells us how easy it is to penetrate the ionic layer around the NP's.

3. **Raman Spectroscopy:** A technique used for analyzing chemical structure, crystallinity and molecular interactions.



How this info will help to the thesis

Because the NP's are to be used against bacteria, it is important to make sure that the NP's comply with some requirements, being the most important ones the size, shape and composition, because efficiency of the inhibition capacity of the NP's, bioaccumulation and cytotoxicity depend on said characteristics.



Staphylococcus aureus

Inhibition tests

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