

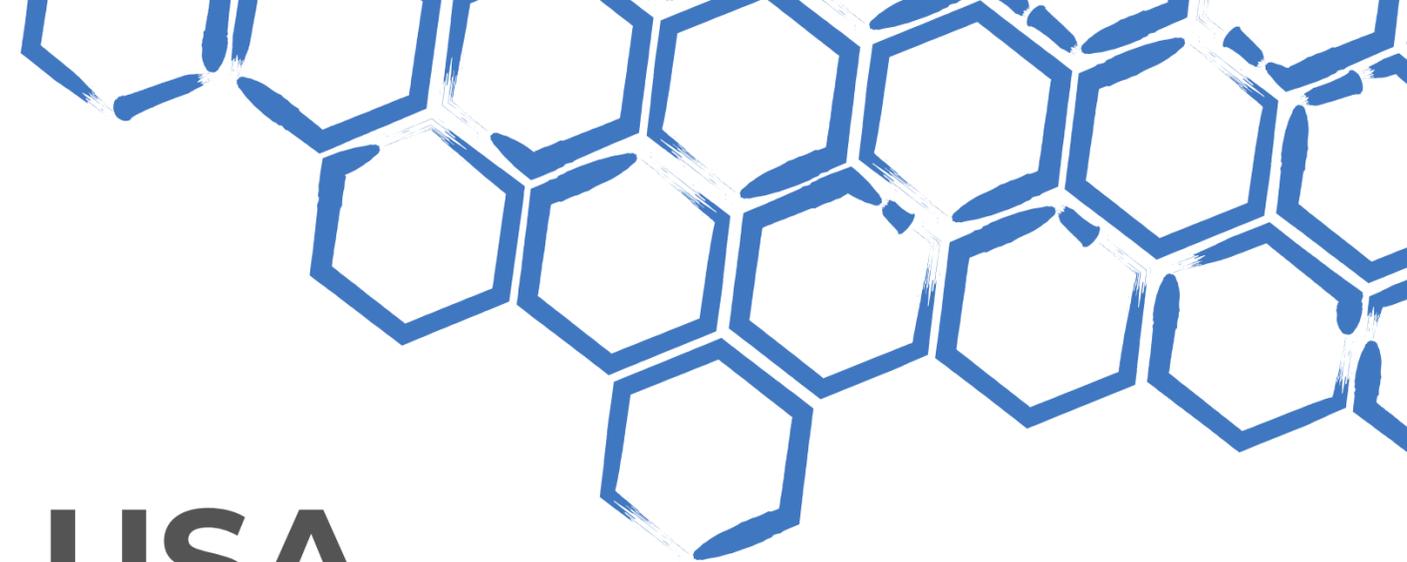


Molecule to Market: Your Trusted Partner

A professional services summary

Process Optimization for Scale-Up





Raybow USA Responses

- reproduced the established procedure
- examined different reaction conditions
- identified the critical parameters for repeatable results
- scaled up in a stepwise fashion to a pilot-like scale of 30L
- conducted purification via dialysis and centrifugation

