# Secondary Organic Aerosol from Domestic Cooking Emissions


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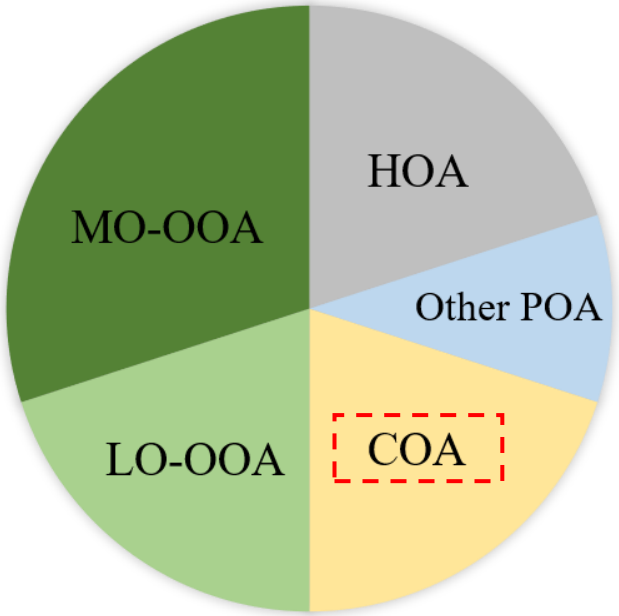
# Introduction: Background

The **cooking emission** is a common area source, closely linked with daily lives of inhabitants.

It is a considerable **source of POA** which accounts for **10-35%** of ambient OA mass in **urban area**.




(Hu *et al*. ACP, 2017; Allan et al. ACP 2010; Sun et al. ACP, 2011)

# Introduction: Limitation

However, the formation of **SOA** derived from cooking emissions are **poorly understood**, leading to the underestimation of its contribution and effect.

The characteristics of SOA from heated cooking oils or charbroiled meat have been studied in lab. But those of SOA aged from **real-life domestic cooking emissions** are still uncertain.

We have characterized four **Domestic Cooking-SOA** for the first time.

(Liu *et al*. ACP, 2017; Kaltsonoudis *et al*. ACP 2017)

