

Nanoparticle Deposition on Powder Supports from the Gas Phase

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Introduction

Current synthesis methods

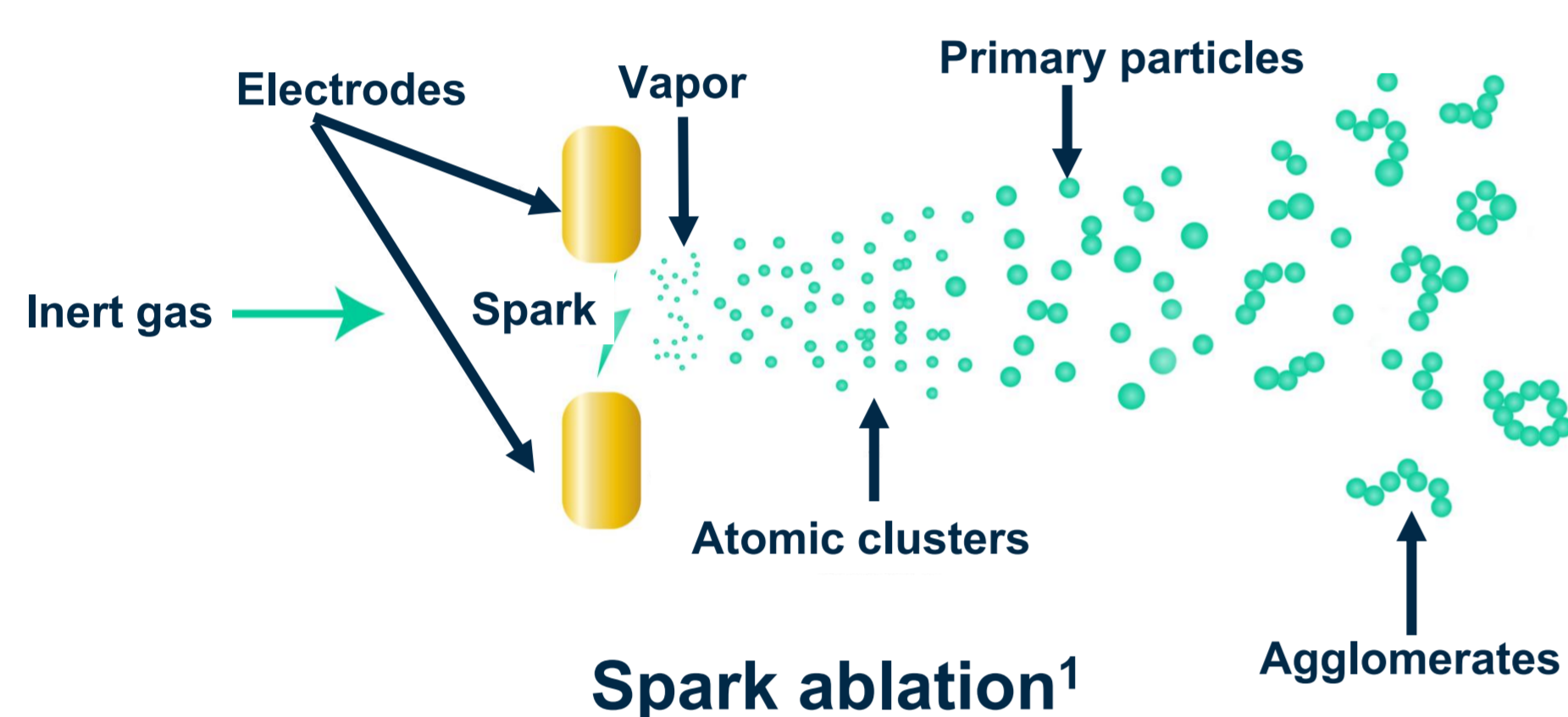
- Conventional wet-chemical methods → Enrichment and depletion of nanoparticles on support, no defined particle size distribution, limited combination of material, multiple steps, difficult to scale
- Thin-film techniques → Precise, but costly and unsuitable for powders

