Physical characterization of tire wear particles emitted from eco-friendly tires under constant driving speed

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Vehicles are one of the main source of particulate matter (PM) in urban areas. The interest in the health effects of PM associated with road traffic has been studied to characterize the particles and sources[1)]. Many researches focused on exhaust emissions, but recent studies have reported that non-exhaust sources such as road dust, tire wear particles and brakes wear particles account for an equal amount of exhaust emissions. Among those, we have focused on the tire wear particles, which mainly consist of PM_{10} or $PM_{2.5}$ and are of special concern due to their adverse effects on human health. The wear mechanism of tire is related to tire type and pavement type[2)].

Recently, eco-friendly tires have been available on the market. Which help to reduce the fuel consumption by its low rolling resistance coefficient (RRC). The purpose of this study is to characterize the amount of PM emission according to RRC. To compare the particle emission from the eco-friendly tires, we have used 5 tires as described in Table 1.

Table 1. Tested tires

Tire	Type	RR grade
Tire A	Eco-friendly	1 (RRC ≤ 6.5)
Tire B	Eco-friendly	1 (RRC ≤ 6.5)
Tire C	Eco-friendly	2 (6.6 ≤ RRC ≤ 7.7)
Tire D	Eco-friendly	2 (6.6 ≤ RRC ≤ 7.7)
Tire E	Normal	4 (9.1 ≤ RRC ≤ 10.5)

In this study, we investigated the characteristics of PM emission depending on RR of tires. We measured the mass concentration and number concentration of PM on both a tire simulator and on-road driving condition. All experiments were conducted under constant speed conditions without acceleration or deceleration (tire simulator: 20, 40, 60, 80 km/h, on-road condition: 50, 80, 100, 140 km/h). Particle mass concentrations, particle number concentrations, and particle size distributions were measured using Dusttrak, aerodynamic particle sizer (APS) and fast mobility particle sizer (FMPS).

The experimental results showed PM emission was slightly increased with the increase of driving speed in both tire simulator and on-road condition. However, the PM emission does not depend on the RRC. Results of the number concentration of ultrafine particles also showed there was no strong relationship between the RRC and ultrafine particle formation under constant speed condition. From these results, we need to further experiments which including acceleration or braking condition are necessary to adequately define the relationship between the RRC and PM emission.

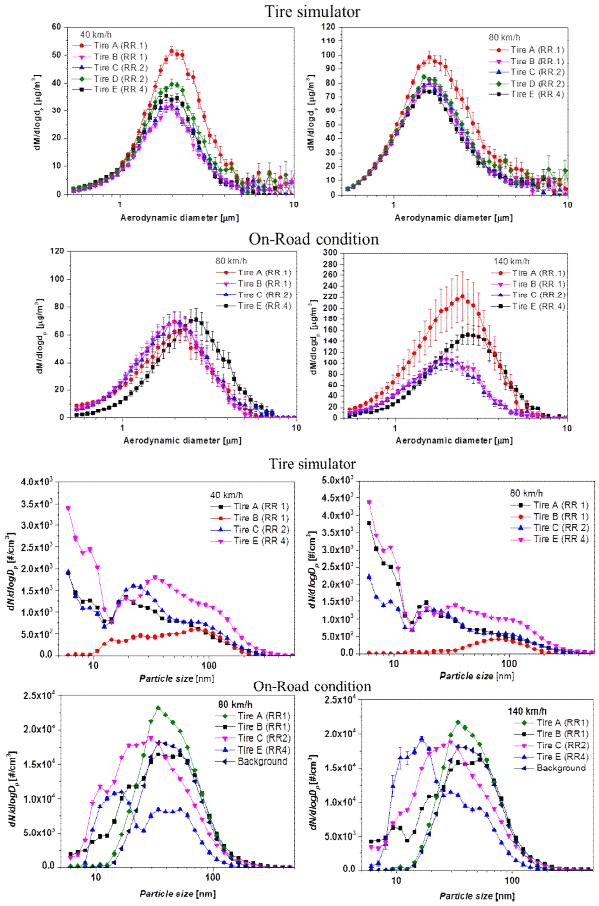

Figure 1. Mass and number size concentration of tire wear particles.

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