25th Conference on Combustion Generated Nanoparticles, 2022
Poster Presentation, Tuesday June 21, 10:20 to 12:00

Environmental Temperature Effects on Formation of Secondary Organic and Inorganic Aerosols formed from Vehicle Exhausts

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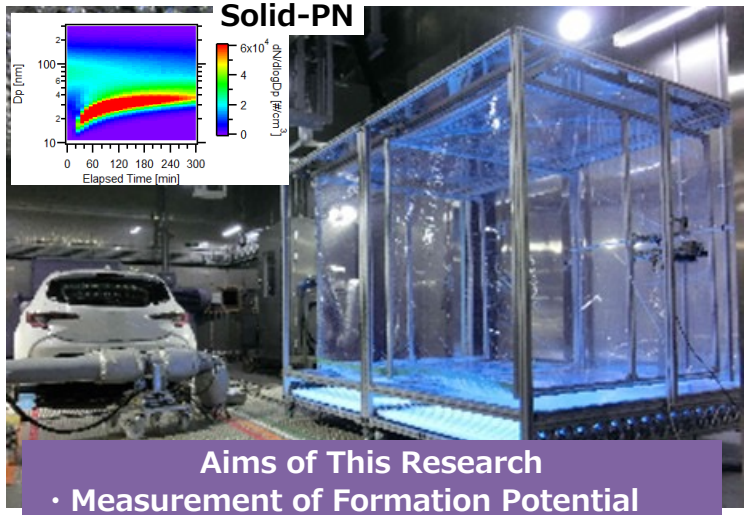
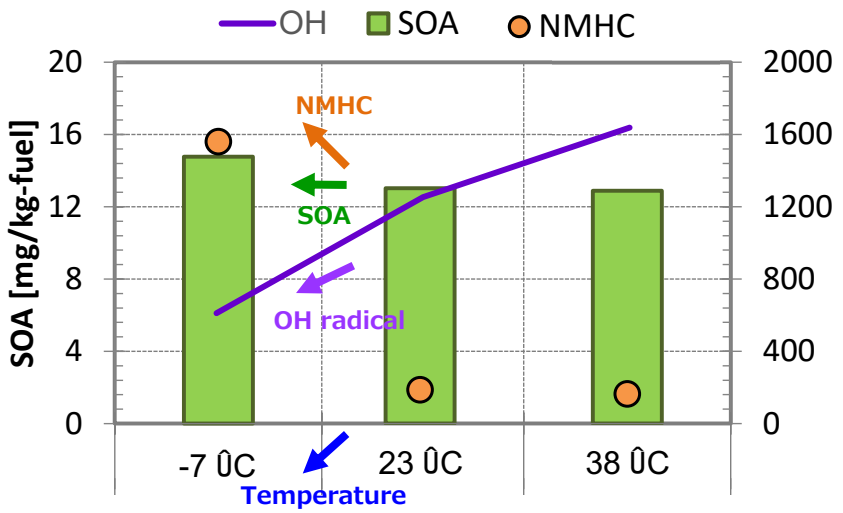
Environmental Chassis Dyno & Photochemical Smog Chamber

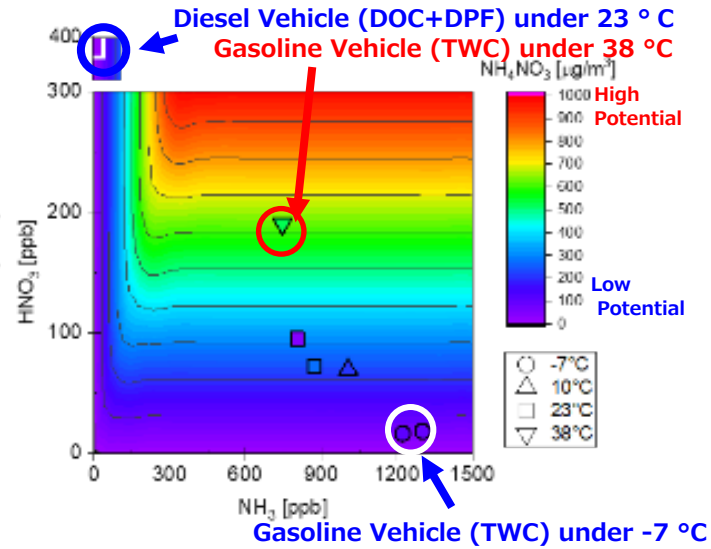


Aims of This Research
- Measurement of Formation Potential
- Sensitivity Analysis of Precursors to Environmental Impact Substances

