

# Investigation of the simplified measurement technique of the secondary aerosols formed from gaseous emissions of vehicle exhaust

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TOYOTA Environmental Action

- Steadily introduce low-emission vehicles that contribute to improving the urban environment in each country and region.
- Contribute to atmospheric environment improvement through collaboration with research organizations in each country.

## Motivation Needs(1)

Understanding the actual atmospheric situation of the secondary aerosols **derived from automobile exhaust.**

- Generation of the secondary aerosols
- Contribution ratio to the PM<sub>2.5</sub>

## Needs(2)

Evaluation method of the secondary aerosols.

[ **Small, Simple, Swift** ]

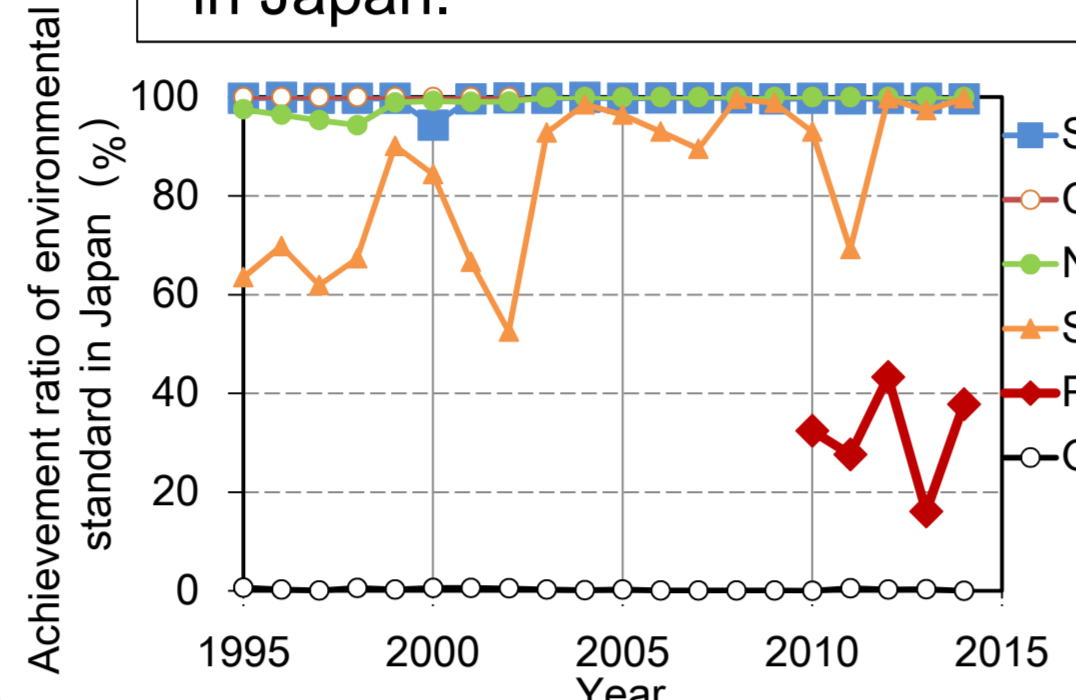
- Application to engine bench and chassis dynamometer
- Survey of various vehicle systems

## Objective

To investigate the evaluation methods of the secondary aerosols formed from gaseous emissions **with flow reactor.**

