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中国科学院广州地球化学研究所
Guangzhou institute of geochemistry,chinese academy of sciences

Effects of heterogeneous reaction with NO_2 on ice nucleation activities of mineral dust

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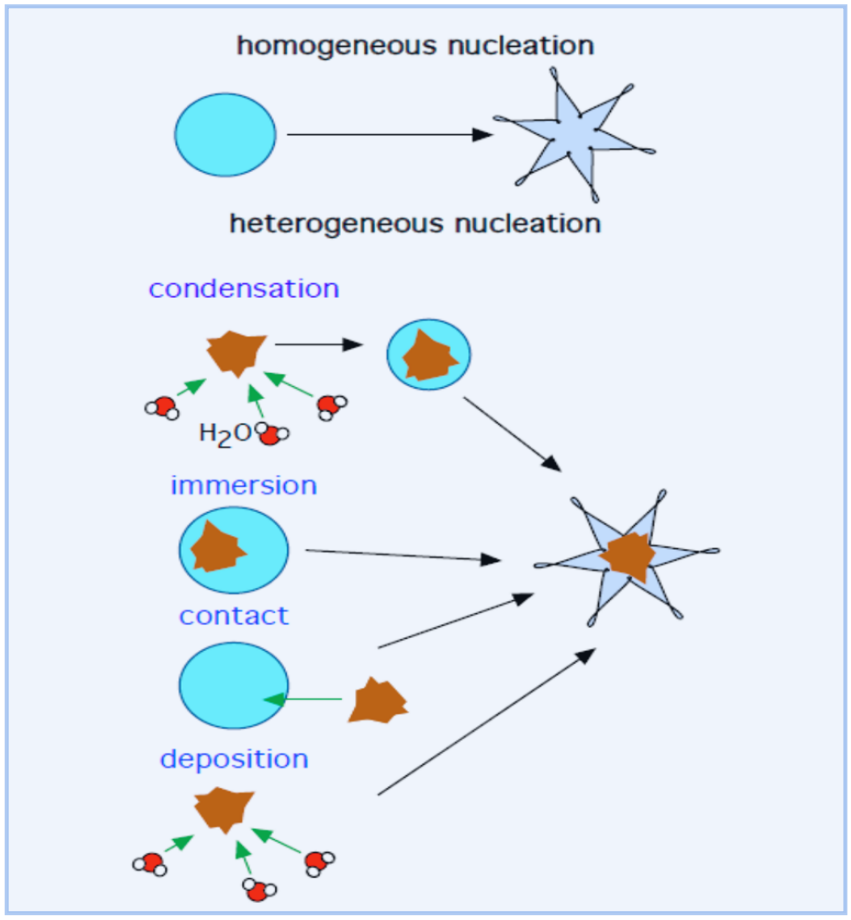
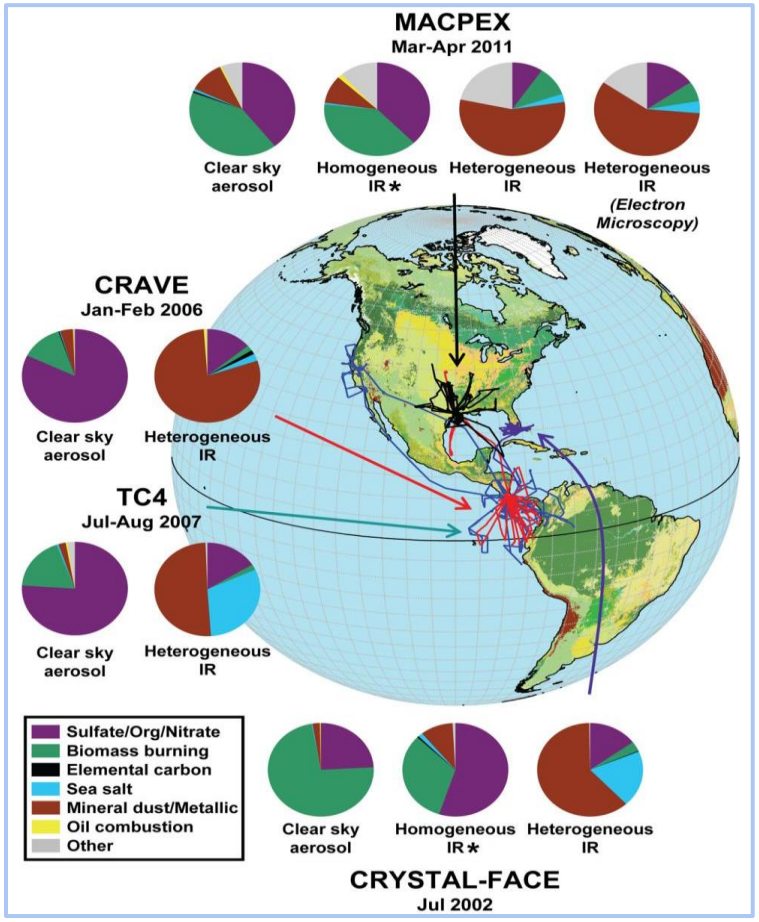
Mineral dust: an important INP

