Institut für Sensoren und Signale

Fachhochschule Aargau
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Soot Production by Pyrolysis

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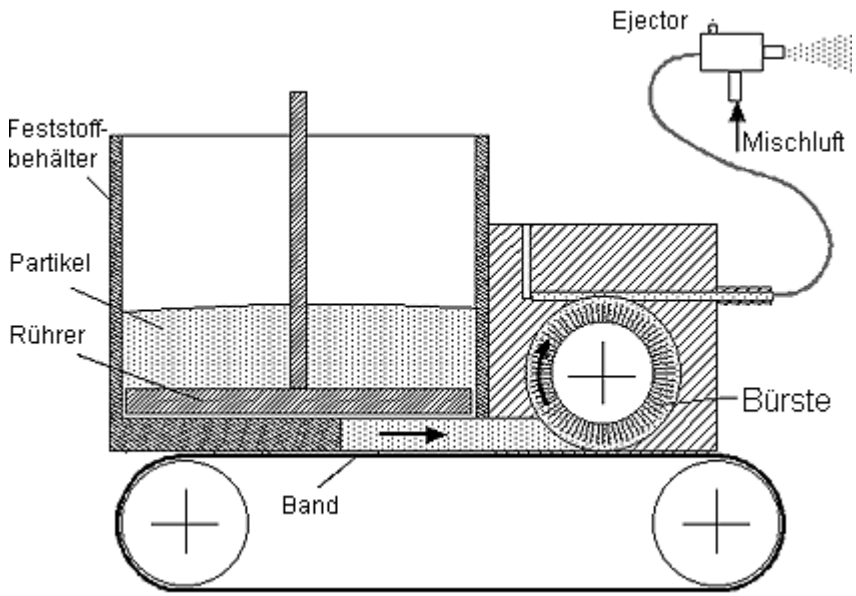
Requirements

- Stable and reproducible soot production
- Size distribution similar to ‘real soot’
- Morphology and composition similar to ‘real soot’
- Adequate mass output
- For filter regeneration tests similar burn-out behavior

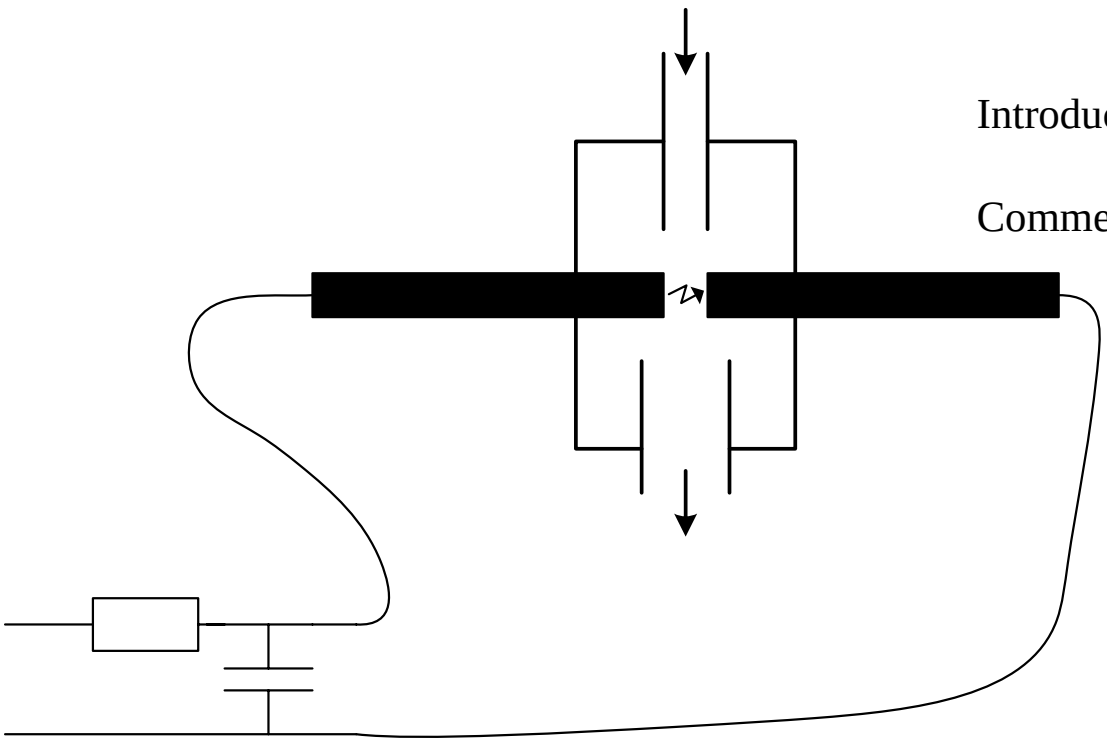
Types of model soot generators currently in use

- Redispersion of collected soot
- Spark discharge
- Sooting flame

Redispersion of collected soot (e.g. NIST reference soot) by dry dispersion (dispersion nozzles)