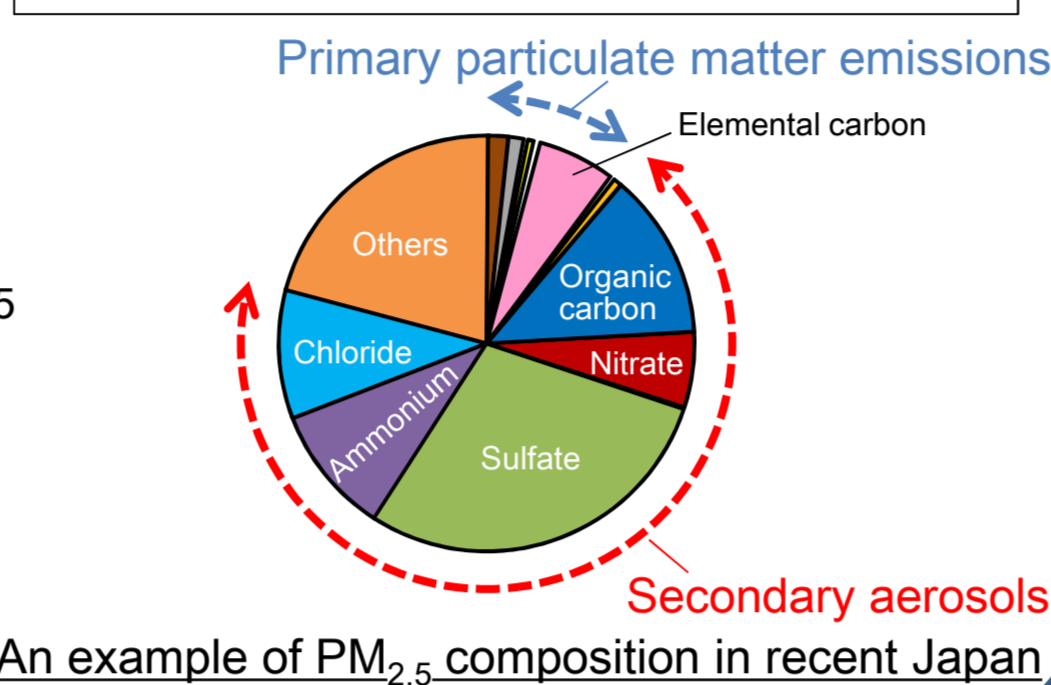
### Background

The achievement ratio of PM<sub>2.5</sub> environmental standard is low in Japan.



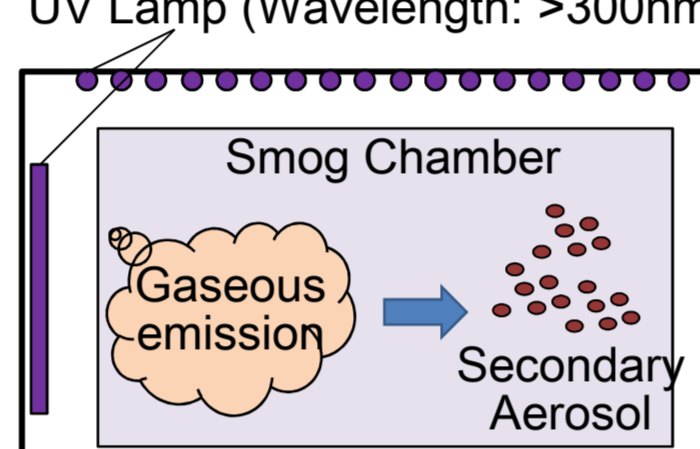
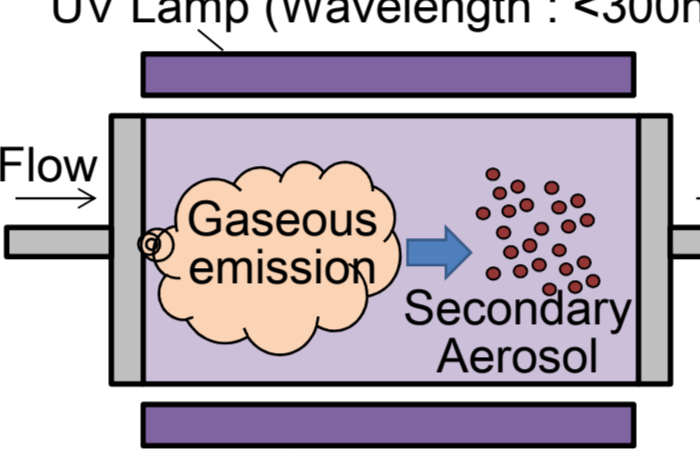
Achievement of environmental standard in Japan

- The ratio of **secondary aerosols in PM<sub>2.5</sub>** is high in Japan.
- The **contribution of automobiles** to the secondary aerosols is **unidentified.**



