Cu-Ni spark discharge nanoparticles from alloy feedstock of varied composition

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Since its inception by (Schwyn et al 1988), spark discharging has been applied to produce particles from a broad range of electrode materials, both pure metals and semiconductors. The method's ability to produce particles from arbitrary conducting feedstock material and therefore its versatility is one of its advantages.

Recently, particle size distributions and evaporation rates for a number of pure metallic and semiconductor electrode materials were determined by (Tabrizi et al 2009a, Vons et al 2011). Furthermore, it was shown that the spark discharge method may be used to produce bimetallic particles by employing electrodes made of two different materials or using alloyed or sintered electrodes (Tabrizi et al 2009b).

The variance in composition of the resulting particles is reported to be much higher when using electrodes of two different materials in comparison to alloyed electrodes. The average composition may be controlled by discharge characteristics to some extent when using two electrodes of different composition. However, since the average composition of particles from alloyed electrodes is known to be close to the feedstock composition, the use of alloyed or sintered electrodes appears to be the most promising route towards reliable production of bimetallic nanoparticles.

In this study, nanoparticles were produced using alloyed copper/nickel electrodes of varying composition. Copper and nickel were chosen as primary metals as these elements are known to produce homogenous alloys, i.e. they only form a single solid phase. Both materials, as well as their alloys, exhibit a face-centred cubic crystal structure with similar lattice constants.

Particle production was conducted using a spark discharge generator (c.f. Fig. 1) with conventional RCL-circuit (C=15 nF) and nitrogen as carrier gas The major part of the setup was evacuated and purged with nitrogen (purity 5.0) prior to production. Residual oxygen content in the inert gas was reduced by means of a gas purifier. The produced particles were collected in powder form after precipitation on a surface filter element. Samples were deposited on TEM grids by means of a dedicated low pressure impactor. Fig. 2. depicts the setup used in this investigation.

Mean particle composition was investigated using several techniques including ICP-OES, while STEM-EDX was used to determine the elemental distribution inside the produced nanoparticle agglomerates. Particle morphology and size was characterized by TEM while production rate was measured gravimetrically.

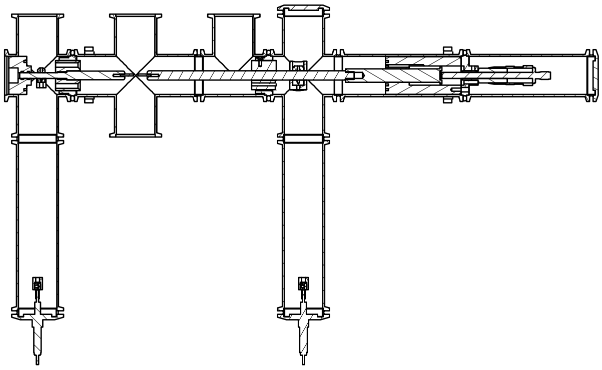

Figure 1. Cross-section of the employed spark discharge generator

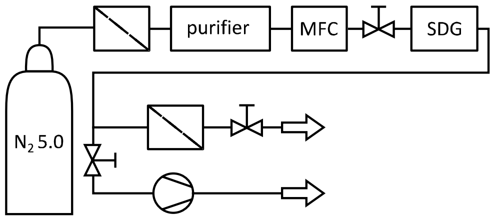

Figure 2. Schematic of the setup

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Schwyn, S., Garwin, E. & Schmidt-Ott, A. (1988). Aerosol generation by spark discharge. *Journal of Aerosol Science* **19**, 639–642.

Tabrizi, N., Ullmann, M., Vons, V., Lafont, U. & Schmidt-Ott, A (2009a). Generation of nanoparticles by spark discharge. *Journal of Nanoparticle Research* **11**, 315–332.

Tabrizi, N., Xu, Q., van der Pers, N., Lafont, U. & Schmidt-Ott, A. (2009b). Synthesis of mixed metallic nanoparticles by spark discharge. *Journal of Nanoparticle Research* **11**, 1209–1218.

Vons, V., de Smet, L., Munao, D., Evirgen, A., Kelder, E., Schmidt-Ott, A. (2011). Silicon nanoparticles produced by spark discharge. *Journal of Nanoparticle Research* **13**, 4867–4879.