SJU Saint Joseph's University

Fabrication of Gold Nanoparticles using Cultured Plant Cells

Lead Inventor

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Unmet Need

Gold nanoparticles (AuNPs) have been widely used in manufacturing applications due to their unique features: bio-compatibly, non-reactivity, and low toxicity. Conventional preparative techniques for synthesis of AuNPs employ physical and chemical methods. These physical methods, including evaporation and laser ablation, are expensive and laborious. In contrast, chemical methods involve the reduction of a gold salt with strong reducing agents and are potentially hazardous to the environment -- either because of the toxicity of the reagents or of the by-products of the reaction[1].

Industry's quest to discover an environmentally friendly and cost-effective method uncovered the potential of inactivated biomass, plant extracts, and intact plants to reduce gold from its ionic form (3+) to metallic (0) form, thereby favoring the process of particle formation[2]. However, these efforts are hampered by their inability to isolate the nanoparticles, by low yield, and by the inability to control AuNP size and shape, which limit their utility.

Therefore, there remains a need for alternative methods to produce gold nanoparticles.

Opportunity

Dr. Sahi and his colleagues have developed a novel method to manufacture gold nanoparticles by using suspended plant cells in culture. In addition, they have developed techniques to alter the physical properties (size, shape, etc.) of the resulting AuNPs by altering the culture media and growing conditions of the plant cells.

There is significant potential for this invention in the manufacturing, advanced electronics, and pharmaceutical industries due to the non-toxic and tunable nature of this method to create a controllable range of sizes and shapes of AuNPs.

Plant extract derived gold nanoparticles are used to coat acrylic glass and window glass; they also have potential as coatings in food packaging materials due to active bacterial mold protection and antioxidant activity. In the same way, plant mediated gold nanoparticles can be used to cover different fabrics such as cotton, silk, and leather to achieve antibacterial properties. AuNPs are widely used in advanced electronics such as sensors, probes, and displays and as catalysts in a number of chemical reactions. AuNPs have also been investigated for use in renewable energy technology, such as solar cells, as they can produce hydrogen from water more efficiently than competing methods.[3]

Further, AuNPs are widely used in therapeutic delivery agents, photodynamic therapy, and diagnostics. The investigators found that the AuNPs developed were significantly less cytotoxic to healthy human cells, while simultaneously being more toxic to cancer cell lines compared to AuNPs synthesized by chemical methods.

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[1] Shankar, S. S. et al. Biological synthesis of triangular gold nanoprisms. Nat. Mater. 3, 482–488 (2004). 4. Sharma, N. C. et al. Synthesis of plant-mediated gold nanoparticles and catalytic role of biomatrix-embedded nanomaterials. Environ. Sci. Technol. 41, 5137–5142 (2007).

[2] Starnes, D. L., Jain, A. & Sahi, S. V. In planta engineering of gold nanoparticles of desirable geometries by modulating growth conditions: an environment-friendly approach. Environ. Sci. Technol. 44, 7110–7115 (2010).

[3] *How gold nanoparticles could improve solar energy storage*. Rutgers University, July 2018.

The overall market was estimated at $4.9B in 2022 and is expected to reach $7.9B by 2026[4], growing at a CAGR of more than 10%. Major drivers of this growth are the increasing usage of AuNPs in the medical and advanced electronics industry.

Unique Attributes

- The method's tunable nature enables the creation of a controllable range of nanoparticle size and shapes in a non-toxic manner.
- Significantly less cytotoxic to healthy human cell lines while simultaneously being more toxic to cancer cell lines than AuNPs created through chemical means.
- Environmentally friendly and efficient synthesis and extraction.

Industrial Applications

Gold nanoparticles have a broad spectrum of industry application areas, including the food industry, water purification, pharmaceuticals, and advanced electronics. In particular, gold nanoparticles are applied to photo-thermal therapy, imaging, sensing, catalysis, and antimicrobials.

Stage of Development

Preclinical Studies

Intellectual Property

United States Patent No. US 12,297,476, issued May 2025.

Collaboration or Licensing Opportunity

Saint Joseph's University is seeking a licensee to commercialize the use of this method for the creation of AuNPs using cultured plant cells in media and the resulting methods of use for industrial purposes.

References and Publications

Starnes, D. L., Jain, A. & Sahi, S. V. In planta engineering of gold nanoparticles of desirable geometries by modulating growth conditions: an environment-friendly approach. Environ. Sci. Technol. 44, 7110–7115 (2010).

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[4] *Global Gold Nanoparticles Market to Reach $7.9 Billion by 2026*, PR Newswire, March 2022.