Need: A scalable method for uniform nanoparticle deposition on powder supports

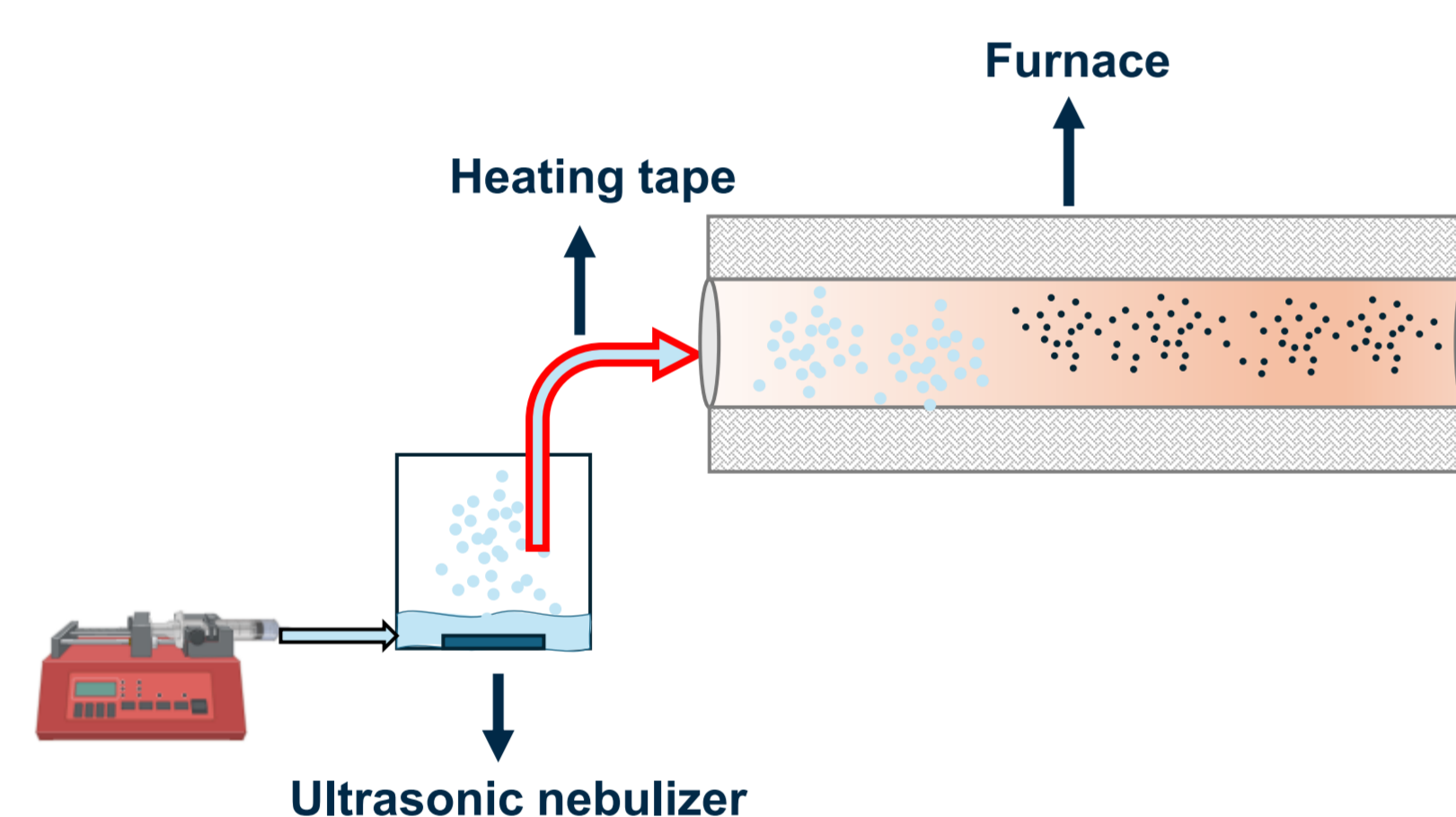
Solution: Gas-phase coating → Pure metallic phases, ligand-free, versatile composition, single step and scalable

