LC column catalog

L-column3

L-column3™
Ver. 02

L-column3
- Feature
- UHPLC column
- Metal-free column
- Application data
- Technical report
- Line up

L-column, L-column2
- Feature
- Line up

CERI
Realizing both excellent chemical stability and top-level low adsorptivity
Unparalleled high-performance, all-around column

- Improving chemical stability, so that usable within the range of pH 1 to pH 12.
- Low adsorptivity is at the top level for various analytes.
- Improvement of separation or peak shape, since the pH of an eluent is flexibly selectable
- A 100% aqueous eluent can be stably analyzed.
Silica-based columns with the many advantages of high separation efficiency and mechanical strength are currently used most generally for the columns for reversed phase chromatography. On the other hand, the pH range of usable eluent is limited because exposure to the alkaline solution are easily dissolved silica.

*L-column3* is an all-around column where the chemical stability (acid and alkaline resistance) of the packing materials is dramatically improved by using newly developed and highly alkaline resistant PCS silica (perfect chemical stable silica) and perfectly stable end-capping with performance much higher than that of *L-column2*.

**L-column3 proposes the possibility of a new analysis.**

<table>
<thead>
<tr>
<th></th>
<th><em>L-column3 C18</em></th>
<th><em>L-column3 C8</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base materials</strong></td>
<td>PCS silica (Perfect chemical stable silica)</td>
<td></td>
</tr>
<tr>
<td><strong>Pore size</strong></td>
<td>12 nm</td>
<td></td>
</tr>
<tr>
<td><strong>Specific surface area</strong></td>
<td>340 m²/g</td>
<td></td>
</tr>
<tr>
<td><strong>Particle size</strong></td>
<td>2 μm, 3 μm, 5 μm</td>
<td>3 μm, 5 μm</td>
</tr>
<tr>
<td><strong>Bonded phase</strong></td>
<td>Octadecyl silyl (C18, ODS)</td>
<td>Octyl silyl (C8, Octyl)</td>
</tr>
<tr>
<td><strong>End-capping</strong></td>
<td>Perfect stable end-capping</td>
<td></td>
</tr>
<tr>
<td><strong>USP category</strong></td>
<td>L 1</td>
<td>L 7</td>
</tr>
<tr>
<td><strong>Usable pH range</strong></td>
<td>pH 1 - pH 12</td>
<td></td>
</tr>
</tbody>
</table>
L-column3 is chemically stable, so that usable within the range of pH 1 to pH 12.

L-column3 offers very high resistance to alkaline, and packing materials are designed to be robust. In addition, it performs similar high resistance to neutrality and acidity.

L-column3 can be used as an all-around column capable of method design for a wide range of pH values.

![Durability test (pH 1)]

[Durability test conditions]
Column: C18, 5 μm; Size: 2.1 mm I.D., 150 mm L.
Eluent: CH3OH/1% TFA in H2O (10/90)
Flow rate: 0.2 mL/min; Temp.: 40°C

- k : Retention factor

An alkaline eluent promotes the degradation of silica-based columns. The dissolution of silica adds vacant space to the column bed and decreases the number of theoretical plates. The loss of the bonded phase and exposure of the silanol group over the surface of silica cause adsorption of basic compounds into the silanol group, which results in a delay of retention (see the technical report on P. 11). A strong acid eluent is also subject to similar degradation, although the change is slow.

L-column3 shows small changes and is stable in durability tests at pH 1 and pH 12 (triethylamine solution and phosphate buffer solution).

Comparison columns are as follows:
- Columns of other company: Usable up to pH 12.
- L-column2: Usable from pH 1 to pH 9.

![Durability test (pH 12, triethylamine solution)]

[Durability test conditions]
Column: C18, 5 μm; Size: 2.0 mm or 2.1 mm I.D., 150 mm L.
Eluent: CH3OH/54 mM TEA in H2O (10/90)
Flow rate: 0.2 mL/min; Temp.: 50°C

![Durability test (pH 12, phosphate buffer solution)]

[Durability test conditions]
Column: C18, 5 μm; Size: 2.1 mm I.D., 150 mm L.
Eluent: CH3OH/10 mM Phosphate buffer (10/90)
Flow rate: 0.2 mL/min; Temp.: 40°C

- N : Number of theoretical plates
Low adsorptivity is at the top level in various analytes.

$L$-column3 shows a sharp peak not only for basic compounds but also for acidic compounds and coordination compounds. $L$-column3 demonstrates low adsorptivity at the top level for various analytes and provides an ideal peak shape.

<table>
<thead>
<tr>
<th>Basic compounds</th>
<th>Acidic compounds</th>
<th>Coordination compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eluent: CH₃CN/25 mM Phosphate buffer pH 7 (35/65)</td>
<td>Eluent: CH₃CN/20 mM H₂PO₄ in H₂O (2/98)</td>
<td>Eluent: CH₃CN/20 mM H₂PO₄ in H₂O (60/40)</td>
</tr>
</tbody>
</table>


$L$-column3

$S(3) : 1.30$

$L$-column2

$S(3) : 1.29$

Brand A

$S(3) : 3.76$

Brand C

$S(3) : 1.69$

Brand D

$S(3) : 1.21$

Brand E

$S(3) : 1.60$

[Analytical conditions] Column: C18, 5 μm; Size: 4.6 mm I.D., 150 mm L; Flow rate: 1 mL/min; Temp.: 40°C; Inj. vol.: 1 μL.