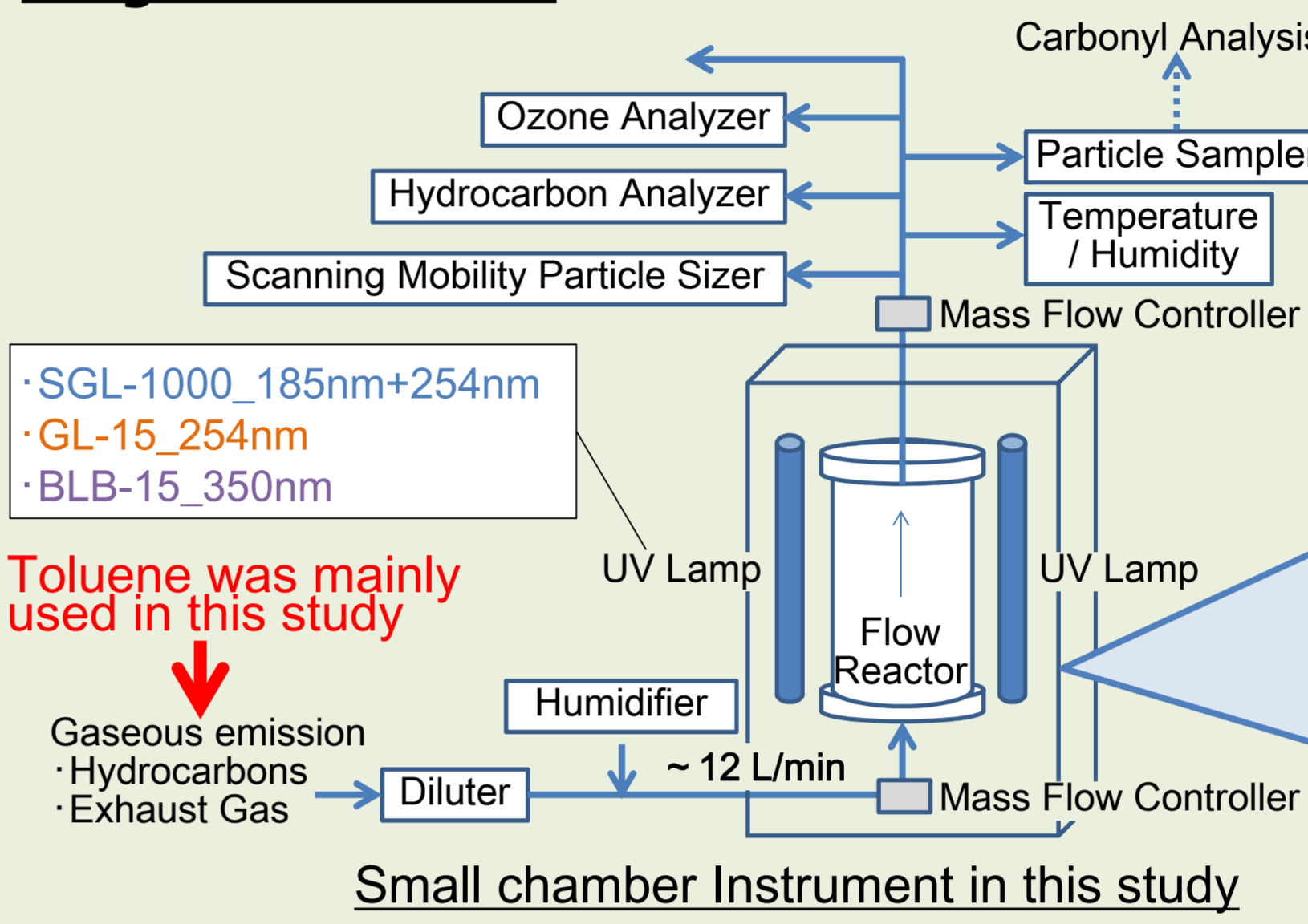
An example of PM<sub>2.5</sub> composition in recent Japan

