

GL Sciences Inc.

Feb.2020



Company Profile

February, 1968: Established Gaskuro Kogyo
October, 1990: Gaskuro Kogyo changed its corporate Name to GL Sciences Inc.
November, 1994: GL head office moved to the top floor of “Shinjuku Square Tower”
September, 1995: Became a listed company on JASDAK.
February, 2005: Established GL , Inc. USA at Torrance, California.
March, 2005: Listed in the 2nd section of Tokyo Stock Exchange.
April, 2014 Established GL Sciences BV, the Netherlands
April, 2017 Acquired FLOM company, Japan
February, 2018 **50th Anniversary**

Number of Employees: 420
(Consolidated: 772 as of April, 2019)
Number of Sales Office in Japan: 10
Number of Worldwide Distributors: 36
Annual Sales in 2019 : Consolidated: JPY20,582 Million)
Subsidiary Companies: 7

GL Sciences Inc.

Chromatography Business

| SPE | HPLC | | GC |
|---|--|---|--|
|  <p>SPE Accessory</p> |  <p>HPLC, LC/MS Columns</p> |  <p>GC, GC/ MS Capillary Columns</p> |  <p>GC, GC/ MS Consumables</p> |
|  <p>SPE Cartridges</p> |  <p>HPLC Consumables</p> |  <p>GC Packed Columns</p> |  <p>Accessories for Packed column</p> |