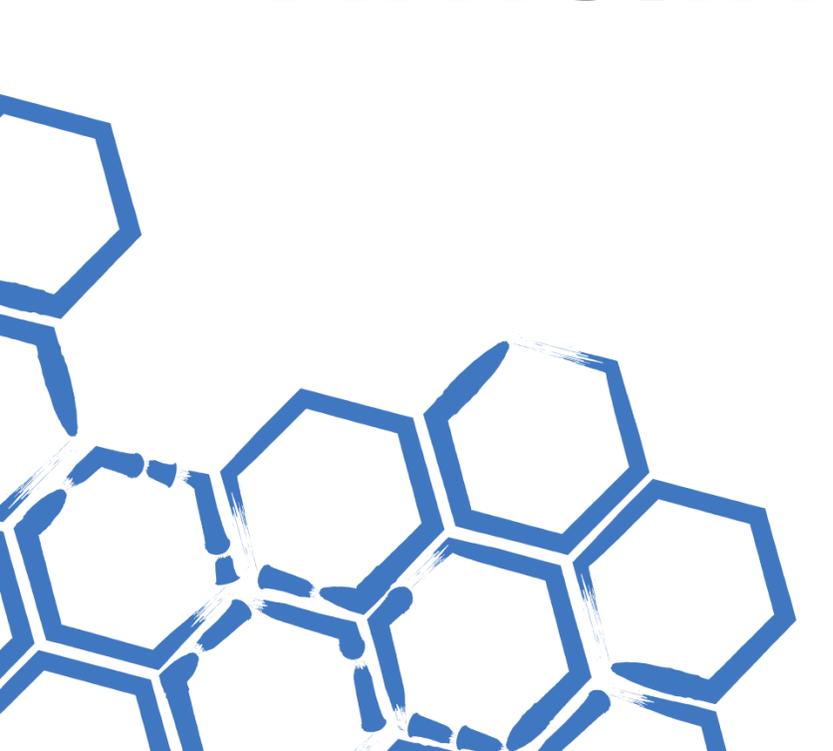
Statement of Need

The client needed a process for preparing gold nanorods by seed-mediated growth, to yield a reliable nanorod size and optical absorption, that could be reproduced on a larger scale.





Process Timeline



May 2023

Raybow USA initiated the quote process

July 2023

Raybow and the client finalized quote terms

December 2023

Client delivered their Purchase Order to Raybow

January & February 2024

Raybow chemists developed process optimization

February 2024

Raybow produced demonstration scale at 300mL, 3L, & 30L

July 2024

Client contracted with Raybow to use material in next phase

October 2025

Prepared manuscript highlighting process refinements' utility

February 2026

Published in "Journal of Industrial and Engineering Chemistry"

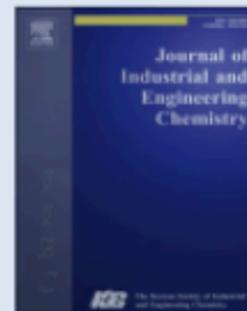


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Short Communication

Industrial-scale chemical synthesis of gold nanorods: process optimization and 30 L scale-up toward GMP manufacturing

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David Perrey, PhD
Group Leader for Raybow USA
and co-author

ABSTRACT

Gold nanorods (GNRs) offer unique photonic properties but remain challenging to reproduce and scale beyond bench volumes. We identify the critical process parameters (CPPs) governing the seed-mediated synthesis of CTAB-stabilized GNRs and translate the process from 30 mL to 30 L. Silver nitrate loading, seed formation (temperature and NaBH₄-addition mixing), and growth-phase hydrodynamics emerge as key drivers of the longitudinal LSPR (LLSPR). Tight control of seed temperature and vigorous mixing during reductant addition yield batch-to-batch LLSPR variations within ± 20 nm; introducing gentle agitation during growth suppresses uncontrolled thermal convection, further improving robustness. The optimized protocol produces optically consistent GNRs at 3 L and 30 L with plasmonic features comparable to lab scale. Beyond the experimental advance, this work frames an industrially relevant route to large-scale chemical production of GNRs, establishing process understanding, reproducibility, and quality criteria that underpin future GMP manufacturing design and ongoing regulatory interactions.

Link to
Journal Article





Outcome Summary



Developed Process and Analytics



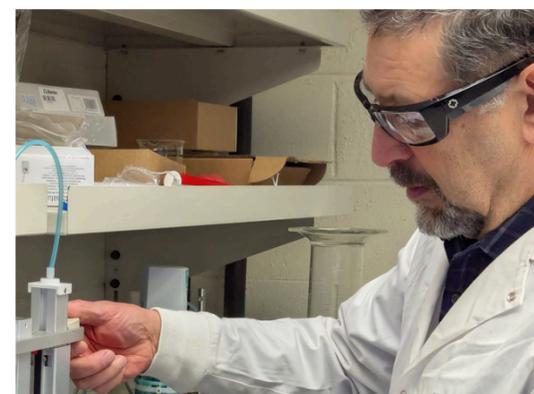
Our actions assured the client that their product could be reliably manufactured.