Spark discharge between graphite electrodes



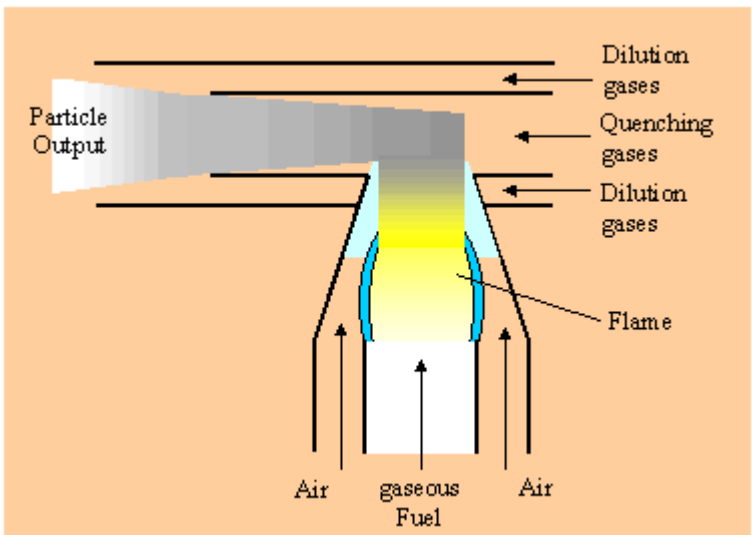
Introduced by Schwyn et al., JAS, 1988

Commercial product by PALAS

Sooting flame: used for very long time, diffusion flames and premixed flames

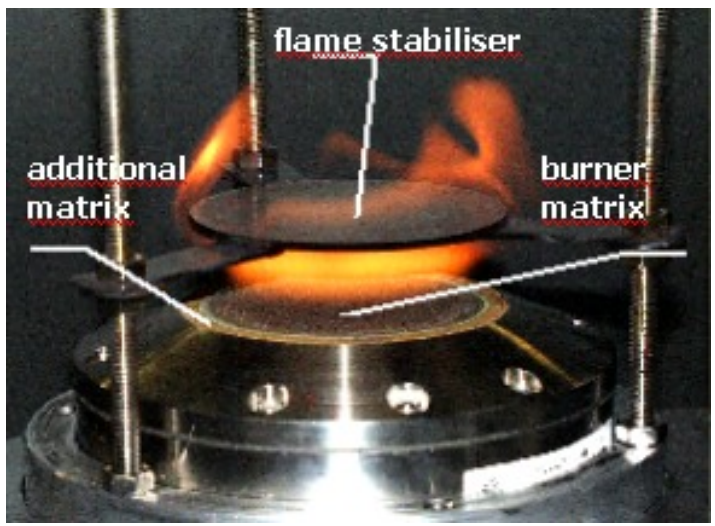
ME: CAST

burner: coannular diffusion flame
fuel: various gases, vaporized liquid fuels