Secondary Organic Aerosols (SOA)
[VOC, IVOC, SVOC] + OH· → SOA



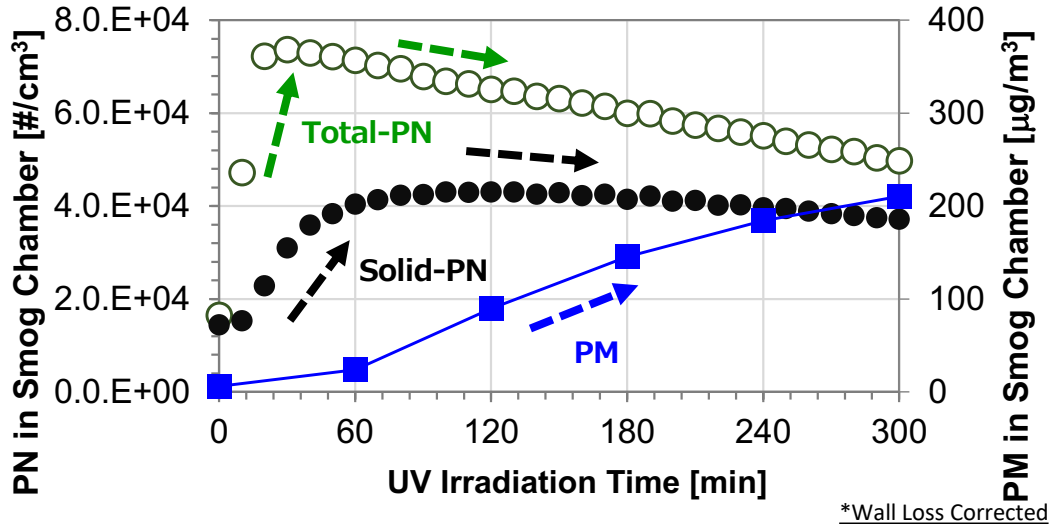
Secondary Inorganic Aerosols (SIA)
$NH_3 + HNO_3 \Leftrightarrow NH_4NO_3$



PM vs PN : Secondary Formation Potential Indicators

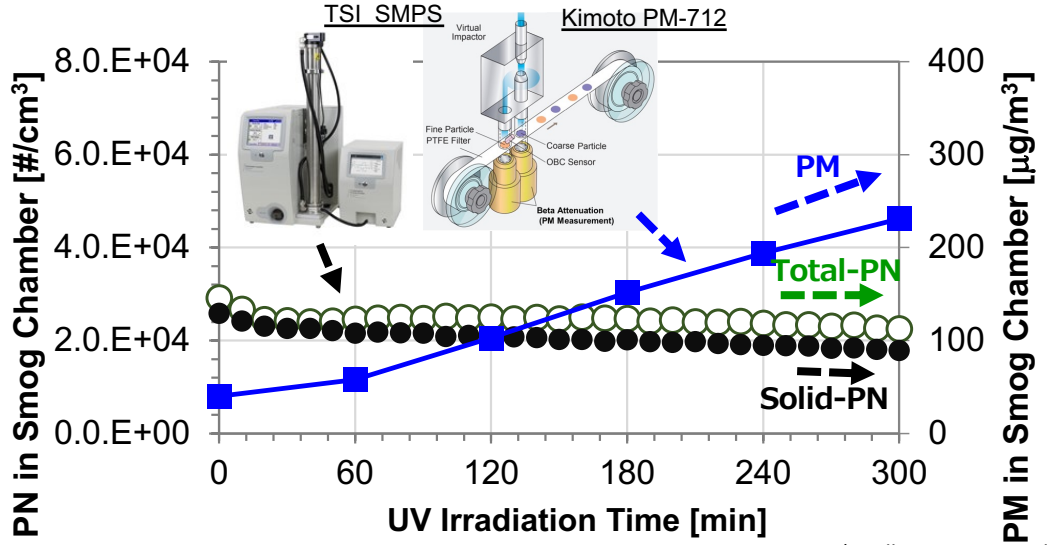
- PN Concentration is NOT generally Increased, since PN since Gas Condenses in Soot Pores or Aggregate Shrinks. Therefore, PN is difficult to determine Secondary Formation.
- PM Concentration is Simply Increased, and it is possible to determine Secondary Formation.
- **PM is a Simply and Robust Indicator of Secondary Particle Formation potential**.