Synthesis of Novel Catalyst

Nanoparticle generation

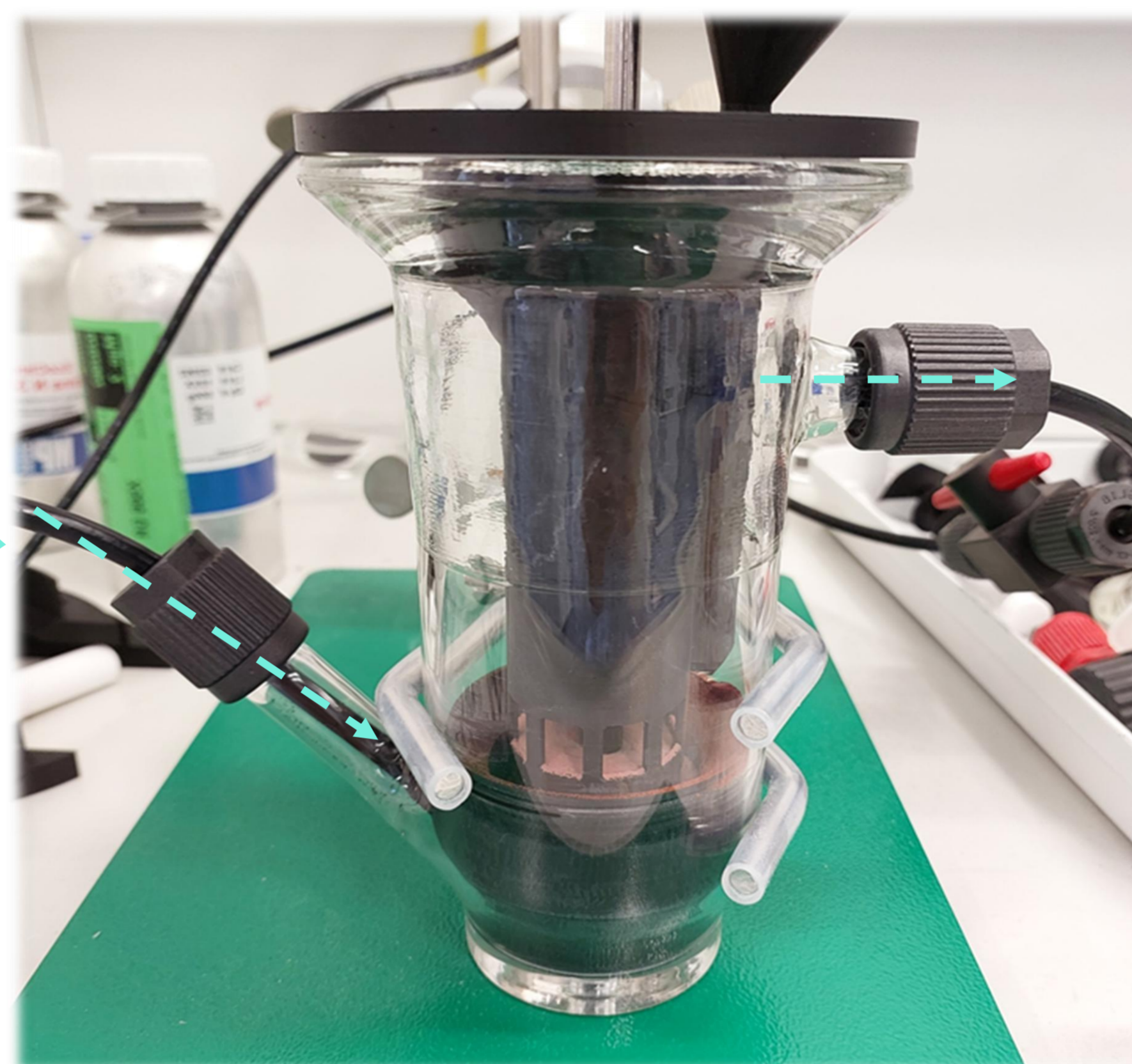


Spark ablation¹

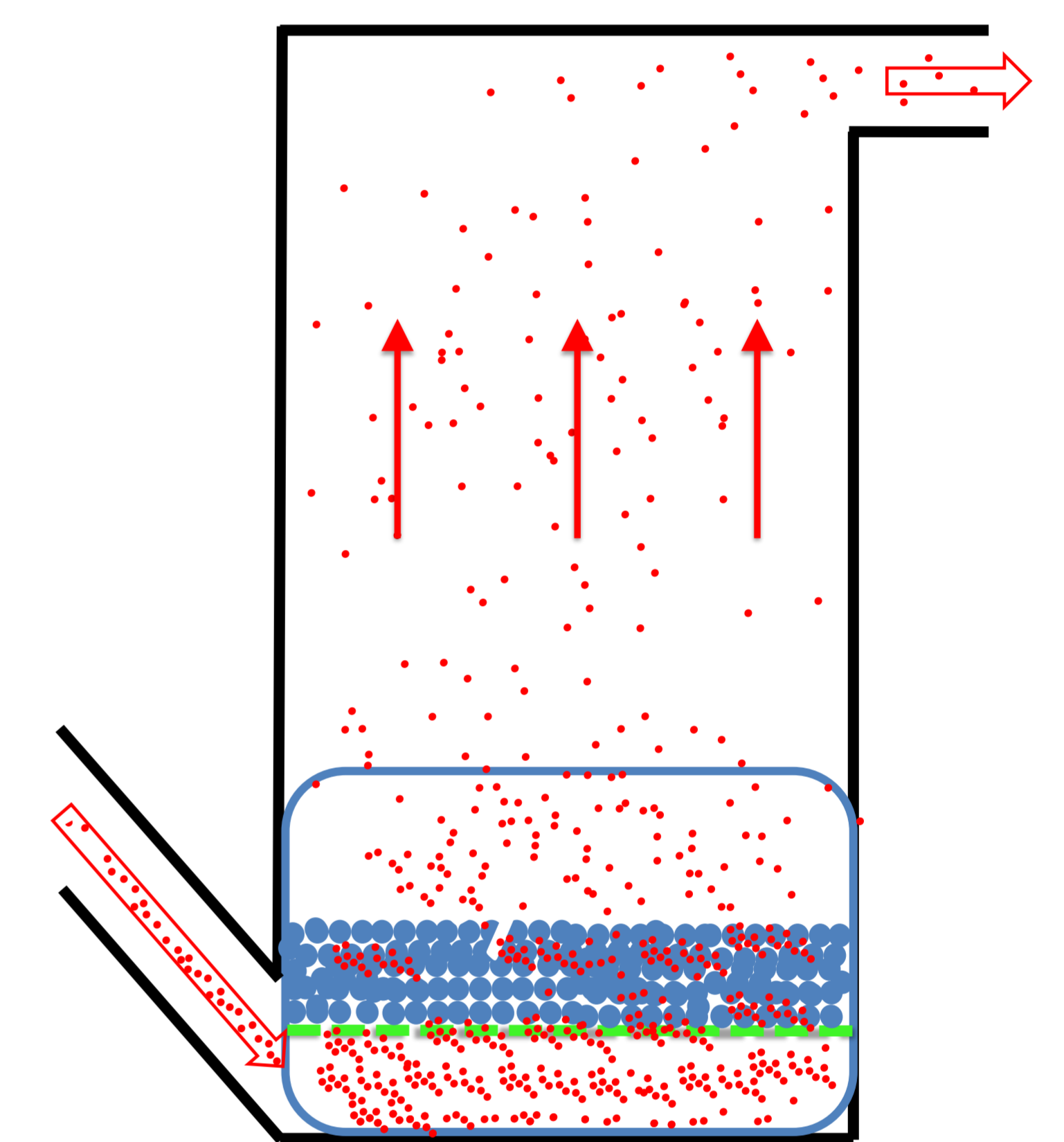


Ultrasonic spray pyrolysis

Powder coater



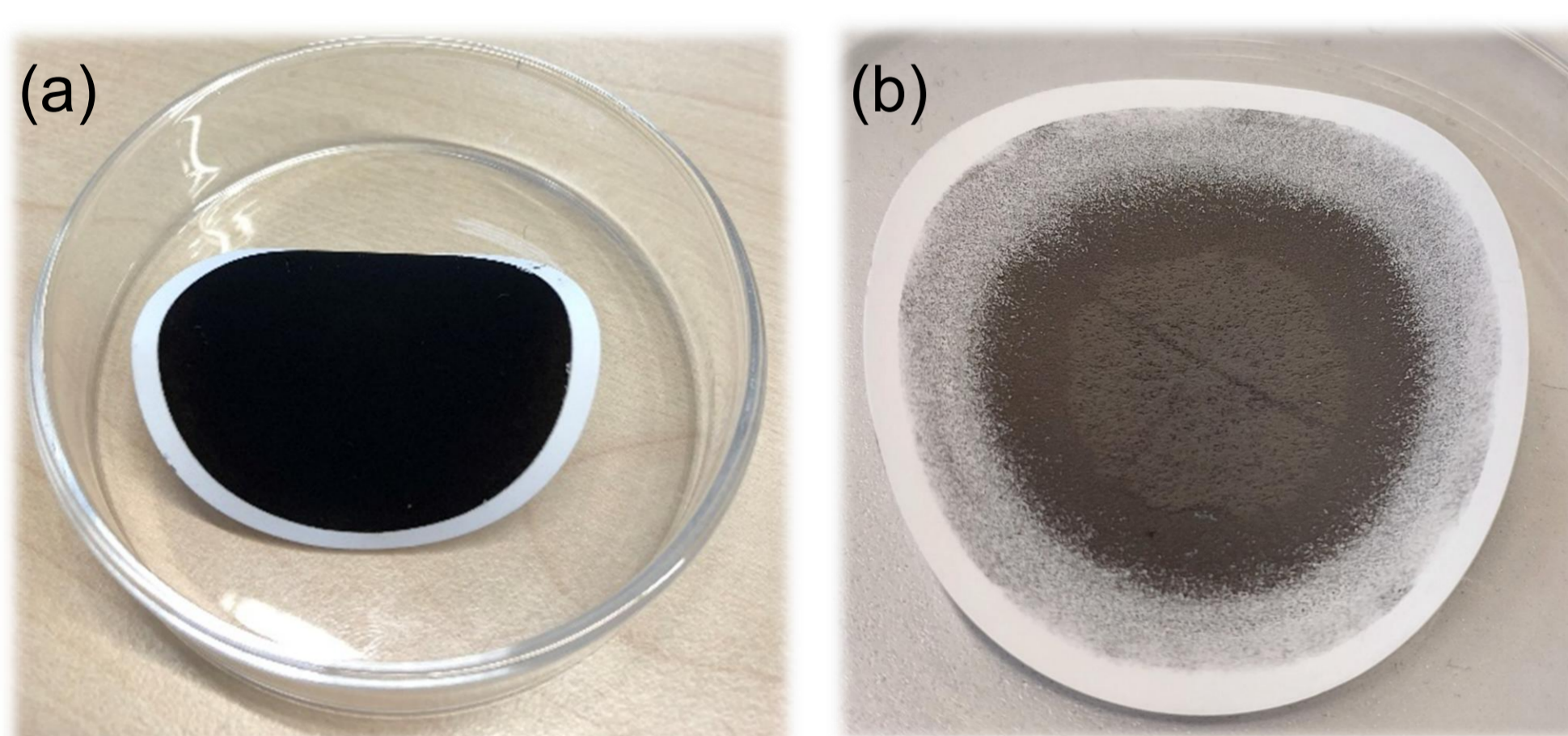
Powder coater schematic



• Powder support 10 - 100 μm

• Gas stream loaded with nanoparticles < 10 nm