HPLC columns

Inertsil

InertSustain



Sample Preparation Products



OP275Proll
Sniffing system
For GC/O analysis



AquaTrace 899
for VOC analysis in water



AERO TOWER
For VOC analysis in Air

Gas Chromatograph



Gas Chromatograph

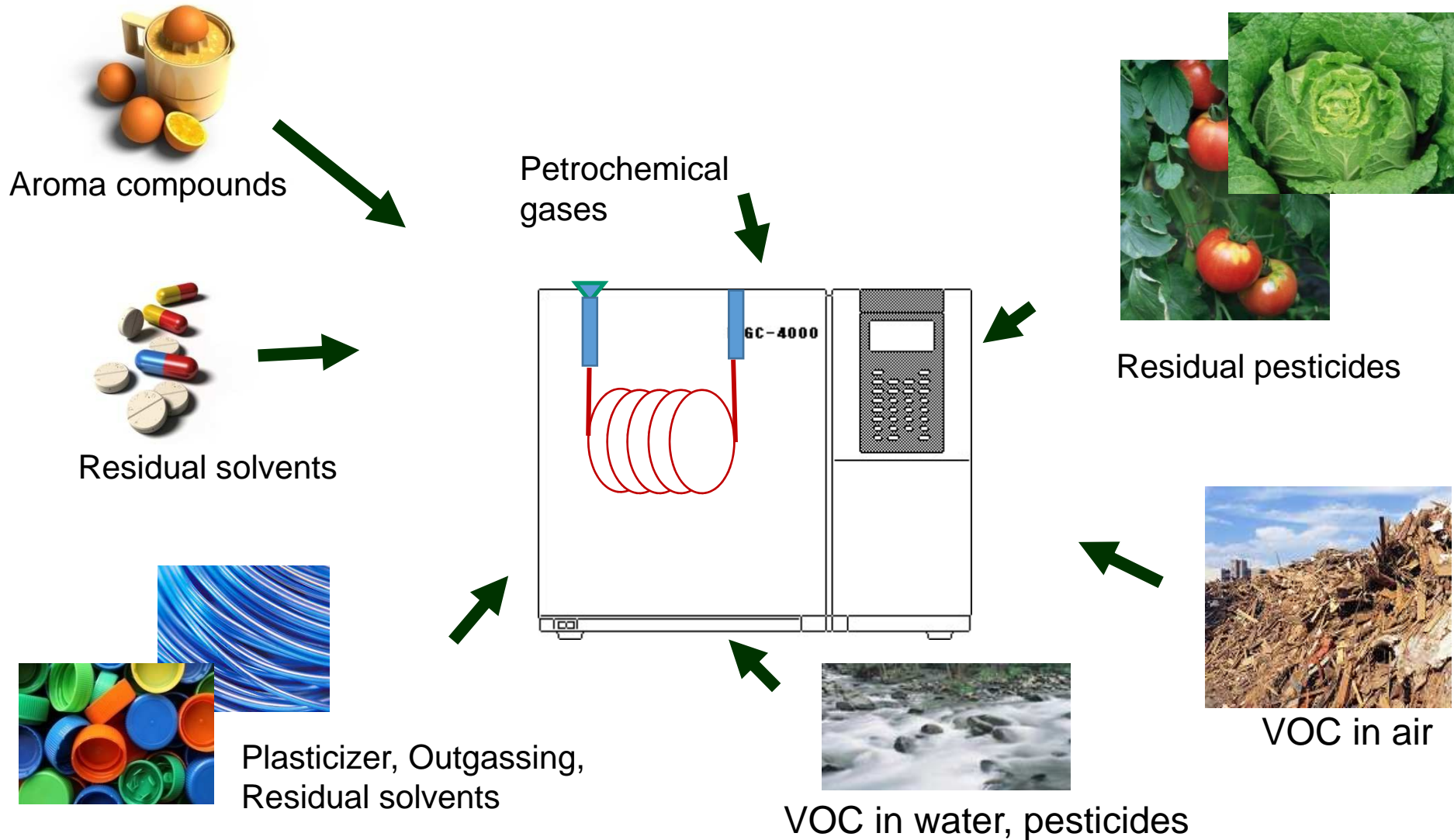
LD239 Helium Gas Detector



GF1010 Gas Flowmeter

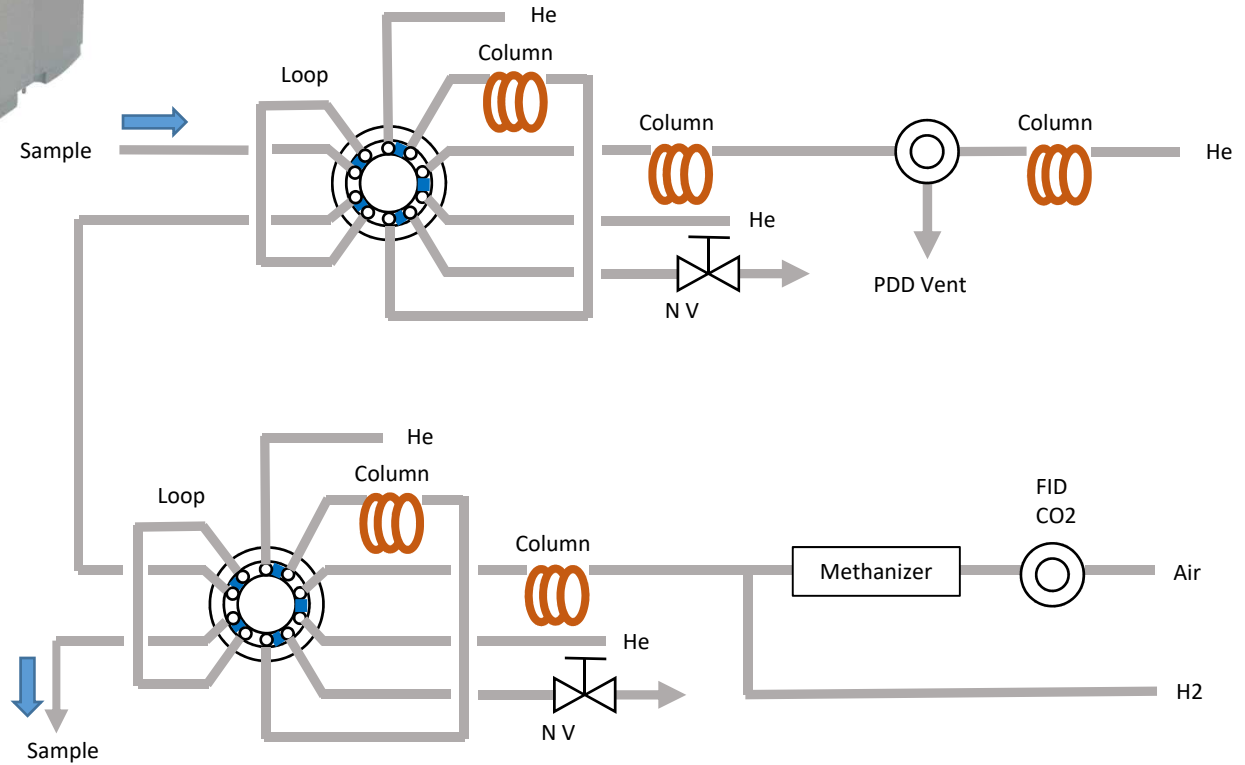


GC's applications





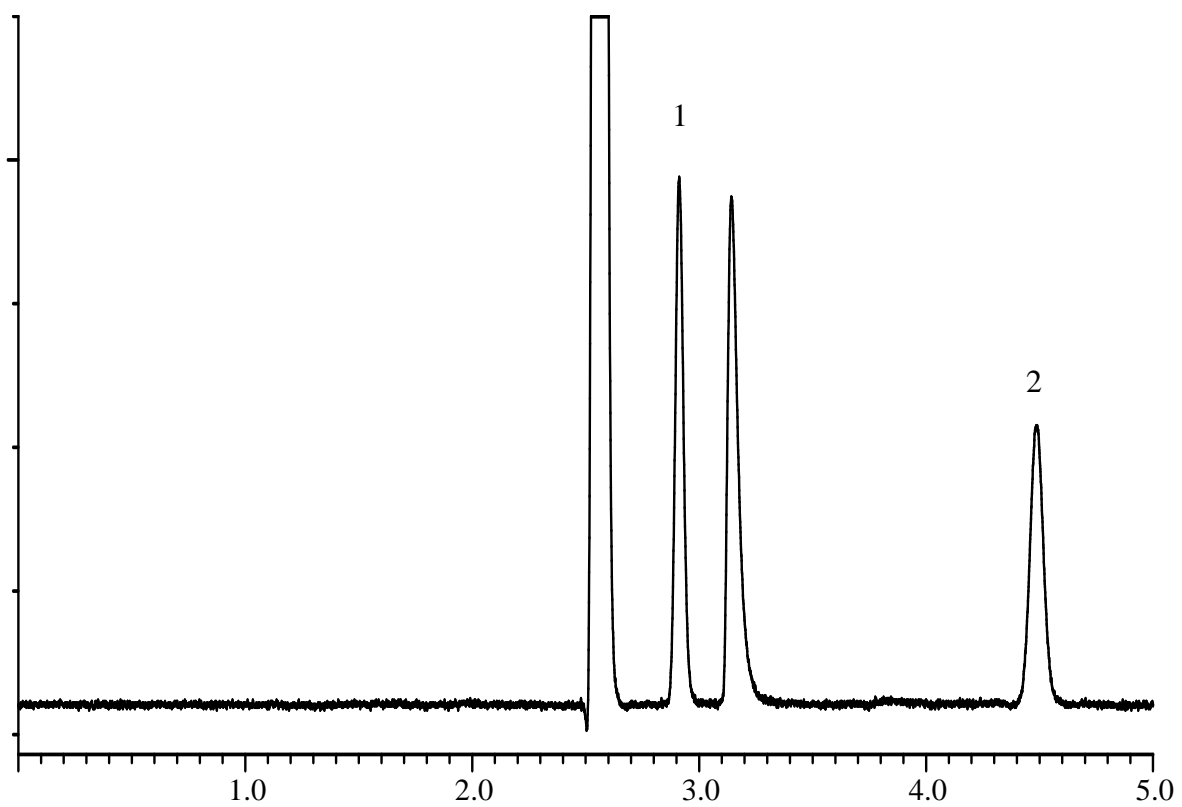
Impurity analyzer flow chart



Gas contact parts such as tubing or fittings used for a pure gas impurity analyzer can be adsorb sulfur or nitrogen compounds.



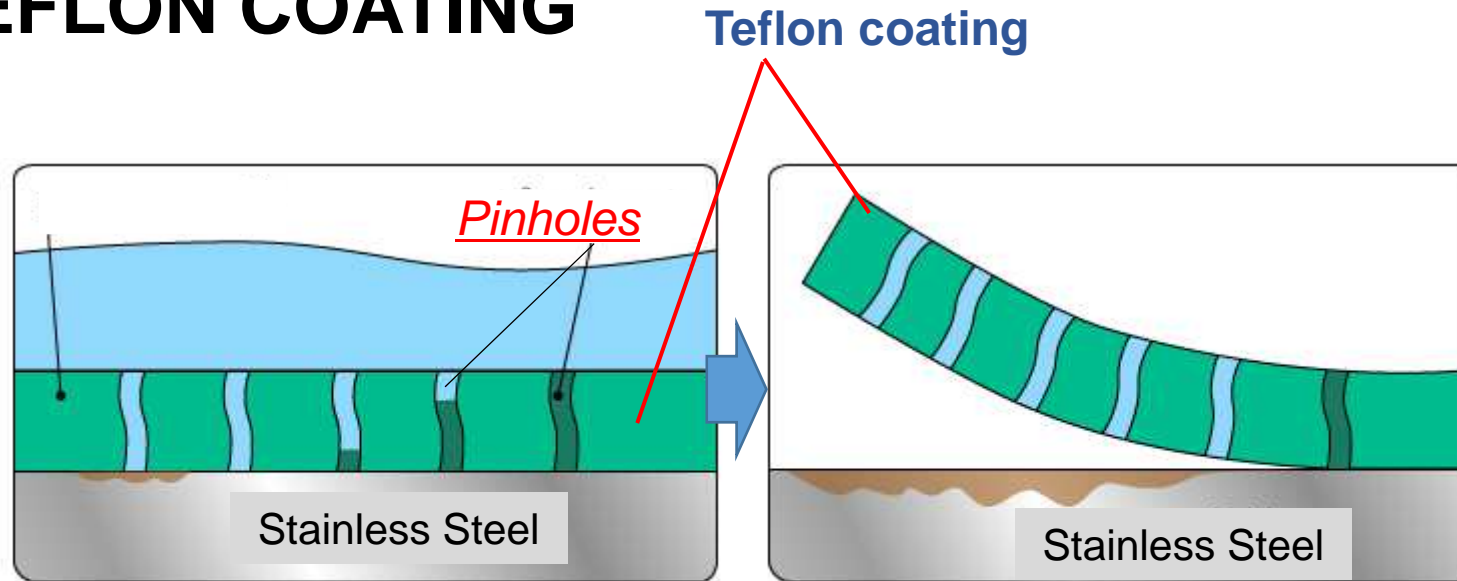
Sulfur compounds



Inactivate coating

- 1. TEFLON COATING**
- 2. GLASS COATING**

1 TEFLON COATING



There are Pinholes in Teflon coating.

Teflon coating is excellent in water repellency and insulation such as a fried pan, a rice cooker, a car surface.

Corrosive gases pass through the countless pinholes of Teflon coating and rust Stainless Steel, then it is easy to peel off the Teflon coating.



NOT SUITABLE FOR GAS ANALYSIS

Surface Inactivation Treatment Technology

It is needed to inactivate not only GC packed columns or capillary columns, but also sample cylinders, fittings and piping before GC.

GL Sciences Coating “InertMask”

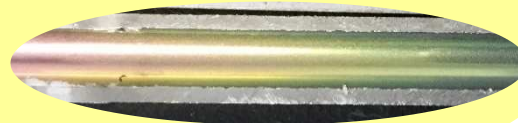
GL Sciences "InertMask" of inactivated treatment technique is chemically treats metal surfaces uniformly to achieve a very high level of passivation.

It is very effective when there is concern about metal adsorption such as acidic compounds or basic compounds since the performance of suppressing adsorption is dramatically improved compared to untreated.

InertMask Features

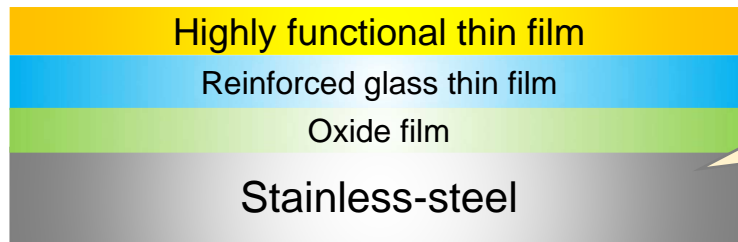
- **Tube Internal surface is coated.**
- **Non-adsorbent**
- **Antifouling property**
- **Water repellency(Hydrophilic)**
- **Solvent resistance**
- **Peelability**

Tube inner surface



Surface Inactivate coating

● Pattern diagram



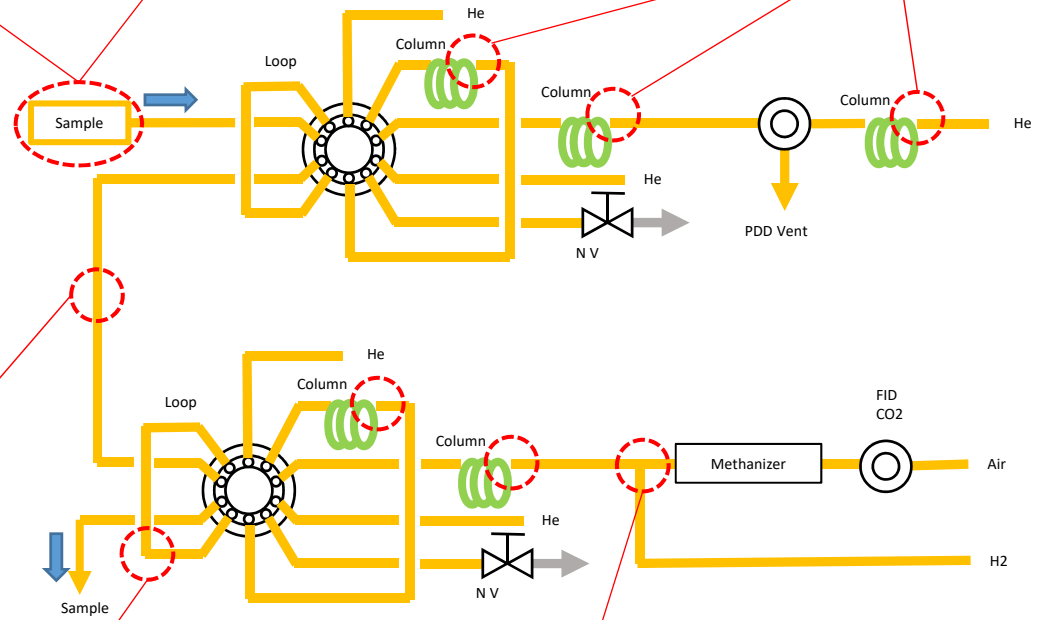
To improve the functionality
of Stainless steel

