

LIQUID FEED- FLAME SPRAY PYROLYSIS

Synthesis of CERAMIC Nano- Powders and some applications

10/25/04

University of Michigan



Materials Chemistry Laboratory

Introduction

Nanosized (<100 nm) ceramic powders (UFP) offer potential for producing transparent monoliths, superplastic processing and low-temperature sintering.

These powders permit the fabrication of fully dense materials with good-to-excellent control of microstructure and materials which undergo chemical reactions or phase transformations upon heating.

Ultra Fine Powder Production

- ♦ Physical Routes
 - ♦ Gas Phase Condensation
 - ♦ High Energy Ball Milling
- ♦ Chemical Routes
 - ♦ Electrochemical
 - ♦ Solution Synthesis
 - ♦ Thermal Routes *
 - ♦ Gas Phase Methods *

Comparison of Routes

♦ Chemical

- ♦ Batch Process
- ♦ Difficult to Tailor
- ♦ Time Consuming
- ♦ Hard to Reproduce
- ♦ Morphology:
 - ♦ Inconsistent
 - ♦ Necking
- ♦ Size:
 - ♦ ~300 nm

♦ Physical

- ♦ Semi Continuous
- ♦ Easily Tailored
- ♦ High Reproducibility
- ♦ Better Final Powders
- ♦ Morphology:
 - ♦ Consistently Spherical
 - ♦ No necking
- ♦ Size:
 - ♦ 2-70 nm

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 - ♦ Electrochemical
 - ♦ Solution Synthesis
 - ♦ Thermal Routes *
 - ♦ Gas Phase Methods *

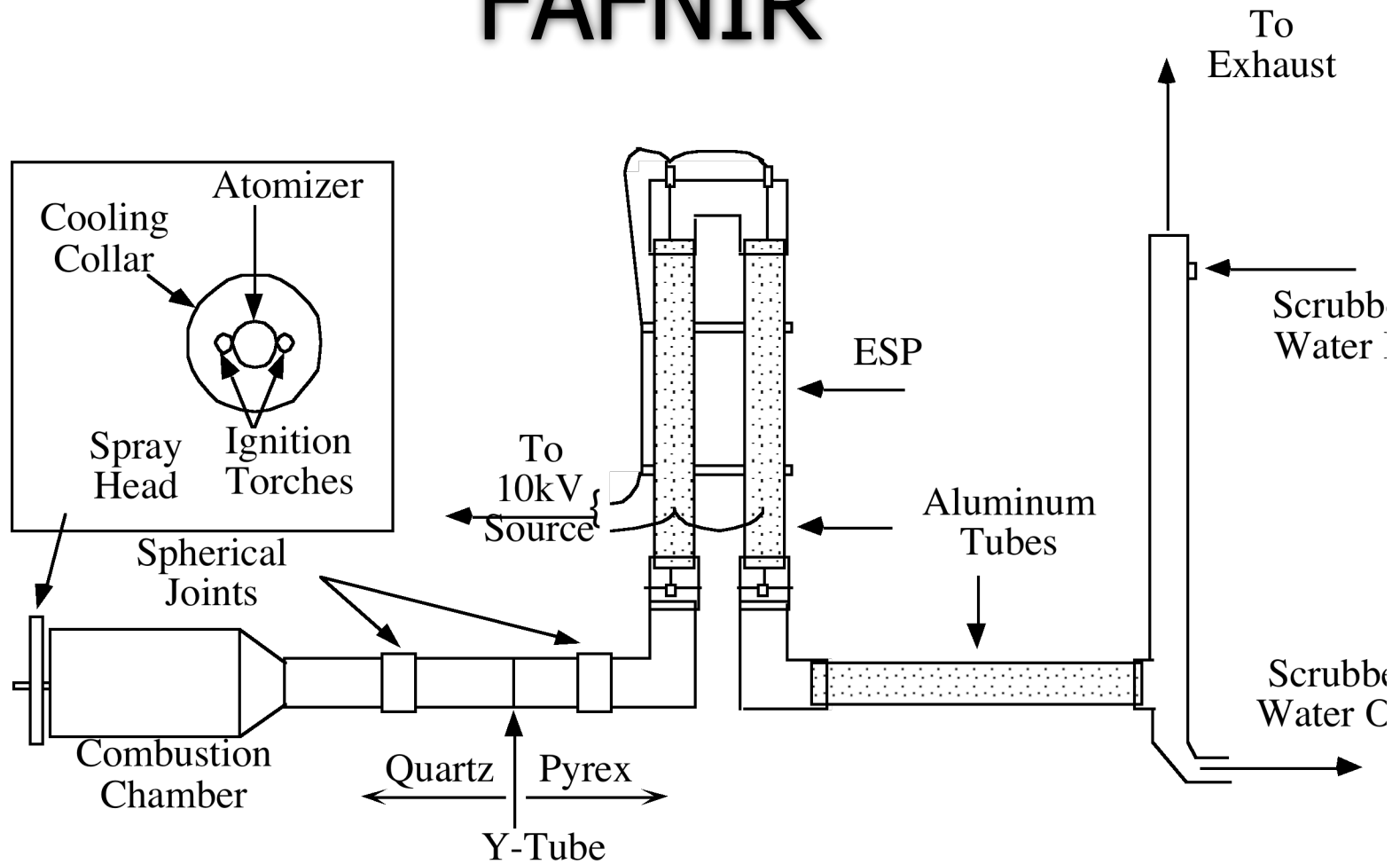
Liquid Feed-Flame Spray Pyrolysis (LF-FSP)