WLTC 23°C (J_{NO2}=0.49 min^{-1})



*Wall Loss Corrected

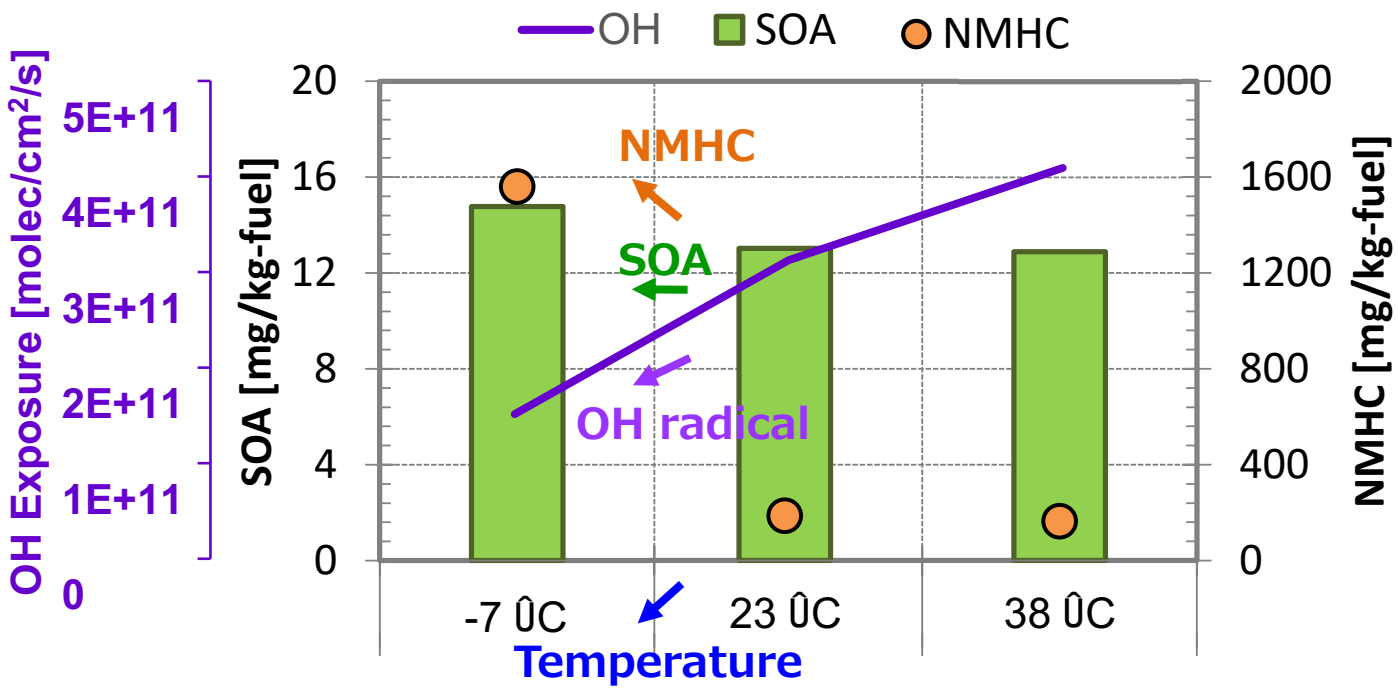
WLTC 0°C (J_{NO2}=0.33 min^{-1})