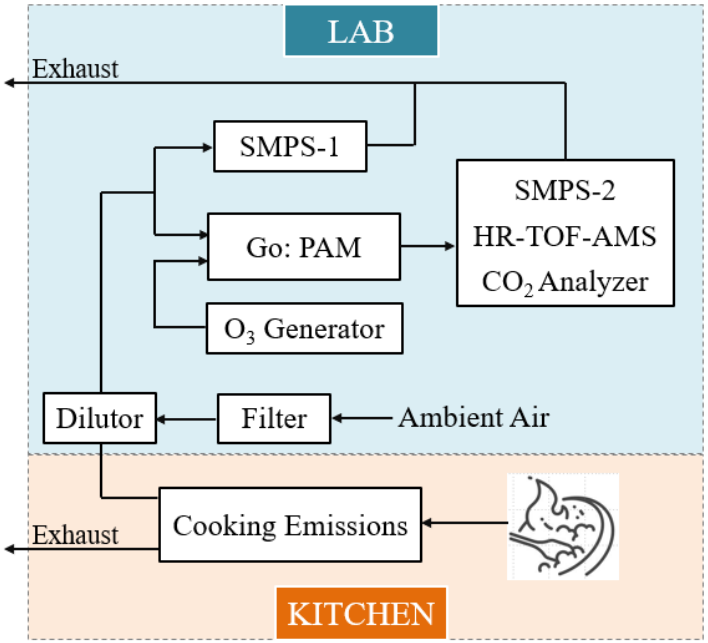
# Materials and Methods

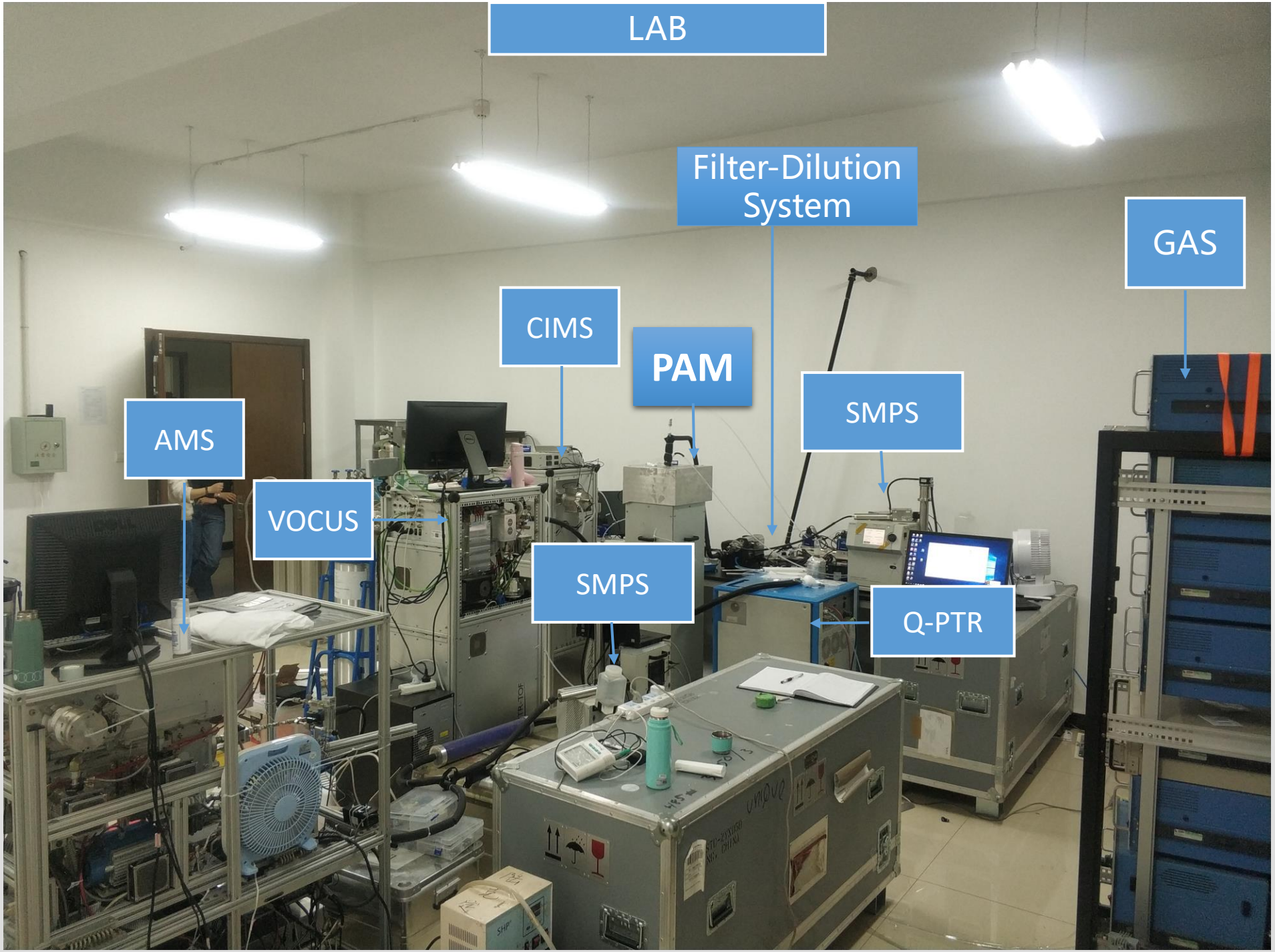
**Table 1. Cooking and oxidation conditions**