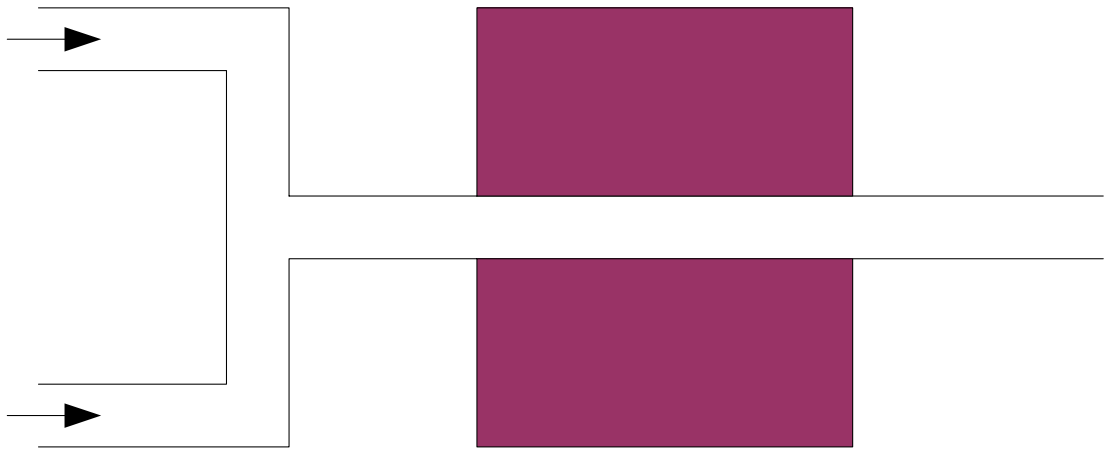


PALAS: VSG-3000

burner: Coflow Matrix burner
fuel: premixed ethene (C2H4) / air



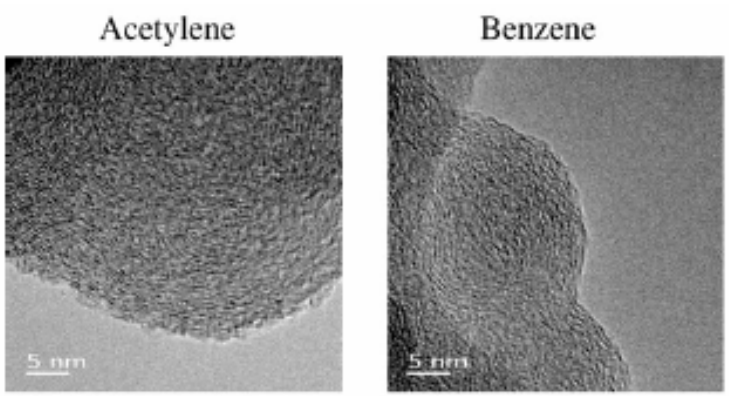
Soot production by pyrolysis



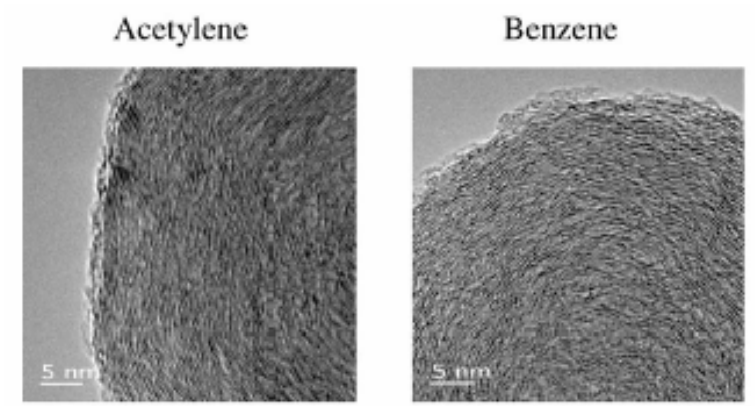
Inert gas

Structure of soot particles, produced by pyrolysis

1250°C: mainly amorphous



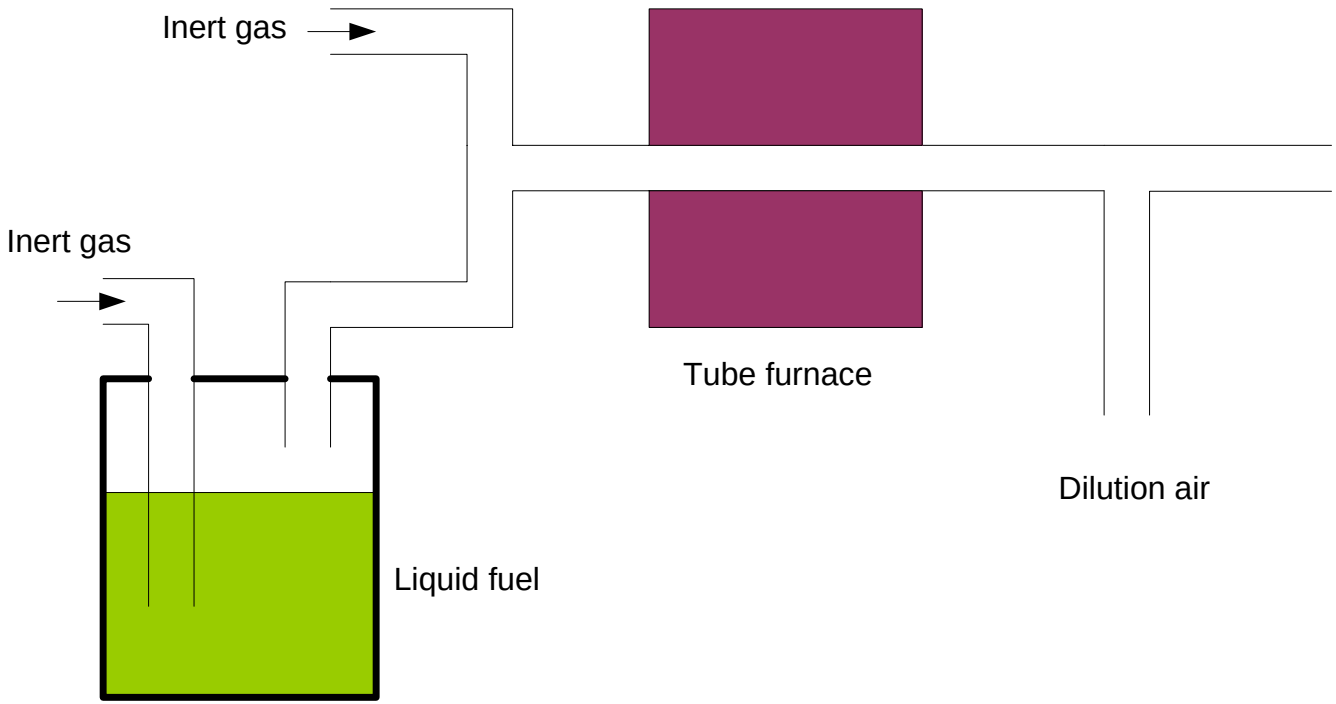
