Stochastic Confinement Assembly: A True Random Number Generator using Silver and Gold Nanospheres

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Standard hardware random number generators often use quantum mechanical phenomena or thermal noise to produce bit streams of random, but often biased, origin. In contrast, colloidal self-assembly of billions of particles on 1 cm^2 can assure bias-free, heterogeneous particle sequences to be employed as bits in a hardware random number generator.

Utilizing template-assisted colloidal self-assembly, well designed building blocks consisting of gold spheres and silver spheres are assembled into heterogeneous single particle lines [1-3]. Those lines are subsequently analyzed via scanning electron microscopy coupled with energy dispersive X-ray spectroscopy (SEM-EDX). Image analysis enables a statistical evaluation, which shows that gold and silver do not assemble in any way preferential to any particle type, therefore generating random distributions only dependent on employed Ag/Au particle share (Fig. 1) [4].

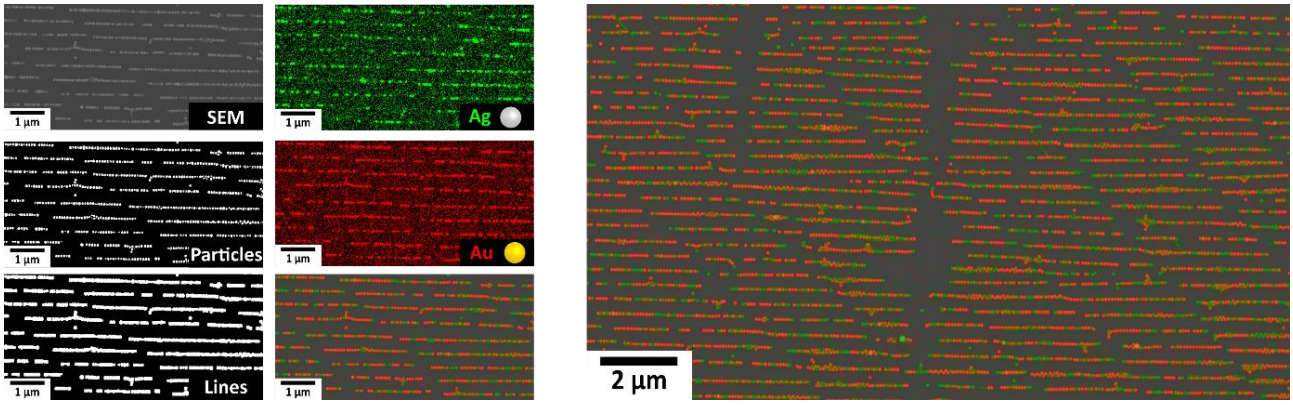

Figure 1. SEM-EDX and subsequent image analysis of the generated particle lines. Algorithms applied to the SEM image allow assigning each single particle to its corresponding line. A comparison of the silver and gold intensities integrated over each particle allows assigning particle composition, which can then be statistically analyzed.

[1] A. M. Steiner *et al.* Macroscopic Strain-Induced Transition from Quasi-infinite Gold Nanoparticle Chains to Defined Plasmonic Oligomers. *ACS Nano* **11** (2017), 8871. DOI:10.1021/acsnano.7b03087
[2] M. Mayer *et al.* Aqueous Gold Overgrowth of Silver Nanoparticles: Merging the Plasmonic Properties of Silver with the Functionality of Gold. *Angew. Chem. Int. Ed.* **56** (2017), 15866. DOI:10.1002/anie.201708398
[3] A. M. Steiner *et al.* Silver particles with rhombicuboctahedral shape and effectively isotropic interactions with light. Chem. Mater. **31** (2019), 2822. DOI:10.1021/acs.chemmater.8b05220
[4] D. Schletz *et al. in preparation.*