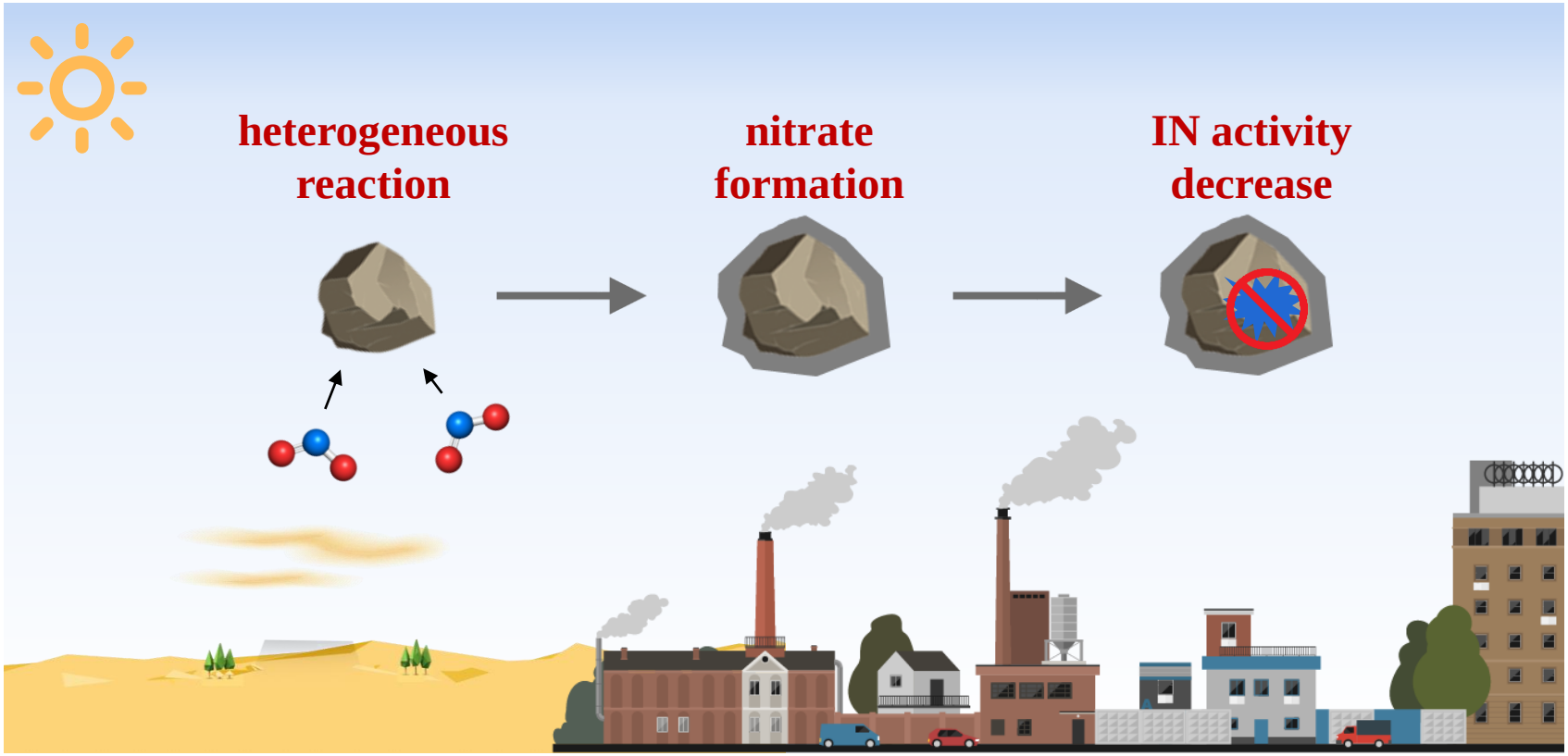




- **Ice nucleating particles (INPs):** aerosol particles that can initiate the formation of ice in clouds

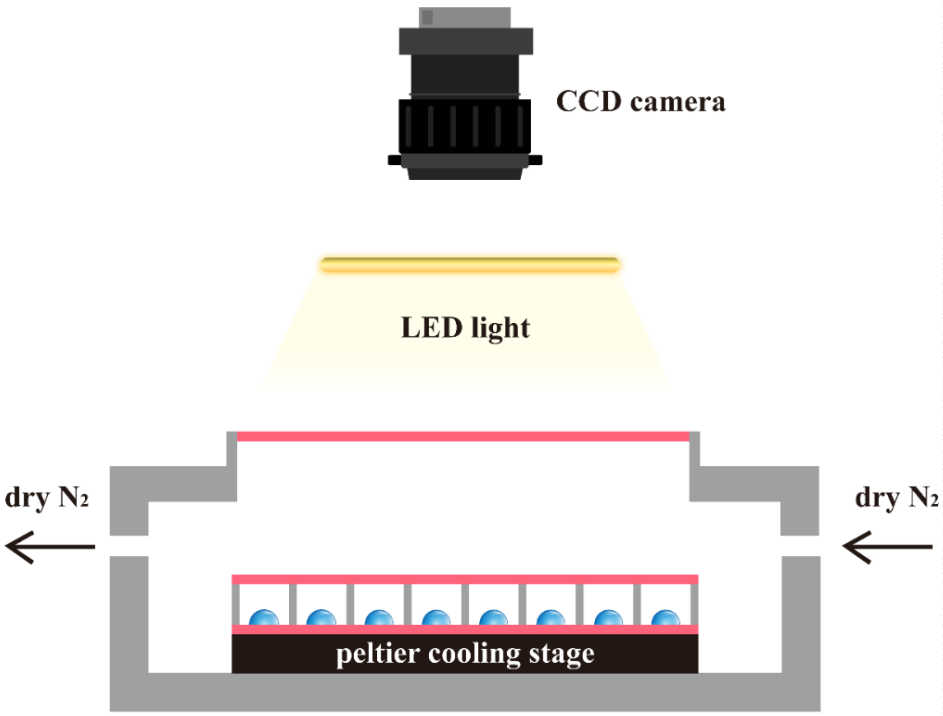
- **Mineral dust particles:** one of the most abundant INPs in the troposphere