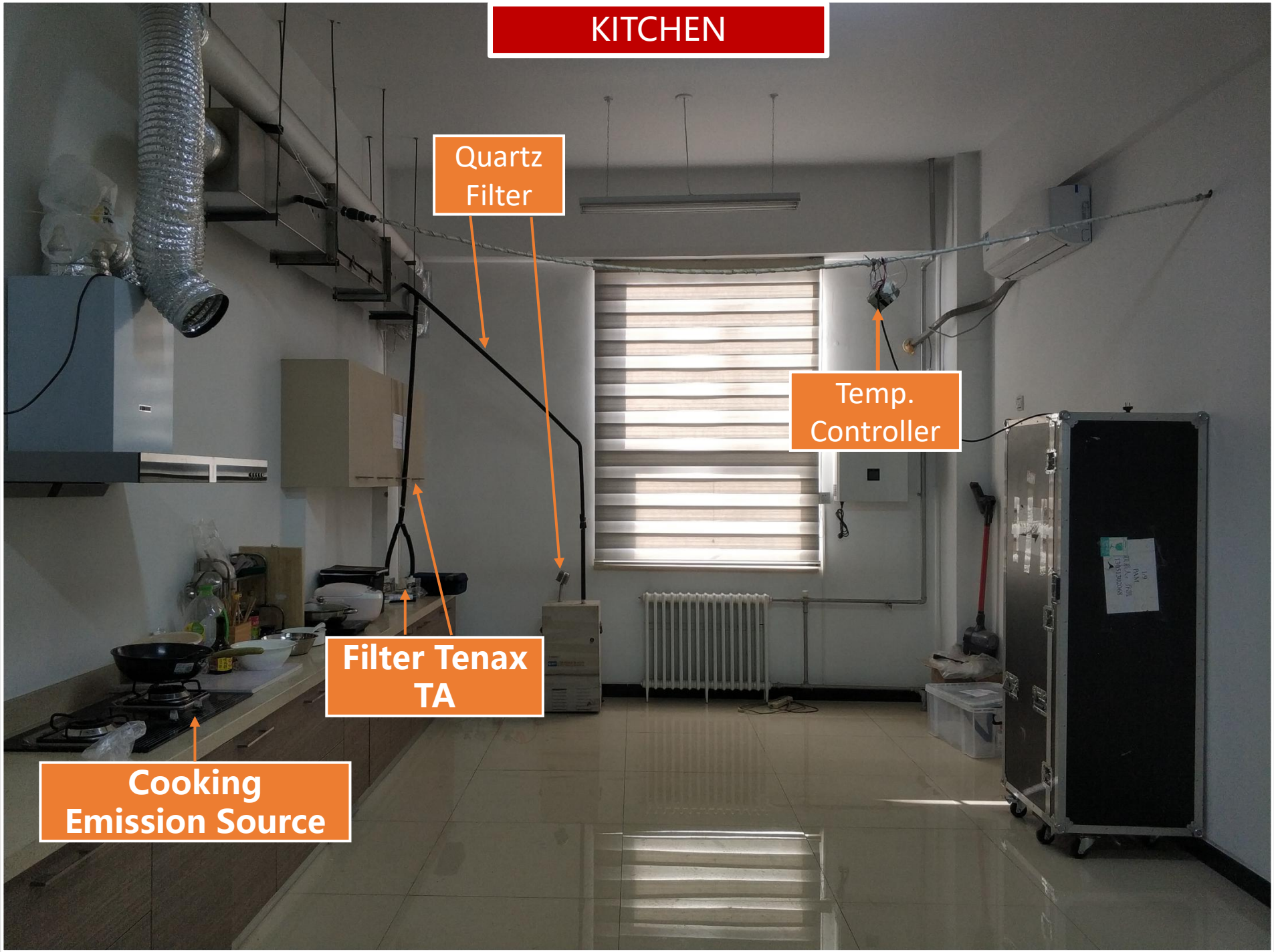
| Experiment | Domestic Cooking | Cooking Material | OH Exposure[a] ($\times 10^{10}$ molecules·cm$^{-3}$·s) | Photochemical Age (days, [OH]=1.5×10$^6$ molecules·cm$^{-3}$) | Parallels |
|---|---|---|---|---|---|
| Meat | Deep-fried chicken | 170 g chicken, 500 ml corn oil and a few condiments | 0 | 0.0 | 3 |
| | | | 4.3 | 0.3 | 3 |
| | | | 9.6 | 0.7 | 3 |
| | | | 14 | 1.1 | 3 |
| | | | 21 | 1.7 | 3 |
| | | | 27 | 2.1 | 3 |
| Bean | Pan-fried tofu | 500 g tofu, 200 ml corn oil and a few condiments | The same as Meat experiments | | |
| Vegetable | Stir-fried cabbage | 300 g cabbage, 40 ml corn oil and a few condiments | The same as Meat experiments | | |
| Asian Cuisine | Kung Pao Chicken | 150 g chicken, 50 g ceanut, 50 g cucumber, 40 ml corn oil and a few condiments | The same as Meat experiments | | |