1650 °C: graphitic structures



Other parameters:
- Residence time
- Fuel
- Fuel concentration

From:
R. L. Vander Wal, a.J. Tomasek
Combustion and Flame, 136, 2004

Soot production by pyrolysis



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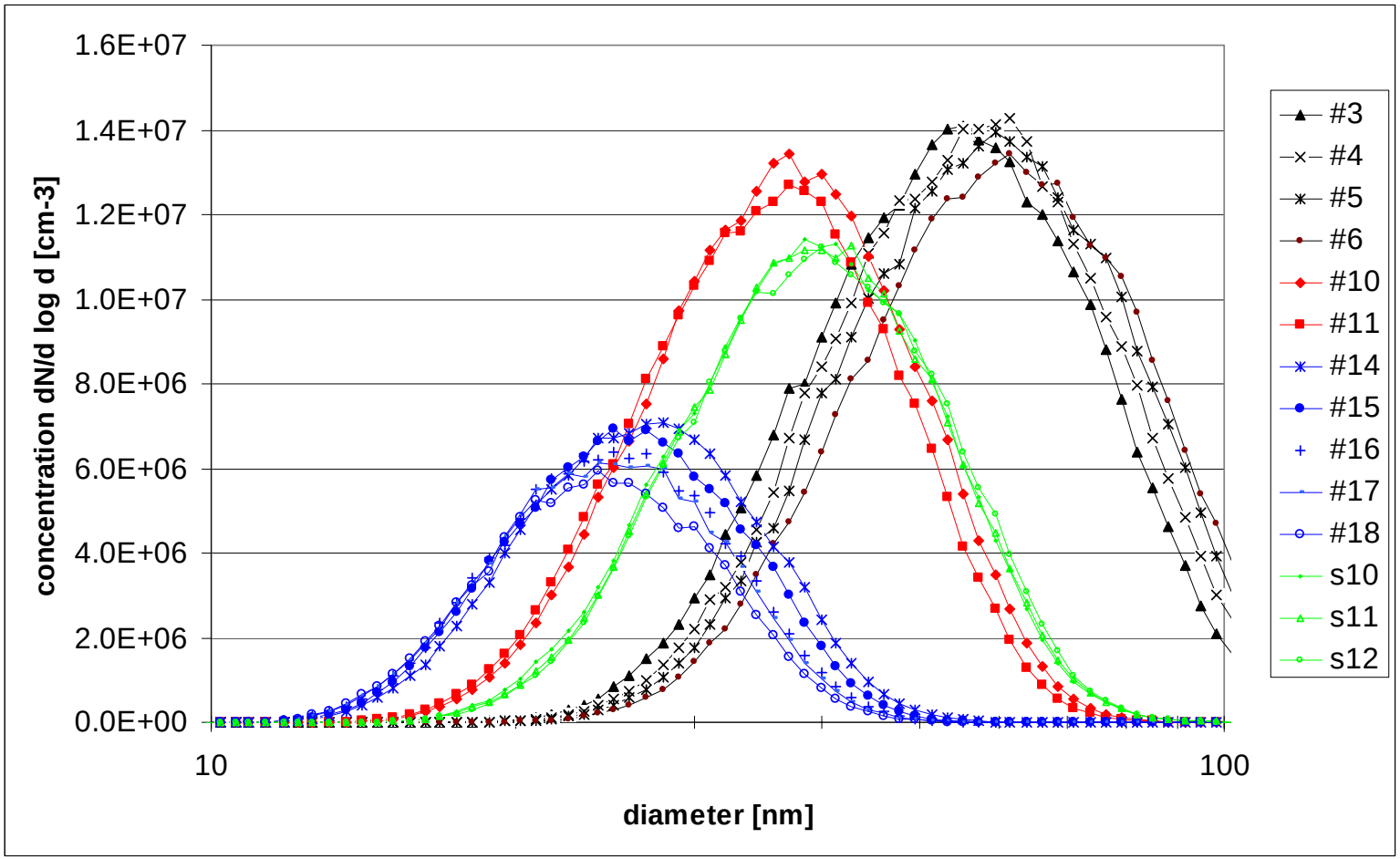
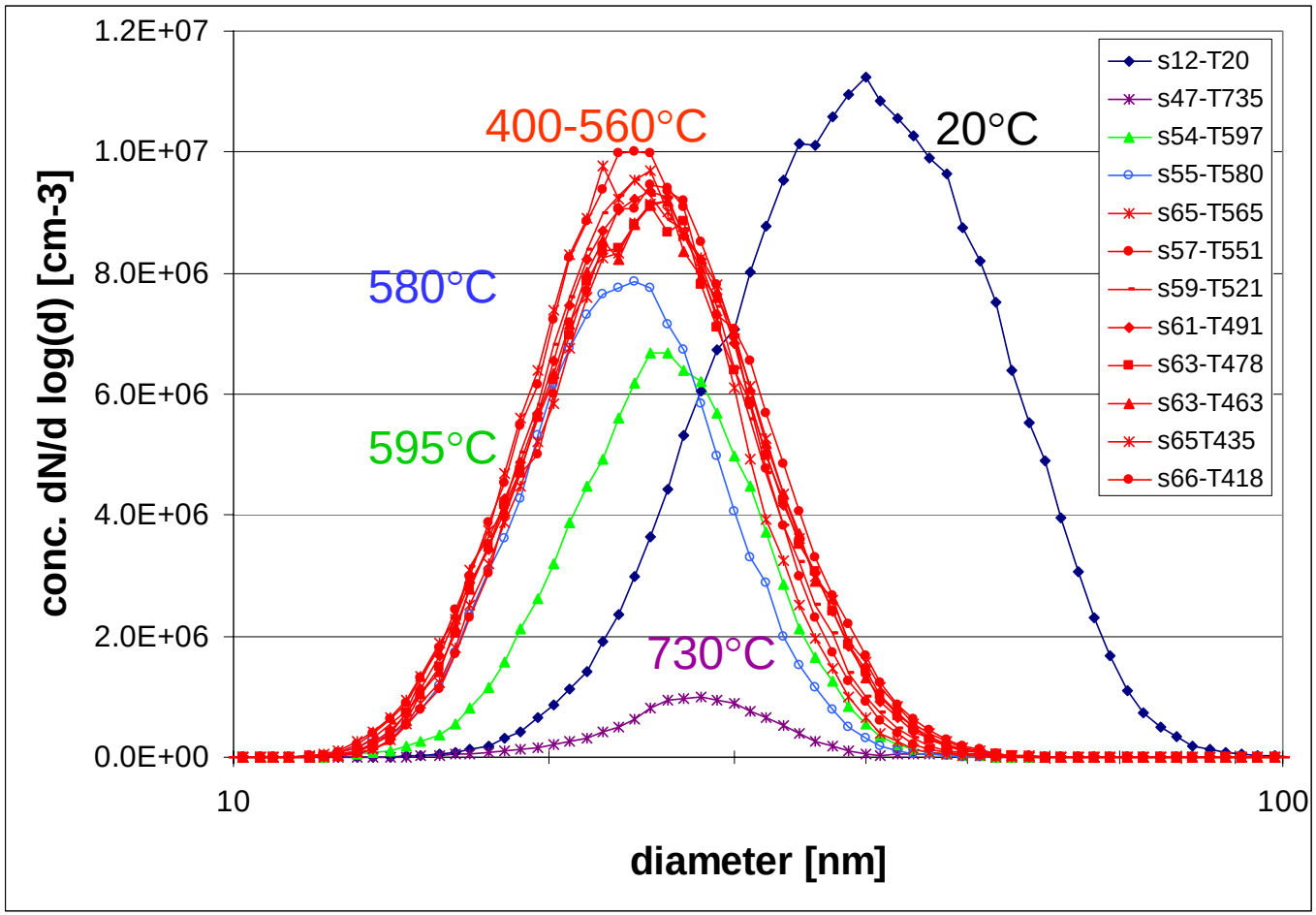
First results