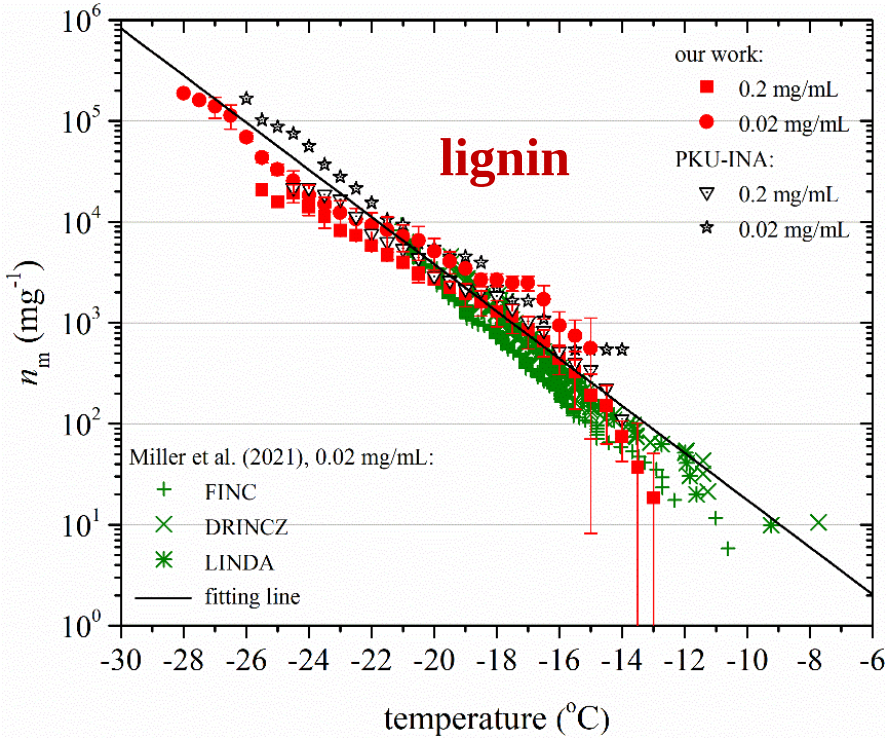
Chemical processing modified INPs



- **The effects of heterogeneous reactions with NO_2** on IN activities of mineral dust remain to be elucidated

Instrument development and characterization



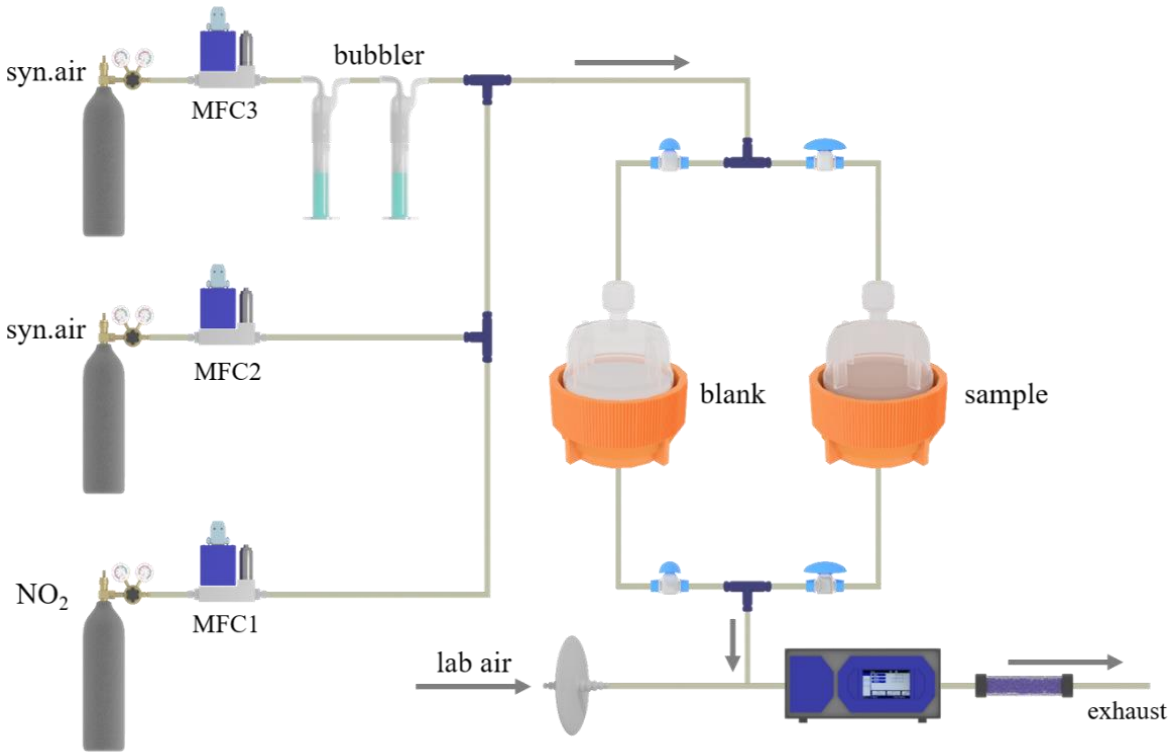


- Guangzhou Institute of Geochemistry Ice Nucleation Apparatus (GIGINA)

