20 Sep 2016 **Immediate release**

News Release & Factsheet

What do we breathe while waiting for the bus?

- Bus stops are hotspots of personal exposure to tiny particles, known as ultrafine, which permeates the bloodstream and can produce or exacerbate existing pulmonary and cardiovascular diseases.
- The size of these particles is estimated to be 27 nanometres in diameter, 100 times smaller than the $PM_{2.5}$ reported by NEA. By comparison, a human hair is at least 50,000 nanometres thick.
- A commuter who makes a two-way bus trip for five days per week, may inhale an average 3.5 times more of these ultrafine particles than at ambient level; and are exposed to these particles while standing at bus stops for nearly 7 hours per month.

1. Singapore – Approximately 63% of Singapore's population commute to work by bus every day. Just how much pollution are we breathing while we're waiting at the bus stops? Dr Erik Velasco, the air pollution expert at the Singapore-MIT Alliance for Research and Technology (SMART) [新加坡-麻省理工学院科研中心], and a former NUS student Ms Tan Sok Huang took measurements of different air pollution parameters at busy bus stops in Singapore. They found that:
    a. Exposure concentration of $PM_{2.5}$ was on average 1.5-3 times higher than the mean concentration at ambient level reported by local authorities.
    b. The pollution levels can be highly variable. At least one spike over 100 µg/m^3 can be expected every 5 min. The magnitude of these spikes is similar to that reported during heavy events of haze. Using NEA's new $PM_{2.5}$ bandings, these spikes will rate as high or very high.
    c. On average, 60% of these particles are composed of soot. The rest is a mix of inorganic and organic compounds, in addition to particles with heavy metals. All of them are highly toxic.
    d. The observed levels of particles are higher than those reported in bus stops of Canada and United States and similar to those along streets and bus stops of Hong Kong and Mexico City.
    e. There is growing scientific evidence that very short (less than one hour) exposure to traffic particles exacerbates existing pulmonary and cardiovascular diseases.
    f. The size of the ultrafine particles is estimated to be 27 nanometers, i.e. 100 times smaller than PM2.5.

2. These findings were published in the paper, 'Particles exposure while sitting at bus stops of hot and humid Singapore' in *Atmospheric Environment* in August 2016. The researchers sought to quantify pollution in-situ at five bus stops in Singapore.

3. These five bus stops include those at: Vivo City, Little India, Bugis, One Raffles Quay and the National University of Singapore (in front of the university sports fields).

4. The exposure concentration of particles at bus stops during the morning and evening rush hours was evaluated through the use of state-of-the-art portable sensors (see factsheet). When buses accelerate and drive off from the bus stop, the particle concentration in the exhaust intensifies. Commuters standing at the curb waiting for the bus will inhale such fumes.

5. Dr Velasco, a research scientist at SMART Centre for Environmental Sensing and Modeling [CENSAM (环境监测及模拟中心)], said: "Waiting at the bus stop for only 10 minutes each time may seem innocuous. But these short exposures all add up. A commuter who takes a two-way trip by bus to work for five days per week, is actually exposed to these particles for nearly 7 hours per month and over 3 full days per year. This exposure can affect people with existing pulmonary and cardiovascular diseases, amongst others."

6. Having worked on this research since 2011, the SMART-NUS team hopes to provide scientific information for devising new environmental and transport policies to reduce commuter exposure to such toxic particles.

7. Both researchers have also investigated the exposure to these particles when commuting by different transport modes. More recently, they have conducted similar studies in the streets of Ho Chi Minh City, Vietnam and along the canals of Bangkok, Thailand, which are used as an expressway by public speed boats.

8. This research was funded by the National Research Foundation Singapore under its Campus for Research Excellence and Technological Enterprise (CREATE) programme. It is a collaborative project between SMART and National University of Singapore.

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About Singapore-MIT Alliance for Research and Technology (SMART)
[新加坡-麻省理工学院科研中心]
Singapore-MIT Alliance for Research and Technology (SMART) is a major research enterprise established by the Massachusetts Institute of Technology (MIT) in partnership with the National Research Foundation of Singapore (NRF) since 2007. It is the first entity in the Campus for Research Excellence and Technological Enterprise (CREATE) developed by NRF.

SMART serves as an intellectual hub for research interactions between MIT and Singapore. Cutting-edge research projects in areas of interest to both Singapore and MIT are undertaken at SMART. SMART comprises an Innovation Centre and five Interdisciplinary Research Groups (IRGs): BioSystems and Micromechanics (BioSyM), Center for Environmental Sensing and Modeling (CENSAM), Infectious Diseases (ID), Future Urban Mobility (FM) and Low Energy Electronic Systems (LEES).

