Alternative plasmonic nanomaterials based on transition metal nitrides: laser-ablative fabrication and appealing prospects for biophotonic applications

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This presentation will overview results of our on-going activities on laser-ablative synthesis of nanomaterials of alternative plasmonics based on transition metal nitrides (TiN, ZrN, HfN) using femtosecond laser ablation in liquids. It will show how these nanostructures provide plasmonic resonances shifted into the biological transparency window, together with excellent stability, scalability, and biocompatibility, thus overcoming key limitations of noble metals. The presentation will describe TiN nanoparticles as sensitizers of photothermal therapy [1] and contrast agents in photoacoustic imaging [2]. It will also highlight ZrN nanoparticles that combine strong plasmonic absorption with near-field enhancement, enabling both highly efficient photothermal therapy and sensitive SERS-based bioimaging [3]. Special attention will be given to HfN nanoparticles, which were synthesized in ultrapure form and exhibited exceptional photothermal conversion efficiency (~62%) along with theranostic potential linked to the high atomic number of hafnium, opening perspectives for combined photothermal and radiological applications [4]. The presentation will emphasize that all these nanomaterials are ligand-free, ultraclean, and colloidally stable, ensuring low cytotoxicity and reliable biological performance. In vitro experiments confirmed their excellent compatibility with living systems, while surface modifications such as PEGylation further extended their biomedical usability. Taken together, these studies demonstrate that transition metal nitride nanoparticles represent a new generation of plasmonic nanomaterials with broad prospects for cancer phototherapy, multimodal imaging, biosensing, and advanced nanomedicine.

Références

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