● Example of the process

After treatment

Before treatment

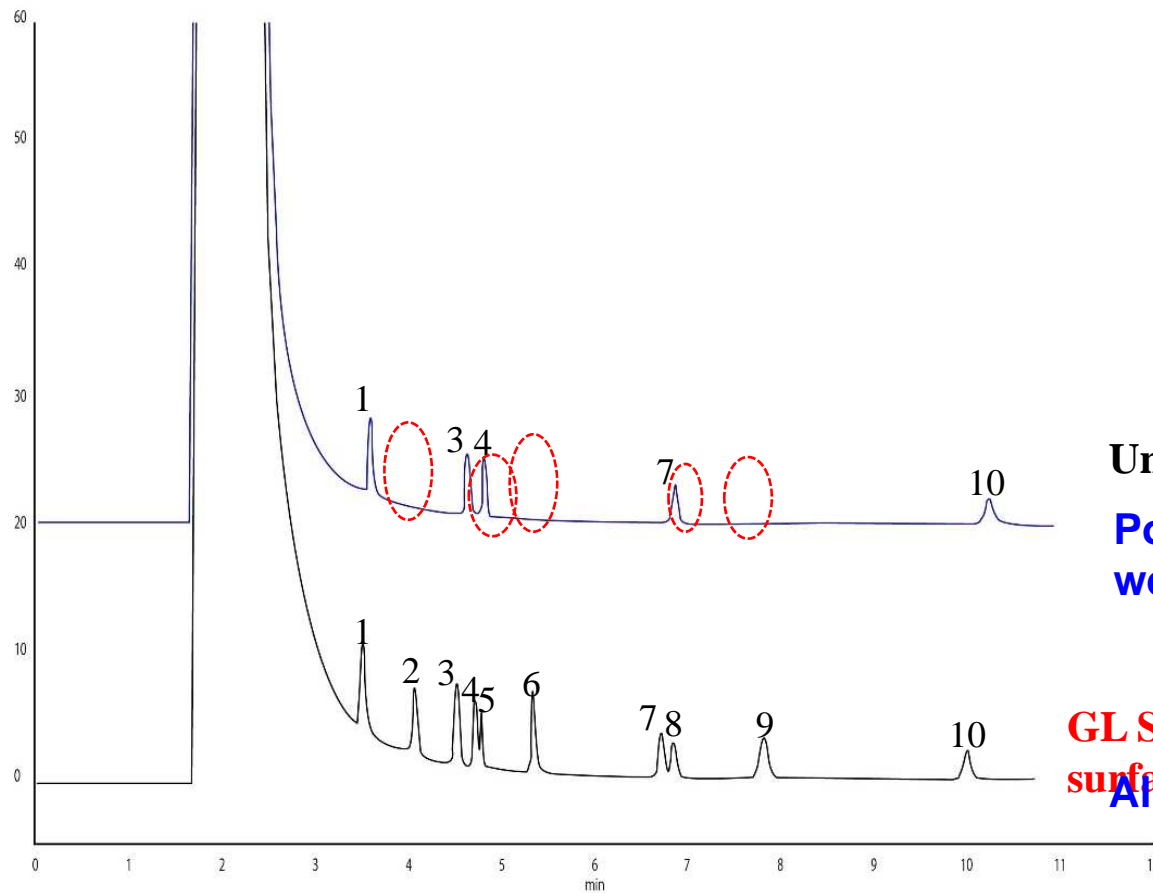




Surface Inactivation Evaluation 1 (Surface Adsorption Properties)

Test sample

1. n-Undecane
2. n-Nonanol
3. Naphthalene
4. n-Dodecane
5. 1,7-Heptanediol
6. n-Decylamine
7. n-Tridecane
8. Methylcaprate
9. 2,4,5-Trichlorophenol
10. n-Tetradecane



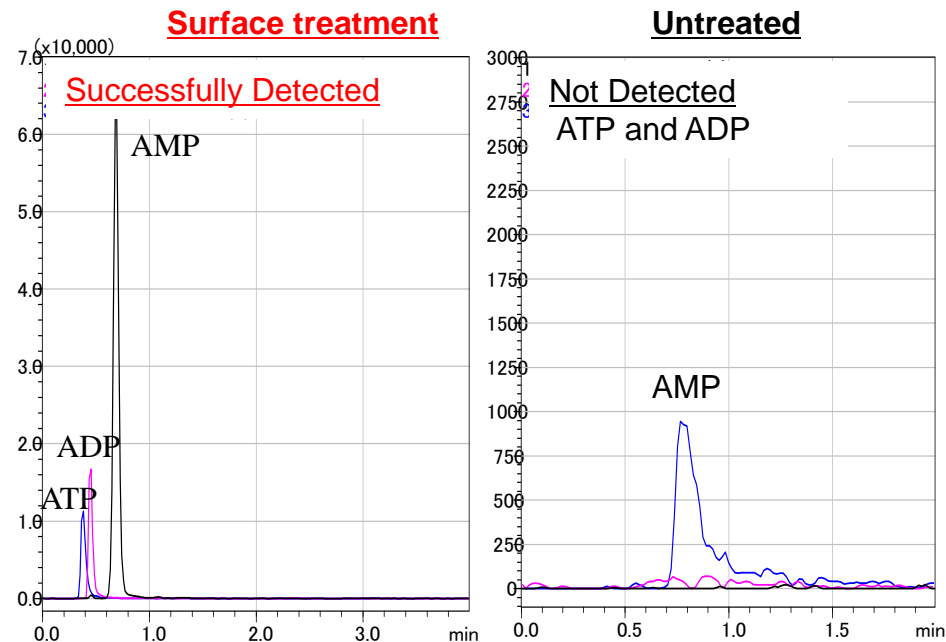
Untreated SUS tubes

**Polar compounds (2, 5, 6, 8, 9)
were adsorbed**

**GL Sciences
surface-treated SUS tubes
All samples were detected**

Surface inactivation Performance Evaluation (Adsorption Properties)

Nucleotides



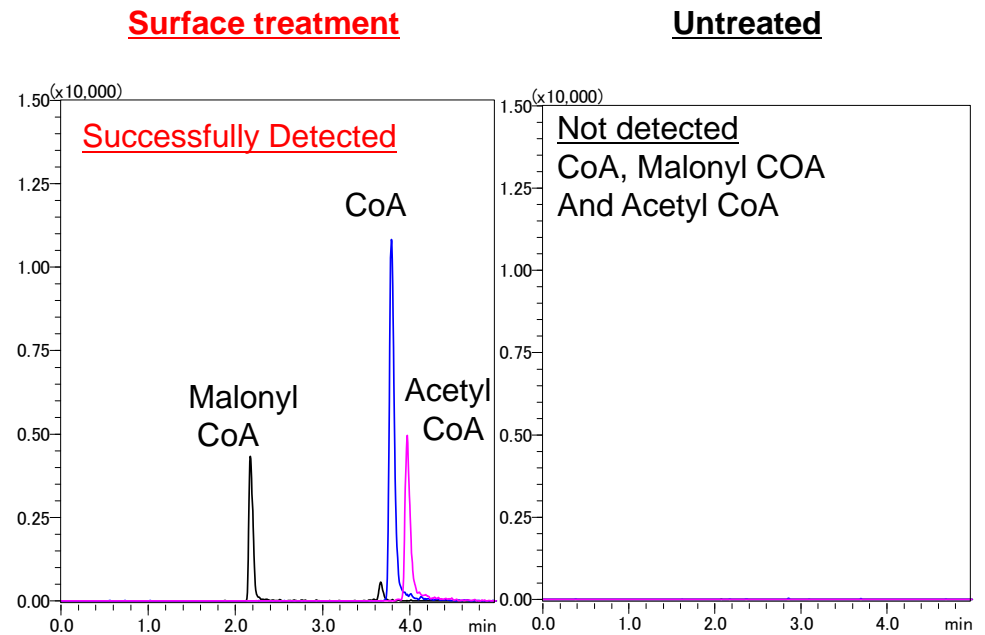
Conditions

Column : InertSustainSwift C18
(3 μm , 50 \times 2.1 mm I.D.)

: A) 5 mM Ammonium Formate in H₂O Eluent

Detection : LC/MS/MS (ESI, Positive, MRM)

Coenzyme A



Conditions

Column : InertSustain AQ-C18
(3 μm , 150 \times 2.1 mm I.D.)

