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# Experimental observation of fine particle production decrease at ignition temperature level of wood samples

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## Introduction

Understanding of particles formation and their behavior related to biomass burning process are objective of the intense research. Fine particles generated from laboratory biomass combustion are shown in this poster. The approach combines the thermogravimetric analysis during thermal decomposition of beech wood sample with detailed monitoring of the size distribution of fine particles produced.

## Setup and measurement

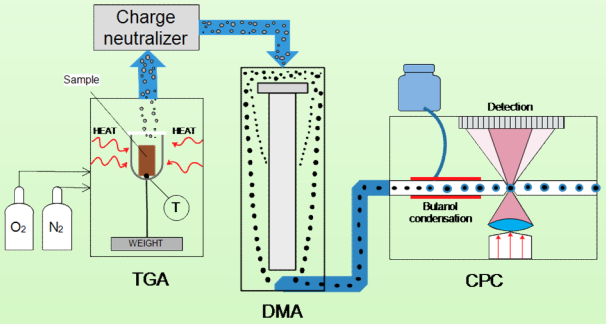


**Fig. 1** The measurement setup scheme: TGA - Thermogravimetric analysis; DMA - Differential Mobility Analyzer; CPC - Condensation Particle Counter

- The measurement was carried out with utilizing the TGA device *NETZCH – Jupiter F3*.
- Thermogravimetric analysis (TGA) allows monitoring the exact temperature influence of a small fuel sample (wood) according to the desired schedule.
- TGA also influences the composition of the atmosphere flowing around the sample.
- During the test, the TGA monitors the weight of the heat-affected sample and identifies its loss.

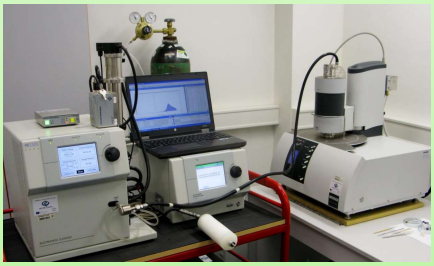

**Fig. 2** The measurement setup – SMPS and TGA devices

- The result of the measurement is a TGA curve showing the weight change in dependence on the temperature of the sample.
- From the analysis of the development of temperature rise, it further identifies the presence of endothermic and exothermic reactions.
- The cool aerosol stream leaving TGA enters a Scanning Mobility Particle Sizer (SMPS) where the particle size fractions are separated.

- The monodisperse aerosol is counted by the condensation particle counter (CPC).
- The parametrical study was carried out to assess the influence of composition, size and surface of the wood sample on the production and size distribution of ultrafine particles.
- Particles in the range from 10 to 550 nanometers in diameter were measured.

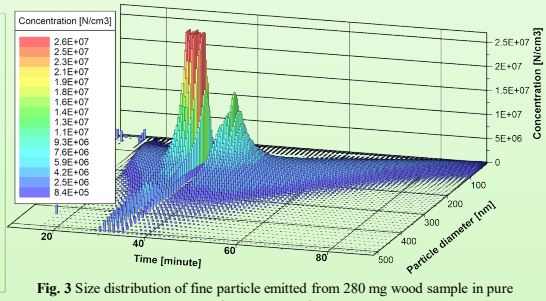


**Fig. 3** Size distribution of fine particle emitted from 280 mg wood sample in pure nitrogen atmosphere.

## Studied samples and their properties

- Three different sample sizes shown in *Fig. 4* were measured.
- Samples varied in their dimensions, weight and surfaces (*Table 2*).
- Samples were collected from dry Beech wood (*Fagus sylvatica)* material.
- The cell walls components, are principally the lignin fraction and the total carbohydrate fraction (cellulose and hemicellulose), termed holocellulose.
- The percentage of the composition is shown in following table.

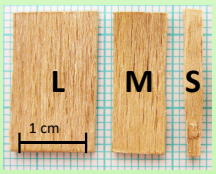


**Fig. 4** Measured samples

**Table 1** Wood composition and material

| Material: | Beech heartwood |
|---|---|
| Density | 730 kg/m3 |
| Water content | 6.1% |
| Lignin | 20% |
| Holocellulose | 78% |
| α-cellulose | 50% |
| Extractives | 2% |

**Table 2** Studied samples and their properties

| Sample Label | Sample dimensions | Weight | Surface |
|---|---|---|---|
| **L** (Large) | 20×13×2 mm | 280 mg | 652 |
| **M** (Medium) | 20×8×2 mm | 150 mg | 432 |
| **S** (Small) | 20×3×2 mm | 80 mg | 180 |

