Sampling of initial stages of gold particles formed during spark discharge

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Keywords: Spark discharge, TEM, Proximity Sampling

The number of nanoparticle-based products on the market is expected to increase considerably during the coming decades. This forces the industry to have highly meticulous manufacturing of large amounts of nanoparticles using cheap and environmentally friendly methods. For production of metal and metal oxide nanoparticles spark discharge generation is a promising route to fulfill these demands, Tabrizi (2009). The scalability of the process makes it suitable for mass production due to its simple design solely by placing several units in parallel.

Before doing so, one first needs to optimize a single spark discharge generator unit. To optimize the spark discharge generator in a controlled way the first stage of nanoparticle formation needs to be understood. Matsoukas (1991) and others have done extensive investigations on generation of nanoparticles and large effort has been put into deriving models on how these particles actually are formed. However the fundamentals of metal nanoparticle formation during spark discharge is not as well investigated. To improve this understanding we have constructed a customized nanoparticle TEM sampler; see Figure 1.

The constructed TEM sampler allows for collection of particles formed close to the very first moments of generation, only a few mm from the discharge. Our results show that single crystalline particles with diameters smaller than the primary particle size in the final agglomerated particles (3nm vs 5 nm) are possible to collect as seen in figure 2. A varied gas flow also shows an effect on the particle size, already 9 mm below the discharge. Understanding of these initial steps in particle formation is crucial in order to further optimize and realize mass production of metal nanoparticles in a cheap and environmentally friendly way.

Acknowledgements
This work was supported by the European Union’s Seventh Framework Program (EU FP7) under Grant Agreement No. 280765 (BUONAPART-E).

References

Figure 1 – Schematic of the sampling setup during production of gold nanoparticles

Figure 2 – Particles sampled at a flow of 0.5 lpm $N_2$ sampled 9 mm from the electrode gap