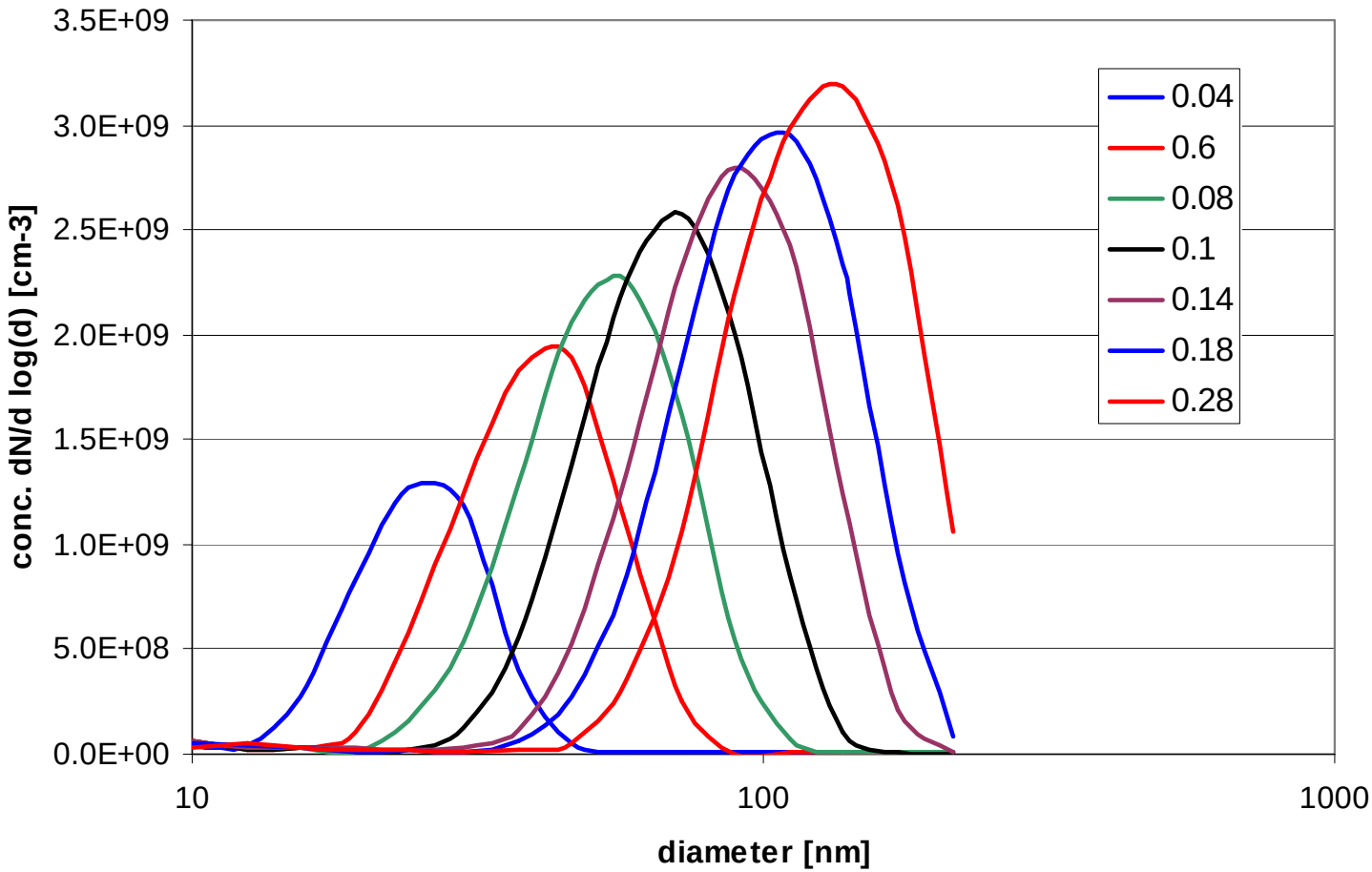


Desorption/soot combustion

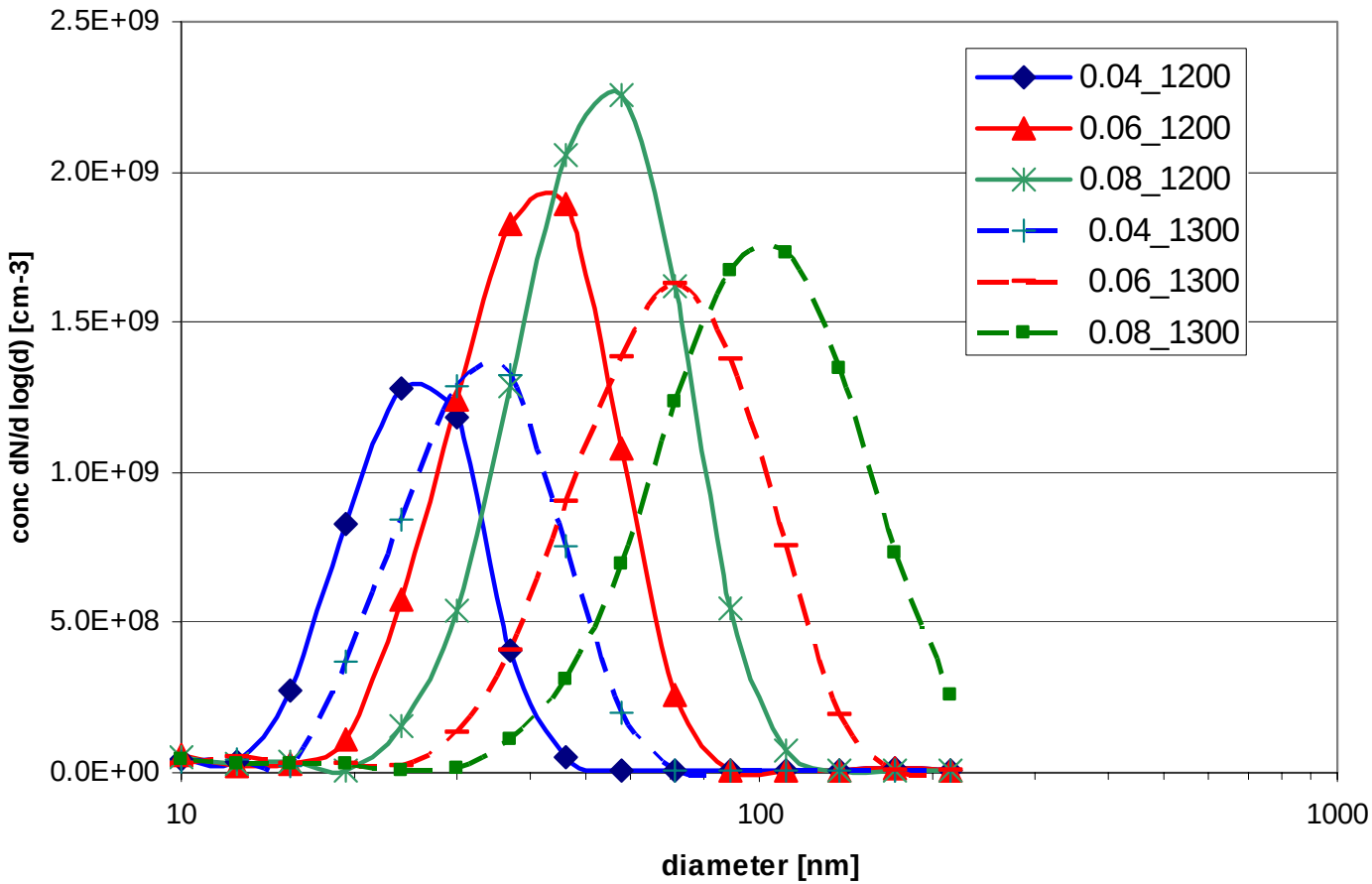