- The results measured by GIGINA agreed well with other instruments

Heterogeneous reaction with NO_2

NO_2 concentration: 10±0.5 ppmv; relative humidity: 40%



- **Mineral dust sample:**

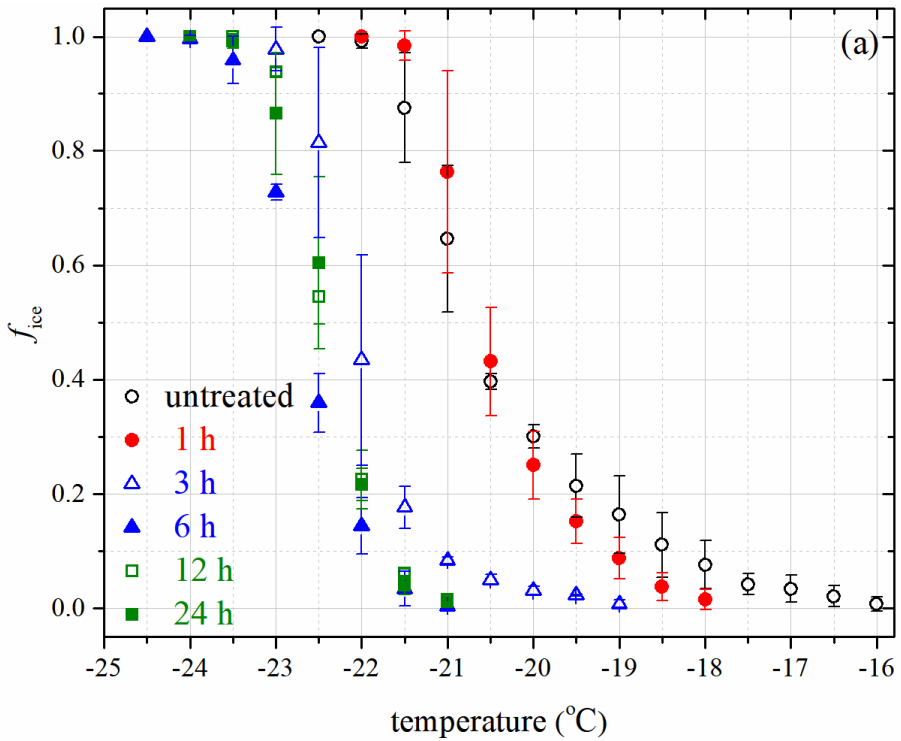
  feldspar: high IN activities

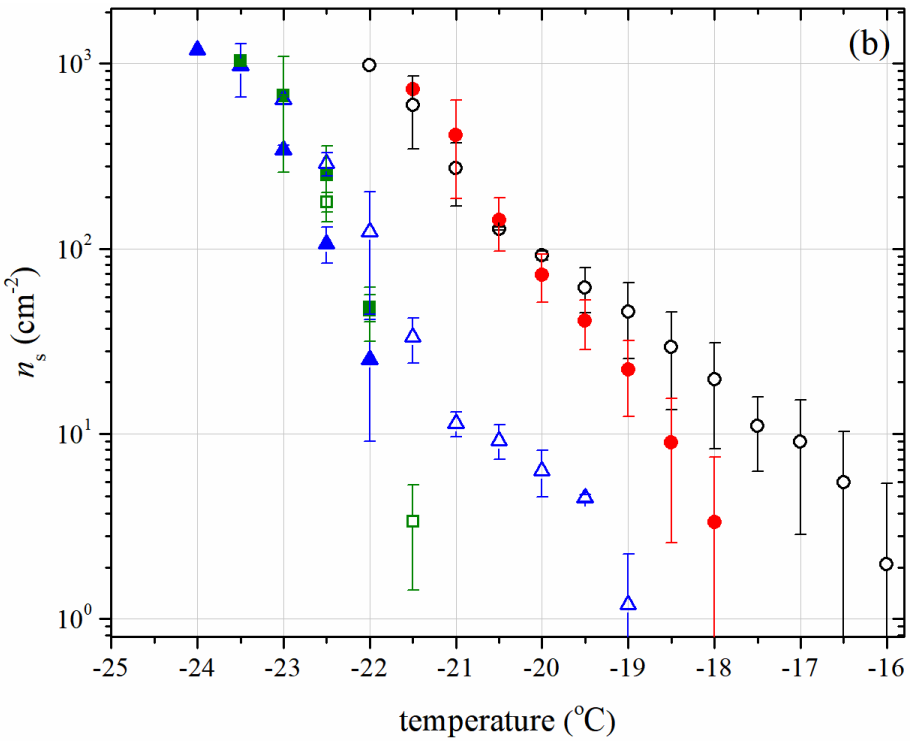
- **Analysis methods:**

  GIGINA: IN activities

  IC: the amount of nitrate

Effect of NO_2 uptake on IN activities: feldspar





➢ **The change of freezing temperature**

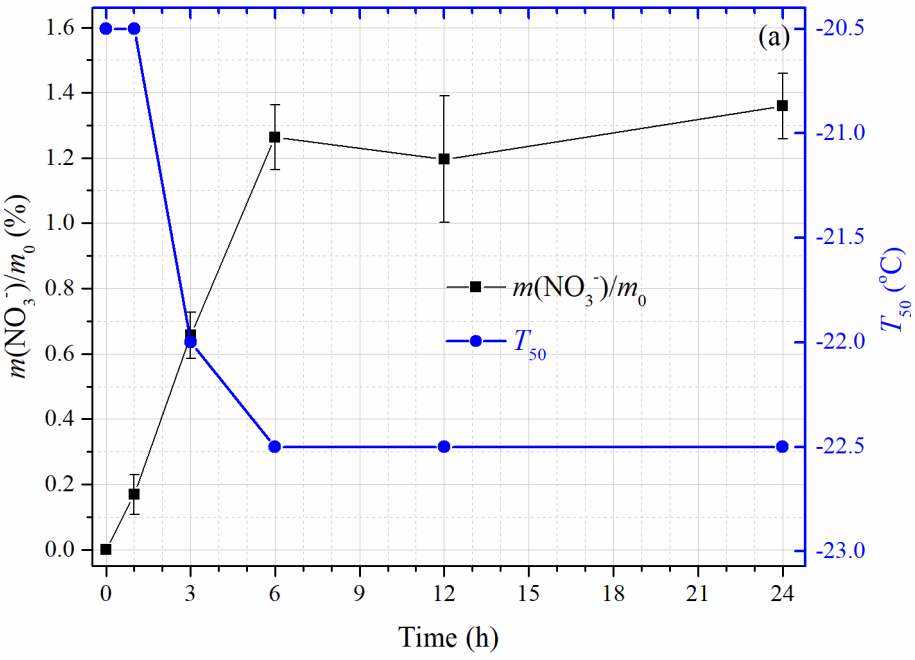
- T_{50} was decreased from -20.5 to -22.5 °C (24 h)

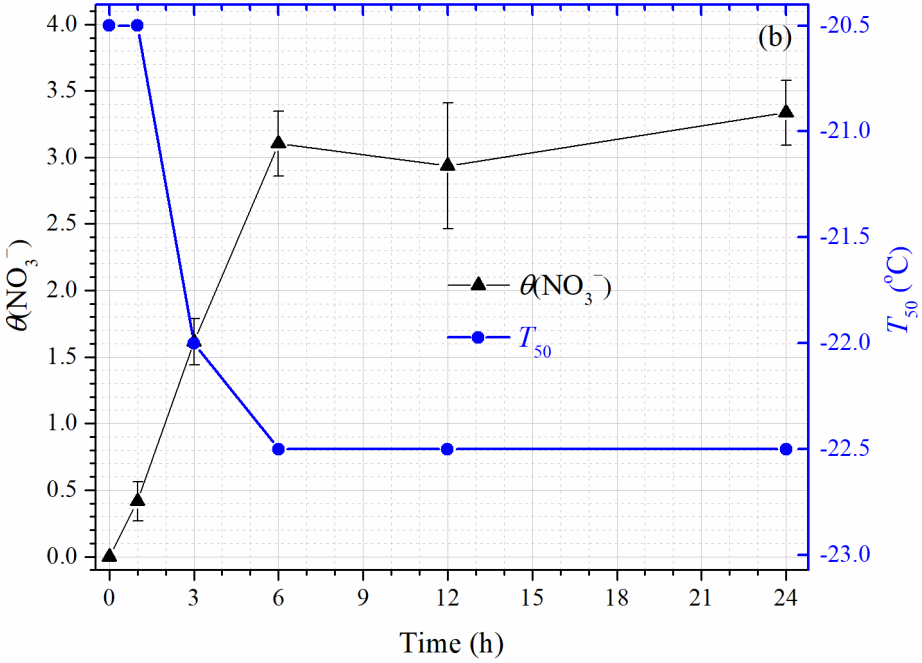
➢ **The change of n_s**

- n_s was reduced by 2 orders of magnitude (24 h)