### Standard Tools

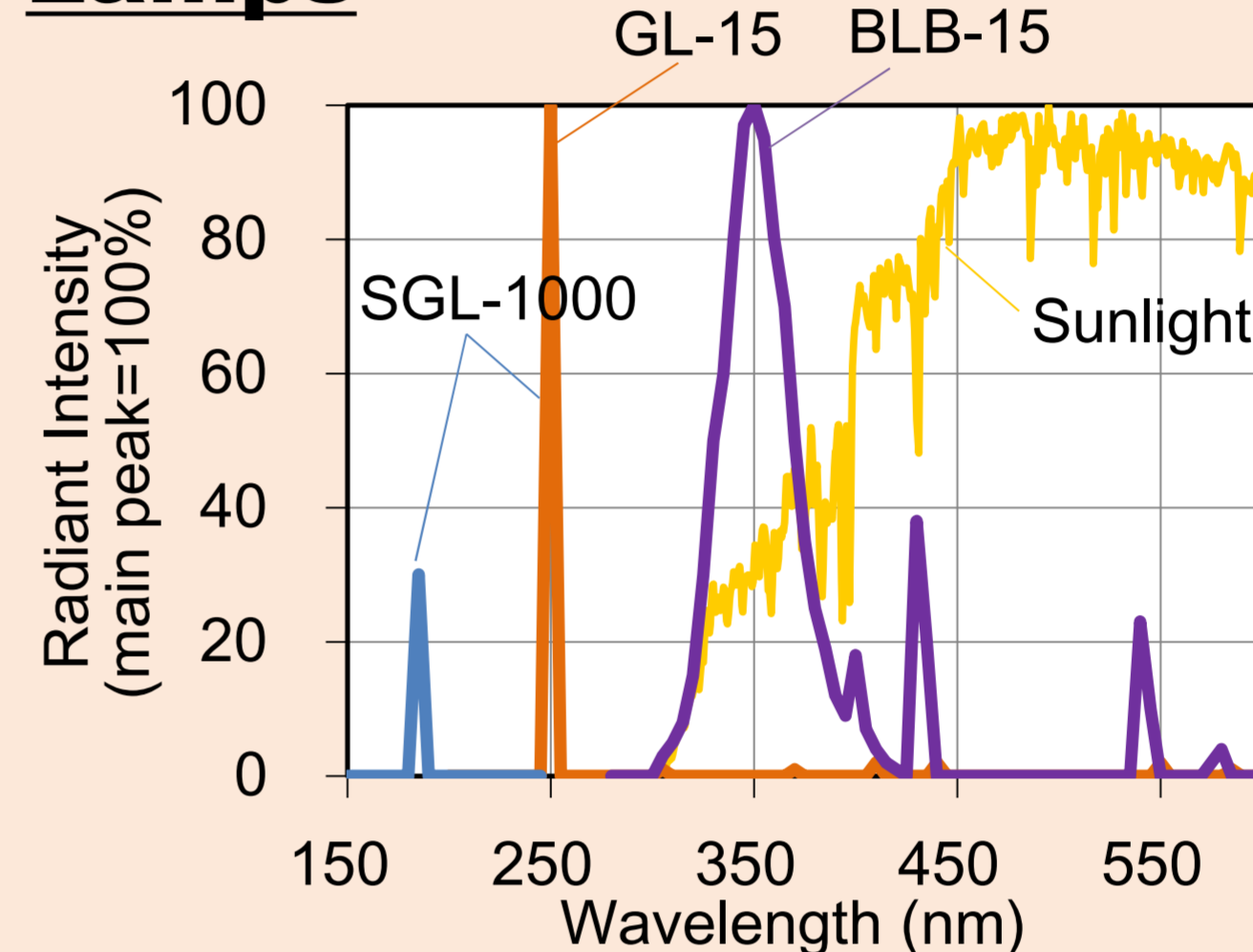
	Smog Chamber	Flow Reactor
Outline	UV Lamp (Wavelength: >300nm) 	UV Lamp (Wavelength: <300nm) 
Advantage	Can simulate the reaction in atmosphere	Portability (Small, Simple) Short reaction time
Weak Point	Complicated handling Long reaction time (>1hr)	High wall loss Different from the atmospheric reaction

## Methods

### Toyota Tools



### Lamps



Ultraviolet(UV) of short wavelength are used for the acceleration of the photochemical reaction.

