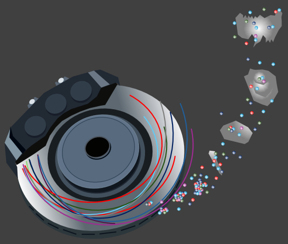
Real-time simultaneous measurement using ICP-TOFMS of carbon and trace metals in brake wear particles

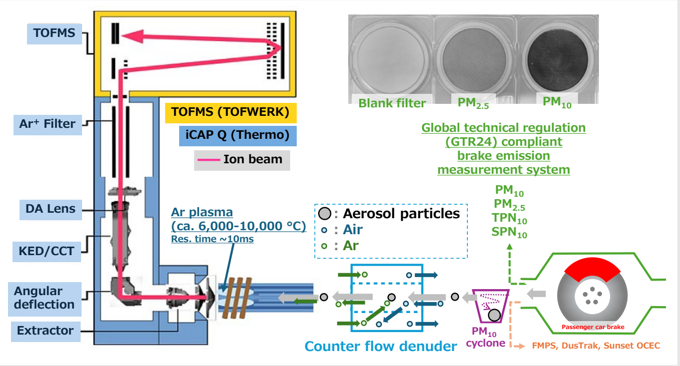


Hiroyuki HAGINO, Japan Automobile Research Institute

Summary

- Laboratory experiments were conducted using a current passenger car brake system under realistic driving and braking conditions.
- Elements in brake wear particles were detected in real time using an inductively coupled plasma time-of-flight mass spectrometer[1] (ICP-TOFMS) equipped with a counterflow denuder[2].
- Simultaneous measurement during braking events revealed changes in the composition ratio of carbon and metal in brake particles.
- Future investigations using diverse sample types are needed for brake wear particles, tire wear particles, and exhaust gas particles.

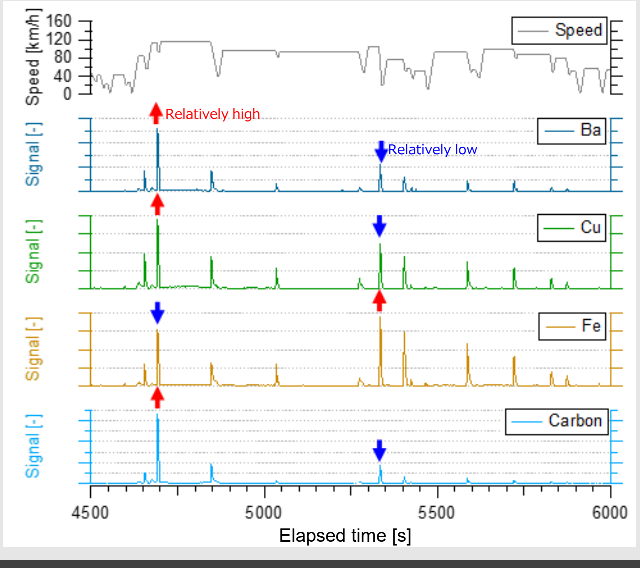
Experimental setup



- Brake dynamometer retrofitted with improved heavy-duty diesel engine dynamometer[3].
- Reproduction of realistic vehicle driving and braking conditions for a single-axle passenger car brake system.
- Particle sampling system compliant with European Global Technical Regulation No. 24 (UN GTR24)[4].
- Particle size measurement and chemical composition analysis are not permitted according to UN GTR24.
- ICP-TOFMS, particle size measurement, and particle composition measurement conducted with modified PN measurement line.
- Four realistic brake cycles were examined: WLTP-Brake (world average)[5], CBDC (California Brake Dynamometer Cycle)[6], LACT (Los Angeles City Traffic) cycle[7], and Tokyo[8].

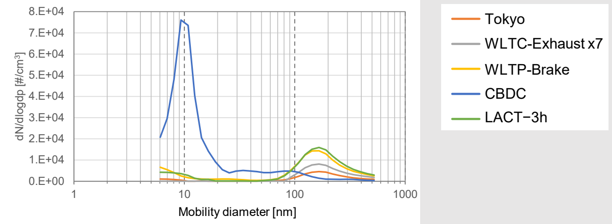
Real-time measurement

- Clarification of elemental emissions during braking events.
- Representative speed and elemental emissions profiles obtained for the LACT cycle.



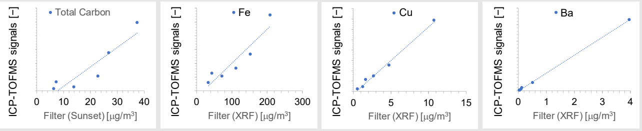
Brake particle number size distributions

- Particle size distributions obtained under realistic brake cycles.



Correlation with filter analysis

- Linearity between ICP-TOFMS (on-line) and filter analyses (off-line: Sunset OCEC or XRF).
- Proposal of real-time composition measurement of carbon and metals in particles.
- Elemental mass vs. signal slopes as sensitivity for total carbon, Fe, Cu, and Ba.



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