NO_2 uptake could significantly reduce IN activities of feldspar

Nitrate and IN activities with time: feldspar





➢ **$m(NO_3^-)/m_0$ and $\theta(NO_3^-)$:**

- 0-6 h : increased with reaction time
- 6-24 h: no additional changes

➢ **IN activities (T_{50}):**

- 0-6 h : decreased with reaction time
- 6-24 h: no additional changes

Effects of heterogeneous reaction with NO_2 on ice nucleation activities of feldspar and Arizona Test Dust

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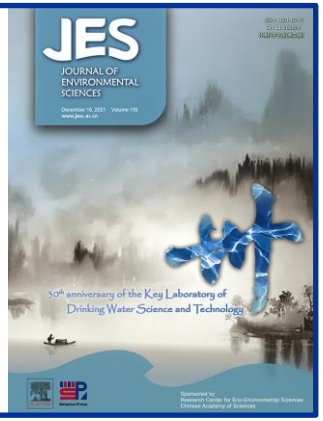

Thank you very much !

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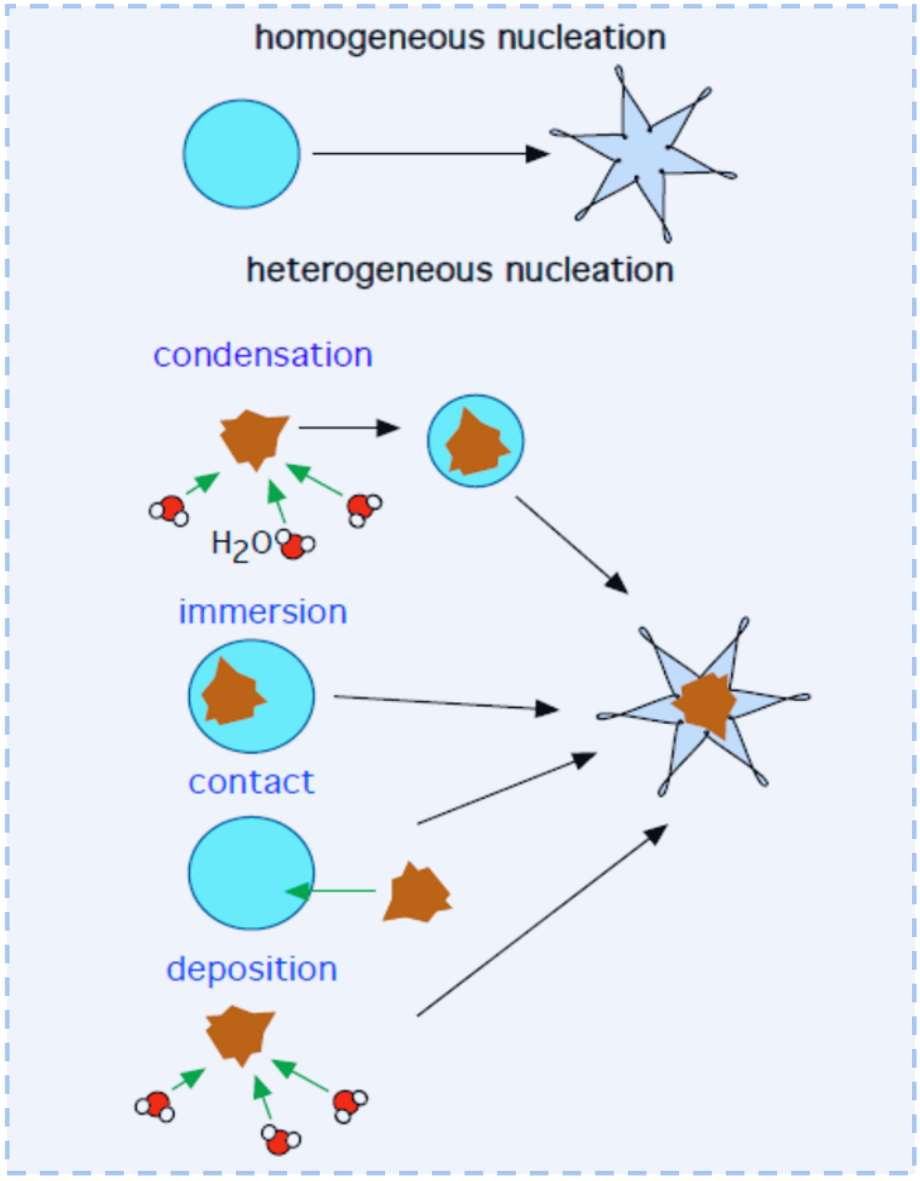
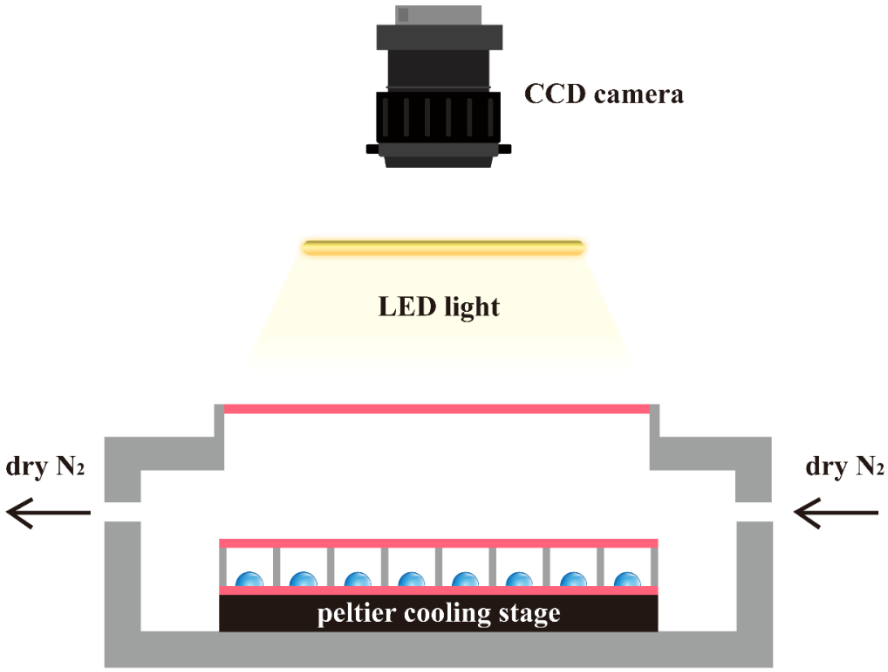
Ice nucleation mechanisms



