Title	サクランにおける機能性ナノ粒子の形成とハイブリッド化
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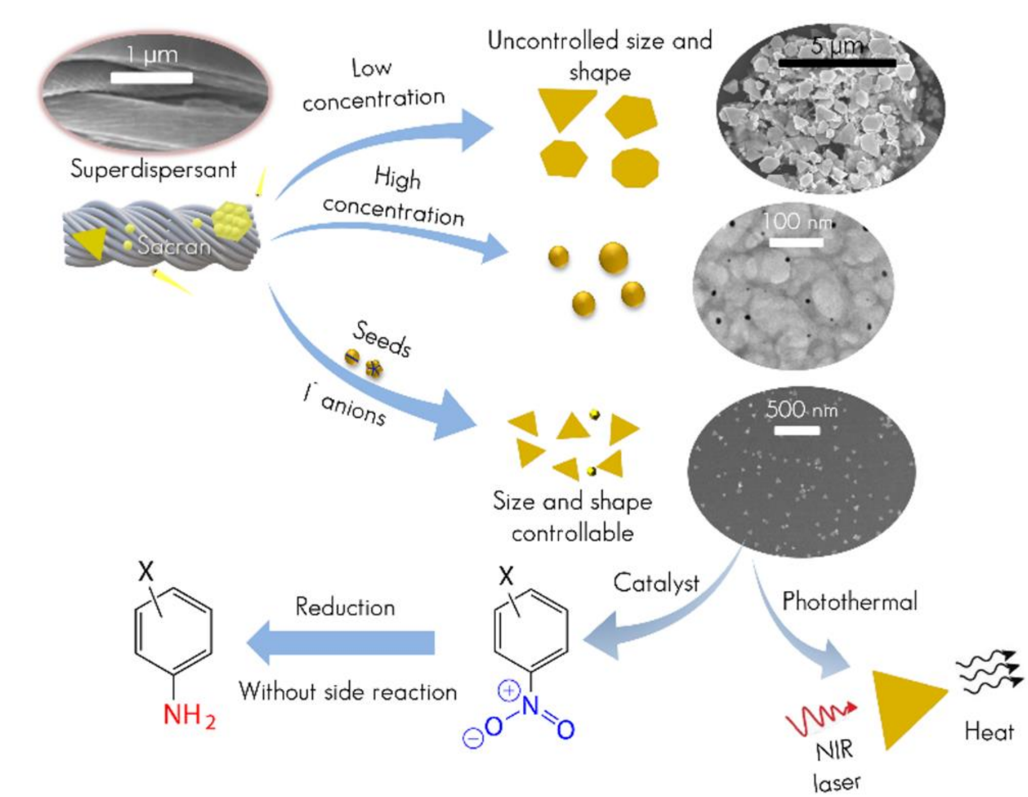
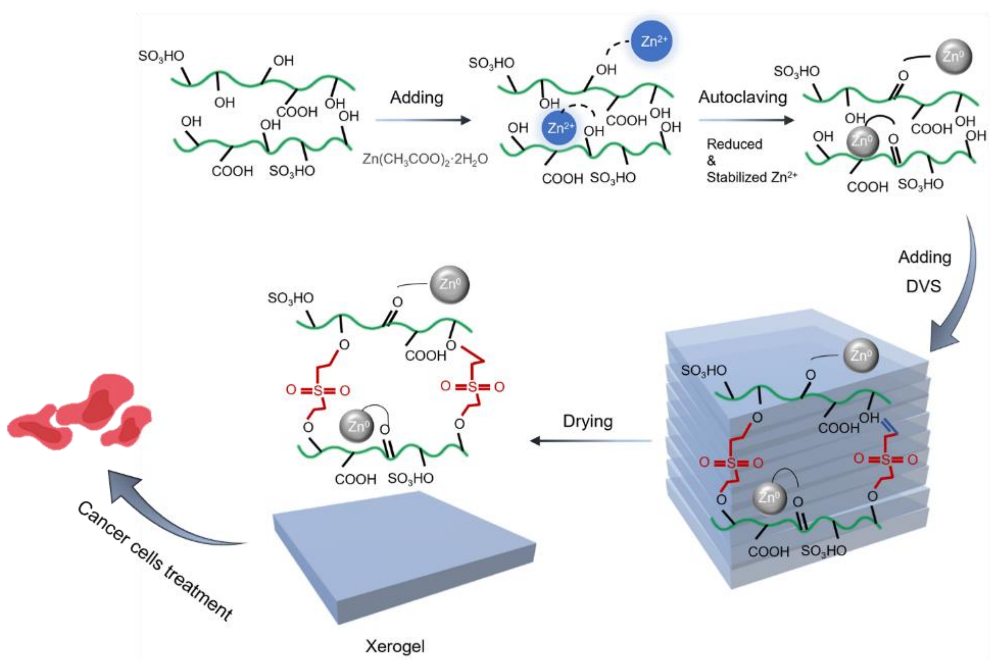
Abstract





