# Study of High-temperature Oxidation of Wood Combustion Particles Using Tandem Differential Mobility Analysis

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## INTRODUCTION

- Wood combustion is a significant source of fine particles
  - adverse effects on human health and climate
- Soot particles are a problem especially in residential combustion
  - batch combustion process
  - simple appliance & lack of precise combustion control
  - emissions well-controlled in large-scale units
- To better understand the behaviour of wood combustion particles, their oxidation was studied using a high-temperature tandem differential mobility analyser (HT-TDMA) system and real-life combustion appliances

## METHODS

- High-temperature TDMA system
- Pellet boiler, normal and low output
- Wood stove (one particle size 84 nm)
- Particles classified into 40 nm, 100 nm and 200 nm
- Reactor temperatures up to 950 °C
- Changes in particle size measured using an SMPS (DMA + CPC)

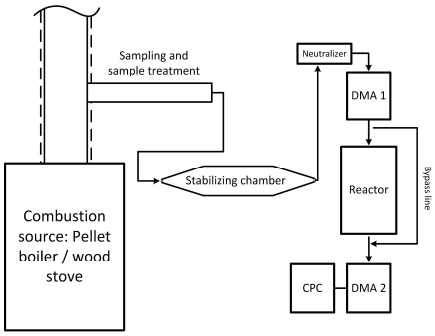


Figure 1. Experimental setup.

## RESULTS

- Only moderate changes in the particle size below 450 °C with all selected particle sizes (Figure 2) in pellet boiler
- The largest changes between 500 °C and 710 °C with both 100 nm and 200 nm initial particle size
  - between 450 °C and 650 °C with 40 nm (Figure 3)
- At 860 °C, only spherical zinc containing core particles were left in the samples of 100 nm and 200 nm particles
- Wood stove particles oxidized about 150-250 °C higher temperatures than pellet boiler particles
  - Wood stove particles contained less inorganic salts and more soot compared with pellet boiler emissions
- The residual particle size varied with the studied classified particles
  - differences in the inorganic fraction that does not evaporate in 700 °C
- Wood stove particles were still found to oxidize in lower temperatures compared with previously studied diesel soot particles

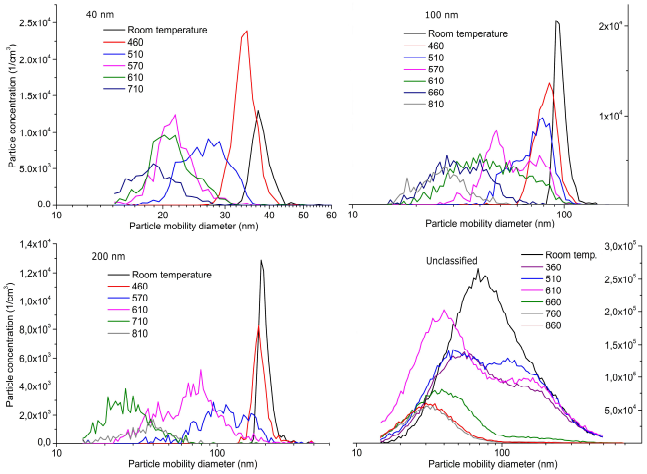


Figure 2. Particle number-size distributions after high temperature TDMA at various reactor temperatures. The particles are from a pellet boiler operated with low output power.

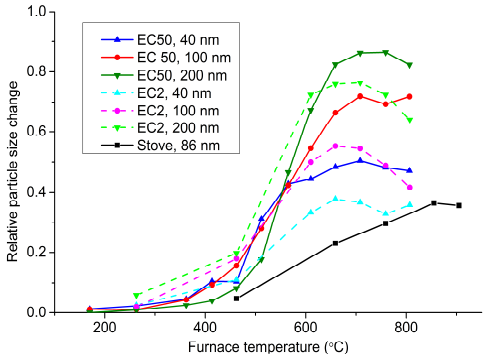


Figure 3. Particle size changes. EC50, deteriorated pellet combustion in which $PM_1$ contains about 50% of EC. EC2, normal pellet combustion in which about 2% of $PM_1$ is EC.

## CONCLUSIONS

- Wood combustion particles oxidize at much lower temperatures compared to soot particles generated with soot generators and diesel engines
- Lower oxidation temperature is due to the presence of alkali metals that catalyze the particle oxidation
- Mixing conditions, residence times and oxygen concentrations also limit the real-life particle oxidation in combustion processes
- The results of this study can be used in optimizing the combustion chamber conditions in wood combustion appliances

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