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ONLINE LECTURE

"Flame Nanoparticle and Device Engineering for Biomedicine"

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Thursday, June 17, 2021, 12:00

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Flame Nanoparticle and Device Engineering for Biomedicine

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Nanoscale materials show great potential in the biomedical field as they can serve as superior bioimaging contrast agents, diagnostic and therapeutic tools while a key element for the successful implementation of nanoscale materials in clinical applications is multi-functionality. However, the two main bottlenecks for the successful commercialization of such nanotechnologies, that are often neglected in studies, are scalability and reproducibility. Here, a few recent examples will be shown of how flame nanoparticle synthesis, a nanomanufacture process famous for its scalability and reproducibility, may be employed for the production of sophisticated nanoscale materials to tackle important medical challenges.

We focus on nanoparticle formation by flame spray pyrolysis, a highly versatile nanomanufacture process and advance the knowledge for synthesis of complex nanoparticles and their direct integration in multi-scale biomedical devices. We place specific emphasis in multifunctional and responsive nanoparticles that may be used either as transducer elements or as diagnostic probes to monitor biological processes. We have demonstrated functionalization of luminescent nanoparticles with targeting proteins, whose receptors are overexpressed in cancer cells, and detected them by fluorescence cell imaging. We have also recently explored the potential of flame-made nanoparticles in H_2O_2 biosensing, using enzyme-mimetic luminescent CeO_2:Eu nanoparticles that exhibit catalase-mimetic activity and decompose H_2O_2. We have also shown the potential of stimuli-responsive nanoparticles as both photothermal agents by near-IR irradiation as well as superparamagnetic nanoparticles for the enhanced triggered-drug-release from alginate beads by hyperthermia. Finally, flame nanoparticle synthesis allows for the single step deposition on surfaces enabling the fabrication of smart medical devices against biofilms.

Flame aerosol reactors for nanoparticle synthesis are a powerful toolbox for the scalable and reproducible production of sophisticated nanoparticles and their devices with properties not easily attained by other nanomanufacture processes. Their systematic employment in biomedicine has the potential to open up several avenues for nano-enabled solutions to medical challenges.

This research has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (ERC grant agreement no. 758705), the Karolinska Institutet Faculty Board, the Swedish Research Council (no. 2016-03471), the Torsten Söderberg Foundation (no. M87/18), and the Swedish Foundation for Strategic Research (no. FFL18-0043).