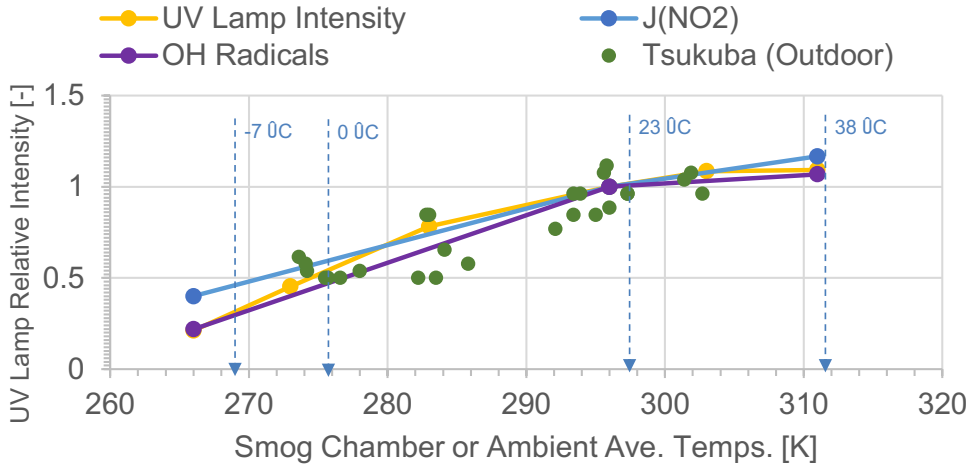


*Wall Loss Corrected

SOA Formation

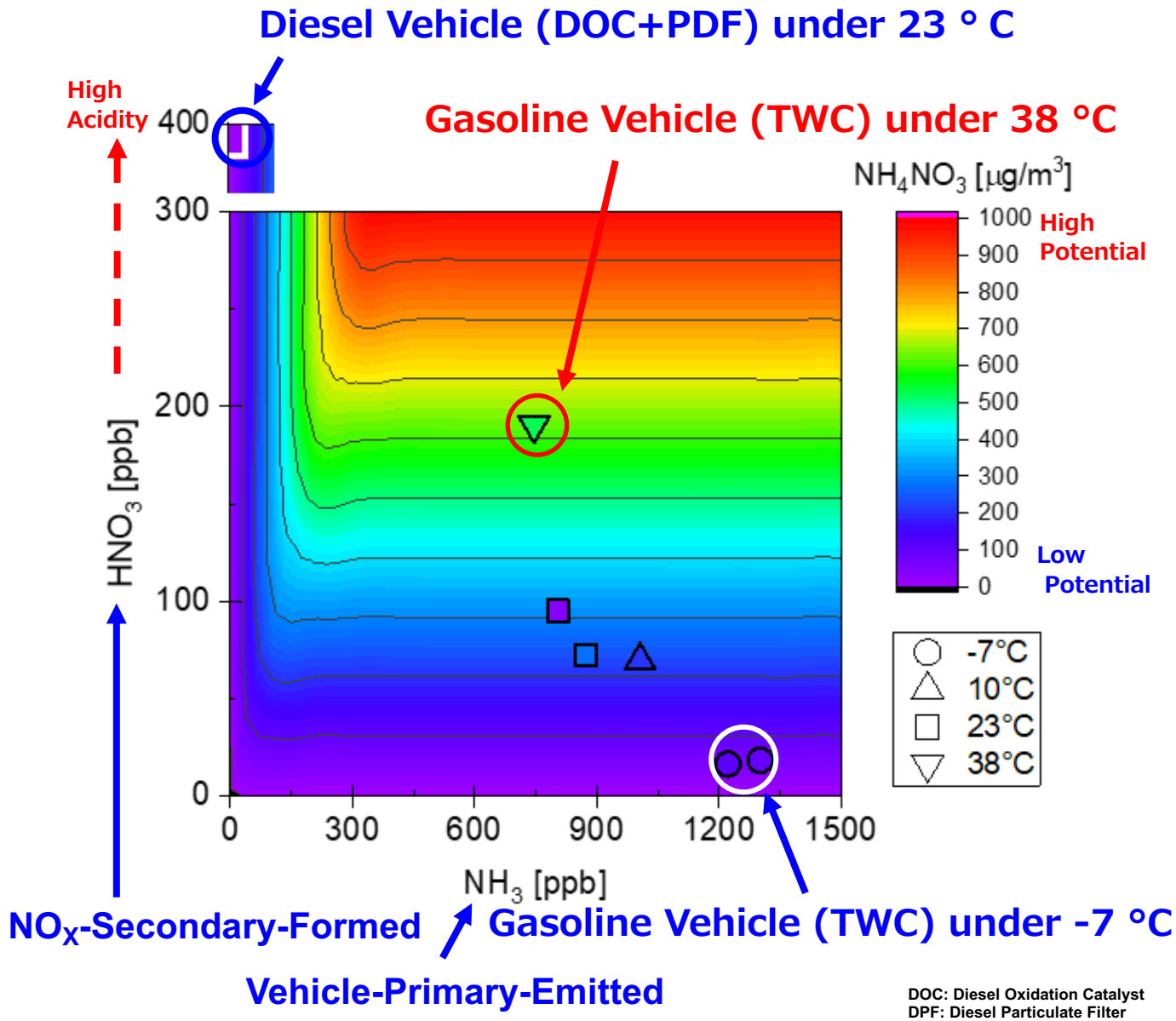
- Increase in SOA is NOT LINEAR with increase in Precursor NMHC at Low Temperatures.
- OH radicals required for Oxidation Reaction are reduced in Low-Temperature Environments.
- **<u>NMHC Increase at Low Temperatures may NOT Linearly reflect a Worst-Case Scenario for SOA Formation Potential.</u>**