## Results

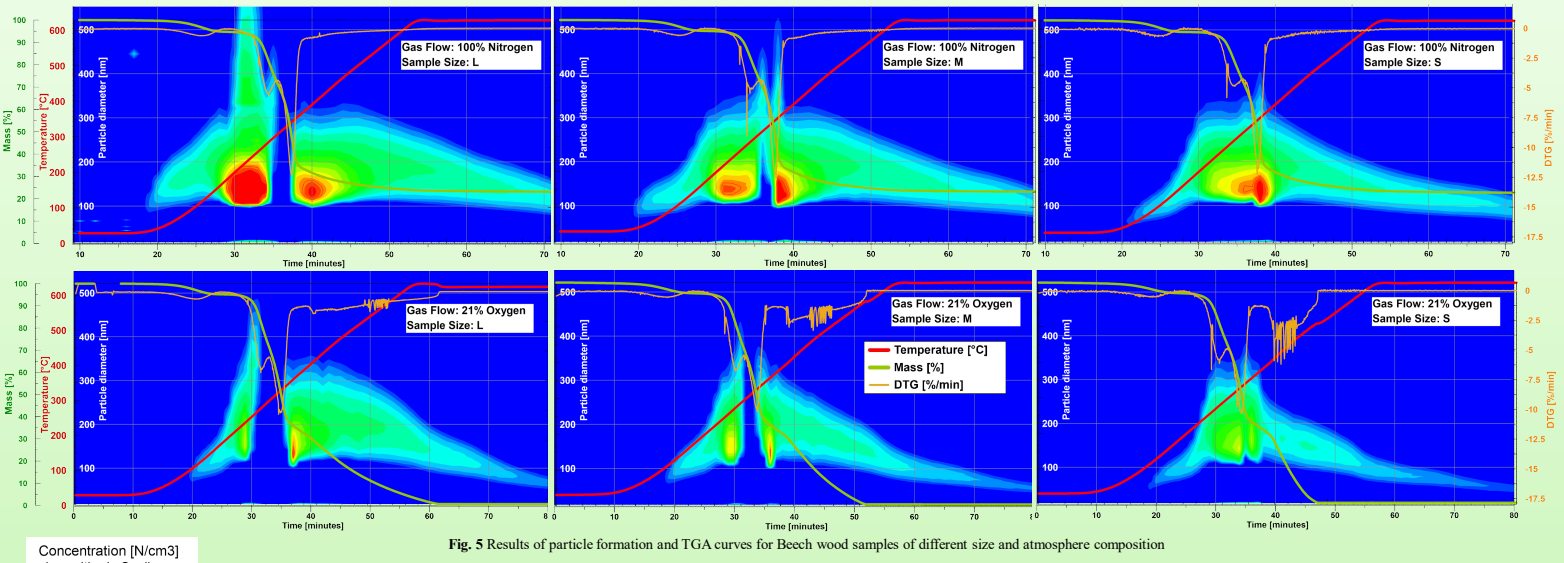


**Fig. 5** Results of particle formation and TGA curves for Beech wood samples of different size and atmosphere composition

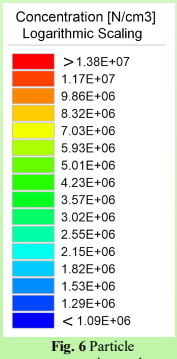


**Fig. 6** Particle concentration scale

**The following has been monitored:**

- The decrease in particle production is observed, in most cases, at a temperature of about 280 - 360 °C where significant weight loss started
- The reduced production depended on sample size and composition of gases in the experimental combustion chamber
- This occurrence of the decrease was also found in an inert atmosphere with nitrogen
- The time of reduced production was 4 to 6 minutes for large sample and has diminished with smaller samples
- In the case of the small samples, the decrease in particle formation was less significant
- Particle formation was more distinct before and shortly after the reduced production

## Conclusions, summary

- By SMPS and TGA method, particle size distributions and sample weight loss of individual wood samples were measured.
- The result of this experiment is, inter alia, that in a certain stage of the laboratory combustion process of the biomass sample a rapid decrease in fine particle formation appears.
- Particle production monitoring for biomass burning under laboratory conditions is key to understanding the overall process of fine particle formation in large applications; i.e., fireplace stoves and biomass boilers.

## References

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