[a]OH exposure was calculated based on the decay of $SO_2$

**Figure 1. Schematic of system**



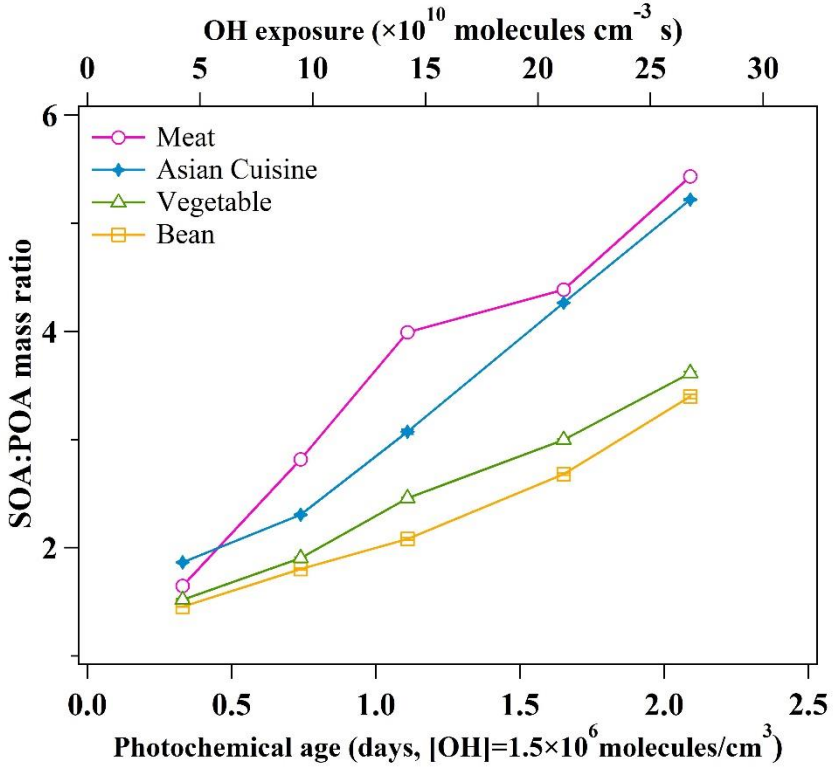

LAB
Filter-Dilution System
GAS
CIMS
PAM
SMPS
AMS
VOCUS
SMPS
Q-PTR


KITCHEN
Quartz Filter
Temp. Controller
Filter Tenax TA
Cooking Emission Source

# Preliminary Results

## 1. Mass growth potentiality of Domestic Cooking-SOA.

Evolutions of SOA mass growth potentiality

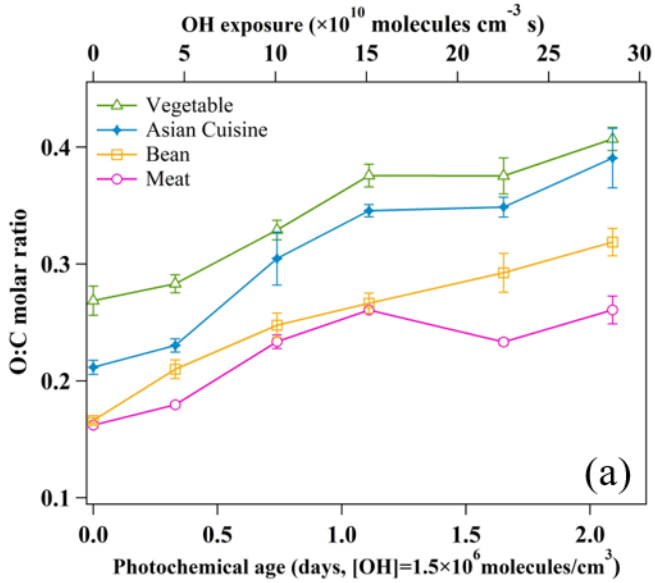