NH_4NO_3 formation

- Contour map showing Secondary Formation of NH_4NO_3 Particles from NO_X-derived HNO_3 and Vehicle-emitted NH_3.
- **Secondary formation of NH_4NO_3 is NOT Linear and it is important to further study the balance of Neutralizing Nitric Acid formed from NO_X with NH_3.**



DOC: Diesel Oxidation Catalyst
DPF: Diesel Particulate Filter
TWC: Three-way catalyst

Take-Home Messages

- PM is a Simple and Robust Indicator of Secondary Particle Formation.
- NMHC Increase at Low Temperatures may NOT Linearly reflect a Worst-Case Scenario for SOA Formation Potential.
- Secondary formation of NH_4NO_3 is NOT Linear, and it is important to further study the balance of Neutralizing Nitric Acid formed from NO_X with NH_3.

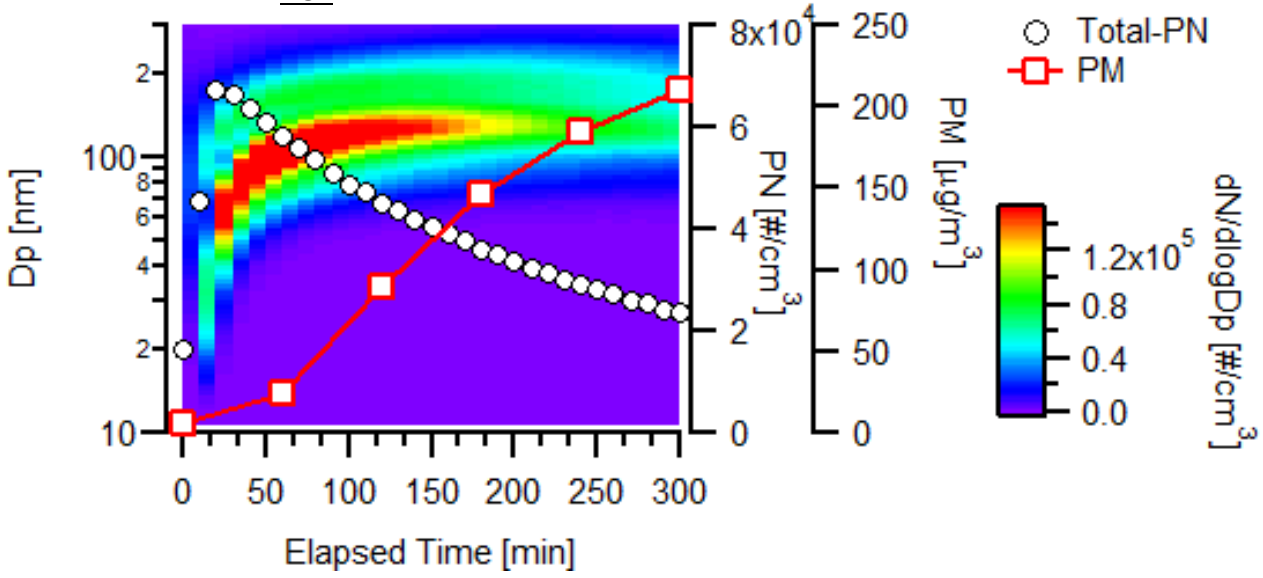
Next Steps

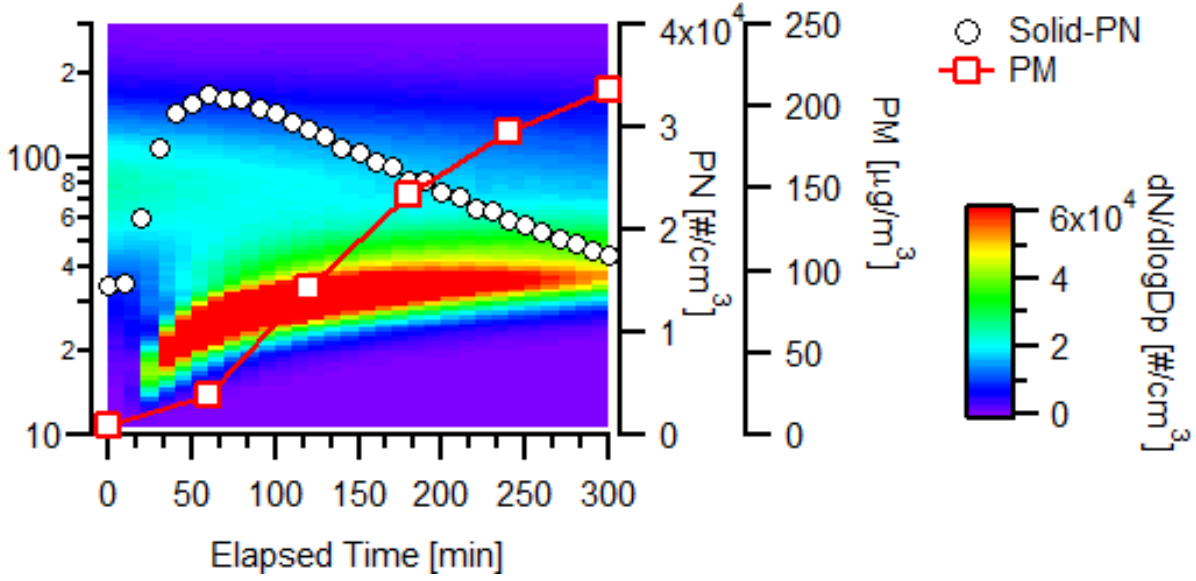
- Relationship between SOA formation and Oxidative Potential (e.g. DTT assay) in case of NMHC Reduction.
- Effects of Acidity (or pH) on NH_3 Reduction.
- Correlation of SOA and SIA Formation Potentials with Total PN and Solid PN Emissions.

Appendix

PM vs PN Sizes

WLTC 23°C (J_{NO2}=0.49 min^{-1})