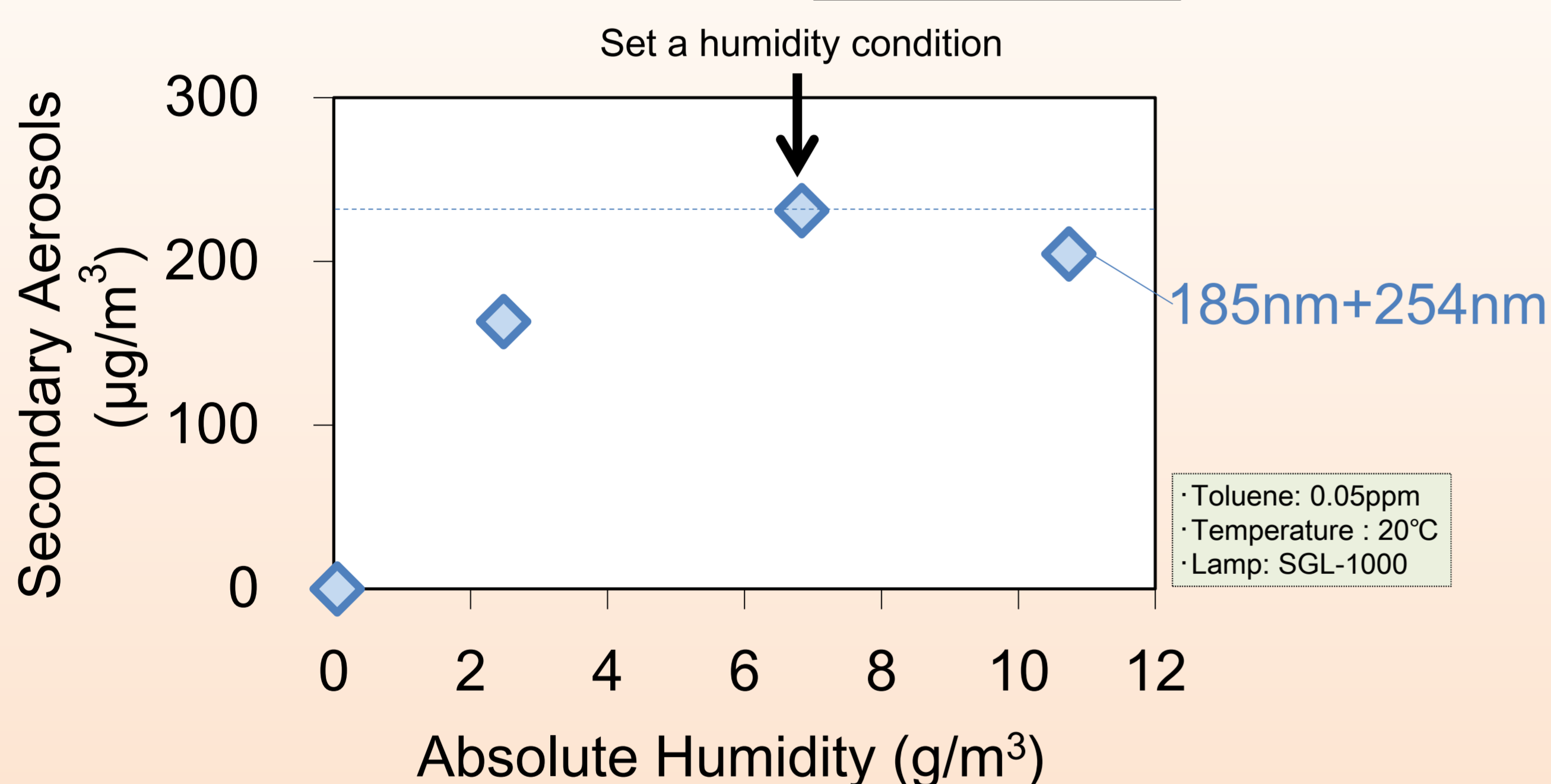
- UV185nm O<sub>2</sub>→O<sub>3</sub>  
\_Generation of Ozone
- UV254nm O<sub>3</sub>→·OH  
\_Generation of Hydroxyl radical
- UV350nm  
\_As **control test** of photochemical reaction

## Results

### 1. Effect of Humidity

Around 7 g/m<sup>3</sup> of the absolute humidity stabilized generation of the second aerosol