**Functionalization reactions** may play a leading role in the formation of Domestic Cooking-SOA

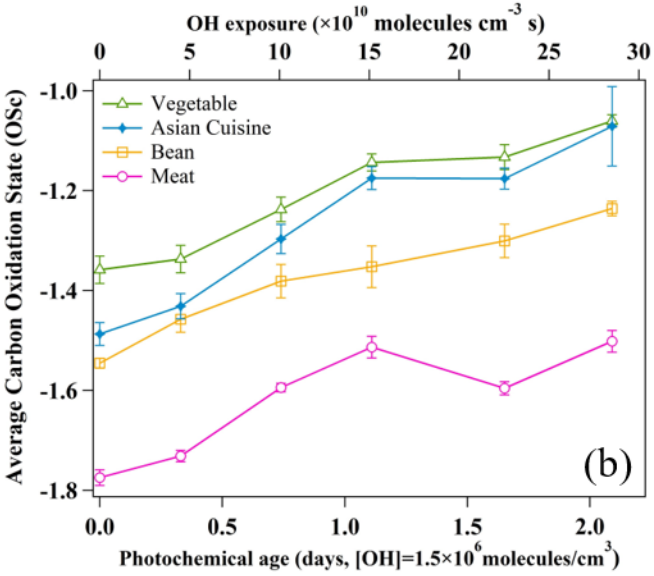
# Preliminary Results

## 2. Oxidation degree of Domestic Cooking-SOA.

**(a).** Evolutions of O:C molar ratio




**(b).** Evolutions of average carbon oxidation state (OSc)




Less oxidized OA

**Vegetable:**

O:C=0.27~0.41, OSc=-1.36~-1.06

**Asian Cuisine:**

O:C=0.21~0.39, OSc=-1.49~-1.10

**Bean:**

O:C=0.17~0.32, OSc=-1.55~-1.24

