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Research group: Hybrid nanomaterials

Photochemically Controlled Synthesis of Anisotropic Silver Nanostructures for Combined Cancer Therapies

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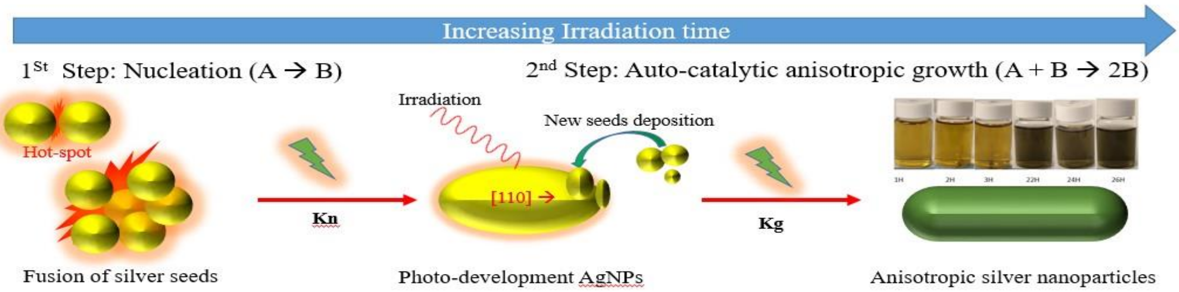
Silver nanoparticles (AgNPs) have attracted extensive interest as plasmonic nanomaterials owing to their tunable optical, electronic, and surface properties, which strongly depend on particle size, morphology, and crystallographic structure. In particular, the localized surface plasmon resonance (LSPR) behavior of AgNPs enables enhanced light–matter interactions, making them promising candidates for applications in photocatalysis, optoelectronics, biosensing, and advanced biomedical systems. However, conventional chemical synthesis approaches based on reduction -oxidation reactions using common chemical reagents still face significant limitations in achieving precise anisotropic growth control and high uniformity in nanoparticle size and morphology. In the present study, a photochemical seed-mediated synthetic strategy under different LED irradiation intensities was developed for the controlled fabrication of anisotropic silver nanostructures.



Surface-stabilizing ligands, including trisodium citrate (TSC), polyvinylpyrrolidone (PVP), and polyethyleneimine (PEI), together with morphology-directing additives such as hydrogen peroxide and halide ions, were systematically investigated to elucidate their influence on crystal growth behavior, anisotropic structural evolution, and plasmonic properties of AgNPs. UV–Vis spectroscopic analysis demonstrated that irradiation wavelength and surface chemistry play critical roles in directing the formation of silver nanorods and nanotriangles exhibiting plasmonic absorption bands extended into the near-infrared region, while TEM analysis confirmed effective morphological control and particle size distribution. PEG–DOX-functionalized AgNPs systems were prepared for subsequent biological evaluation of anticancer cytotoxicity and drug-delivery capability. Photothermal experiments under 800 nm NIR irradiation revealed efficient light-to-heat conversion, rapidly reaching therapeutically relevant temperatures, thereby highlighting the potential of the synthesized anisotropic nanostructures for hyperthermia-assisted cancer therapy. Overall, the proposed photochemical approach provides a simple, efficient, and highly controllable platform for the fabrication of anisotropic silver nanostructures for advanced biomedical applications.

Literature:
[1] Lee G. P., Shi Y., Lavoie E., Daeneke T., Reineck P., Cappel U. B., Huang D. M., Bach U., ACS Nano. 2013, 7, 5911–5921.
[2] Mota D. R., Lima G. A. S., Helene G. B., Pellosi D. S., ACS Appl. Nano Mater. 2020, 3, 4893–4903.