Soot morphology and internal structure variations with fuel aromatics inside the cylinder of a diesel engine

S. Kook[1]

[1]The University of New South Wales, Sydney, Australia

Aromatics are important in maintaining fuel stability and lubricity but have a negative impact of increased soot formation in a diesel engine. This study systematically evaluates the fuel aromatics impact on soot formation in a diesel engine by applying thermophoresis-based direct particle sampling. In a running optical diesel engine, the sooting regions are identified via high-speed luminosity imaging and planar laser-induced incandescence (PLII) imaging. The soot particles are sampled on a carbon-coated grid securely held up at the tip of a probe mounted on the piston-bowl wall. The sampled particles are imaged using both a standard transmission electron microscope (TEM) and high-resolution TEM for visual inspection and statistical analysis of key morphology parameters (Figure 1). This method is used for custom-made fuels with 4%, 14% and 24% aromatic content with minimal variations in other physical and chemical properties. From soot luminosity and PLII images, the soot distribution and development pattern are found not to change due to fuel aromatics. However, a higher aromatic fuel shows earlier soot inception and higher growth rate, leading to higher peak soot and increased remaining soot at the end of main combustion event. Detailed analysis of sampled soot particles shows carbon layers within the soot primary particles grow more for a higher aromatic fuel, which forms more mature, graphitised internal structures. The increased soot formation for a higher aromatic fuel is closely linked to increased soot aggregates size. Both the TEM images and size distribution plots indicate significantly enhanced soot aggregation caused by higher aromatics.

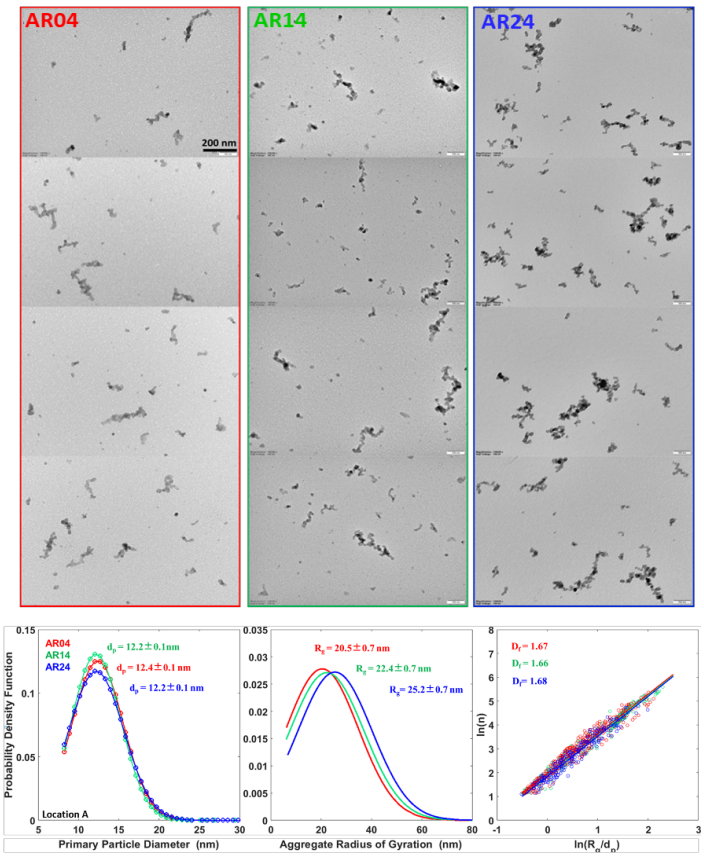

Figure 1 TEM images of soot particles sampled directly from the flames in a diesel engine running on fuels with 4, 14 and 24% aromatics (top) and size distributions of soot primary particles and aggregates as well as the fractal dimension (bottom)