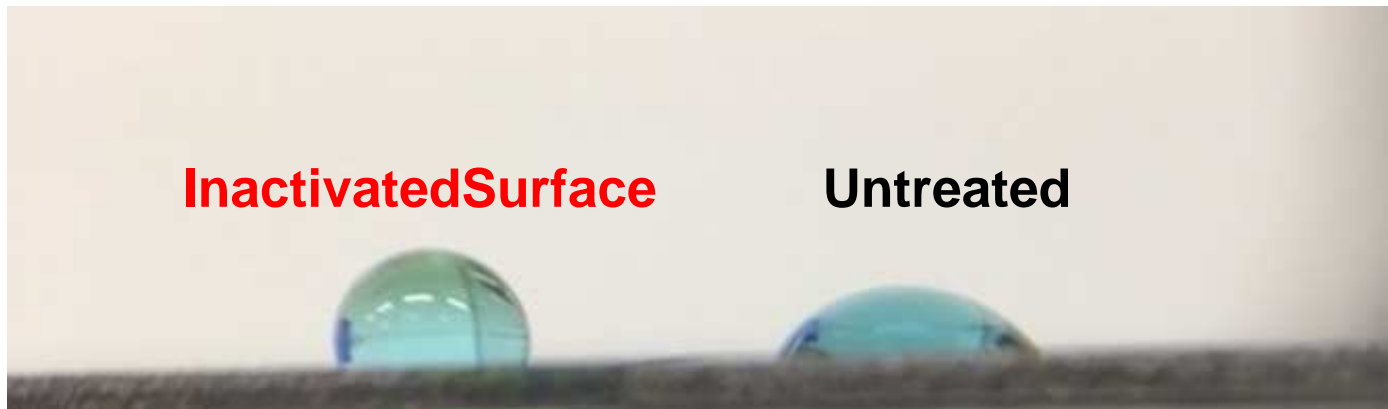
: A) 5 mM HCOONH₄ in H₂O Eluent
B) 5 mM HCOONH₄ in MeOH

A/B=97/3 – 5 min - 0/100 – 5 min
- 0/100 - 0.1 min - 97/3

Detection : MS/MS (ESI, Positive, MRM)

Surface Characteristic Evaluation 1

Solvent: Water (contains pigment)



Surface Characteristic Evaluation 1

Close-up angle measurement

Conditions

Solvent : H₂O

Drop volume : 2 μ m

Method : $\theta/2$

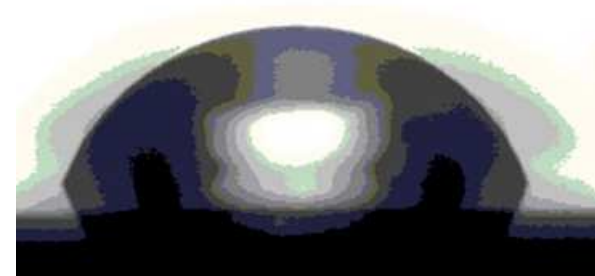
Inactivated Surface

Close-up angle 110°



Untreated

Close-up angle 75°

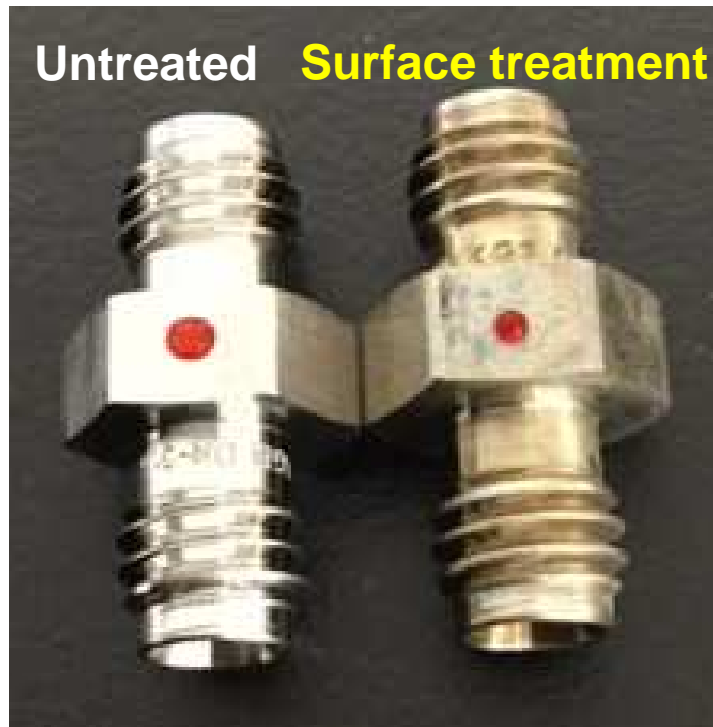


Surface Characteristic Evaluation 2 (Surface Wettability)

Solvent : Water (contains pigment)

Drop volume : 1 μ L

Right after water dropping



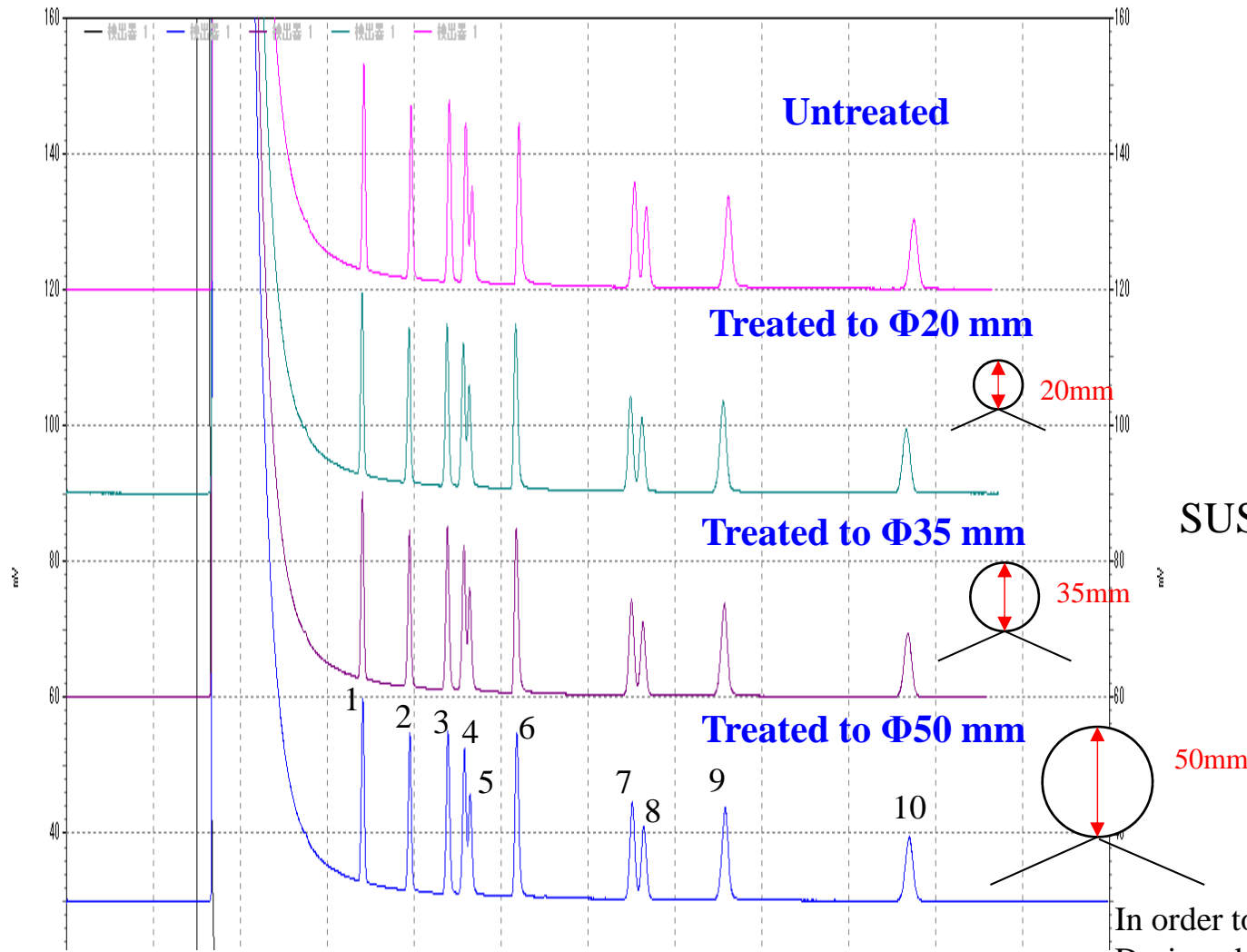
After drying



Bigger Diffusion

Smaller Diffusion

Surface Treatment Performance Evaluation (Flexibility)



Test sample

1. n-Undecane
2. n-Nonanol
3. Naphthalene
4. n-Dodecane
5. 1,7-Heptanediol
6. n-Decylamine
7. n-Tridecane
8. Methylcaprate
9. 2,4,5-Trichlorophenol
10. n-Tetradecane

SUS tube : 0.8 mm I.D.
1/16 mm O.D.



In order to improve processability (flexibility)
Designed at a heat-stable temperature of 300°

The thin film performance has been kept with treated 20mm Tube.