Inlet Flux Measurement



PTFE membranes after nanoparticle deposition at 3 L min⁻¹ Ar flow

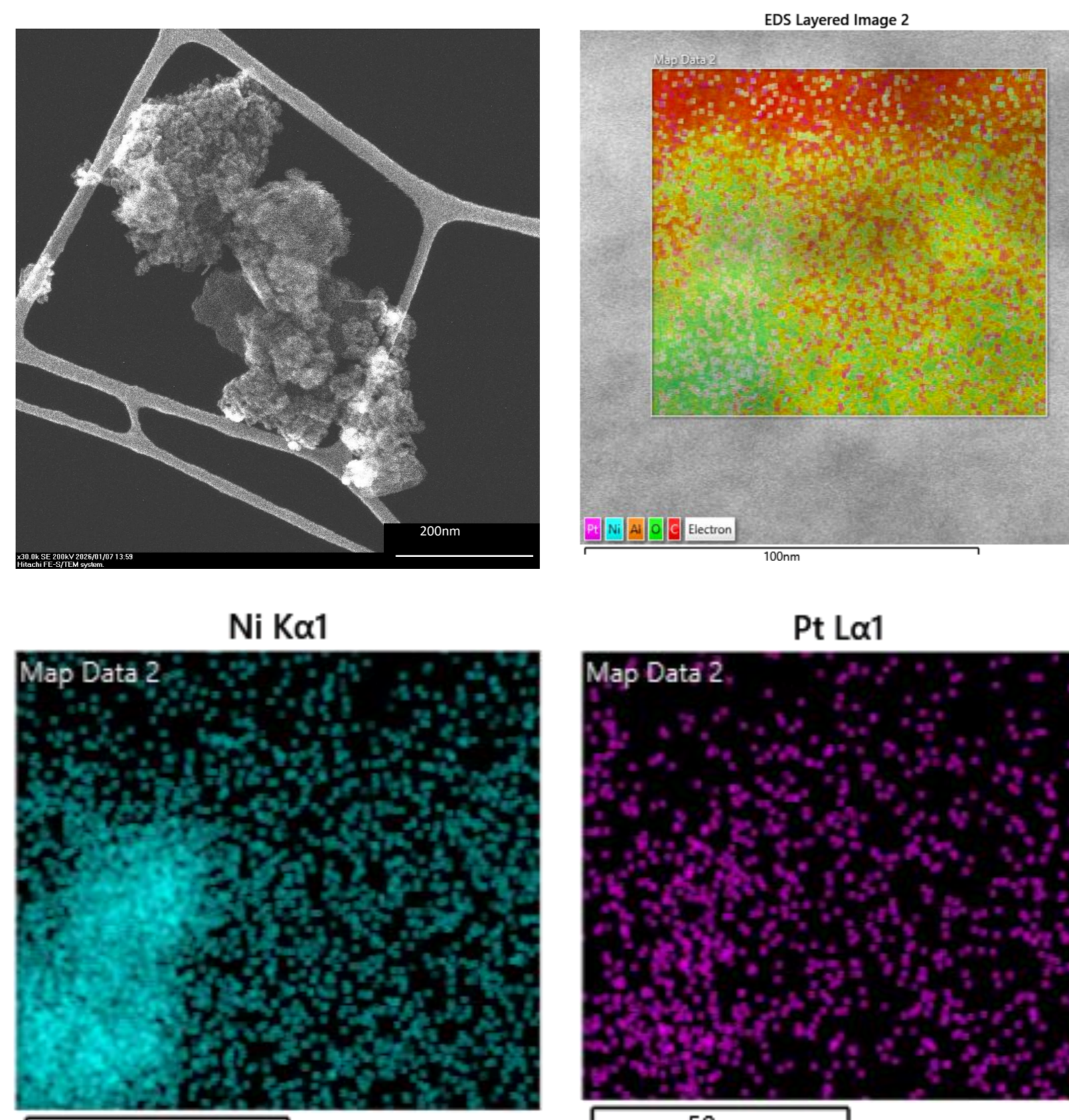
(a) NiPt nanoparticles deposited from spark ablation (~5 h)

(b) From ultrasonic spray pyrolysis (~1 h)

Nanoparticle inlet flux comparison:

- Spark ablation: 1.6 mg h⁻¹
 - Ultrasonic spray pyrolysis (USP): 26.3 mg h⁻¹ (~16× higher)
- USP is more suitable for scaling up.

Experimental Results & Outlook



TEM/EDX analysis of 0.014wt.% Ni₉₅Pt₅/Al₂O₃
Spark ablation + Powder coater
72h, 3L/min, 30g Al₂O₃

➤ Powder coater capture efficiency \approx 4%

Design of Experiment for Spark Ablation

Amount of support (35 – 80 g)

Flow rate (1 – 3 L/min)

Deposition time (8 – 48 h)

✓ Total 8 experiments

Hydrodynamic Mode Study

Fixed bed
1L/min

Expanded bed
3L/min

Fluidized bed
5L/min

➤ **Outlook:** Improve powder coater design to achieve higher catalyst loading and uniform deposition.

1. Taken with permission from: <https://vsparticle.com/products/vsp-g1-nanoparticle-generator>