

Production and characterization of internally-mixed soot aerosols

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Diesel soot is one of the major pollutants in the world and is classified as carcinogenic by the WHO's International Agency for Research on Cancer (Benbrahim-Tallaa *et al*, 2012). In North America and Europe, soot is mainly emitted by diesel engines, whereas in other parts of the world residential cooking and heating are responsible for the highest emissions. (Ramanathan and Carmichael, 2008). Soot/black carbon also has the second largest impact on global warming after CO₂ (Bond *et al*, 2013).

To minimize emissions, particulate filters are used. Regeneration of the filter is done by oxidation (combustion) of the soot. Uncatalyzed oxidation requires temperatures > 600 °C in O₂, which results in poor fuel efficiencies. Additives enhance the soot reactivity during soot formation, leading to internally-mixed soot and possible oxidation temperatures under 400 °C. Previous results showed that besides oxides, also salts were able to lower the temperatures for soot oxidation significantly (Bladt *et al*, 2014), which means that there must be some kind of interaction. Until then, only small amounts of soot were sampled, which were not enough for BET sorption measurements. Therefore, a homemade propane/air diffusion burner was optimized for the controlled production of higher amounts of soot by introducing mass flow controllers, best possible conditions for maximum soot production and a thermophoretic precipitator for soot collection.

Ion Chromatography was used to characterize the salt content in the soot samples, Raman Microscopy was applied to analyse the graphitic soot structure and the presence of salts/minerals or hydrocarbons. It was found that there is no significant difference in the soot structure with and without salts, confirming previous results (Bladt *et al*, 2014).

To simulate combustion in a Diesel Particulate Filter, Temperature-Programmed Oxidation (TPO) was used. Soot samples were combusted in a defined atmosphere (5 % O₂ in N₂) and temperature range (100 °C - 700 °C; 5 °C/min). Combustion products were detected in an FTIR spectrometer. The temperature of maximum CO and CO₂ emission (T_{max}) was used as a benchmark for soot oxidation reactivity. Increased salt-contents lead to lower T_{max} and lower ratios of CO/CO₂ at T_{max}. Both findings indicate that salts promote complete soot oxidation.

Another way to get insight on structural changes of solids is BET analysis, which is a method to determine specific surface areas. If there is an interaction between the salts and the primary soot particles and/or a change in the inter-layer spacing between the graphene planes, there should also be a change in the specific surface areas of the internally-mixed soots. First measurements with laboratory-produced soots and several salts were started.

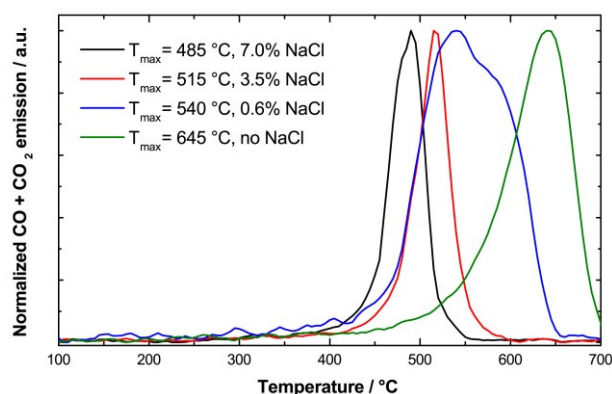


Figure 1. TPO profiles of 4 soot samples with different NaCl content normalized to soot mass.

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