Surface Property Evaluation

Organic solvent resistant

Evaluation method

Surface treated SUS board is soaked into organic solvent (Room temp.-1 hour)

Observed changes of the surface conditions (water repellency)

Rate of change

☆☆☆ : Within 10 %(No change) ☆☆ : 10~20 % (a little influence), ☆ : over 30 %

| | acetone | chloroform | ethanol | hexane | methanol | THF | toluene |
|----------------------------|---------|------------|---------|--------|----------|-----|---------|
| Organic solvent resistance | ☆☆☆ | ☆☆☆ | ☆☆☆ | ☆☆☆ | ☆☆☆ | ☆☆☆ | ☆☆☆ |

Heat resistance test

Evaluation method

Surface SUS board treated is heat treated at 200, 300, 400°C for 3hours, and observed changes of the surface conditions (Contact angle, Water repellency)

Rate of change

☆☆☆ : Within 10 %(No change) ☆☆ : 10~20 % (a little influence), ☆ : over 30 %

| | 200 °C | 300 °C | 400 °C |
|------------------|--------|--------|--------|
| Heater Resistant | ☆☆☆ | ☆☆☆ | ☆☆☆ |

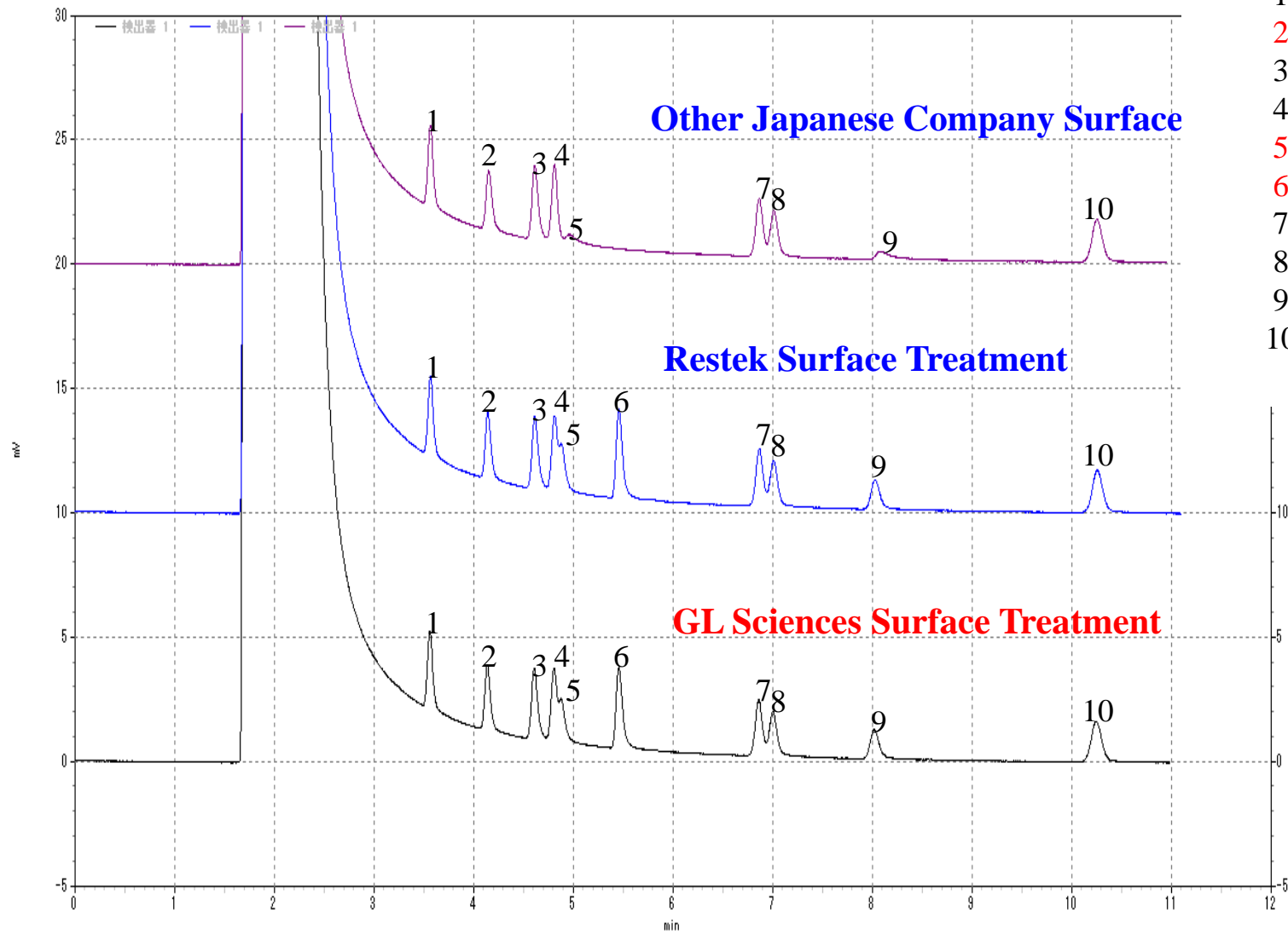
Treated tube “InertMask”

Treated tube “InertMask” available size

<Tube>

| Material | Shape | Length | I.D. | O.D. |
|--------------------------|----------|----------|-------|----------------------------|
| Stainless- steel Iron | Coil | 1 ~ 10 m | 0.8mm | 1/16" ~ 1/8" (1 ~ 4 mm) |
| Aluminum others | Straight | Max.2 m | 2.0mm | 1/8" ~ 1/2" (3 ~ 30 mm) |

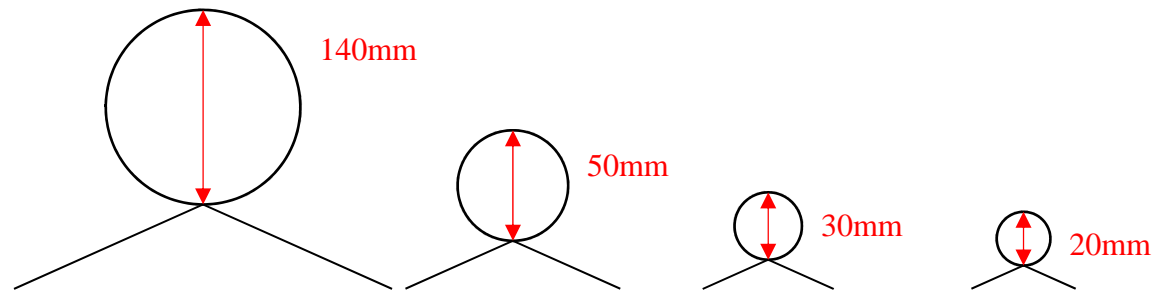
Surface Treatment Performance Evaluation (Surface Adsorption Properties)



Test sample

1. n-Undecane
2. n-Nonanol
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7. n-Tridecane
8. Methylcaprate
9. 2,4,5-Trichlorophenol
10. n-Tetradecane