- ♦ Liquid » Vapor » Solid route
- ♦ Aerosol FSP
 - ♦ Particle size < 70nm
 - ♦ Purity: same as solution
 - ♦ Surface Area 40-100m²/g
 - ♦ Semi continuous process
 - ♦ Controlled phase purity
 - ♦ Controlled surface chemistry
 - ♦ Production Rates: 25nm @ 50g/h; 80nm @ 400g/h

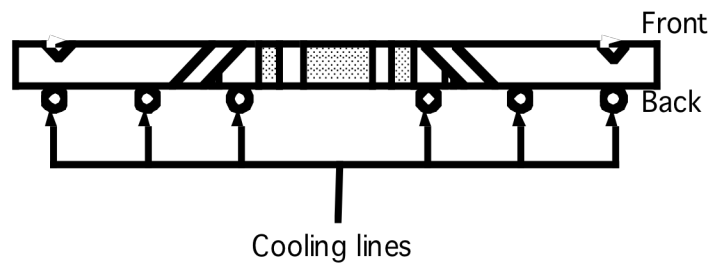
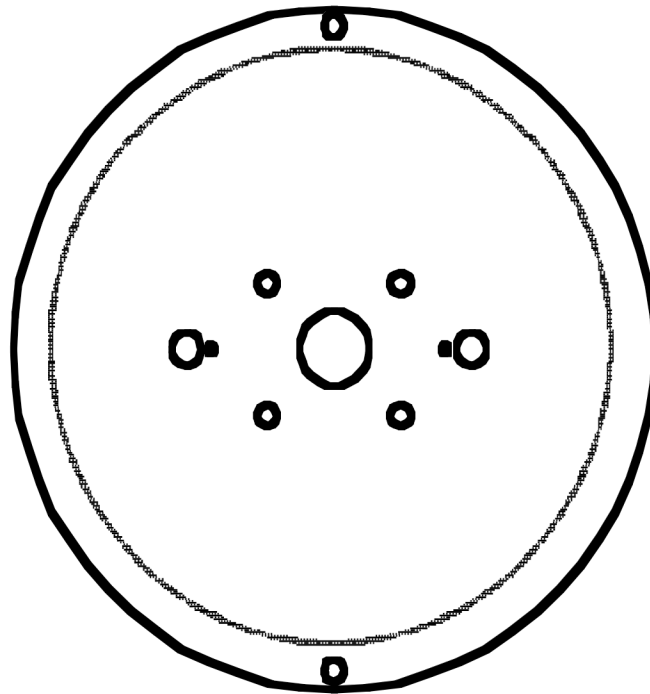
LF-FSP Process Steps

- ♦ Prepare precursors:
 - ♦ Complex of metal hydroxide mixed with a multi-dentate organic
 - ♦ $\text{Ti(OH)}_3 + \text{TEA (triethanolamine)} = \text{complex}$
- ♦ Prepare solution
 - ♦ Mix with volatile organic (ethanol)
- ♦ Shoot/Burn solution
- ♦ Collect powder