Operation with toluene

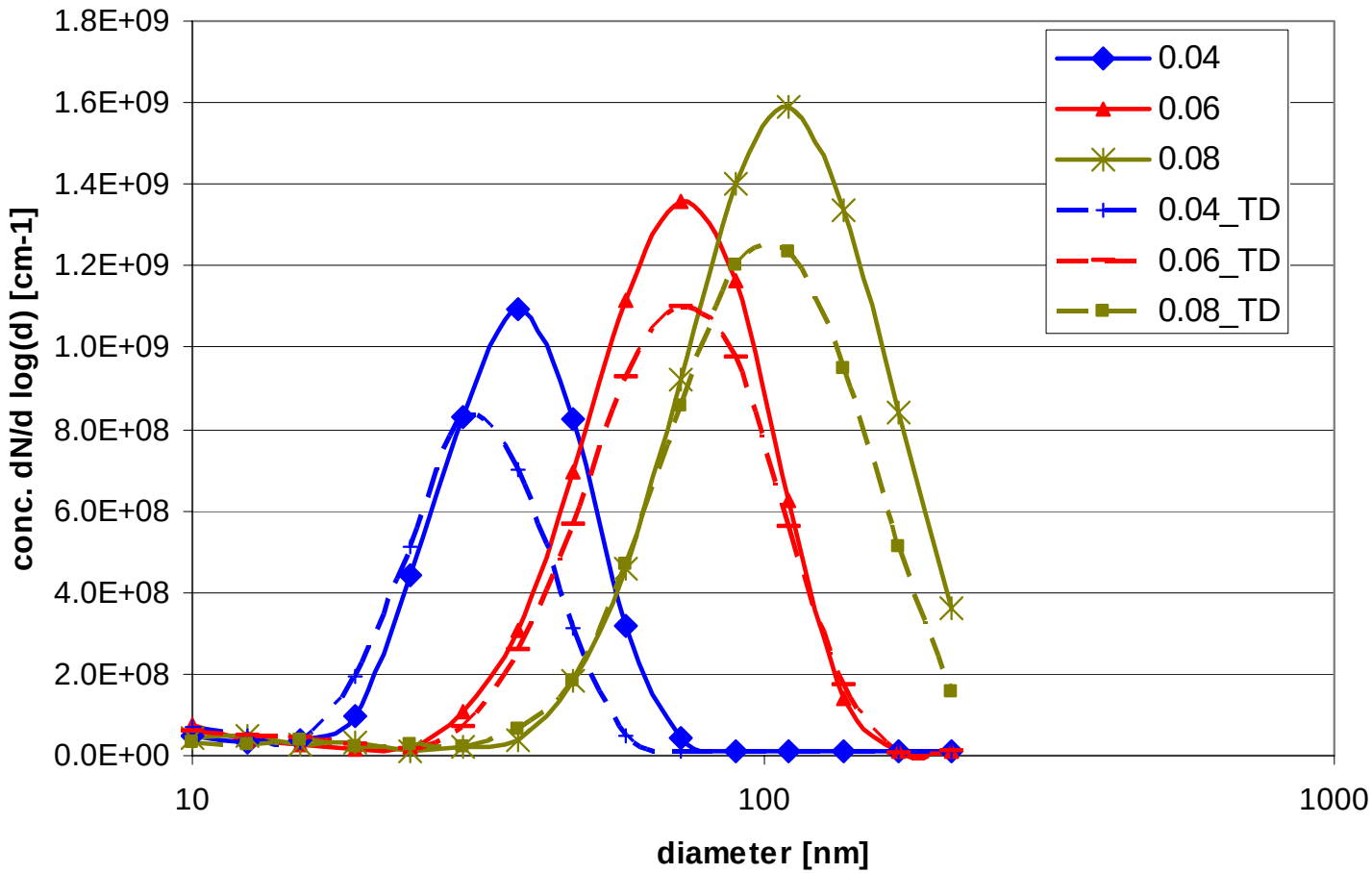
1200°C, 2.5 l/min AG, parameter: fuel flow