Bending Test-Inertness

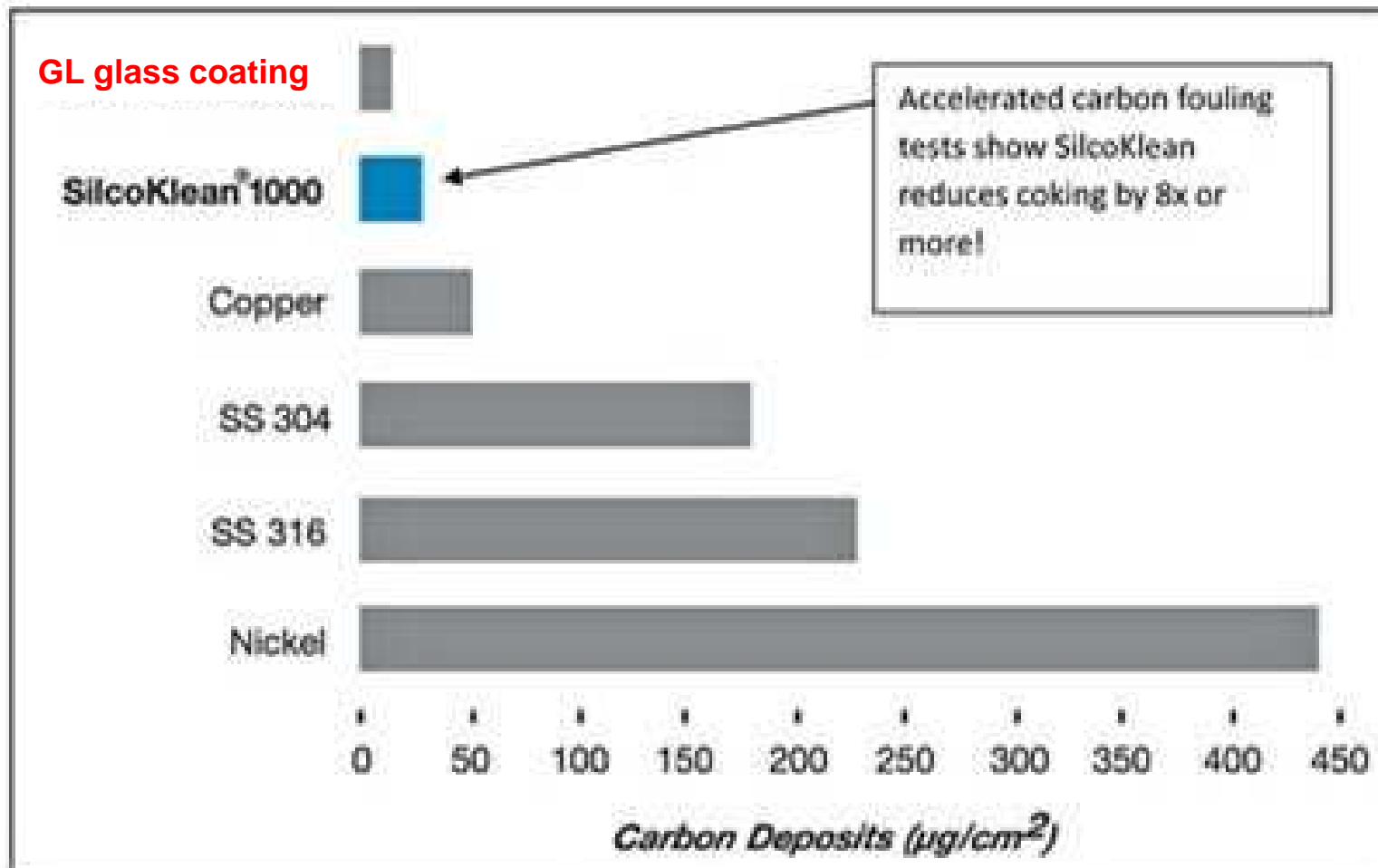


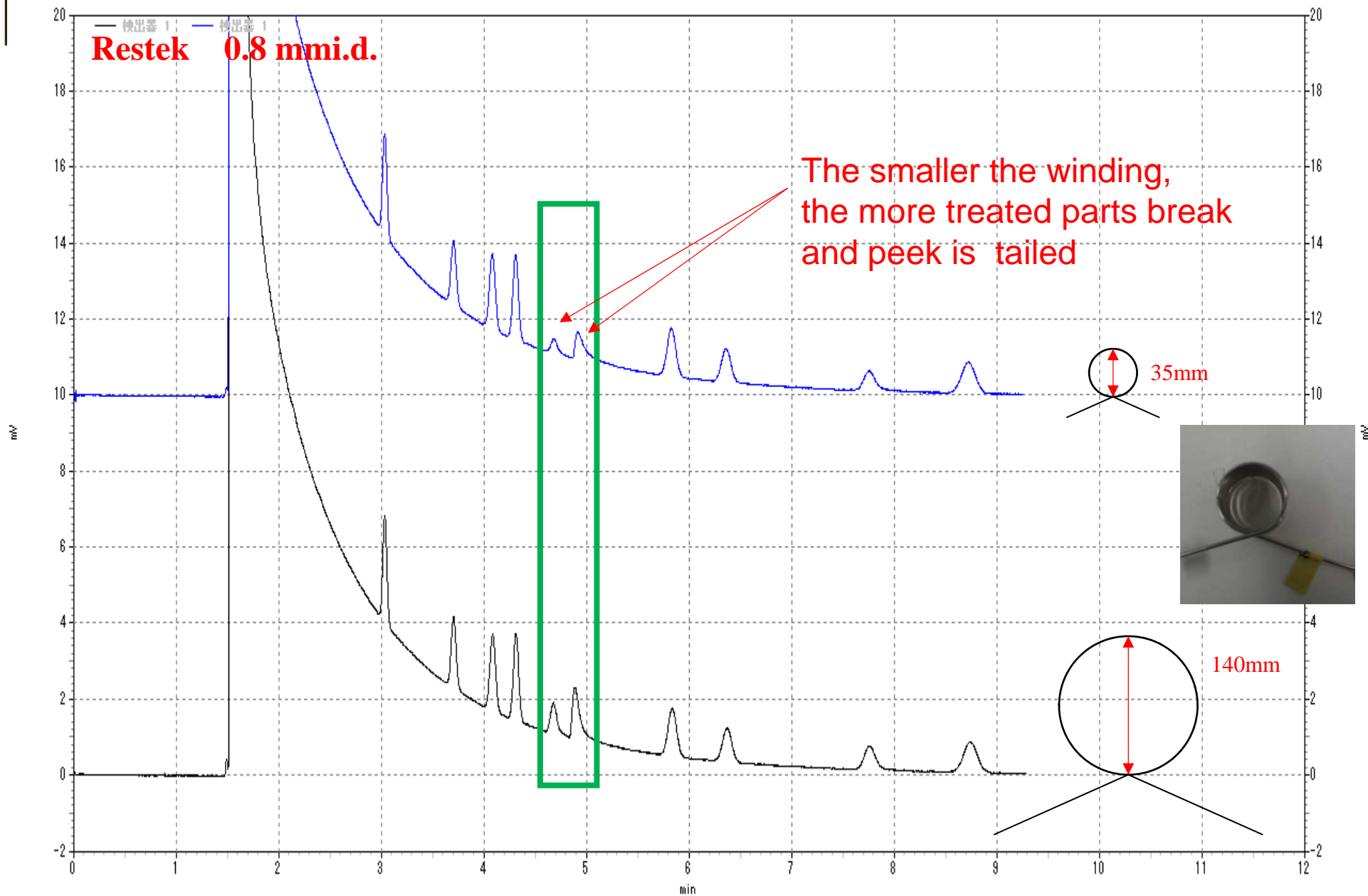
| | R140 | R50 | R35 | R20 |
|--------|------|-----|-----|-----|
| GLS | ☆☆☆ | ☆☆☆ | ☆☆☆ | ☆☆☆ |
| Restek | ☆☆☆ | ☆☆☆ | ☆☆ | ☆☆ |
| Other | ☆☆☆ | NG | NG | NG |

☆☆☆ : No change,
 ☆☆ : A little deterioration,
 NG : Completely deterioration

Restek: Deterioration depending on lot

Incineration Residue





Heat resistance test-Inertness

Heat resistance test result

| Temp. (°C) | Metal Surface treatment (GLS) | Sulfinert (Restek) |
|------------|-------------------------------|--------------------|
| 400 | NG | ☆ |
| 350 | ☆☆ | ☆ |
| 300 | ☆☆☆ | ☆ |
| 250 | ☆☆☆ | ☆☆ |

Conditions

Temp. : 250~400 °C

Time : 10 h

Atmosphere : Air

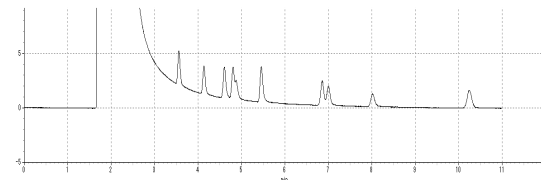
Inertness test result (Right figure)

☆☆☆ : No change

☆☆ : A peak behavior change

☆ : 2 peaks behavior change

NG : 3 peaks behavior change



Behavior change is 30% or higher rate of change

Restek treated tubes are tailed or behavior change at 250°C



| Company | GLS | RESTEK | Other |
|------------------|-----------------------|------------------------|-----------|
| Model | IneatMask | Silcosteel (1000•2000) | — |
| Name | | Sulfinert | |
| | | | |
| Tube length | 2000mm | 1800mm | None |
| Size (inch) | 1/16•1/8•1/4/•3/8•1/2 | 1/4• | — |
| | | | |
| Coil length | 5~30m | | 5~30m |
| Size (inch) | 1/16•1/8 | 1/16•1/8 | 1/32•1/16 |
| Bending diameter | | More than R50 | |

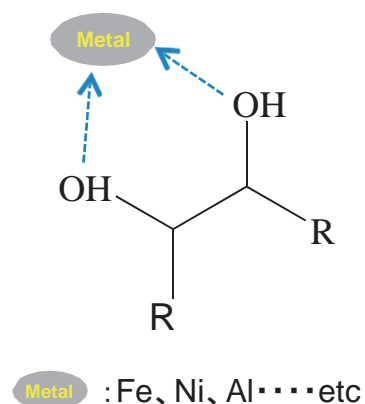


Compare with Teflon

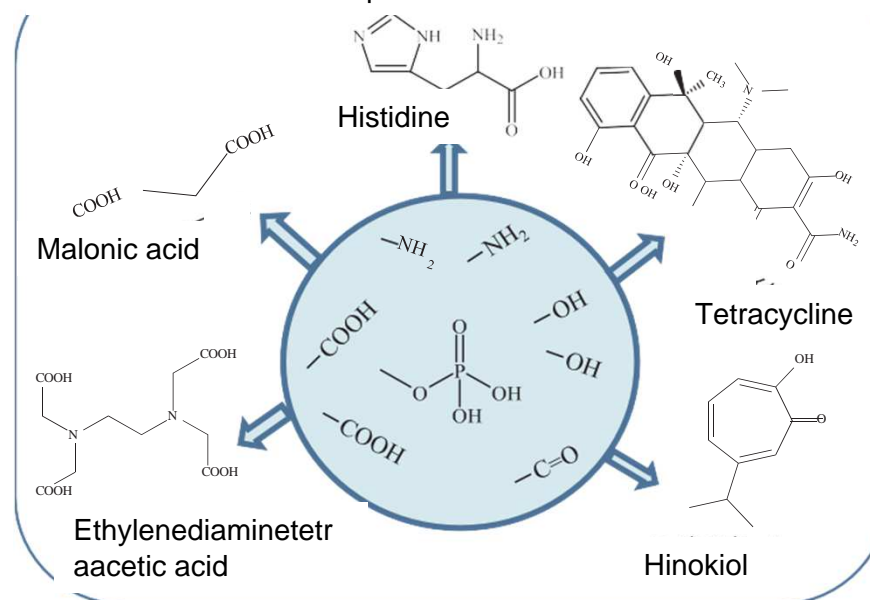
| | Teflon treatment | InertMask (water repellent) |
|----------------|------------------|--------------------------------|
| Heat-resistant | 260°C | 400°C |
| Peelability | Easy | Hard |