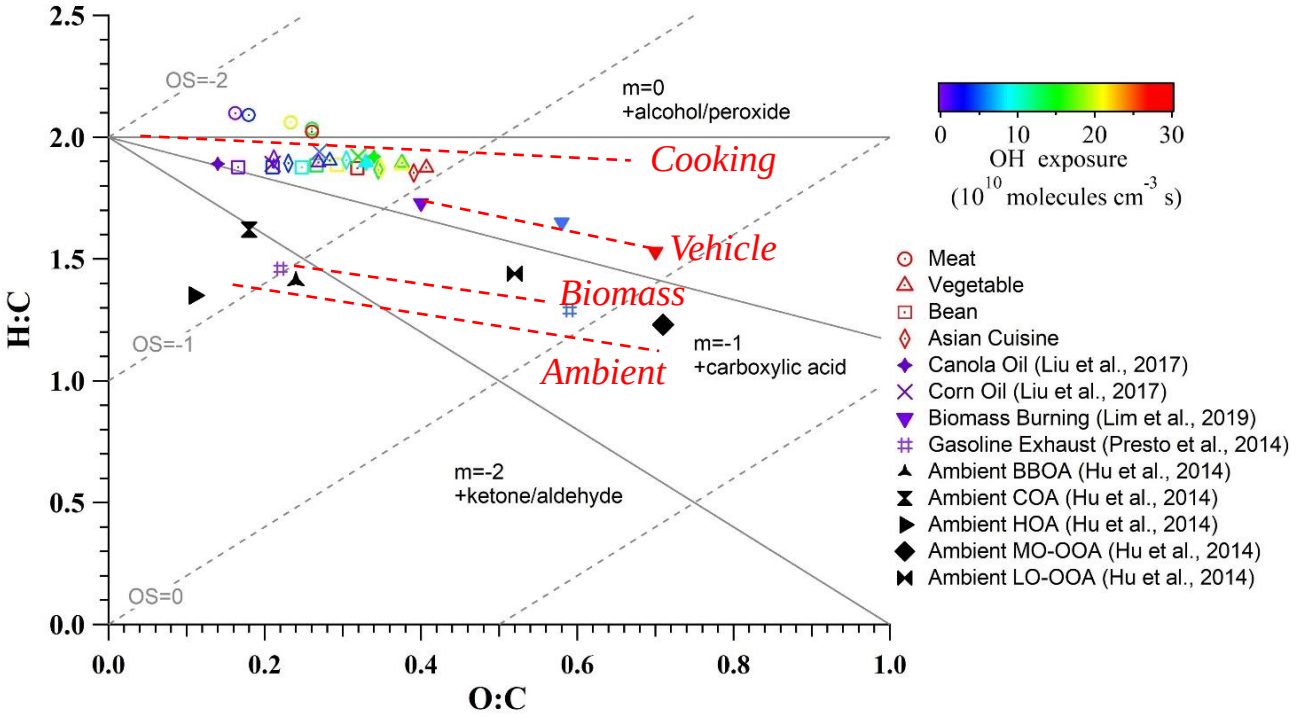
**Meat:**

O:C=0.16~0.26, OSc=-1.77~-1.50

# Current Results

## 2. Oxidation pathway of Domestic Cooking-SOA.

Van Krevelen diagram of POA and SOA from domestic cooking emissions, heated oils, a biomass burning, a gasoline exhaust as well as ambient results.




**An alcohol/peroxide oxidation pathway**

**Domestic cooking (slope≈-0.1)**

Biomass burning (slope≈-0.63),

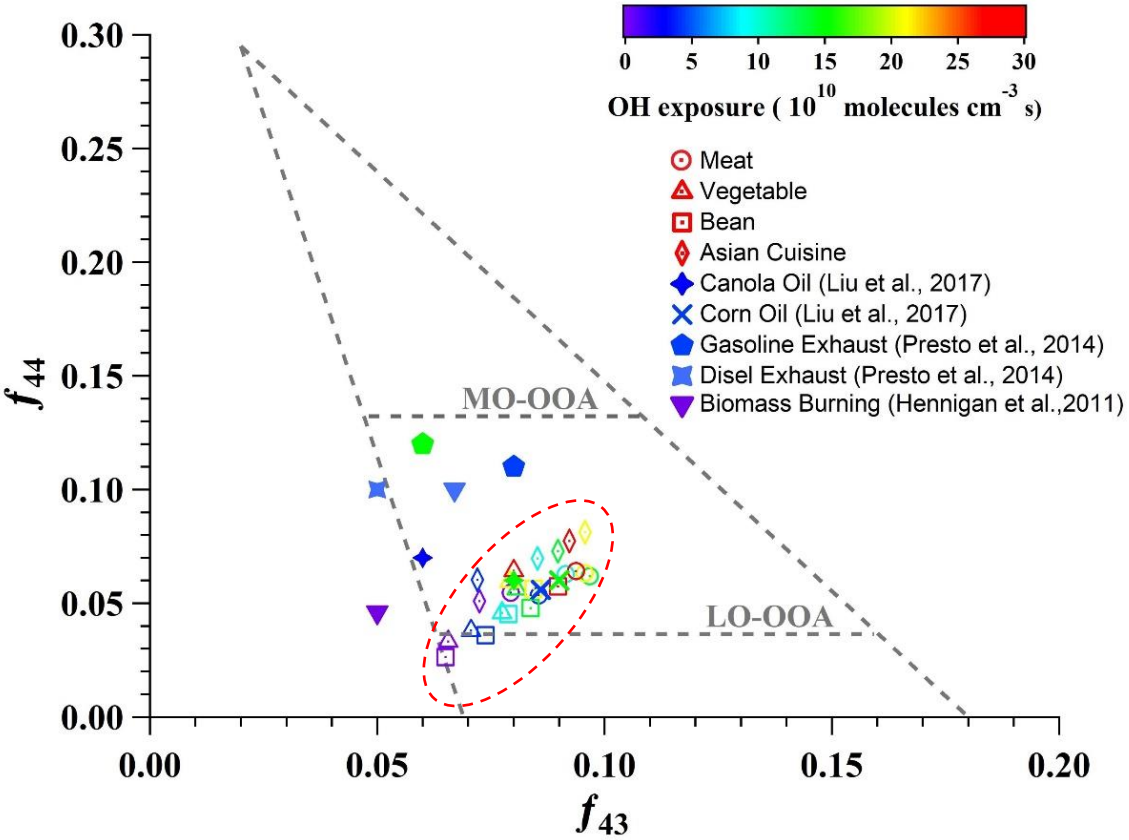
Vehicle exhaust (slope≈-0.46)

