Real-time measurement of lubricant oil additive elements in automotive exhaust particles
by inductively coupled plasma time-of-flight mass spectrometry

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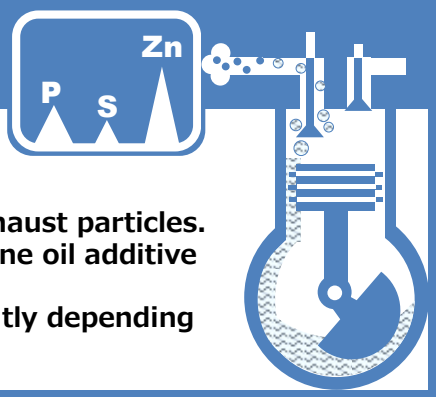


Summary & Conclusions

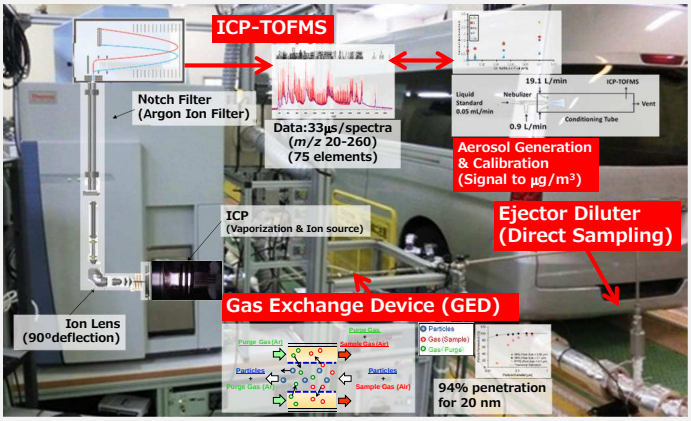
- The online ICP-TOFMS technique is capable of sub-0.1 s measurement of engine oil additive elements (e.g. P, S, Ca, Zn, and Mo) in vehicle exhaust particles.
- There are significant differences in the emission behavior of PM and engine oil additive element concentrations in automotive exhaust.
- Effects of after-treatment devices (e.g. poisoning) may change significantly depending on elements and driving pattern.

Introduction

- Inductively coupled plasma mass spectrometry (ICP-MS) is widely used for elements in particulate matter (PM) .
- An online analysis technique without difficult handling method is required.
- To establish this technique, time & mass resolution, gas exchange for replacing air with argon, and calibration techniques for elements in PM are needed.

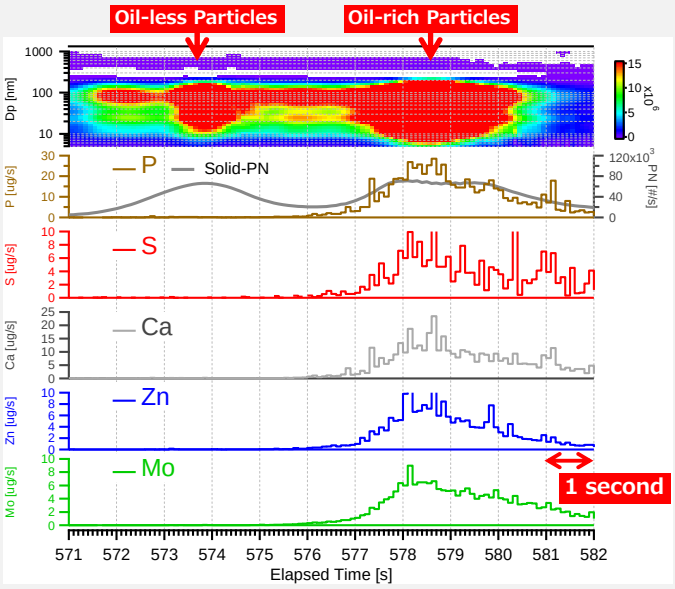
Methodology and Vehicle Test

- ICP-TOFMS system was used for high time & mass resolution measurement.
- The aerosol inlet interface, equipped with a GED, was used to introduce aerosol particles into the ICP ion source.
- To determine engine oil additive elements in gasoline vehicle exhaust particles, a microflow glass concentric nebulizer was used for instrument calibration.
- Emission cycles, including testing at high loads and cold start driving conditions were tested for a gasoline vehicle.



Result I : Sub-0.1 s Measurement

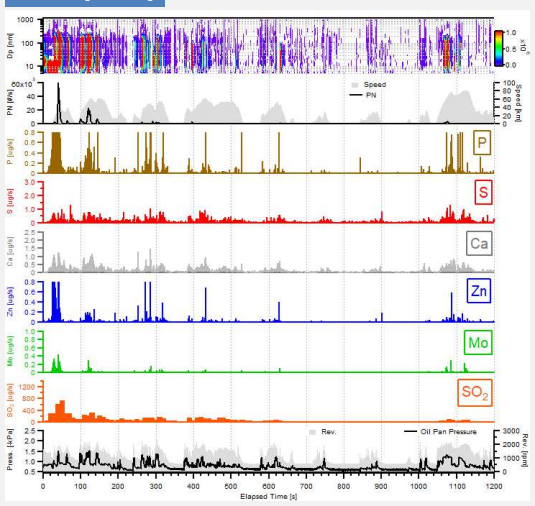
- Capable of sub-0.1 s measurement of engine oil additive elements (e.g., P, S, Ca, Zn, and Mo) in automotive exhaust.

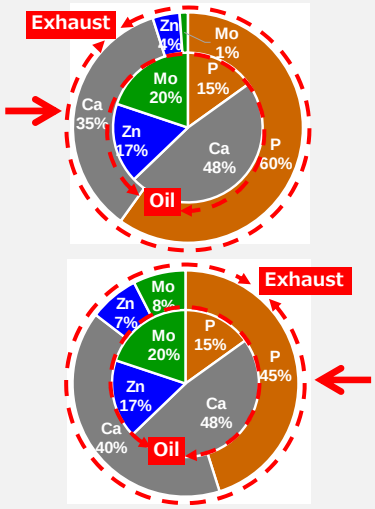


Result II : Non-Uniform Emission Pattern

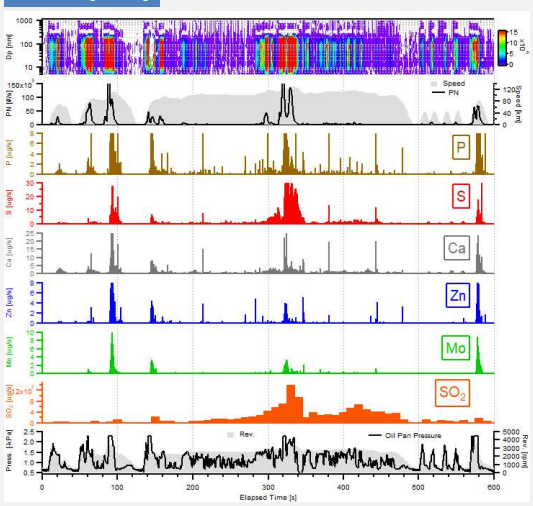
- Engine ignition at cold start and under high loads increased the particle emissions, in some cases by a substantial amount.
- However, the engine oil additive elements were not uniform, unlike the composition ratio in engine oil.

JC08 (Cold)





US06 (Hot)



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