National Taiwan University

Characterization of nanoparticles in mass rapid transit, train and bus stations in Taipei

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Objective

This study is designed to compare number concentrations of nano particles in public transportation stations in Taipei.

Introduction

Recent toxicological studies have concluded that at the same mass concentration, nanoparticles (diameter less than 50 nm) are more toxic than larger particles with the same chemical composition. It is important and necessary to quantify nanoparticle emission levels and to determine nanoparticle behavior from different types of traffic-related stations: mass rapid transit (MRT), train and bus transportation stations

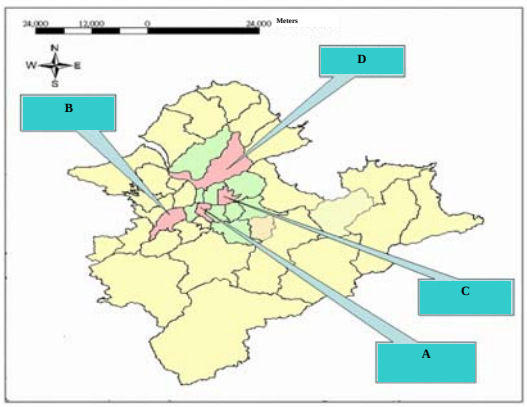

Fig. 1. Sampling Locations

Location A, Taipei Main Station, is a central public transportation station in downtown Taipei City.
Location B, Xinpu Station, is a major transferring station in Taipei County.
Location C, Yongchun Station, is the main transferring station for students in Taipei City where many schools are distributed nearby.
Location D, Jiantan, is an outdoor MRT station in Taipei City, where we aim to measure the distribution of particle in vertical height.

Methods

***Measurement instrument*:** The number concentrations and size distribution of PM with size range of 9.8-874.5 nm were measured by a scanning mobility particle sizer and counter (SMPS+C, GRIMM model 5.403).
***Study locations*:** The study was conducted in four bus stations, three train stations, and four MRT stations in Taipei.
***Study period*:** Each sampling duration was 17 hours (from 6:00 to 23:00) from January 17th to March 18th, 2005. And the sampling periods during the day were approximately the same for the different transportation stations.
***Data analysis*:** The particle data were classified to ultrafine particles (number concentration with size between 10nm ~ 100 nm, NC0.01-0.1) and nano particles (number concentrations with size between 10nm ~ 50 nm, $NC_{0.01-0.05}$). One-way ANOVA and Scheffe-test was used to compare the difference among three types of stations.

Results

•The particle number concentrations 9.8 nm to 50 nm (NC0.01-0.05) increased during rush hours. The particle concentrations of 9.8nm hours (07:00-09:00 and 17:00-19:00) and decreased during non-rush hours. Usually on workday, the traffic began to increase at 07:00, which corresponded to the higher particle number concentration.

•Our findings indicated that the particle concentrations in bus stations are the highest, followed by train stations, and MRT stations.
•For MRT stations, the outdoor station (location D) has highest particle number concentration.

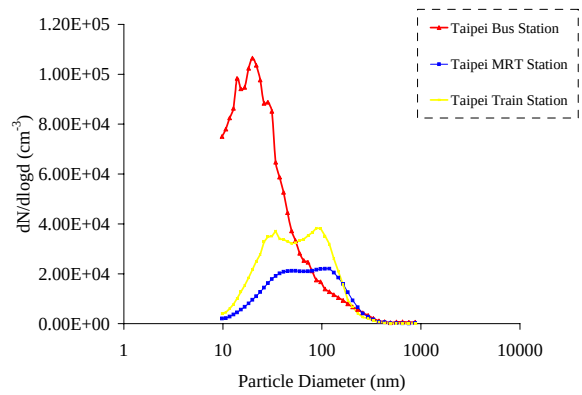

Fig. 2. Comparison of number size distributions

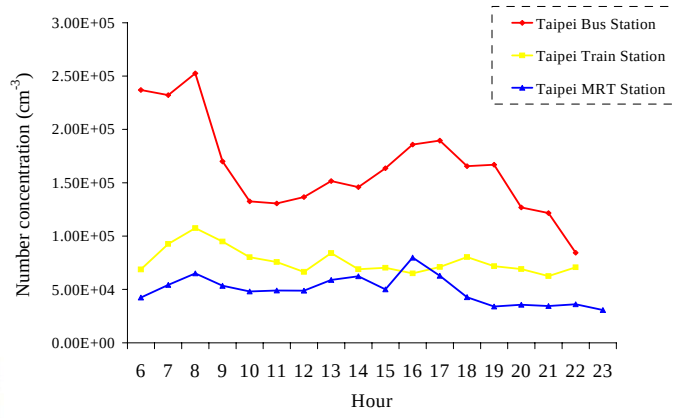

Fig. 3 Comparison of hourly particle number concentration in Bus, Train, and MRT stations

Table 1. Number concentrations (particle/cm³) of nano particles ($NC_{0.01-0.05}$) in different public transportation stations.

	Location	Rush hour A (N=18)		Rush hour B (N=18)		Non-rush hour (N=18)	
		Mean	SD	Mean	SD	Mean	SD
Bus Station							
	A	19.1×10^4	5.89×10^4	15.2×10^4	4.35×10^4	10.9×10^4	2.93×10^4
	B	10.5×10^4	4.12×10^4	4.78×10^4	1.47×10^4	3.36×10^4	0.99×10^4
	C	22.7×10^4	8.90×10^4	20.8×10^4	6.22×10^4	11.9×10^4	3.59×10^4
	D	13.3×10^4	4.23×10^4	11.3×10^4	4.05×10^4	3.79×10^4	2.10×10^4
Train Station							
	A	3.73×10^4	3.56×10^4	3.67×10^4	3.07×10^4	3.78×10^4	3.35×10^4
	B	3.43×10^4	2.01×10^4	3.62×10^4	2.00×10^4	4.10×10^4	2.67×10^4
	C	2.87×10^4	0.49×10^4	4.61×10^4	1.17×10^4	2.22×10^4	0.74×10^4
MRT							
	A	3.12×10^4	0.69×10^4	2.35×10^4	0.86×10^4	1.94×10^4	0.29×10^4
	B	4.92×10^4	1.16×10^4	4.67×10^4	0.69×10^4	2.55×10^4	0.33×10^4
	C	5.64×10^4	1.94×10^4	3.57×10^4	1.15×10^4	3.69×10^4	1.04×10^4
	D	2.08×10^4	1.11×10^4	2.99×10^4	1.50×10^4	1.18×10^4	0.39×10^4

Note: Rush hour A, 0700-0900; Rush hour B, 1700-1900

Discussion and Conclusions

•For bus commuters, they would likely to have higher exposure than people who take MRT and train as their transportation tools.

•For bus stations and MRT stations, the concentration significantly vary with the rush and non-rush hours.

•Since Chan et al.(2004) has reported that exposure to a 10000-particle-cm³ increase in $NC_{0.02-1}$ was associated with decreases in heart rate variability in both young panel and eldrely panel, we would like to suggest future studies focusing on investigating how to lower the particle number concentration in bus stations.