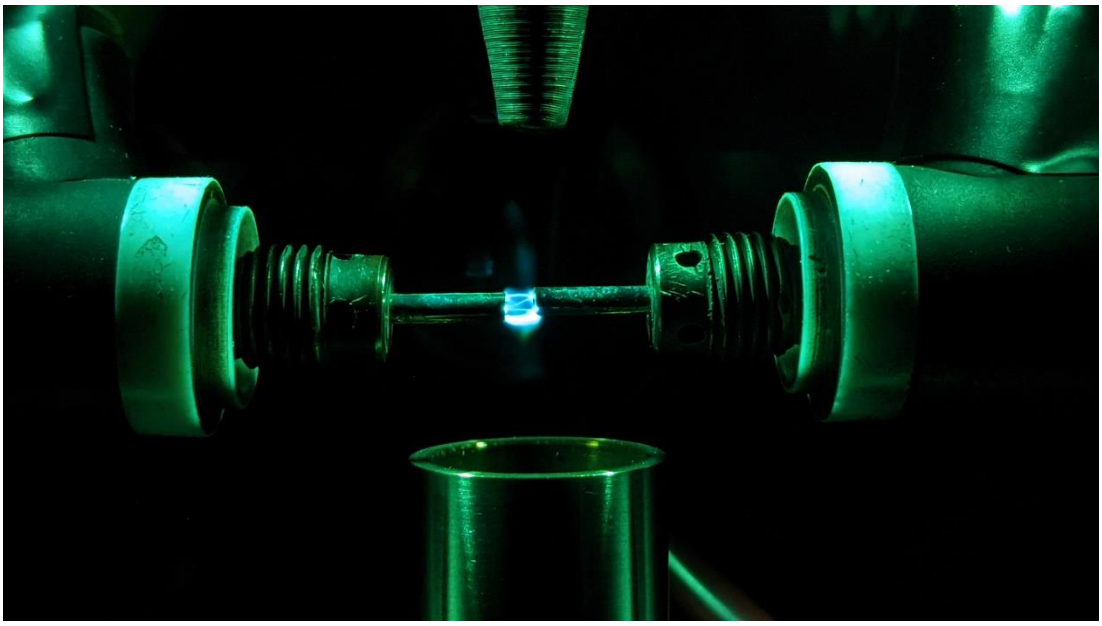
Catalyst nanomaterials and catalyst layers for hydrogen technologies

Technology overview

The apparatus is used to produce samples of catalytic layers for membrane-electrode-assembly (MEA) for a fuel cell or to produce a platinum catalyst in powder form for further use. The laboratory equipment is based on innovative spark discharge technology to produce platinum nanoparticles. The apparatus has already been turned over to a semi-operational scale and tested for a long time.

The presented technology uses spark evaporation technique for the synthesis of metal nanoparticles in the sub-5-nanometer size range. Short and intense spark discharges are used to vaporize a solid metal source periodically. The metal vapors are subsequently cooled by an inert carrier gas, which results into condensation of nanometer-sized particles. The gas stream simultaneously transports the formed particles and allows for their deposition into functional layers.

Our synthesis and deposition device can form precise functional layers with tailored composition and thickness, and with high purity and uniformity. It offers cost-reduction potential for the development and manufacture of electrochemical devices, e.g. membrane-electrode-assemblies for low-temperature fuel cells or electrolyzers. The device ranks TRL4.



Benefits

The spark-ablation synthesis is a simple gas-phase process, which results in high purity of produced nanoparticles and low fraction of waste by-products compared to traditional liquid-based nanoparticle synthesis approaches (sol-gel). The synthesis is running at atmospheric pressure avoiding the need for vacuum components as is the case for PVD/CVD or magnetron sputtering techniques. The process is continuous, reproducible and allows for scale-up by increasing the spark frequency or using multiple spark ablation units in parallel. Process parameters can be adjusted to tailor the size of nanoparticles as well as their composition in case mixed nanoparticles (nanoalloys) are being synthesized, e.g. Pt/Ru. Direct deposition of generated nanoparticles into high-porosity, uniform, micrometer-thick functional layers is achieved in the gas phase, which represents a cost-effective way of manufacturing catalyst layers for hydrogen fuel cells and electrolyzers. Our fuel cell MEA tests, with catalyst layers deposited by the presented method, currently show 460 mW/cm^2 power density for 0.2 mg/cm^2 cathode Pt loading with H_2/air at 1.5 bar backpressure.

Implementation areas

- hydrogen technologies - fuel cells and electrolyzer stacks
- catalytic synthesis
- spectroscopy
- supercapacitors
- gas sensors
- research and development

In particular:

- optimization of catalyst layer structure and composition for electrochemical devices
- production of membrane-electrode-assemblies for fuel cell and electrolyzer stacks

Partnering

We look for companies who would like to:

- develop and optimize catalyst nanomaterials (size and composition) and functional layers made thereof (porosity and microstructure) for various electrochemical processes
- automate the process of spark-ablation nanoparticle synthesis and deposition for scaled-up production
- integrate novel catalyst layers into custom products, e.g. hydrogen fuel cell and electrolyzer stacks

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