Multinanostar gold-silica nanoparticles for dual cancer therapy

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Nanomaterials exhibit unique physicochemical properties arising from their high surface-to-volume ratio, which enhances reactivity, functionalization capacity, and loading efficiency. These features have enabled broad applications in catalysis, sensing, energy conversion, and biomedical delivery. Multicomponent nanostructures further expand this versatility and functionality by integrating several components with different properties into a single platform. Architectures such as core–shell, Janus, patchy, and yolk–shell nanoparticles provide controlled interfaces, anisotropic functionalities, or compartmentalized domains, allowing the design of multifunctional systems tailored for complex tasks. [1]

Among the materials used in multicomponent nanosystems, gold nanostructures are notable for their tunable plasmonic properties, which depend strongly on particle geometry. [2] Gold nanostars display intense near-infrared LSPR responses suitable for biomedical imaging, photothermal applications, and chemical detection, among others, since their branched shape shifts the plasmon resonance into the biological transparency window and provides tip hot spots. Silica, in contrast, offers chemical stability, biocompatibility, and high loading capacity, making it an ideal complementary component for controlled delivery and optical engineering.

In this work, we develop complex patchy Au@SiO_2 nanoparticles in which a gold core is partially coated with silica domains, leaving exposed regions that serve as nucleation sites for gold nanostar growth. This architecture creates a heterogeneous surface combining the plasmonic activity of the nanostars with the tunable chemistry and loading capacity of silica. To synthesize these anisotropic hybrid systems, we exploited the ability of the thiolated ligands, MUA and PEG, to segregate on the gold surface [3] . When both ligands are co-adsorbed, their phase segregation generates chemically distinct surface domains, patches. Silica growth is promoted on the MUA patches, generating anisotropic silica deposition, or lobes. By tuning the MUA:PEG ratio, we can control the number of silica lobes formed around the gold core, and consequently, the amount of exposed gold available for subsequent nanostar growth, and the generation of multinanostar nanoparticles with promising applicability in sensing, hyperthermia, etc.

We have explored the capabilities of these nanoparticles in biomedical applications for cancer therapies. For that, the nanoparticles were loaded with the anticancer drug doxorubicin into the silica component, and it was subsequently released by the use of photothermal activity. Preliminary results in vitro show an excellent anticancer effect, and a promising alternative as anticancer nanotreatment, opening the door to less invasive, low-dose medical treatments.

[1] *Materials Today Chemistry* **2022** , 26, 101220
[2] *Chem.Soc.Rev* **2017** , 46, 3866-3885
[3] *ACS Nano* **2023** , 17, 955-965

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References:

[1] *Materials Today Chemistry* **2022** , 26, 101220
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