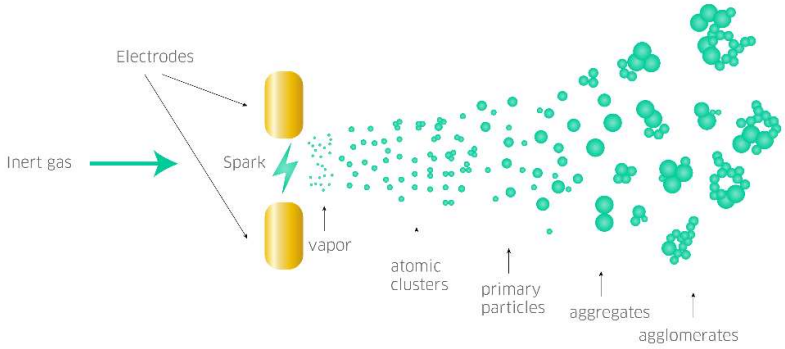
Joerie Gennisse

VSPARTICLE technology as a manufacturing method for atomic clusters

Spark ablation or spark discharge generation refers to electrical discharges of 1-10 µs duration that are induced in the gap between two electrode rods. This principle has been firstly introduced for the precursor-less, gas-phase production of very small particles by Burtscher and Schmidt-Ott (Burtscher and Schmidt-Ott, 1982). Since then, many milestones have achieved in literature proving the scalability and versatility of this method across many different fields (Schmidt-Ott, 2019).



VSPARTICLE has developed a fully automated system, the VSP-G1 Nanoparticle Generator, that uses spark ablation as core technology for the generation of ligand-free nanoparticles with a very narrow size distribution. The size of the produced particles of the standard product configuration is in the size range of 1 – 20 nm and can be easily tuned via the power and flow rate parameters. The whole process takes place under atmospheric pressure and the device is compatible for the production of any conductive or semi-conductive material, including alloys. After synthesis, the produced nanoparticles can be directly deposited on the desired substrate using one of the available deposition accessories, allowing for the synthesis of new materials. Since these materials are made using very small nanoparticles as building blocks, they can also be tailored towards new unique properties.

The advantageous capability of spark ablation to control the size and purity of generated particles in these very small size regimes unlocks great potential for its application in sub nano dimensions research areas such as cluster synthesis. The operational parameters of spark discharge generation that were found to have an effect for producing atomic clusters are the energy per spark, the inert gas flow and the electrode configuration (Maisser et.al, 2015). The spark energy is of paramount importance because it determines the amount of material that gets evaporated from the electrode's surface. Modification of this parameter can be achieved via the capacitance used in the electrical circuit and by the gap distance. By reducing the energy per spark, the size of the produced particles can also decrease even further. Following this principle, a modified VSP-G1 Nanoparticle Generator, using lower energy per spark, has already been used successfully for the production of clusters.

Finally, evaluation of the upscaling potential of a manufacturing method is also essential for its broader adaptation especially in the catalysis and electrocatalysis field. Difficulty to achieve cost efficient and industrially relevant output rates is one of the greatest limitations of the most commonly used cluster synthesis methods such as wet chemistry processes and ion beam methods (Schmidt-Ott, 2019). With spark ablation, upscaling of the produced output can be achieved by increasing the spark frequency (Pfeiffer, 2014) and VSPARTICLE is already actively collaborating with companies to ensure that the technology can soon be used for the manufacturing of industrially relevant volumes.

References

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