Metal coordination adsorption

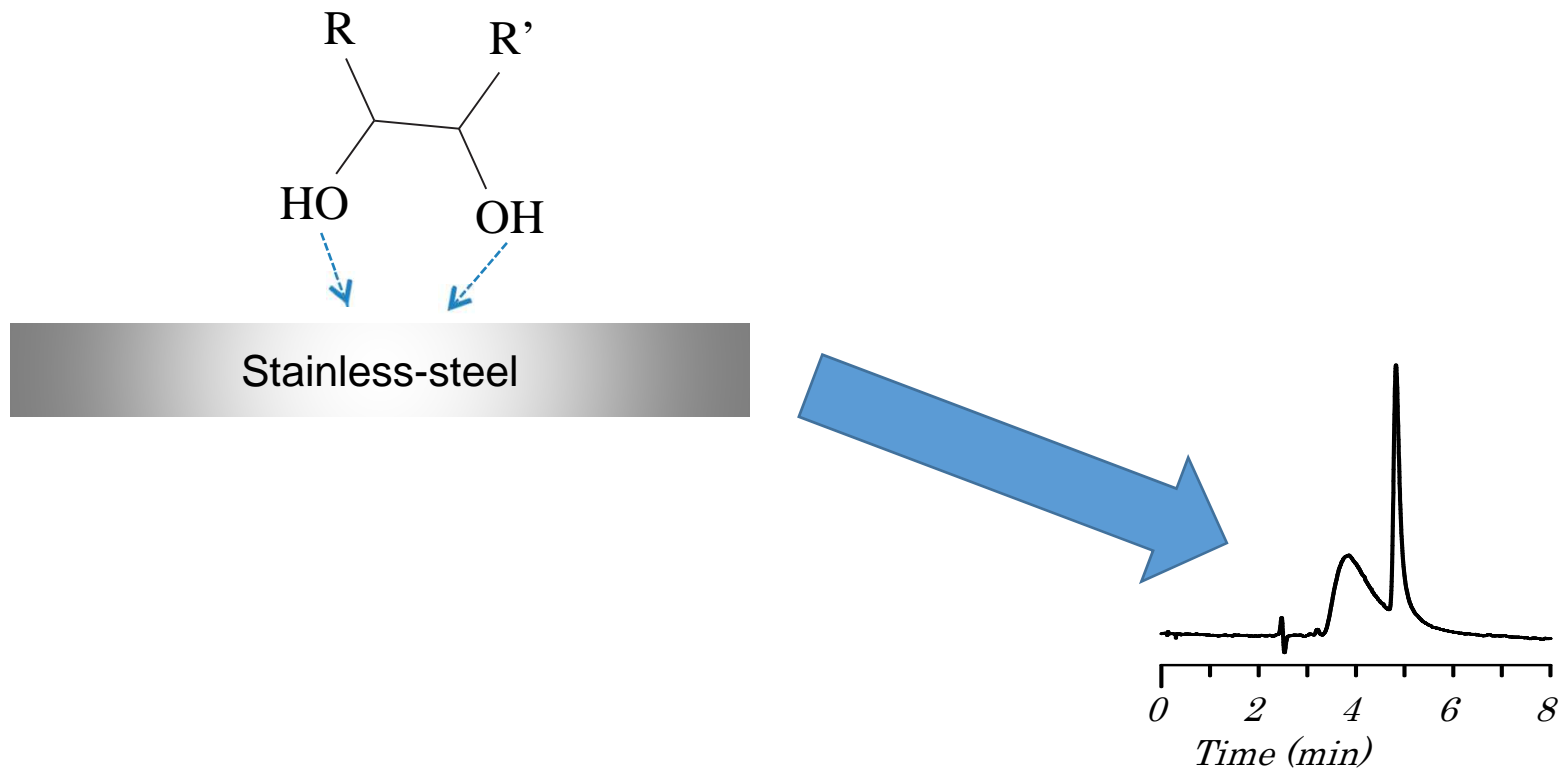
If there are two or more atoms with lone pairs in the same direction, they coordinate to the metal and cause adsorption, as shown in the figure below. As a result, the quantitiveness becomes worse and the qualification becomes difficult.



Representative functional groups and compounds exhibiting metal coordination adsorption

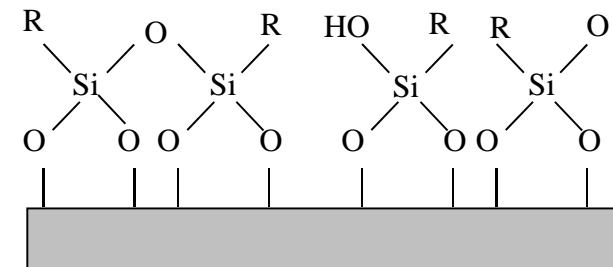
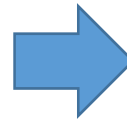
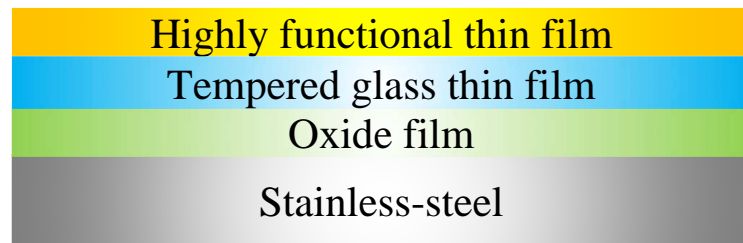


In a general SUS tube, the metal coordinating compound is adsorbed on the SUS surface and cannot be detected or causes tailing.



Metal Surface Treatment

The stainless steel surface is coated with glass and functional thin film

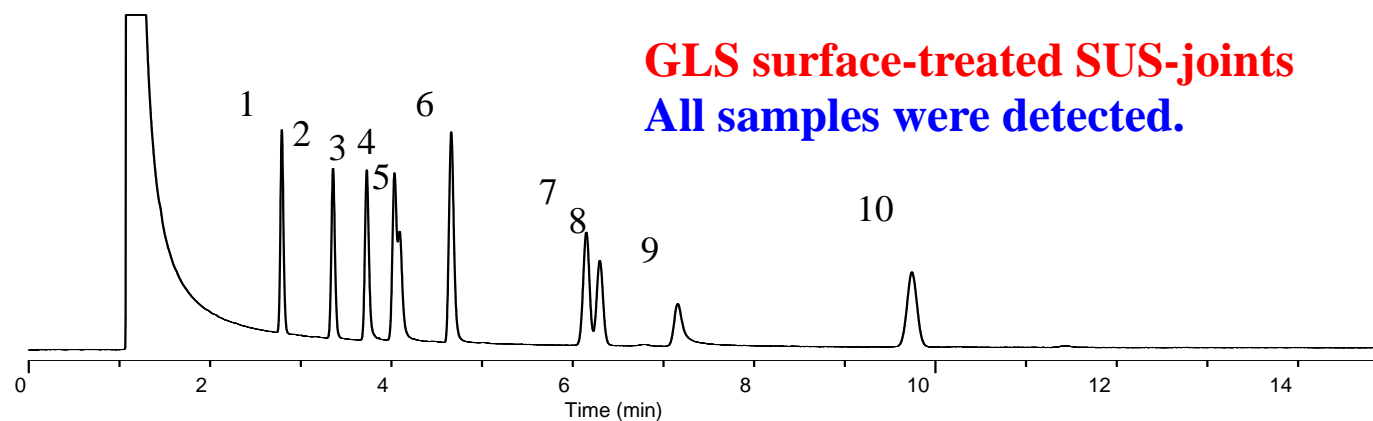
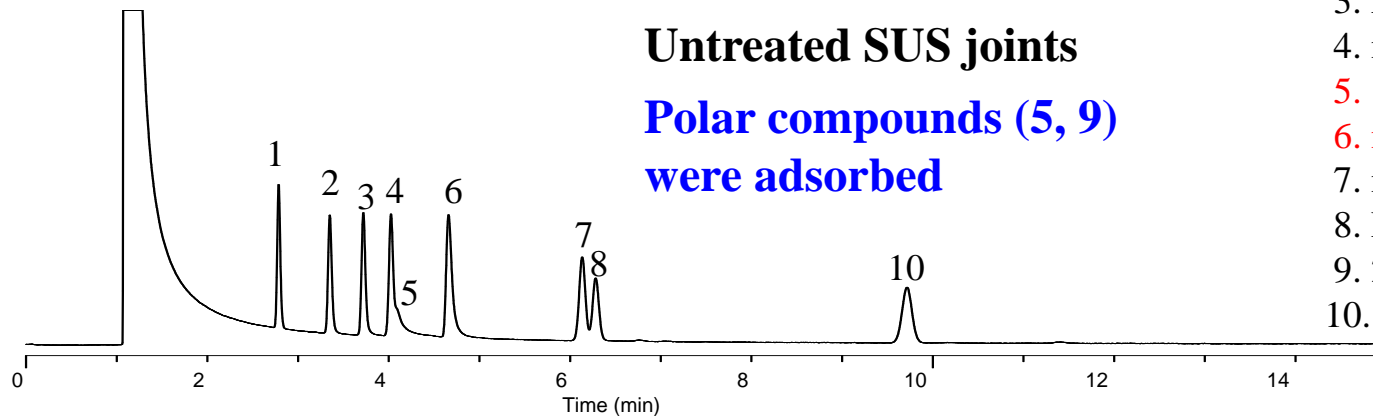