- **Ice nucleating particles (INPs):** aerosol particles which can initiate heterogeneous ice nucleation
- Immersion freezing: freezing initiated by INPs immersed in liquid droplets
- **Immersion freezing** is most relevant for ice nucleation in mixed-phase clouds

Description of the Instrument



- **Working principle:**

  The droplets will be placed on a cold stage, the freezing behavior of droplets are monitored by camera during cooling

- **Instrument composition:**

  cold stage (Linkam 120), enclosed droplet chamber, LED light, CCD camera, N_2

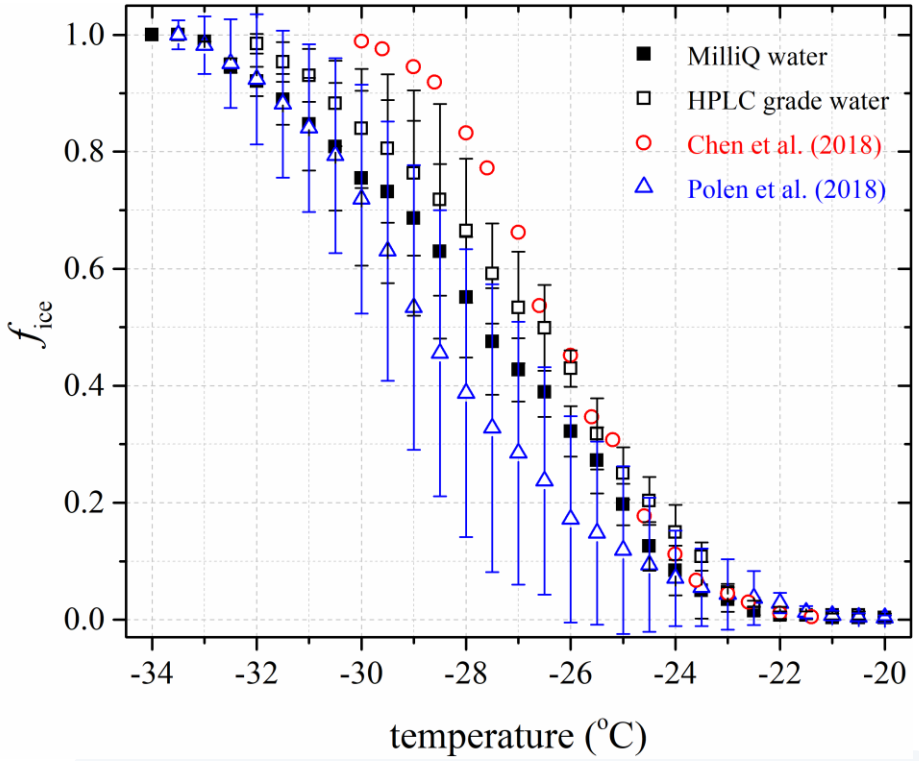
- **Key experimental conditions:**

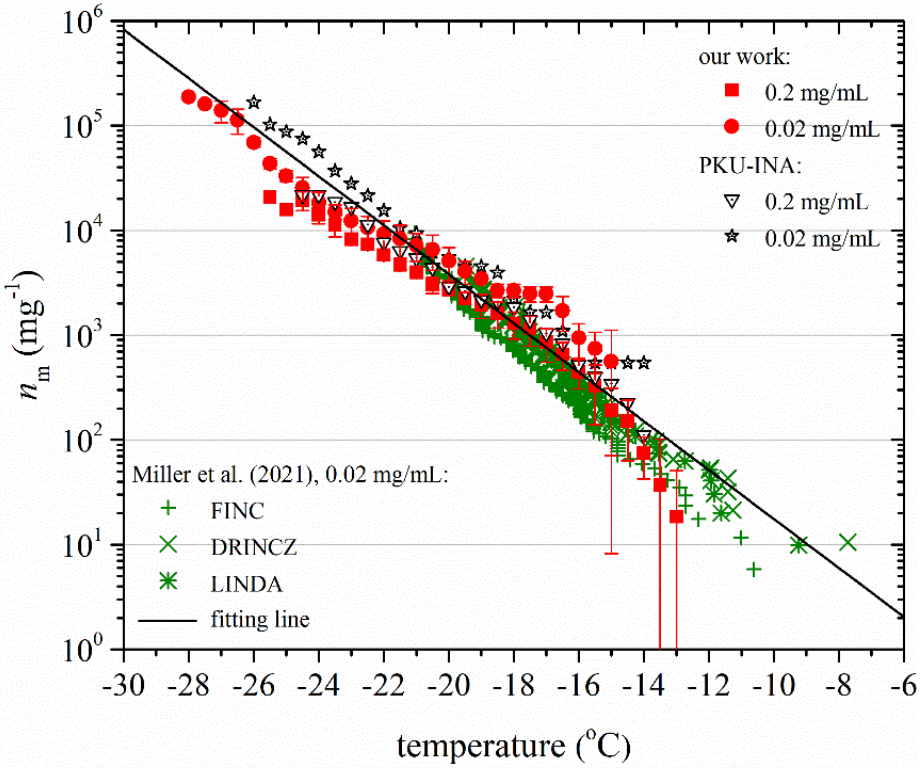
  - droplet volume: 1 µL
  - cooling rate: 1 ^{o}C/min

