

# Measurement and Emission Characteristics of PM<sub>2.5</sub> in Work Environments

## Introduction

- PM<sub>2.5</sub>: fine particles  $\leq 2.5 \mu\text{m}$ , **harmful to human health**
- Usually low in Japan, but increases during **dust, pollution, or volcanic events**
- Health and economic impact: over **2% of Japan's GDP**
- Past studies have reported measurements near an open window during soldering
- **Quantitative comparisons between work and living environments are limited**

## Experimental Method & Equipment

### Sensor

- ZH03B Winsen
- Sensor capacity: up to 1000 values
- Arduino UNO R3

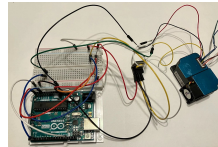


Figure 1. Components

### 1. Work Environment

For soldering work, PM<sub>1.0</sub>, 2.5, 10 levels were measured for 30 seconds (s) before, 60s during, and 60s after soldering



Figure 2. Measurement position during soldering

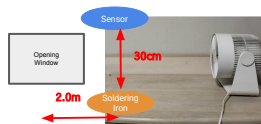


Figure 3. Measurement position during soldering with fan

## Results

### 1. Work Environment

- PM<sub>2.5</sub> values were the highest (approx.  $290 \mu\text{g}/\text{m}^3$ ) when measured 30cm directly above the soldering activity.
- Compared to the sharp increase in PM<sub>2.5</sub> levels during soldering with no control, with levels **rose more gradually and reached significantly lower peak values** when soldering with ventilation and fan.

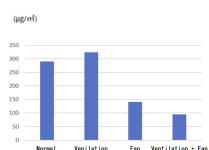


Figure 7. Average PM<sub>2.5</sub> concentrations measured during soldering

※Ventilation: Window Open

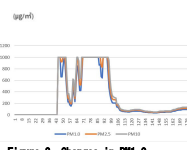


Figure 8. Changes in PM<sub>1.0</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub> concentrations 20 cm directly above the soldering iron during soldering

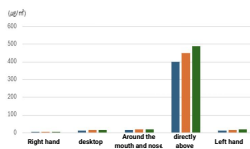


Figure 6. Comparison of average PM<sub>1.0</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub> concentrations at various locations during soldering

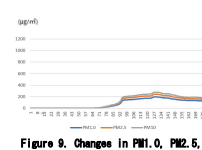


Figure 9. Changes in PM<sub>1.0</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub> concentrations while soldering under ventilation and fan operation

### 2. Living Environment

We regard household chores as “work”, and studied PM<sub>2.5</sub> emissions produced by home appliances including gas grill and toasting.

To examine the relationship with the strength of ventilation, we measured 3 patterns below: After grilling/toasting bread for 3 min 30s, opening door for 30s, and after grilling/toasting for 2 more mins before reopening.

To examine the relationship with the degree of browning, we measured 3 patterns below: After grilling bread for 3 min 30s, opening door for 30s, and reopening door several times. Time until opening the grill door was extended by 15 s with each bread replacement.



Figure 4. Measurement positions around grill and toaster

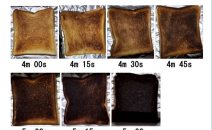


Figure 5. Degree of browning

### 2. Living Environment

- The higher the ventilation fan mode, the higher the PM levels near the toaster.
- PM was detected even when butter was not heavily burnt.
- The higher the ventilation fan mode, the higher the PM levels near the grill.
- When the grill was opened at 5 mins, the value measured near the grill peaked rapidly.

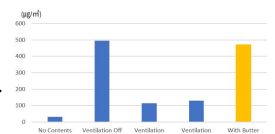


Figure 10. Levels in toaster operation

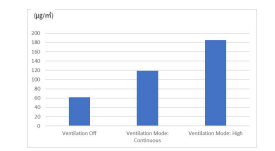


Figure 11. Comparison of PM<sub>2.5</sub> levels in grill operation

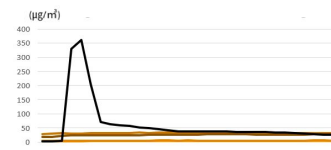


Figure 12. Changes in PM<sub>2.5</sub> levels with bread browning

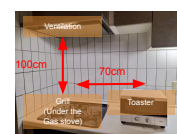


Figure 13. Layout of kitchen



Figure 14. Condition of bread toasted with butter

## Discussion

- Because of the way the smoke rises, it is dangerous to have our face 30 cm directly above the soldering iron.
- We can reduce PM<sub>2.5</sub> exposure by using a fan and an ventilation fan, but we should avoid the airflow path.
- PM<sub>2.5</sub> is emitted when toast is completely burnt, but it is unclear whether the PM from bread is actually harmful.

## Conclusion

- Both during bread toasting and soldering → PM levels will be **higher with the vent** on than with the vent off.
- During soldering → PM levels will **change depending on the measurement position**.
- During bread toasting → PM levels **rise rapidly when the toast is completely burnt**.

## Future Studies

- Expand PM<sub>2.5</sub> level measurements to industrial tasks such as welding, lathe operation, and laser processing.
- Develop methods to measure PM<sub>2.5</sub> levels in different rooms simultaneously for comparative analysis.

## References

- 1)Public Relations Office, Graduate School of Arts and Sciences / College of Arts and Sciences, The University of Tokyo. (2025, July 28). PM<sub>2.5</sub> Reduces Labor Supply in Japan: Empirical Evidence from Statistical and Observational Data – Air Pollution Reduction May Bring Economic Benefits. (The University of Tokyo News & Topics). <https://www.c.u-tokyo.ac.jp/info/news/topics/20250728140000.html>
- 2)Tominaga, A. (2022, April 30). Indoor air fine particulate matter logger—Is soldering this bad? Kattena Denshi Kosaku (Hatena Blog). <https://a-tomi.hatenablog.com/entry/2022/04/30/210847>
- 3)Rie Aoki, Yuko Yamamoto, Michiyo Kojima, Yasuko Koike, Yoshitomo Ikai, Hiroko Minagawa, "Concentration of PM<sub>2.5</sub> in room air", *The Reports of the Aichi Institute of Public Health* 2017, No.67,39-47, <https://www.pref.aichi.jp/eiseikan/teikankankou/syoho67.pdf>
- 4)Natter, A. (2023, January 9). US safety agency to consider ban on gas stoves amid health fears. Bloomberg News. <https://www.bloomberg.com/news/articles/2023-01-09/us-safety-agency-to-consider-ban-on-gas-stoves-amid-health-fears>