R-CH₃, C₂H₅ etc

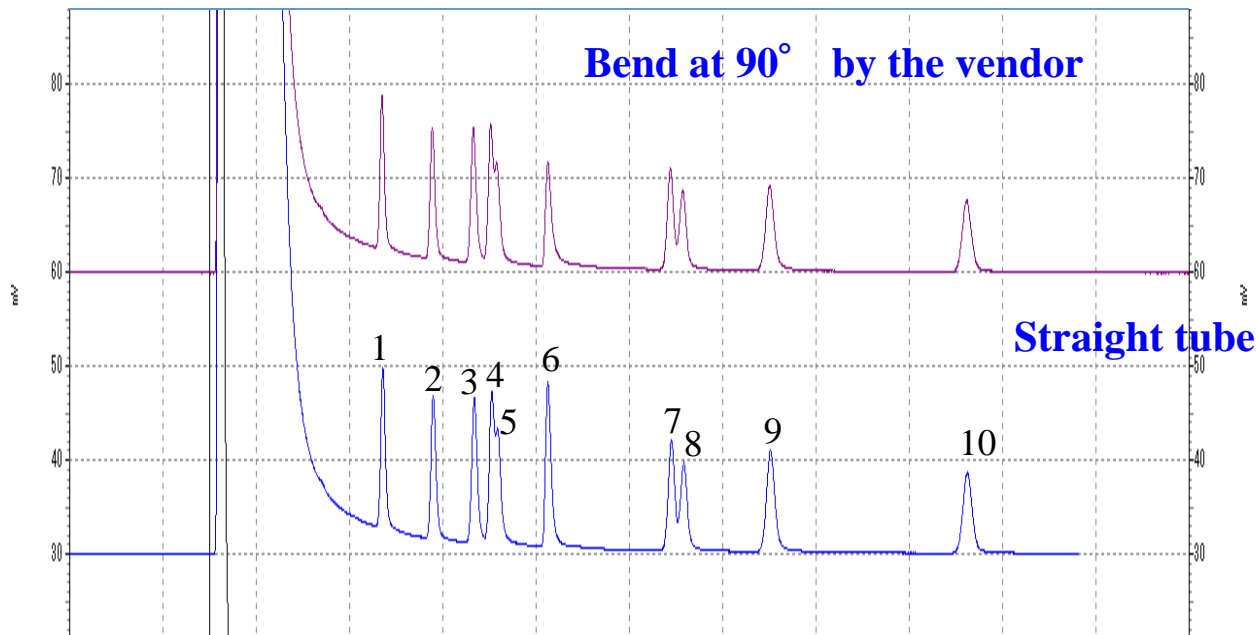
Surface Condition Evaluation 1 (Surface Adsorption Properties)

Test sample

1. n-Undecane
2. n-Nonanol
3. Naphthalene
4. n-Dodecane
5. 1,7-Heptanediol
6. n-Decylamine
7. n-Tridecane
8. Methylcaprate
9. 2,4,5-Trichlorophenol
10. n-Tetradecane



Surface Treatment Performance Evaluation (Flexibility)



Test sample

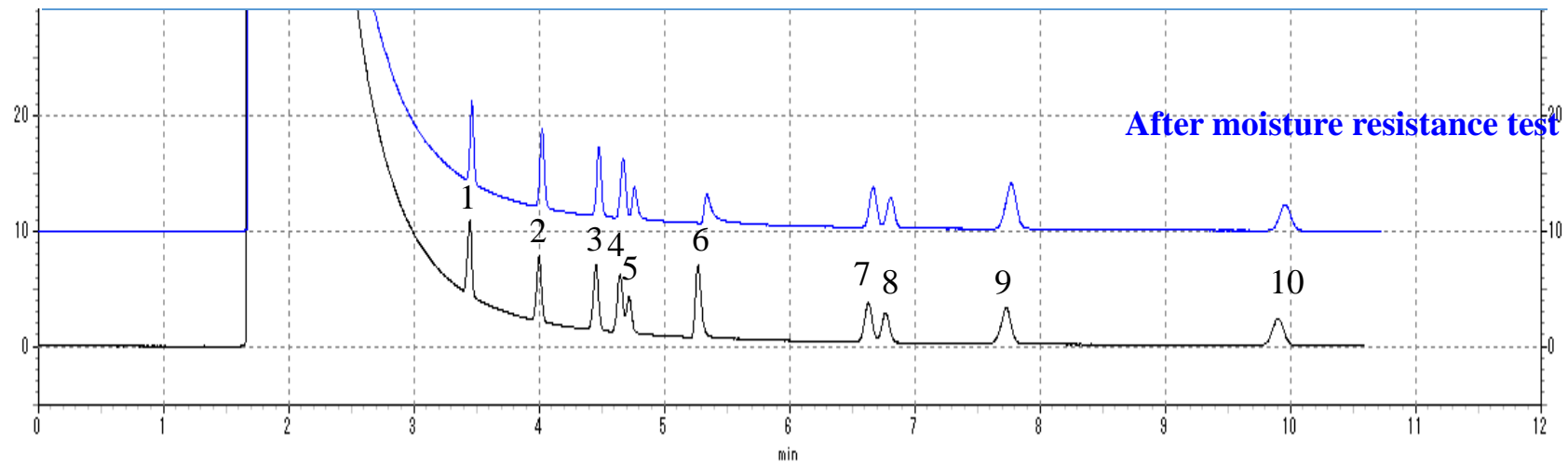
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7. n-Tridecane
8. Methylcaprate
9. 2,4,5-Trichlorophenol
10. n-Tetradecane

SUS tube : 2.1 mm I.D.
1/8" mm O.D.

The thin film performance has been kept good condition even with 90° tube bending

In order to improve processability (flexibility),
Designed at a heat-stable temperature at 300°C

Surface Treatment Performance Evaluation (Water-resistant Steam)

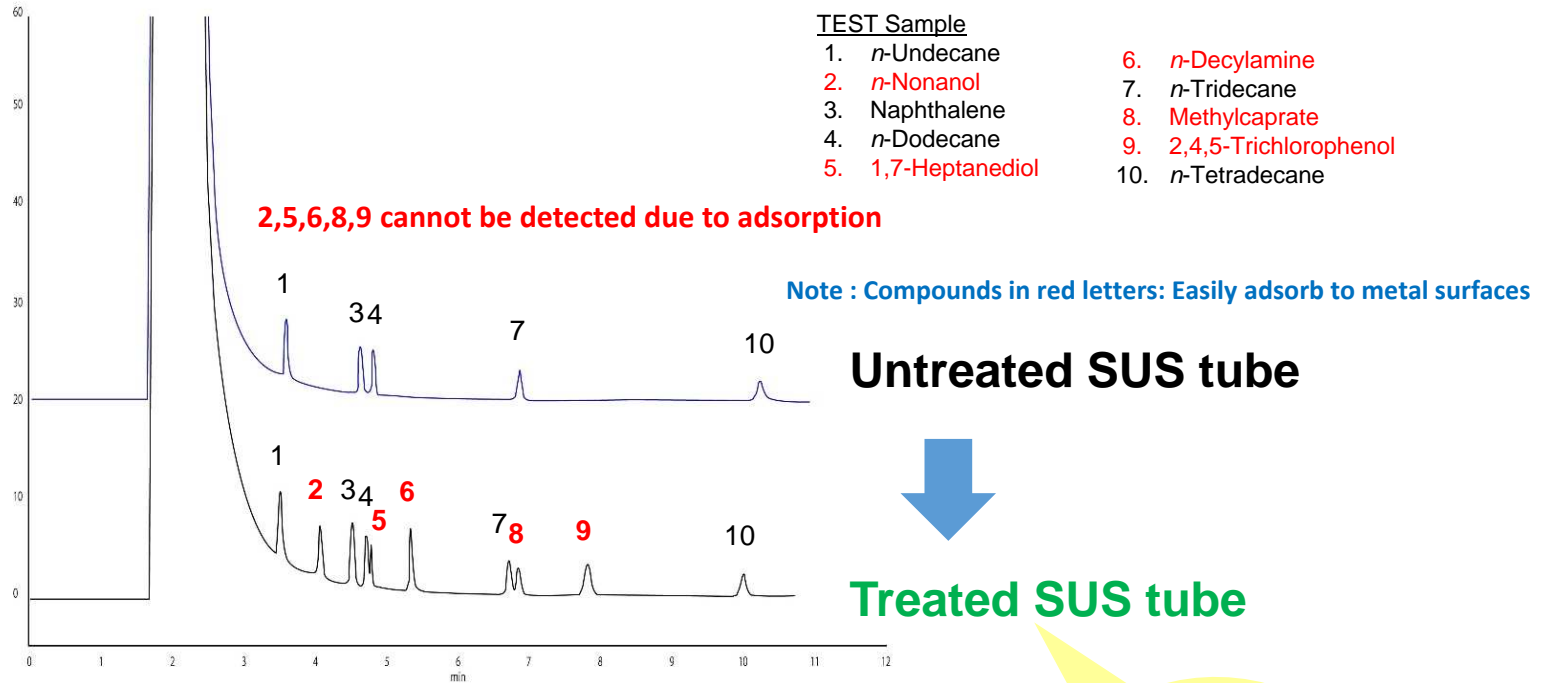


The good surface condition was kept even after flowing water vapor into the tube heated at 300°C (65 h)

Test sample

- | | |
|--------------------|--------------------------|
| 1. n-Undecane | 6. n-Decylamine |
| 2. n-Nonanol | 7. n-Tridecane |
| 3. Naphthalene | 8. Methylcaprate |
| 4. n-Dodecane | 9. 2,4,5-Trichlorophenol |
| 5. 1,7-Heptanediol | 10. n-Tetradecane |

Performance comparison between treated sus tube and untreated sus tube



Conditions

System : GC/FID

Column : Treated sus tube (0.8 mm I.D. × 100 mm)
or
Untreated SUS tube (0.8 mm I.D. × 100 mm)
+
InertCap 1 (0.53 mm × 30 m df = 1.00 μm)

Col.Temp. : 140 °C

Carrier Gas : He or N₂ 30 kPa

Split flow : 30 mL/min

Injection : 250 °C

Detection : 250 °C

Liner : Auto-sampler liner There is wool

Sample : TEST Sample is diluted 100times with dichloromethane 1.0 μL (0.001 %~0.005 % density)