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Generation of thermally stable and spherical 100nm silver particles

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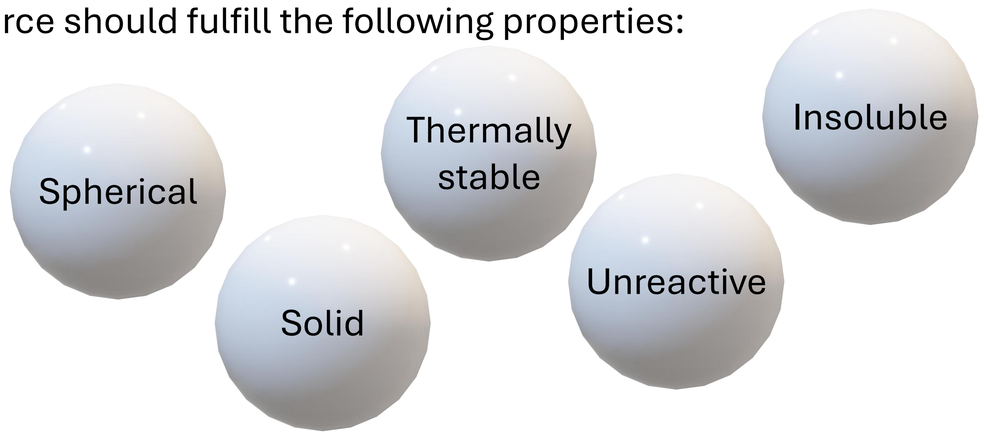
Background

A stable and well-characterized aerosol source is crucial for standards and calibration processes. Particles generated with such a source should fulfill the following properties:



Commonly used test particles, such as salts, emery oil, or soot, do not satisfy all these requirements (Wlasits et al, 2020; Giechaskiel and Melas, 2022). In contrast, silver particles can meet these criteria if the aerosol is generated and treated appropriately.

The **°Silver Particle Generator** (SPG) presents a robust, flexible, and convenient approach for producing thermally stable and compact spherical silver particles up to 100 nm in diameter.

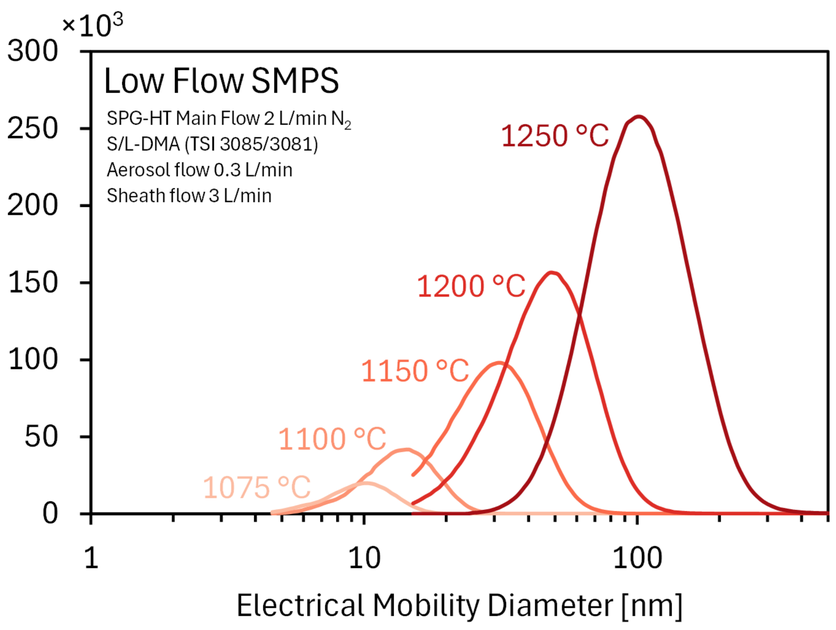


Fig. 1: Raw concentration output of the **°Silver Particle Generator** at different temperature setpoints measured with an SMPS system.

Particle Sintering

Large agglomerates with sizes up to 300nm formed during silver nanoparticle generation in the **°Silver Particle Generator** are sintered at 400 °C in the **S8000 °Particle Sintering Device** to yield thermally stable, spherical particles.

Fig. 2: Transmission Electron Microscopy (TEM) images of silver nanoparticles before (left) and after (right) sintering in the S8000 °Particle Sintering Device. Agglomerated particles (left) with an electrical mobility diameter of approximately 300 nm transform into 100 nm spherical particles (right) under the prevailing experimental conditions (air as the carrier gas).