Generated Consistent Results



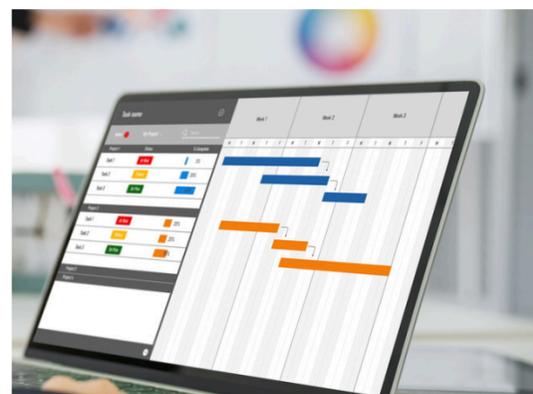
We controlled the diagnostic UV peak within the desired range.



Prepared Product for Scale-Up



We demonstrated a large-scale process that could support predicted future needs.



Met Client's Timeline Needs



We provided results within the client's deadlines for their next steps.

Scope of Lab Work



Fluid Interactions

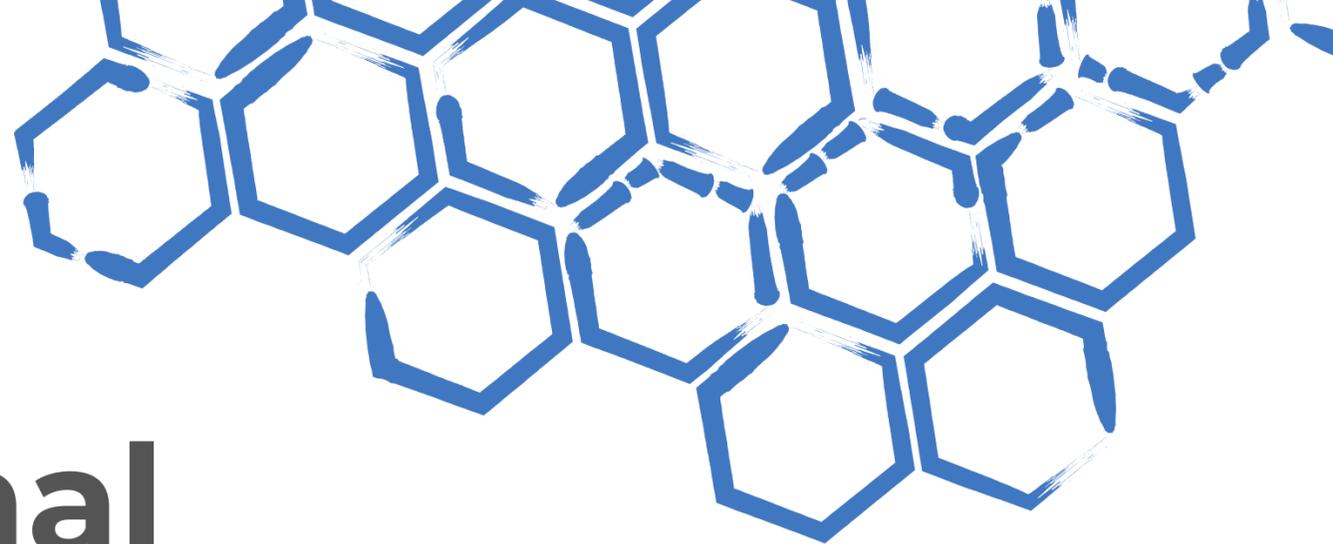
Interactions are key to project success. We employed multiple methods to achieve the client's project goals, to keep the client informed of progress and results, and to receive feedback and direction from the client.

- **Virtual Meetings**
- **Phone Calls**
- **Emails**
- **Shipping**
- **Secure Electronic Document Sharing**

Ownership

All IP belongs to the client.
Including refinements.
Always.





Guiding Professional Concepts

Dedication

We allocated time, equipment and human resources to ensure all client needs could be met in a timely fashion.

Responsiveness

We listened to the client's needs and determined an action plan to meet their goals and deadline.

Knowledge

We drew upon our team's education and experiences to fine-tune protocols to deliver the highest quality data.

Attention

We applied best established practices to ensure quality and accuracy throughout the project.





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