Graphical abstract

The size and shape of nanoparticles play a pivotal role in determining their properties and applications. Gold nanotriangles (AuNTs), in particular, exhibit anisotropic electrical conductivity, generating potent electric field enhancements at their vertices and surface plasmon resonance (SPR) in the near-infrared (NIR) region. These distinctive attributes render them exceptionally promising across various fields, including catalysis, sensors, cancer therapy, and as robust substrates for surface-enhanced Raman spectroscopy (SERS). The most effective method documented in the literature for synthesizing nanoparticles with high yields involves template-assited synthesis, where a surfactant is used as the morphology-controlling agent. However, the toxicity of some surfactants highlights the need to establish a green synthesis process for AuNPs that ensures both high yield and precise control over shape and size distribution. The complexity arising from various components, such as reducing and stabilizing agents found in bio-products, presents a challenge for nanoparticle synthesis.

Polysaccharides are the most abundant group of bio-products. Despite their prevalence, there have been limited studies in recent decades investigating the utilization of pure polysaccharides for synthesizing Au nanoplates, and these studies often lack elucidation on the factors influencing nanoparticle shape control. The anisotropic shape formation are strongly affected by the hydroxyl or caboxyl functional groups in polysaccharide. Sacran is one of the fascinating cyanobacteria polysaccharide that is extracted from the freshwater cyanobacteria Aphanothece sacrum. It possesses remarkable attributes, including its high molecular weight (10^6 – 10^8 g mol^{-1}) and a composition comprising more than ten types of sugars. Unlike other polysaccharides, sacran contains two types of anions, carboxylic acid and sulfate groups (22 mol% and 11 mol% to sugar residues in total, respectively), as well as neutral hexose and pentose units. The 11,000 sulfates efficiently attract cations in water, while the 22,000 carboxylates strongly bind with them. Sacran also posseses other functional groups, such as –OH and $–NH_2$, which likely influence the control of AuNPs shape. In addition, ultrahigh dispersion properties of sacran have been demonstrated using carbon-nanotubes. These multifunctional characteristics motivated us to investigate the development of AuNPs in the presence of sacran.

This study investigates a method for inducing morphological changes in anisotropic AuNPs using sacran and elucidates its mechanism. Initially, the morphology of anisotropic AuNPs was manipulated by varying the concentration of sacran-to-gold precursor to influence the shape outcomes. While this approach did not afford complete control over the morphologies of anisotropic AuNPs, it did enable size control over specific morphologies at particular operating temperatures. Subsequently, controlled morphologies of Au nanoplates were attained by employing seeds and halide anions as shape-directing agents, ensuring high shape purity. **This green synthesis of AuNPs holds significant potential as an eco-friendly catalyst and shows promise for diverse applications in plasmonic photothermal therapy and biomedicine.**

Another investion was focused on the synthesis of ZnO nanocomposite materials. Sacran, a supergiant polysaccharide, serves as a green reducing agent for the formation of ZnO nanoparticles (NPs) within the sacran matrix. The incorporation of ZnO NPs significantly influences the physicochemical properties of the resulting xerogels. The liquid crystalline structure of sacran contributes to the formation of anisotropic xerogels. Through systematic studies, including swelling behavior analysis and mechanical testing, the impact of various parameters, such as pH variations and DVS-to-OH ratios, on the performance of sacran-ZnO nanocomposite xerogels is thoroughly evaluated. Additionally, cell viability studies using A549 cancer cells shed light on the biocompatibility and potential use of these nanocomposite xerogels as wound dressing. The comprehensive characterization and evaluation presented in this chapter provide valuable insights into the development of sacran-based materials for biomedical applications.

Keywords: Sacran Polysaccharide, Gold nanoplates, Shape controller, Cancer selective, Photothermal therapy.