

Morphology and Crystalline Structures of Engine-like Soot from KATECH's Soot Generator

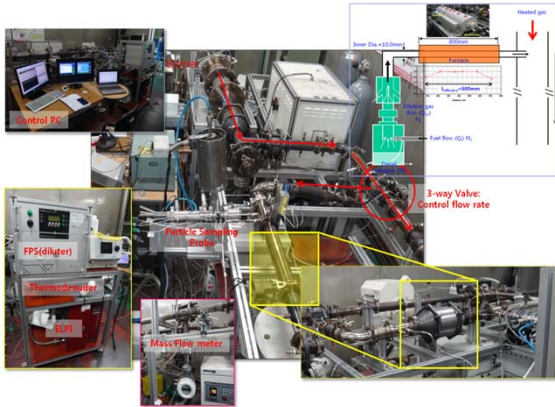
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Relevance and Objective

- Particle generators are useful devices
 - Calibrations of soot mass and particle sizes
 - Convenient tests for engine applications: aftertreatment systems, soot sensor and more
- Particulate morphology and properties are sensitive to operating conditions.
- Detailed information of morphology and properties helps understand how close these particles resemble engine particulates.
- Morphology, nanostructures and crystalline structures of particulates are evaluated, which were produced from by using a KATECH diesel-aerosol particle generator at various dilution flow rates.

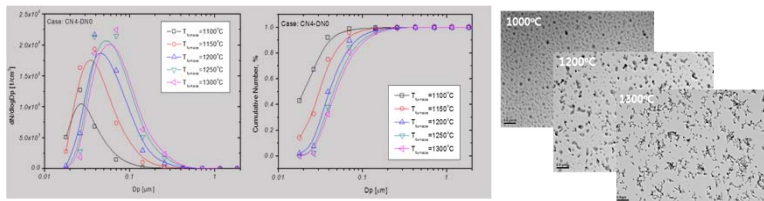
Experimental



- Equipment operating variables
 - Furnace temperature, carrier gas flow rate and dilution gas flow rate
- Morphology study
 - Equipment operation:
 - furnace - 1300°C, fuel flow rate - 0 l/min, dilution gas flow rate - 0 ~ 3.5 l/min
 - Measurements
 - Transmission electron microscope (TEM) & Raman microscope

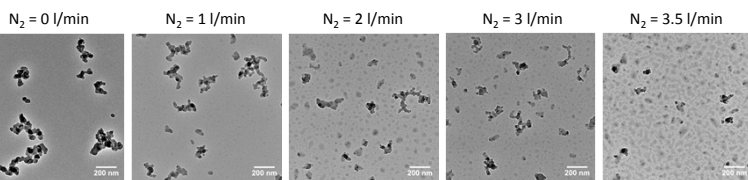
Results

Effects of furnace temperature

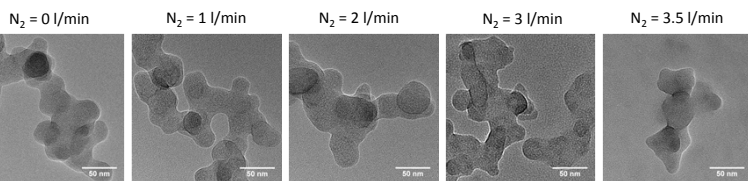


- With increased furnace temperature,
 - Particle number increases.
 - Particle grows from young nucleated particles to matured aggregated particles.

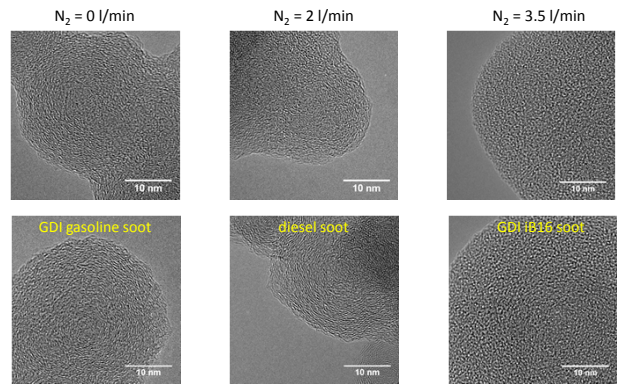
Effects of dilution flow rate



TEM images taken at 15,000X

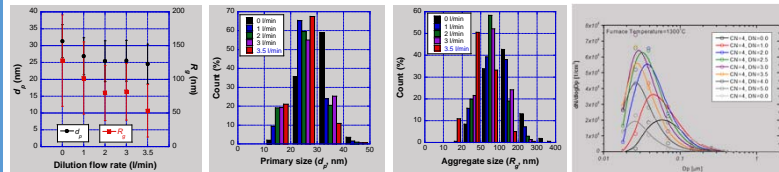


TEM images taken at 100,000X

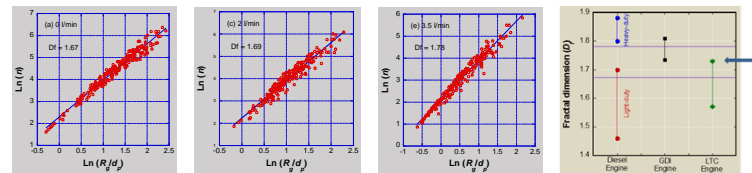


TEM images taken at 600,000X

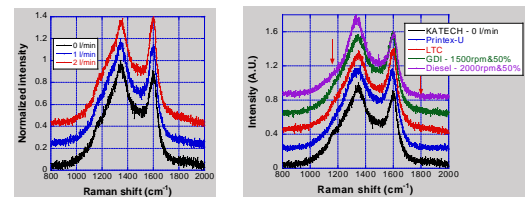
- With decreased dilution flow rate,
 - Particle grows from young nucleated particles to matured aggregated particles.
 - Primary particles become spherical.
 - Nanostructures tend to be more graphite-like from amorphous structures.
- Nanostructures show fringe patterns comparable to those of engine soot.



- Primaries and aggregates shift to smaller sizes with dilution, resulted from delayed soot formation.
- Aggregate sizes from TEM analysis appear to be larger than those from ELPI.



- Aggregates become more compact with dilution.
- Particle geometry is in the range of that of light-duty engine soot.



- As expected, carbon crystallites tend to less ordered with dilution.
- More organics & GDI soot-like structures, rather than diesel soot structures.

Conclusion

- With controlling furnace temperature and dilution gas flow rate, soot particles produced from KATECH's soot generator are quite comparable to engine soot particles in terms of nanostructure, primary & aggregate sizes, fractal geometry and carbon crystalline structure.

Acknowledgement

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