Microfluidics encounters nanoparticles - reforming the synthesis of plasmonic active nanomaterials

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The characteristic localized surface plasmon resonance (LSPR) of metal nanoparticles (meNPs) is used for various kinds of sensors. The LSPR-signal is strongly related to intrinsic factors (size, form, composition) of the individual NP, which will be determined during the synthesis [1]. However, in the last years research was focused on NP-design, whereas for many applications a fine adjustment is still needed or one has to improve further criteria like quality, yield, reproducibility and simplicity. These requirements limit the classical batch synthesis and require a general rethinking of synthesis strategies [2]. A promising solution is the use of microfluidic platforms, as their advantages overcome the problems of classical batch synthesis. Based on this, we will present strategies to fabricate meNPs in micro reactors. By using a continuous microfluidic set-up that contains a certain arrangement of micro mixers (Fig. 1) a fast synthesis of small AgNP could be reached, with improved properties compared to the classical synthesized counter parts. Furthermore by using this AgNP as seeds for a later growing to Ag-nanoprisms, a higher yield and better reproducibility was observed [3]. The synthesis of Au-nanocubes could be improved by transferring the highly time critical production steps into a continuous microfluidic process (Fig. 2). In addition to easier control of the reactions that enables a high reproducibility and precise size tuning, the consumption of Au-precursor could be drastically reduced by keeping the same quantity and quality for the resulting Au-nanocubes. Both meNP types are poly-facetted caused by their anisotropic form and show a high sensitivity, thereby making them ideal candidates for sensing as well as catalytic approaches.

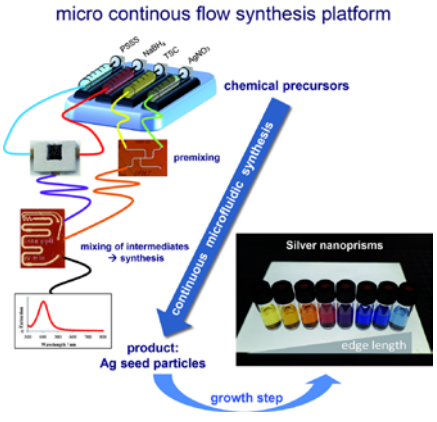

Fig. 1: *Continuous microfluidic synthesis set-up for the preparation of Ag-nanoprisms*

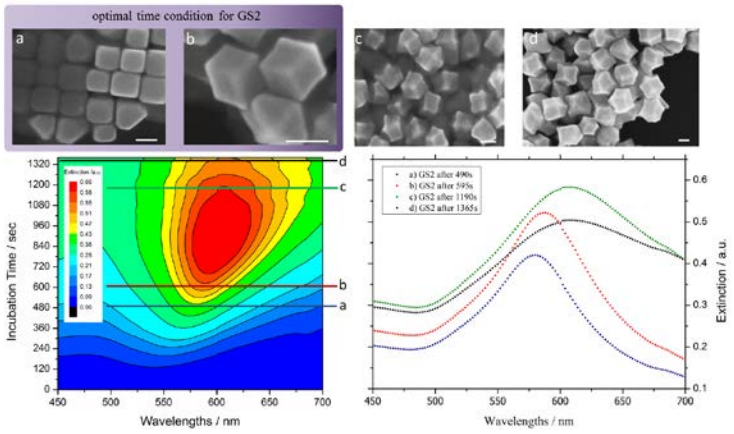

Fig. 2: *Kinetic of Au-nanocube synthesis with spectra at 4 discrete times and corresponding TEM images of NPs. A microfluidic synthesis is needed to control exactly the NP growing with reproducible results.*

*[1] Xia Y., Xiong Y., Lim B., et al., (2009), Shape-controlled synthesis of metal nanocrystals: simple chemistry meets complex physics?, **Angewandte Chemie**, Vol.48 No.1, 60-103*
*[2] Zhang L. and Xia Y., (2014), Scaling up the production of colloidal nanocrystals: should we increase or decrease the reaction volume?, **Advanced Materials**, Vol.26 No.16, 2600-2606*
*[3] Thiele M., Knauer A., Csáki A., et al., (2015), High-Throughput Synthesis of Uniform Silver Seed Particles by a Continuous Microfluidic Synthesis Platform, **Chemical Engineering Technology***