For more information, please visit - http://smart.mit.edu

For media enquiries, please contact:

Ms Pauline Teo
Corporate Communications Specialist
SMART
+65 6601 3354
pauline@smart.mit.edu

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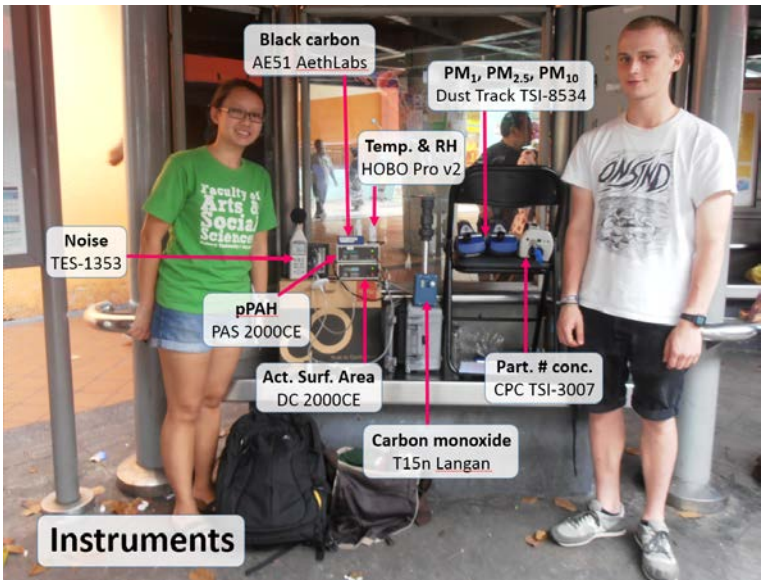
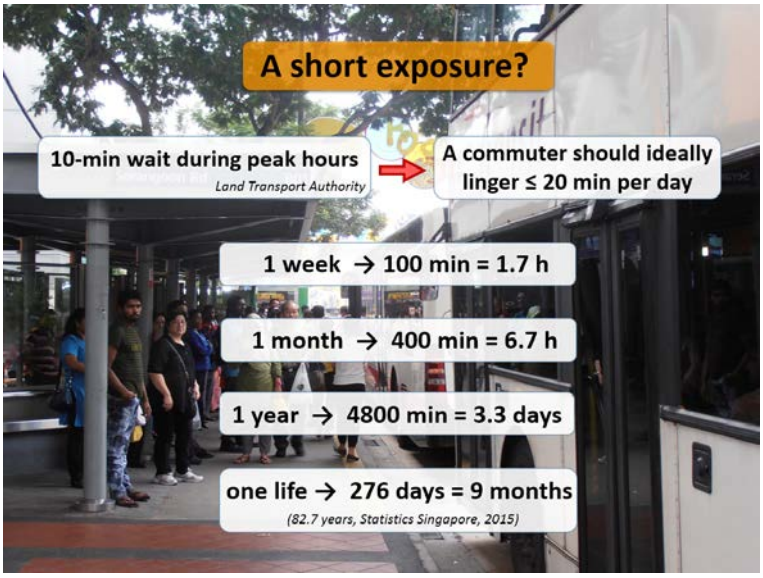
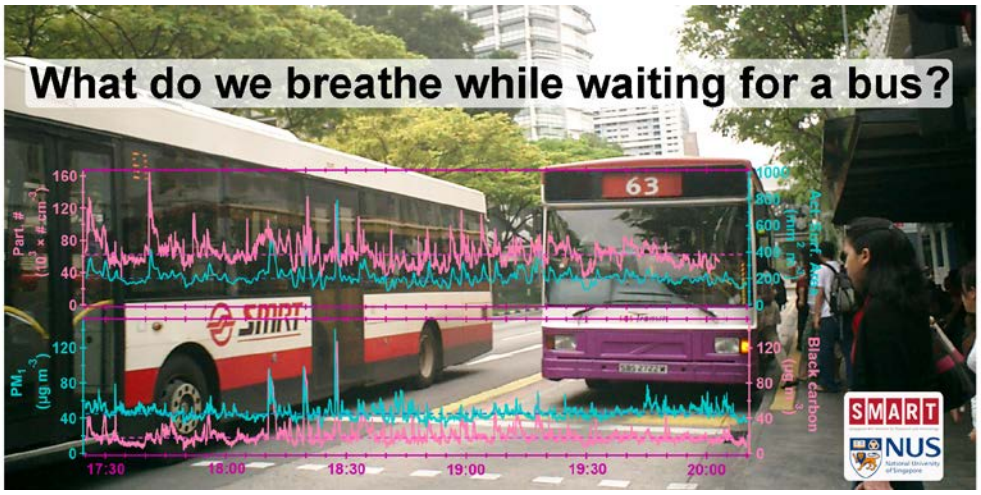
Pic 1: A complete assessment of the health impacts produced by vehicular traffic needs to consider the commuters exposure at bus stops. They are hotspots of pollution. At bus stops, commuters stand exactly next to the exhaust plumes of accelerating buses.



Pic 2: A comprehensive set of instruments were used to evaluate in real-time, different parameters of the traffic particles. To capture the variability of these particles embedded in the exhaust plumes, the research team took readings every second. (L-R) Then-NUS student Ms Tan Sok Huang and Mr Seth Nabarro, a summer intern from Imperial College.



Pic 3: An exposure to high levels of particles for a few minutes per day may seem innocuous. However, if we sum up the exposure across days, months and years, it begins to seem more serious.



Pic 4: Many physical and chemical parameters of the traffic particles were evaluated in-situ using state-of-the-art instrumentation, to provide scientific information for the design of future environmental and transportation policies that reduce the commuter exposure to harmful pollutants.