Ambient (slope≈-1~-0.5)

# Current Results

## 3. Mass spectra of Domestic Cooking-SOA.

Fractions of entire organic signals at m/z 43 ($f43$) vs. m/z ($f44$) from domestic cooking emissions, heated oils, a biomass burning, vehicle exhausts as well as Ng triangle plot.

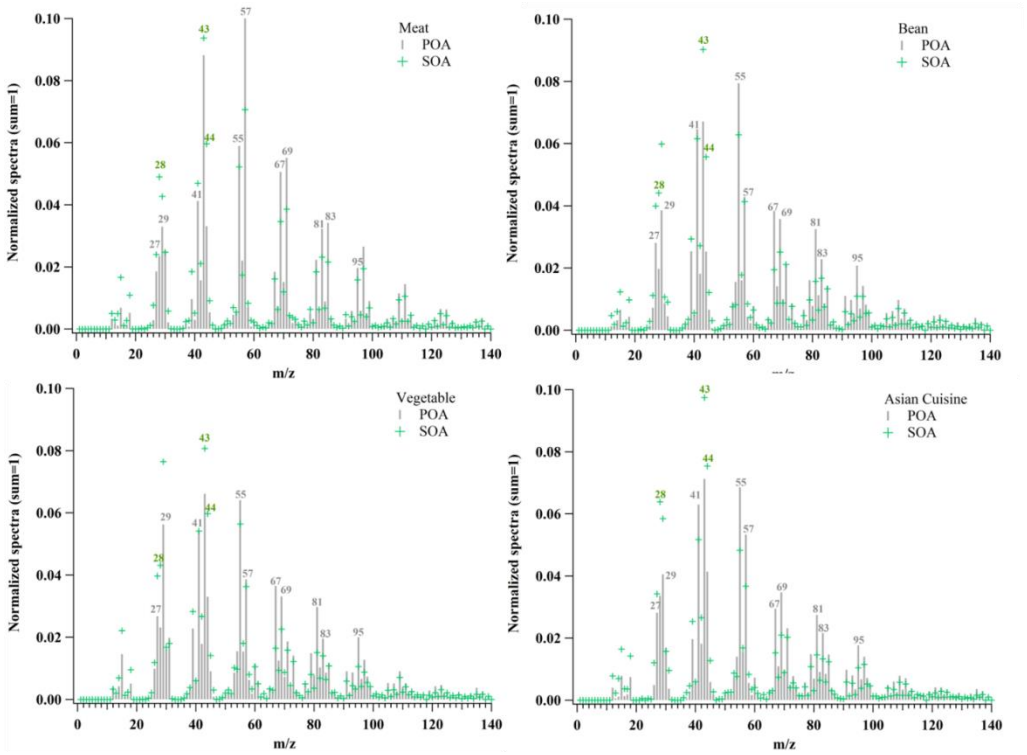


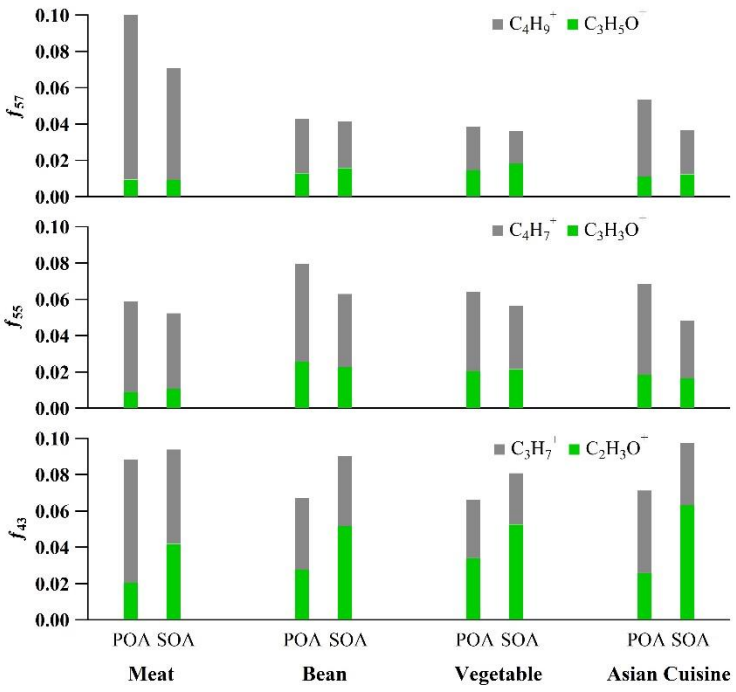

The Domestic Cooking-SOA seems to be **a less oxidized organic aerosol (LO-OOA)** formed by precursors like alkanals and alkenals.

(Liu *et al*. ESTL, 2017)

# Current Results

## 3. Mass spectra of Domestic Cooking-SOA.



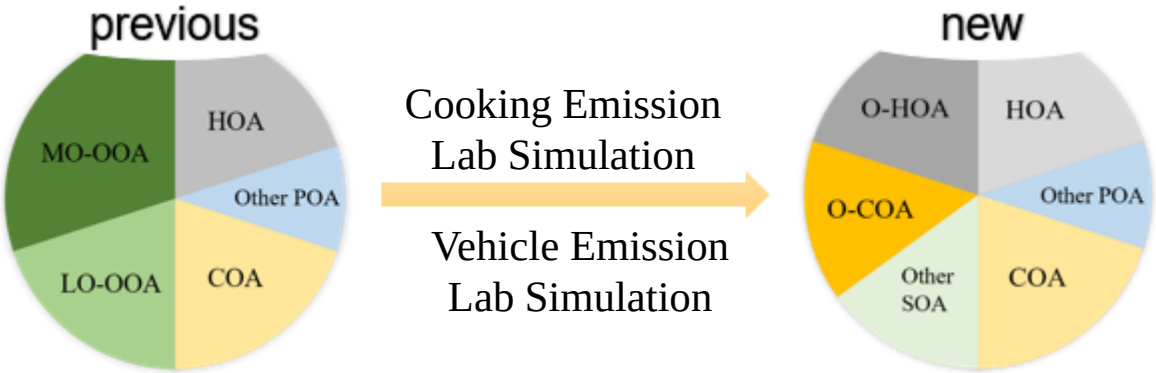

Mass spectra of POA and SOA from domestic cooking emissions

The characteristic peaks are m/z **28, 29, 41, 43, 44, 55 and 57** , dominated by $CO^+$, $CHO^+$, $C_3H_7^+$, $C_2H_3O^+$, $CO_2^+$, $C_3H_5^+$, $C_4H_7^+$, $C_3H_3O^+$, $C_4H_9^+$ and $C_3H_5O^+$ respectively.

# Atmospheric Implications

We have defined a new type of SOA as **Domestic-Cooking SOA** which is likely to be a kind of **LO-OOA** with **unique oxidation pathway** (alcohol/peroxide), **precusors** (alkanals/alkenals) and **mass spectra** (distinct peaks at m/z 28, 29, 41, 43, 44, 55, 57).

These results can be used to estimate the contribution of Domestic Cooking-SOA in real atmosphere, which will be helpful for the policy formulation of pollution source control.

# Thank you for your attention