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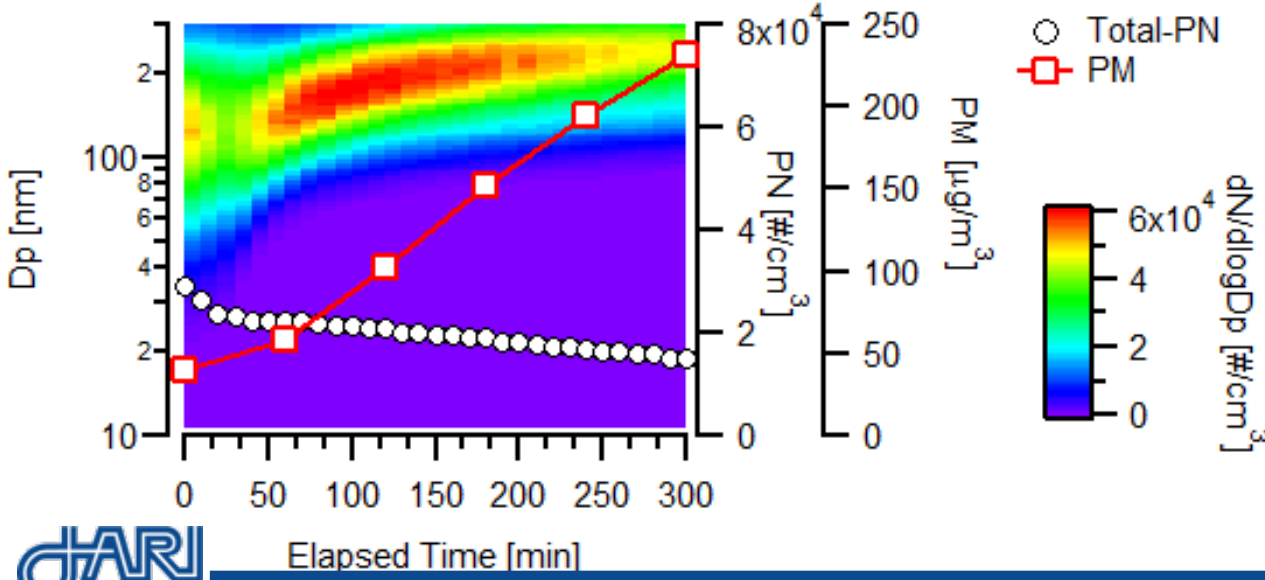

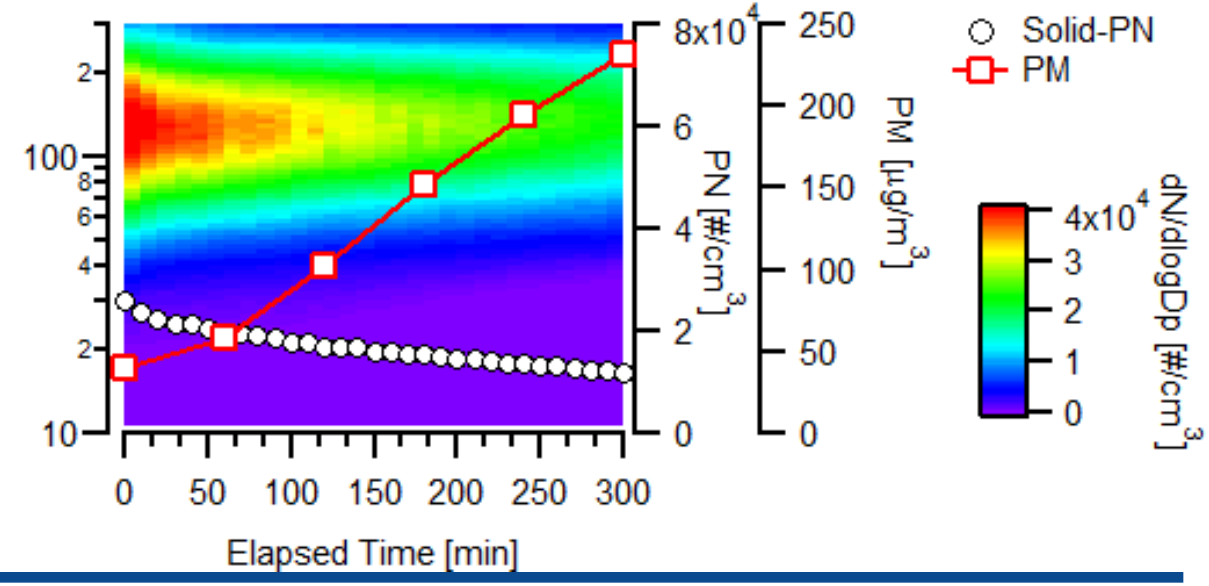

Research Aims & Experimental Method

- Aim of This Study is to measure Formation Potential of SOA and SIA.
- Vehicle Emissions (WLTC (Worldwide-Harmonized Light Vehicles Test Cycle, 4 Phase) were delivered to Photochemical Smog Chamber (7.5 m^3) from Ejector Diluter attached Directly to Tail Pipe.
- Environmental Temperatures (Vehicle and Smog Chamber) were set form - 7, 0, 10, 23, 38 °C, etc.