Instrument development and characterization

Guangzhou Institute of Geochemistry Ice Nucleation Apparatus (GIGINA):

IN activities of atmospheric particles in the immersion freezing mode





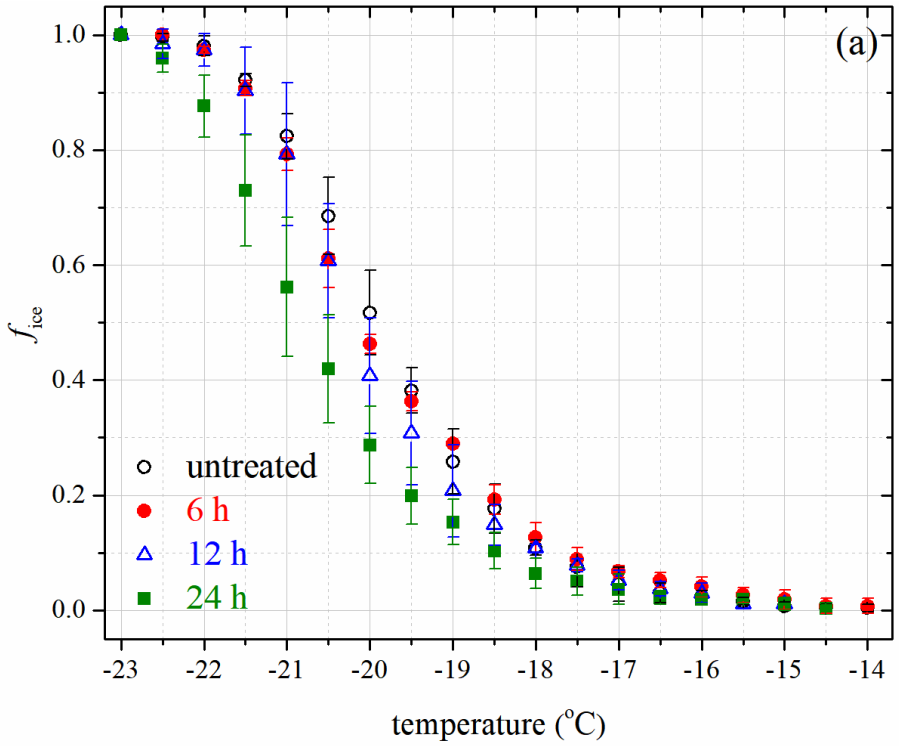
☐ Freezing of water droplets:

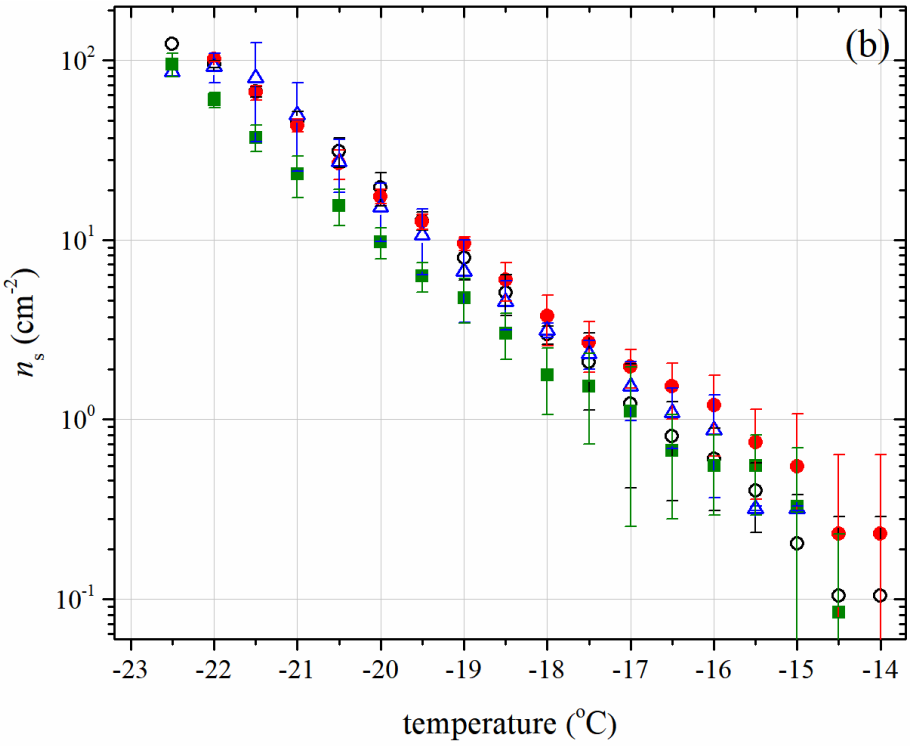
- The background level of GIGINA was satisfactorily low

☐ Freezing of lignin:

- The results measured by GIGINA agreed well with other four instruments

Effect of NO_2 uptake on IN activities: ATD





➢ **The change of freezing temperature**

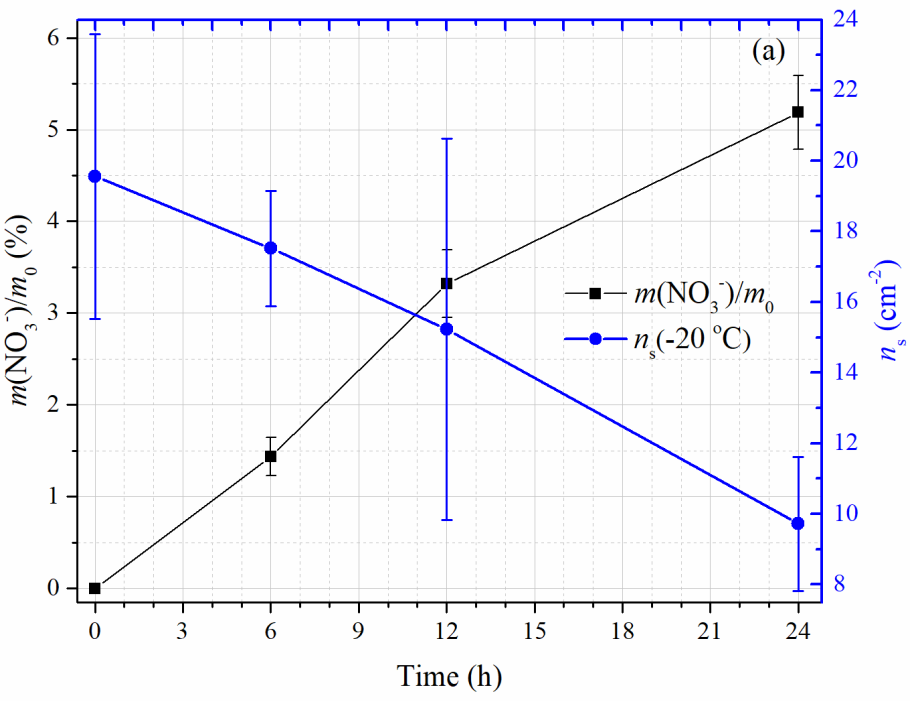
- T_{50} was decreased by 1°C (24 h)