To set up 7 g/m<sup>3</sup> as a humidity condition in this study



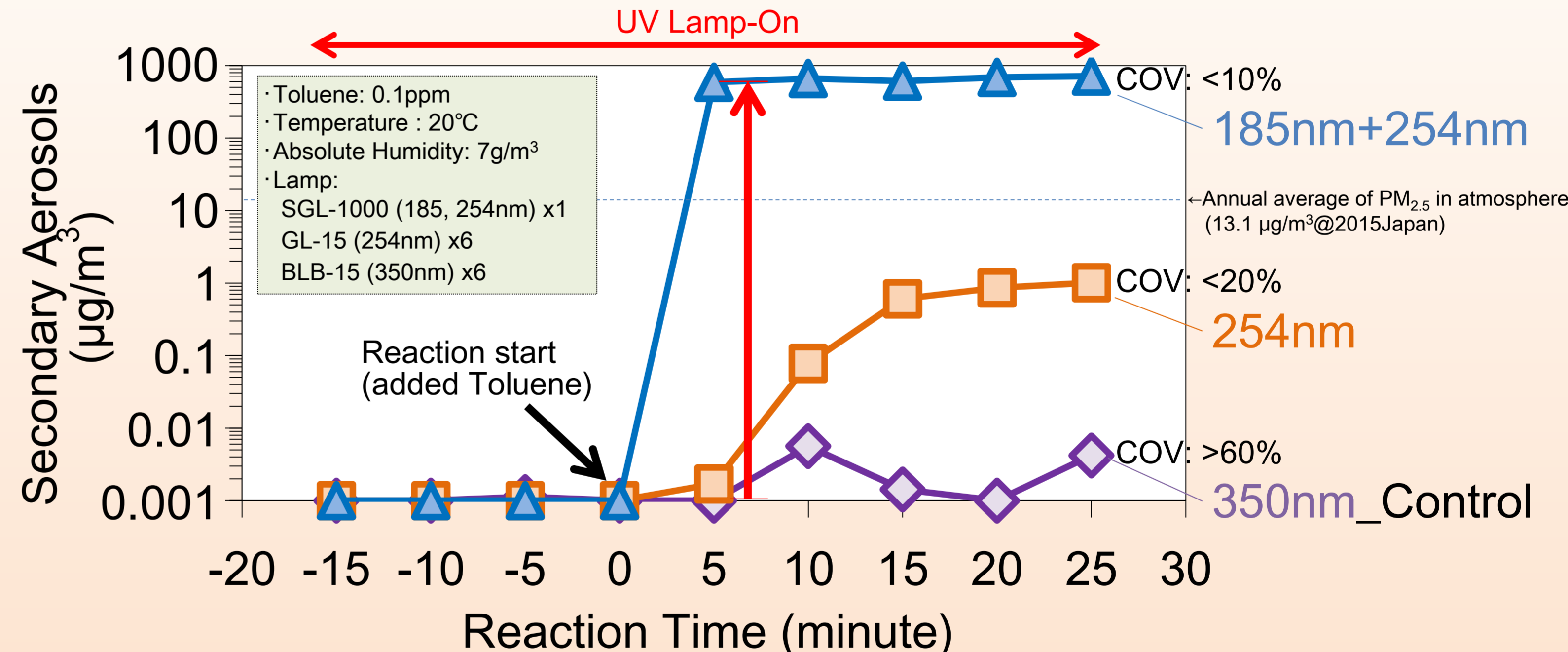
### 2. Effect of UV Wavelength

#### 2-1. Generation of Secondary Aerosols

The secondary aerosols by the irradiation of UV185nm+254nm

- Swift reaction (<2 minutes)\_UV254nm,UV350nm: >20 minutes
- High accuracy (COV\*: <10%)
- High concentration\_ A hundred thousand times as high as UV350nm

