UNIVERSITÄT DUISBURG ESSEN

EMPI PARTICLE SCIENCE AND TECHNOLOGY
Institut für Energie- und Material-Prozesse

Master thesis

Systematic investigation of gold nanoparticle wall adhesion on different tubing materials for continuous synthesis

Background:

Gold nanoparticles (AuNPs) are widely studied due to their unique optical, catalytic, and electronic properties, which make them valuable in fields such as medicine, sensing, and materials science. In continuous synthesis processes, they offer advantages like improved reproducibility and scalability compared to batch methods. However, a major challenge in these systems is wall adhesion, where particles deposit on reactor and, more common, tubing surfaces. This phenomenon can lead to fouling, reduced yield, and poor control over particle size and distribution. Understanding and mitigating wall adhesion is therefore crucial for achieving stable and efficient continuous production of AuNPs.

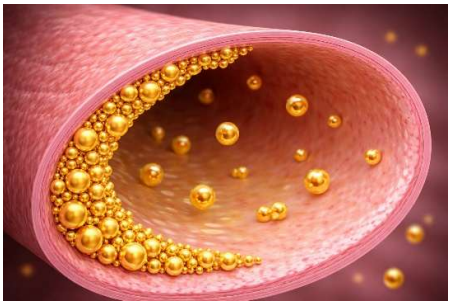

Figure 1: Schematic illustration of AuNP wall adhesion in tubing material for continuous synthesis. AI generated.

The aim of this thesis is to develop a deeper understanding of the mechanisms underlying wall adhesion in the continuous synthesis of AuNPs. A systematic investigation of various tubing materials (e.g., PTFE, FEP, and PFA) will be conducted, with a focus on their influence on yield loss and particle size distribution (PSD). In addition, the effect of different ligand systems - such as citrate-, CTAB-and salt-stabilized AuNPs - will be examined. Ultimately, this work is intended to provide a fundamental basis for selecting appropriate tubing materials for different AuNP synthesis routes in order to minimize wall adhesion and optimize continuous synthesis processes.

Task description:

a) Comprehensive literature review of reported cases of AuNP fouling in continuous synthesis, including the development of a structured overview of published systems in which fouling phenomena have been observed. Collection and comparison of established synthesis protocols for gold nanoparticles stabilized by ligands of varying charge.

b) Batch synthesis of AuNPs employing different ligand systems and surface charges, such as negatively charged (e.g., citrate), positively charged (e.g., CTAB), and thiol-based stabilizers.

c) Systematic investigation of wall adhesion behavior of AuNPs in commonly used tubing materials (e.g., PTFE, PA, PFA), utilizing a combination of analytical techniques including UV–Vis spectroscopy, ICP-OES, TEM, and AUC to assess yield loss and PSD.

d) Opportunities for independent research and creativity: The project offers substantial flexibility for the development and incorporation of the student's own ideas, fostering scientific curiosity and independent problem-solving skills.

Requirements:

Study in engineering or natural sciences; interest in and/or basic knowledge of colloid and surface chemistry as well as familiarity with fundamental analytical techniques (e.g., UV–Vis spectroscopy, ICP-OES, TEM, AUC) are advantageous. Enjoyment of experimental laboratory work and data analysis, a careful working style, initiative, and the ability to work in a team are expected.

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Start: 01.05.2026 **Duration:** 6 Month