

Experiment 8. Synthesis of gold nanoparticles by chemical method.

Theory

Au^{+3} ions are reduced to neutral gold atoms, whereas citrate ions act as both a reducing agent and a capping agent. This formation of gold nanoparticles can be observed by a change in color since small nanoparticles of gold are red. The presence of this colloidal suspension can be detected by the reflection of a laser beam from the particles. The layer of adsorbed citrate anions on the surface of the nanoparticles keeps the nanoparticles separated. Switching to a smaller anion allows the particles to approach more closely and another color change is observed.

Requirements

- 1.0 mM hydrogen tetrachloroaurate: Dissolve 1.0 g $\text{HAuCl}_4 \cdot 3\text{H}_2\text{O}$ in 250 mL distilled water to make a 10.0 mM stock solution of gold(III) ions that can be kept for years if stored in a brown bottle. Dilute 25 mL of stock to 250 mL to make the 1.0 mM concentration for this experiment.
- 1% trisodium citrate: Dissolve 0.5 g $\text{Na}_3\text{C}_6\text{H}_5\text{O}_7 \cdot 2\text{H}_2\text{O}$ (sodium citrate) in 50 mL distilled water.
- NaCl solution: Dissolve at least 0.5 g of NaCl in 10 mL distilled water or use a saturated solution.
- 50 mL Erlenmeyer flask or beaker
- 1" or 1 cm stir bar
- Stirring hotplate
- Droppers and test tubes or cuvettes

Procedure:

1. Rinse all glassware with pure water before starting. Add 20 mL of 1.0 mM HAuCl_4 to a 50 mL beaker or Erlenmeyer flask on a stirring hot plate. Add a magnetic stir bar and bring the solution to a rolling boil.
2. To the rapidly-stirred boiling solution, quickly add 2 mL of a 1% solution of trisodium citrate dihydrate, $\text{Na}_3\text{C}_6\text{H}_5\text{O}_7 \cdot 2\text{H}_2\text{O}$. The gold sol gradually forms as the citrate reduces the gold (III). Remove from heat when the solution has turned deep red or 10 minutes has elapsed.
3. Record the visible spectrum of the solution. If necessary, add additional water to the cuvette to get the absorbance on scale.

Observation

The Orange/red color solution confirms the formation of gold nanoparticles.

Characterization:

Synthesized Au NPs were characterized using the UV-visible spectroscopy technique.

Result

The aqueous gold NPs were successfully obtained by chemical method by the reduction of gold salt.

Color of the gold particle:

λ_{max} was observed at:

Precautions

1. Dispose of waste materials, especially those containing silver ions or nanoparticles, by local regulations and guidelines for hazardous waste.
2. Implement measures to prevent exposure to nanoparticles, such as using a fume hood and avoiding the generation of aerosols. Consider the potential health and environmental impacts associated with nanoparticle release.
3. Regularly monitor and maintain the equipment used in the synthesis process to ensure its proper functioning and prevent accidents or malfunctions.
4. Be aware of emergency procedures and the location of safety equipment, such as eyewash stations and fire extinguishers, in case of unexpected events.