Experimental Setup

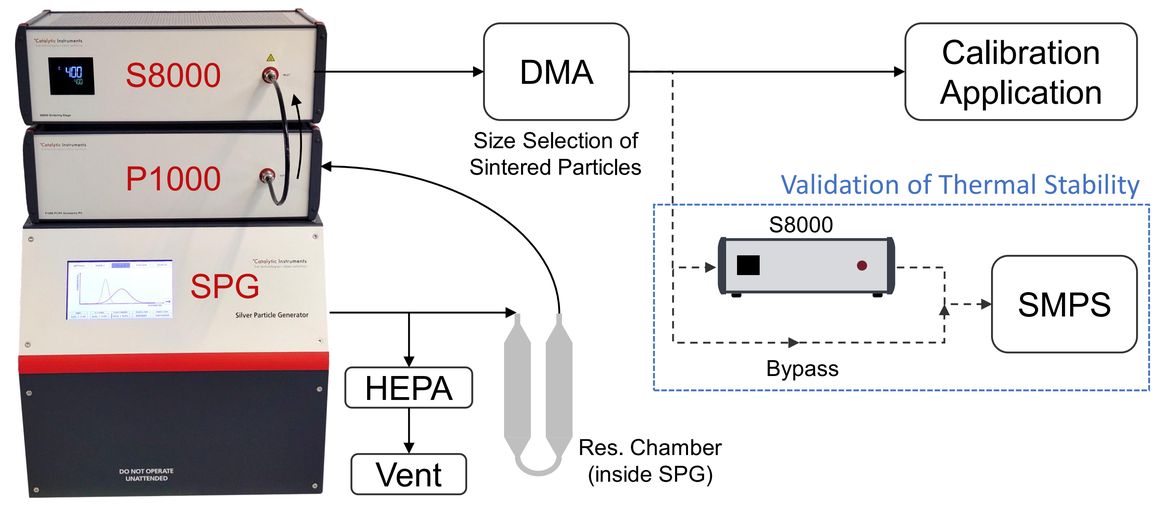


Fig. 3: Setup for generating thermally stable and compact spherical silver particles for CPC and PCRF calibration with the SPG. The produced particles agglomerate in the Residence Chamber and the P1000 PCRF Accessory Kit. The large agglomerates are sintered in the S8000 °Particle Sintering Device and size selected in the DMA for the calibration application. The thermal stability of the particles can be validated by performing SMPS scans on the size-selected particles, with and without thermal treatment in a second S8000.

Results

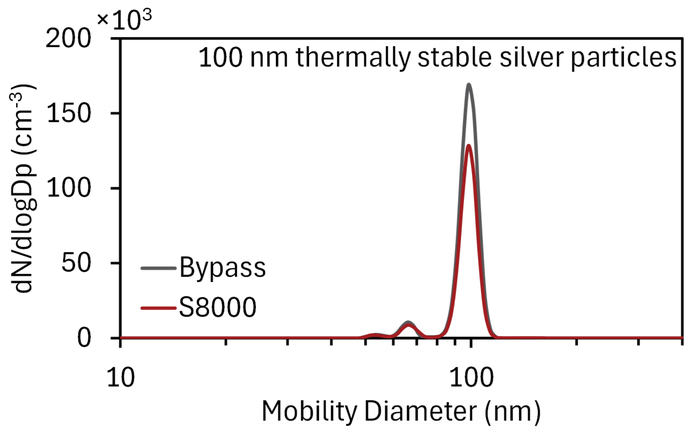


Fig. 3: SMPS size distributions validating the thermal stability of the generated spherical silver particles (after the DMA). No size shift between bypass and S8000 indicates thermally stable particles.

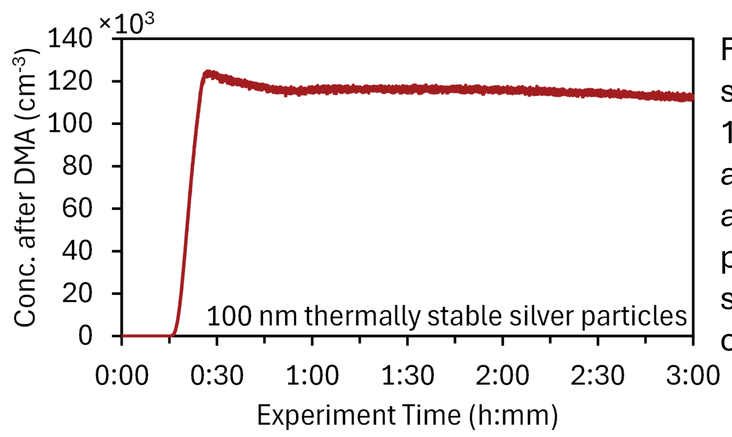


Fig. 4: Concentration of spherical, thermally stable 100 nm silver particles. After a short heat-up phase of about 0.5 to 1 hour the particle concentration is stable and can be used for calibrations.

Conclusions

- With the presented setup it is possible to produce thermally stable and compact spherical silver particles with mobility diameters from 5 nm to 100 nm with concentrations up to 10^6 cm^{-3}.
- The setup proves to generate these particles in an easy, flexible and stable way.
- These solid, unreactive and insoluble Silver particles comply with criteria of a universal calibration standards for CPC or PCRF calibrations or for any other UFP application requiring a highly defined, stable aerosol source.

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