Toluene, 1200 vs. 1300 °C



Det. of volatile fraction with TD



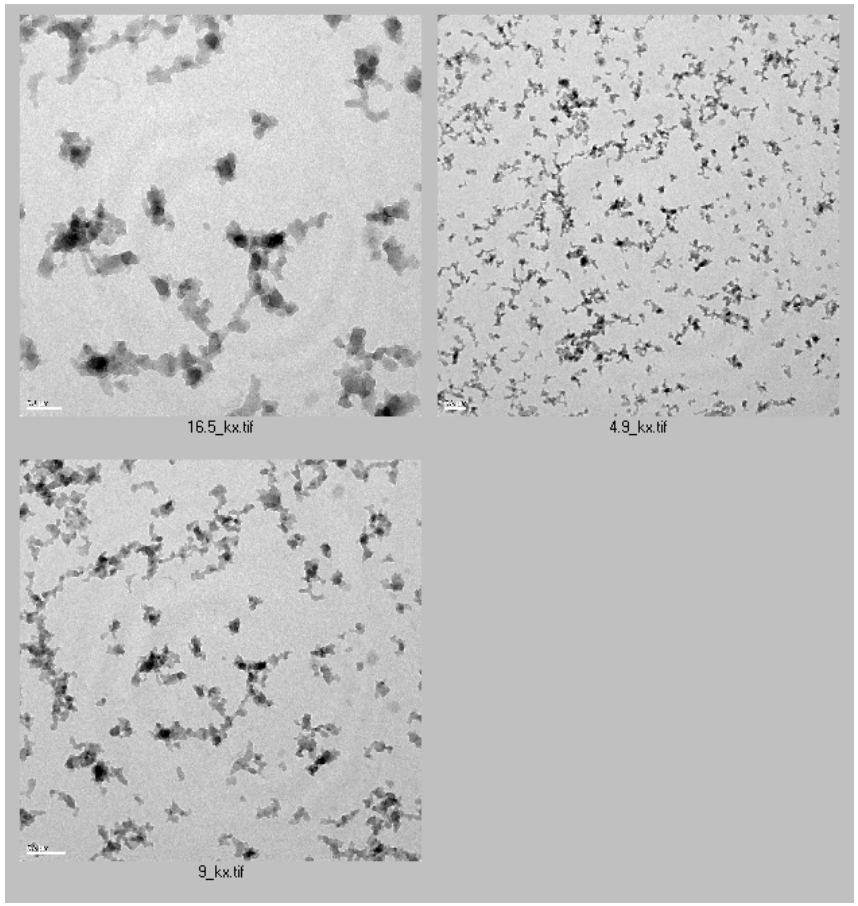
Pyrolysis:
1300 °C

Characteristics of pyrolysis-soot

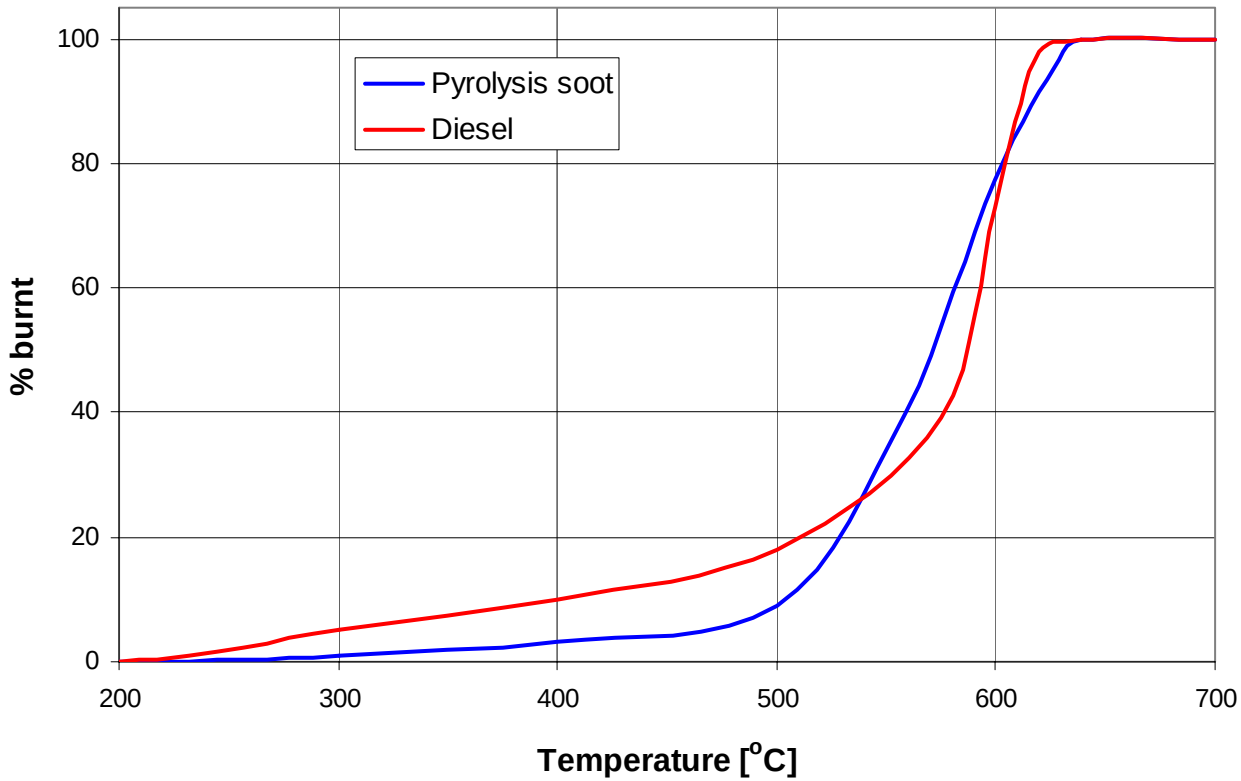
Composition:

C	H	N	O	S
96,5	**1,4**	0,1	1,9	0,01

Primary particle size
d_{BET} 19nm
d_{TEM} 15 nm



Combustion in TGA-analysis



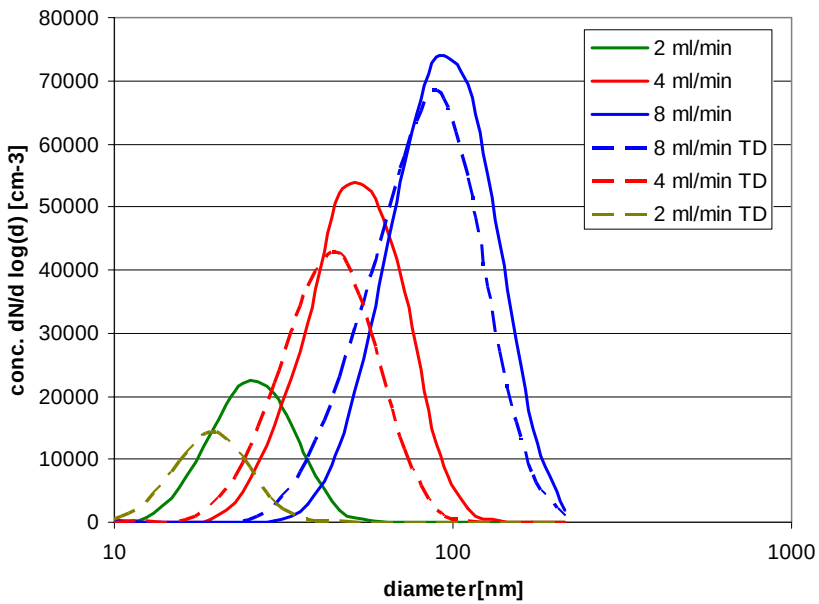
T50: Diesel: 582 °C
Pyrolysis: 575 °C

Sumary

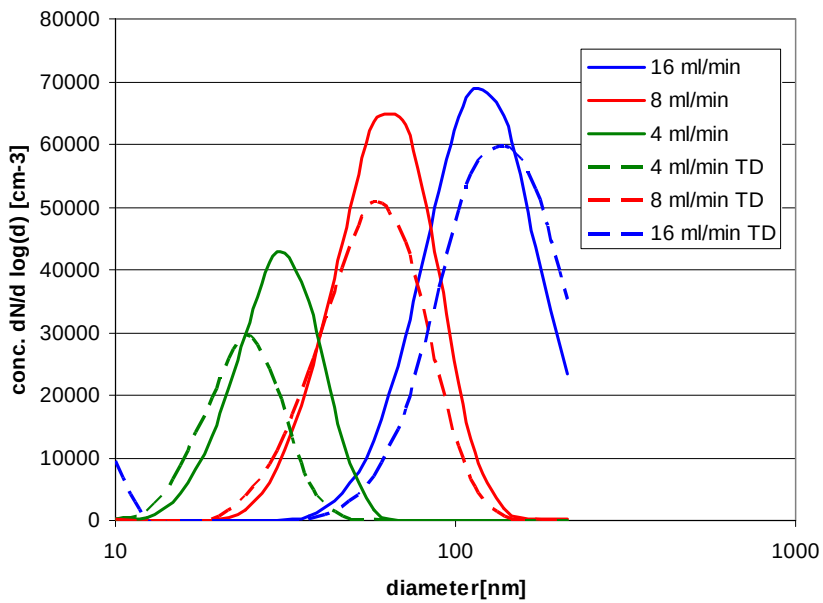
- Similar properties as diesel soot
- Size distribution tunable in wide range
- Stable operation ca. 20 min after furnace reaches operation temperature
- Change in parameters (gas flow) takes 15 min to rech stable operation
- Stable operation >12h
- No high sensitivity to flow changes
- Mass output with current setup: ca. 30 g/h.

Other fuels

Propane



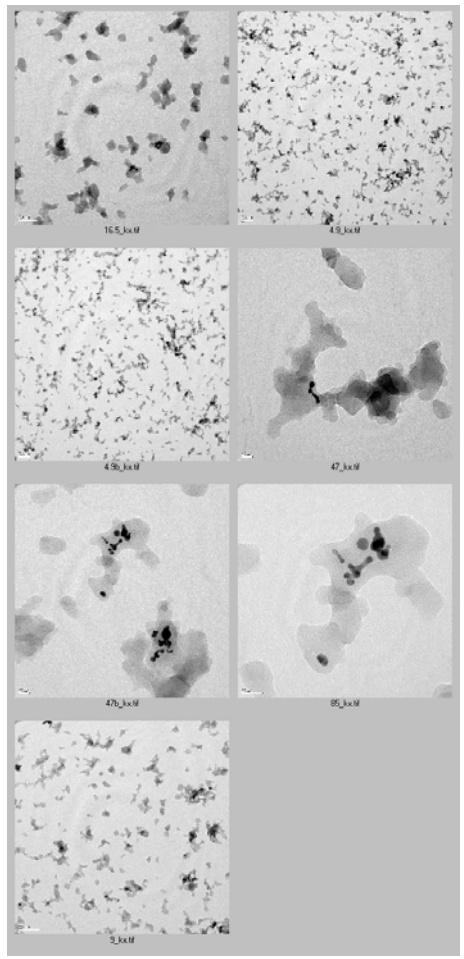
Acetylene



Pyrolysis: 1300 °C

Outlook

- Gas can be doped, e.g. with catalytically active particles
  (example: 5% Pt)
- Upscaling to achieve higher output should be possible
- Use of higher temperature to vary soot structure



Achnowledgelement

Ralph Kägi, EMPA

A. Schmidt Ott, TU Delft