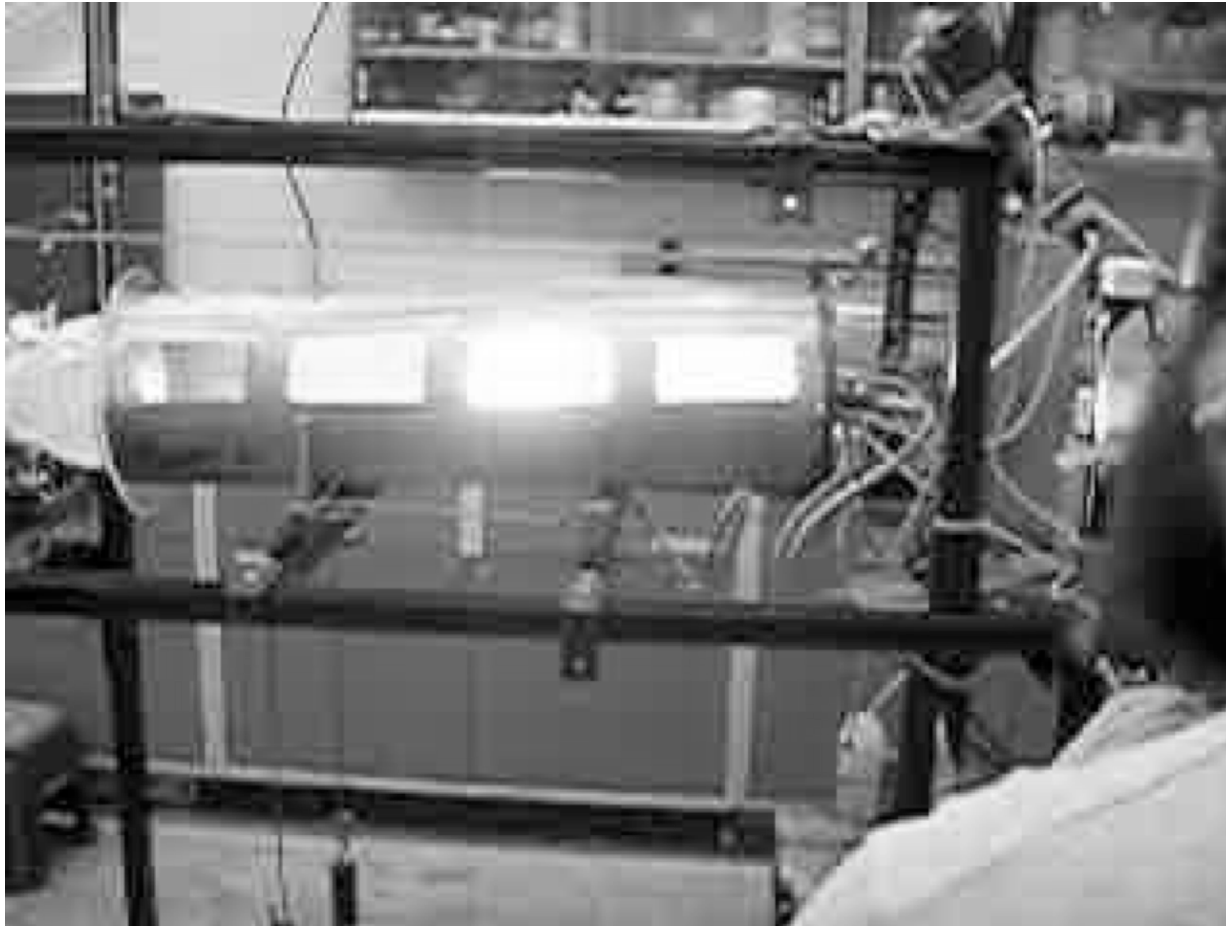
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The Dragon in Action



Applications of UFPs

- ♦ High strength: bullet proof windows
- ♦ Optical: small transparent crystals
- ♦ Electronic/Magnetic: semiconductors, sensors
- ♦ Corrosion/Chemical resistant materials
- ♦ Others:
 - ♦ Paints *
 - ♦ Cosmetics *

Some Ceramic Powder Systems

- ♦ Al_2O_3
- ♦ TiO_2
- ♦ CeO_2
- ♦ ZrO_2
- ♦ MgO
- ♦ CaO
- ♦ $3 \text{ Al}_2\text{O}_3 \bullet 2\text{SiO}_2$
- ♦ MgAl_2O_4
- ♦ BaTiO_3
- ♦ $\text{NiO-Al}_2\text{O}_3$
- ♦ $\text{CoO-Al}_2\text{O}_3$
- ♦ YAG

Questions ?