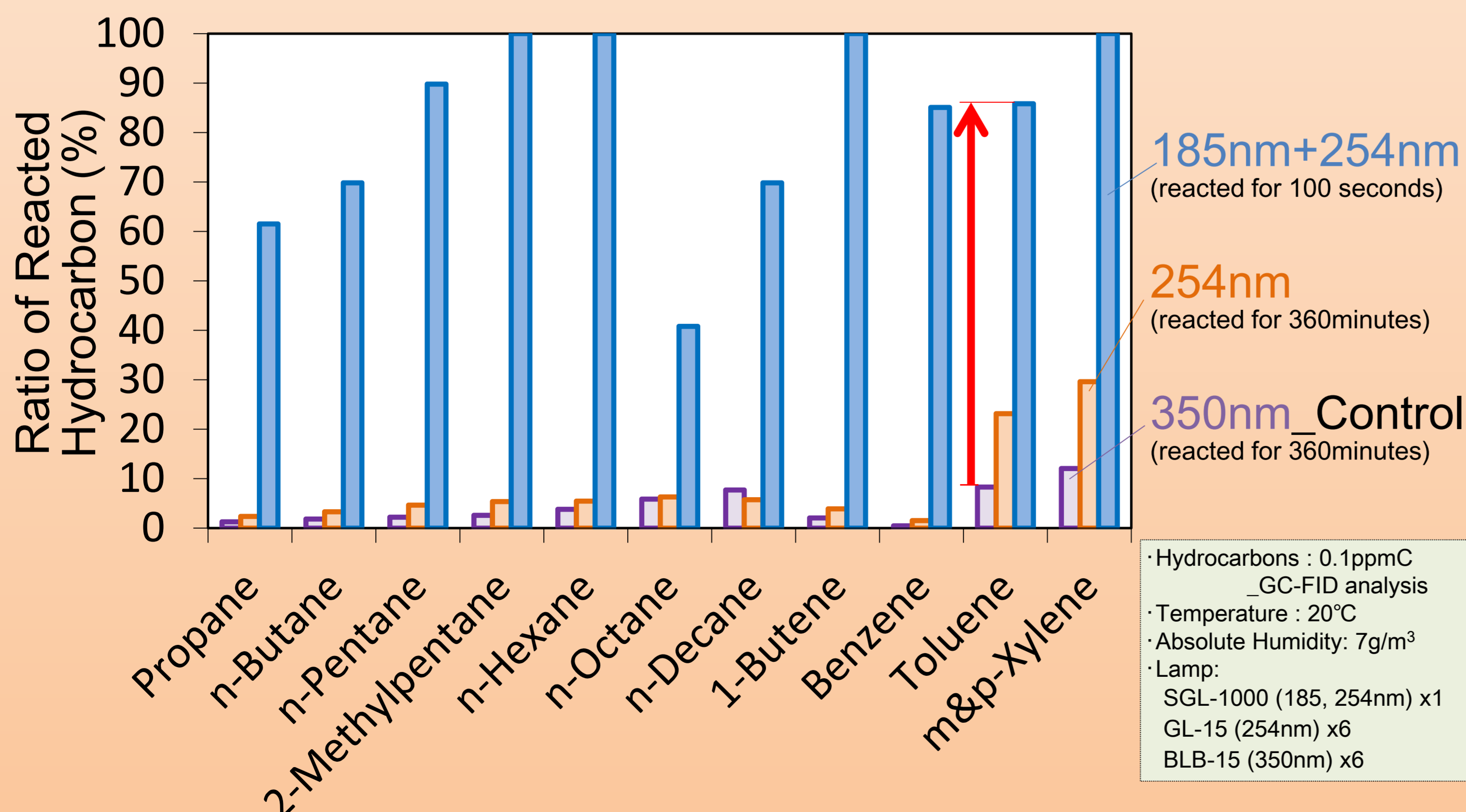
There is the possibility that the secondary aerosols are swiftly evaluated with UV185nm+254nm. The concentration of the secondary aerosols is much higher than the PM<sub>2.5</sub> in atmosphere.



#### 2-2. Precursor Hydrocarbons

Volume of the reacted hydrocarbons were increased by the irradiation of UV185nm+254nm.