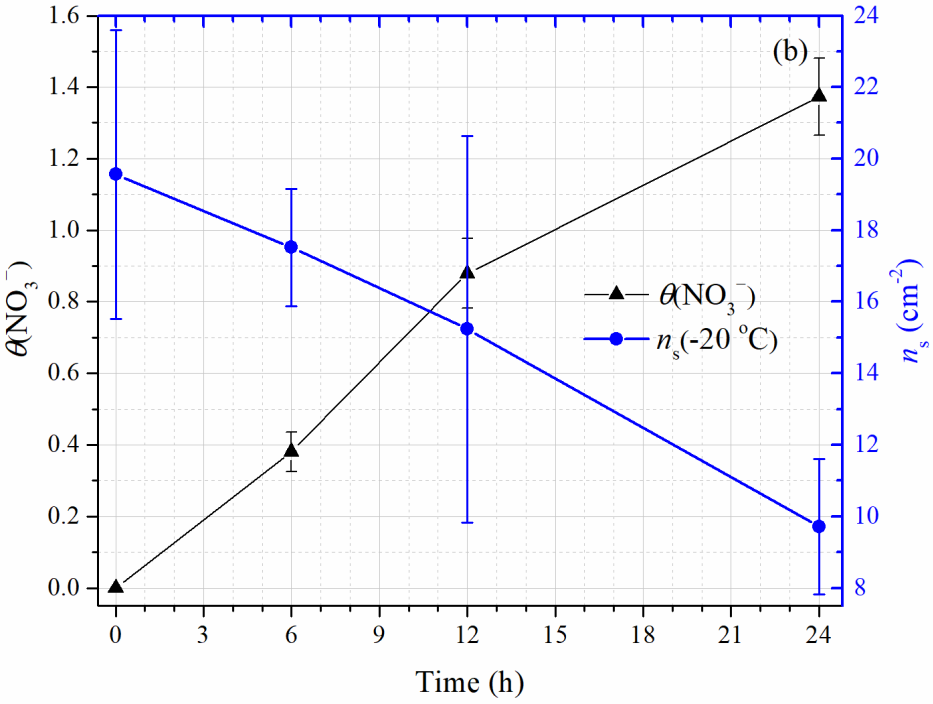
➢ **The change of n_s**

- n_s was reduced by 50% (24 h)

NO_2 uptake could considerably reduce IN activities of ATD

Nitrate and IN activities with time: ATD





➢ ***m*(NO$_3^-$)/*m*$_0$ and *θ*(NO$_3^-$):**

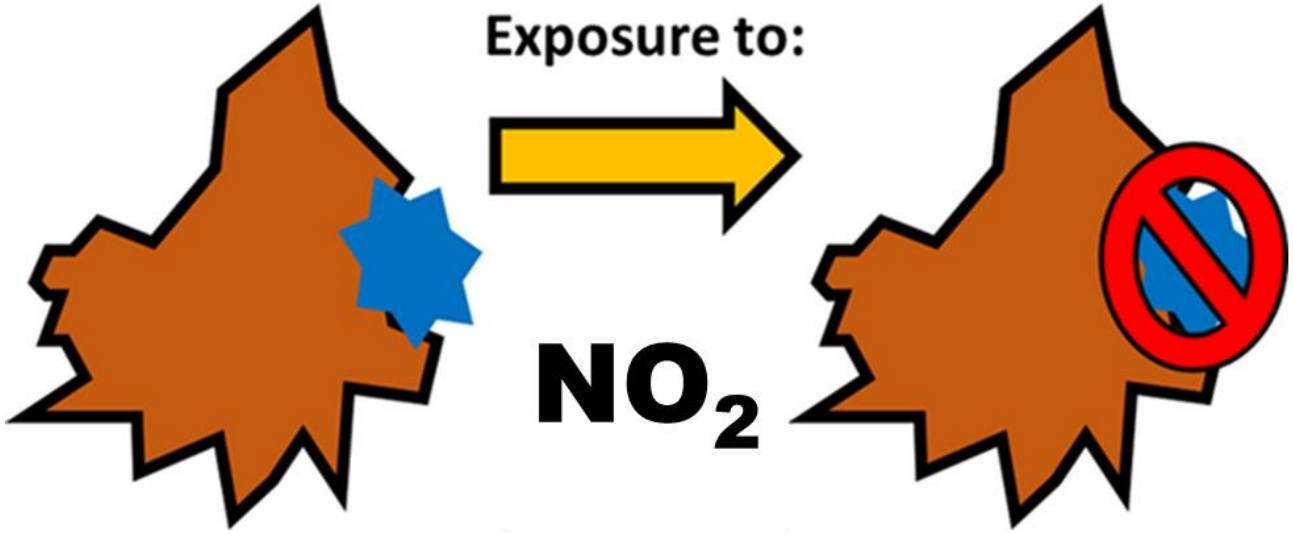
- 0-24 h: increased with reaction time

➢ **IN activities (n_s):**

- 0-24 h: decreased with reaction time

The factors affecting IN activity

Effects of freezing point depression could be neglected (<0.01 ^{o}C)



Possible mechanisms on reduction in IN activities

- K, Na and even Al of particles could be displaced after exposure to NO_2
- OH groups on the particle surface could be consumed after exposure to NO_2