**Experiment 3**

**Object** -**Green Synthesis of Silver and Gold Nanoparticles using leaf extract**

Materials with sizes between 1 and 100 nm are known as nanoparticles, and they have special qualities not seen in bulk materials. Particularly noteworthy are the optical, electrical, and catalytic properties of silver and gold nanoparticles.

Because of their small size, nanoparticles display qualities like a high surface area-to-volume ratio, quantum effects, and distinctive optical characteristics.

**Green Synthesis Principles**

Green synthesis is the process of creating nanoparticles with non-toxic, eco-friendly materials and procedures. This strategy reduces any health hazards and the impact on the environment. An important advancement in the synthesis of nanoparticles is green synthesis, which provides a way forward for more ecologically friendly and sustainable practices. Green synthesis uses renewable resources, energy-efficient procedures, non-toxic chemicals, and waste minimization techniques to meet the increasing demand for sustainable and safe nanoparticle manufacturing. Green concepts will probably be more widely and finely integrated into nanoparticle synthesis as science and technology develop, which will further help conserve the environment and scientific advancement.

**Materials and Equipment**

### Chemicals

* **For Silver Nanoparticles:**

Silver nitrate (AgNO₃),Green reducing agent (e.g., extract of green tea, aloe vera, or lemon juice),Distilled water

* **For Gold Nanoparticles:**

Gold chloride (HAuCl₄),Green reducing agent (e.g., extract of pomegranate, grape juice, or citrus fruits),Distilled water

**Equipment**

* Beakers
* Glass stirrers
* Measuring pipettes
* UV-Vis spectrophotometer

**Experimental Procedures**

**Synthesis of Silver Nanoparticles**

1. Preparation of Silver Nitrate Solution:Dissolve 0.1 g of silver nitrate in 100 mL of distilled water to make a 1 mM solution.
2. Preparation of Green Reducing Agent:Prepare an extract from green tea by boiling 5 g of dried tea leaves in 100 mL of distilled water for 10 minutes. Cool and filter the extract.
3. Synthesis Reaction:Add 10 mL of the silver nitrate solution to 50 mL of the green leaf tea extract in a beaker.Stir the mixture at room temperature for 30 minutes. A color change from pale yellow to dark brown indicates the formation of silver nanoparticles.
4. **Characterization:** Use UV-Vis spectroscopy to confirm the presence of silver nanoparticles by analyzing the absorption peak around 420 nm.

**Synthesis of Gold Nanoparticles**

1. Preparation of Gold Chloride Solution: Dissolve 0.1 g of gold chloride in 100 mL of distilled water to make a 1 mM solution.
2. Preparation of Green Reducing Agent: Prepare an extract from leaves by blending 50 g of plant leaves with 100 mL of distilled water and filtering the solution.
3. Synthesis Reaction: Add 10 mL of the gold chloride solution to 50 mL of the leaf/pomegranate extract in a beaker.Stir the mixture at room temperature for 30 minutes. The color change from yellow to red or purple indicates the formation of gold nanoparticles.

**Results**

**Characterization of silver and gold nano particles by** UV-Vis spectroscopy

For Silver nanoparticles : Take an aliquot of the reaction mixture and measure its UV-Visible absorption spectrum using a spectrophotometer. The peak around 400-450 nm confirms the formation of silver nanoparticles.

For gold nanoparticles : Use UV-Vis spectroscopy to confirm the presence of gold nanoparticles by analyzing the absorption peak around 530-550 nm.

Precautions:

* Handle all chemicals, especially silver nitrate and chloroauric acid, with care.
* Ensure the leaf extract is prepared fresh to maintain its reducing properties.
* Use clean and dry glassware to avoid contamination.
* Operate the UV-Visible spectrophotometer according to its guidelines.

**Pre-Test Questions:**

1. **What is the main advantage of using green synthesis methods for nanoparticle production?**

a) High cost

b) Eco-friendly and non-toxic

c) Requires toxic chemicals

d) High energy consumption

**Answer:** b) Eco-friendly and non-toxic

1. **Which plant part is typically used to prepare the reducing agent in green synthesis of nanoparticles?**

a) Roots

b) Leaves

c) Flowers

d) Stems

**Answer:** b) Leaves

1. **Which of the following metal ions is reduced to form gold nanoparticles?**

a) Ag⁺

b) Au³⁺

c) Cu²⁺

d) Fe³⁺

**Answer:** b) Au³⁺

1. **What type of spectroscopy is commonly used to confirm the formation of silver and gold nanoparticles?**

a) Infrared spectroscopy

b) UV-Visible spectroscopy

c) NMR spectroscopy

d) Mass spectroscopy

**Answer:** b) UV-Visible spectroscopy

1. **Which of the following changes indicates the formation of silver nanoparticles in the reaction mixture?**

a) Colorless to blue

b) Yellowish-brown color

c) Red color

d) Black precipitate

**Answer:** b) Yellowish-brown color

**Post-Test Questions:**

1. **What is the typical surface plasmon resonance (SPR) peak range for silver nanoparticles?**

a) 200-300 nm

b) 300-350 nm

c) 400-450 nm

d) 500-600 nm

**Answer:** c) 400-450 nm

1. **Which characterization technique is used to determine the size and shape of nanoparticles?**

a) UV-Visible spectroscopy

b) Dynamic Light Scattering (DLS)

c) Fourier Transform Infrared Spectroscopy (FTIR)

d) Scanning Electron Microscopy (SEM)

**Answer:** d) Scanning Electron Microscopy (SEM)

1. **During the green synthesis of gold nanoparticles, which color change is typically observed?**

a) Colorless to pink/red

b) Blue to green

c) Yellow to brown

d) Black to white

**Answer:** a) Colorless to pink/red

1. **Which of the following factors can affect the synthesis of nanoparticles using leaf extract?**

a) Temperature

b) pH

c) Concentration of metal ions

d) All of the above

**Answer:** d) All of the above

1. **What role do phytochemicals in the leaf extract play in nanoparticle synthesis?**

a) They provide a color change indicator

b) They act as reducing and stabilizing agents

c) They accelerate the reaction without affecting the result

d) They increase the toxicity of the nanoparticles

**Answer:** b) They act as reducing and stabilizing agents

import matplotlib.pyplot as plt

# Data for Gold Nanoparticles

wavelengths\_gold = [400, 420, 440, 460, 480, 500, 520, 540, 560, 580]

absorbance\_gold = [0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.9, 0.7, 0.4, 0.2]

# Data for Silver Nanoparticles

wavelengths\_silver = [350, 370, 390, 410, 430, 450, 470, 490, 510, 530]

absorbance\_silver = [0.2, 0.3, 0.4, 0.6, 0.8, 1.0, 0.9, 0.7, 0.5, 0.3]

plt.figure(figsize=(10, 6))

# Plot Gold Nanoparticles

plt.plot(wavelengths\_gold, absorbance\_gold, label='Gold Nanoparticles', color='gold')

# Plot Silver Nanoparticles

plt.plot(wavelengths\_silver, absorbance\_silver, label='Silver Nanoparticles', color='silver')

plt.xlabel('Wavelength (nm)')

plt.ylabel('Absorbance')

plt.title('UV-Vis Spectra of Gold and Silver Nanoparticles')

plt.legend()

plt.grid(True)

plt.show()