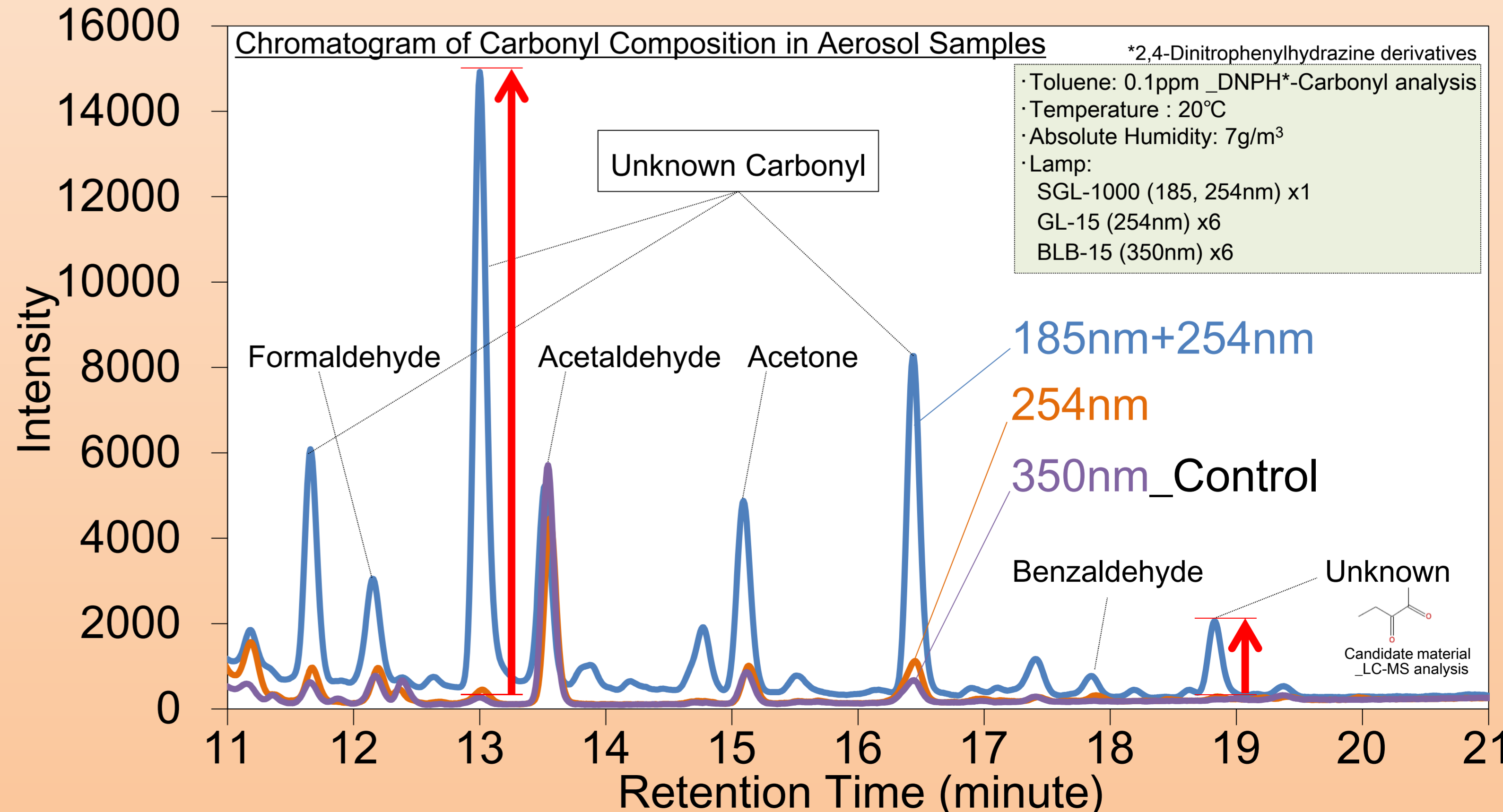
The reason why there was much generation of the secondary aerosols.



#### 2-3. Chemical Composition of Aerosols

Unknown carbonyl compositions of secondary aerosols were specifically increased by the irradiation of UV185nm+254nm.

There is the possibility that the chemical composition of the secondary aerosols generated by UV185nm+254nm is different from those generated by the common smog chamber system.



## Conclusion

- Secondary aerosols can be evaluated swiftly with UV185nm+254nm.
- The chemical composition of the secondary aerosols may be different from those in atmosphere.

We will investigate the method that the gaseous emission is not irradiated by the short wavelength UV in future.