$S$: Symmetry factor
Widening of the pH range of a usable eluent remarkably enlarges the range of the method of analysis. The use of an alkaline eluent, especially, enables analyses where the dissociation of basic compounds is restricted, which is very advantageous.

\[ \text{Analytical conditions} \]

Column: L-column3 C18, 5 μm; Size: 2.1 mm I.D., 150 mm L.
Eluent: A: CH₃CN, B: 25 mM Phosphate buffer
A/B: 20/80; 70/30 (0-20 min)
Flow rate: 0.3 mL/min; Temp.: 40°C; Detection: ESI-MS/MS (+)
Inj. vol.: 1 μL

- The polygonal line graph showed the retention behavior. Actually, retention time never linearly changes because of the existence of the buffer capacity or the influence of the buffer salt.

The change in the pH of an eluent changes the retention behavior of ionic compounds. Generally, for acidic compounds, higher pH results in less retention. Conversely, in basic compounds, higher pH results in greater retention. There is a strong possibility that the use of an alkaline eluent provides a separation pattern different from the acidity and neutral ranges, thus an improvement in separation can be expected.

Peak intensity is important in the LC/MS often used in trace analysis. The high pH of an eluent in the analysis of basic compounds provides sufficient retention and peak intensity. This is the advantage of the use of an alkaline eluent.

\[ \text{Comparison of retention time (Drugs)} \]

[Analytical conditions]
Column: L-column3 C18, 5 μm; Size: 2.1 mm I.D., 150 mm L.
Eluent: A: CH₃CN, B: Aqueous solution
A/B, 40/60-90/10-90/10 (0-10-12 min)
Flow rate: 0.3 mL/min; Temp.: 40°C; Detection: UV 220 nm
Inj. vol.: 1 μL

- Sufficient retention increase of peak intensity

- Comparison of retention time (Basic drugs)

[Analytical conditions]
Column: L-column3 C18, 5 μm; Size: 2.1 mm I.D., 150 mm L.
Eluent: A: CH₃CN, B: Aqueous solution
A/B, 40/60; 90/10-90/10 (0-10-12 min)
Flow rate: 0.3 mL/min; Temp.: 40°C; Detection: ESI-MS/MS (+)
Inj. vol.: 1 μL
The preparation efficiency of basic compounds is improved by using an alkaline eluent.

The use of an alkaline eluent remarkably improves the peak shape of basic compounds. Even a large injection volume does not cause deviations in the retention time but provides a sharp peak. Consequently, the increase in the loads becomes possible, and preparation efficiency is improved.

- The 10 g/L homochlorcyclizine added the hydrogen peroxide and left for 70 hours is used.

**Comparison of injection volume (Basic drugs)**

- Alkaline eluent
  - 10 mM HCOOH+NH₃ in H₂O (pH 11)
  - Inj. vol.: 30 μL (20 g/L)

- Acidic eluent
  - 10 mM HCOOH in H₂O (pH 3)
  - Inj. vol.: 10 μL (1 g/L)

- Neutral eluent
  - 10 mM HCOOH+NH₃ in H₂O (pH 7)
  - Inj. vol.: 2 μL (20 g/L)

**Comparison of the number of peaks (Basic drugs)**

- Alkaline eluent
  - 10 mM HCOOH+NH₃ in H₂O (pH 11)
  - Column Size: 10.0 mm I.D., 150 mm L.
  - Flow rate: 4 mL/min
  - Inj. vol.: 100 μL (100 g/L)

- Acidic eluent
  - 10 mM HCOOH in H₂O (pH 3)
  - Inj. vol.: 10 μL (1 g/L)

- Neutral eluent
  - 10 mM HCOOH+NH₃ in H₂O (pH 7)
  - Inj. vol.: 2 μL (20 g/L)

**Preparative purification (Basic drugs)**

- Purity check:
  - Before purification: 98.2%
  - After purification: >99.9%

The use of an alkaline eluent provides the following advantages in basic compounds:

- Load increases and preparation efficiency is improved
- Capable of preparation without counterion
- Improvement in the separation of the degradation product or impurities.
A 100% aqueous eluent is available for stable analysis.

The deterioration of the silica-based column is promoted when used for a 100% aqueous eluent for a long period of time. Since the packing materials for L-column3 have very high chemical stability, the column is stable for long periods of time even when used for the 100% aqueous eluent.

**Application data**

### Durability test

**[Durability test conditions]**
- Column: C18, 5 μm; Size: 2.1 mm I.D., 150 mm L.
- Eluent: 25 mM Phosphate buffer pH 7
- Flow rate: 0.2 mL/min; Temp.: 50°C
- N: Number of theoretical plates

### Vitamin B6

**[Analytical conditions]**
- Column: C18, 5 μm; Size: 2.1 mm I.D., 150 mm L.
- Eluent: 25 mM Phosphate buffer pH 7
- Flow rate: 0.2 mL/min; Temp.: 40°C; Detection: UV 320 nm
- Inj. vol.: 1 μL
- Sample: 1. Pyridoxamine; 2. Pyridoxal; 3. Pyridoxine

### Antihistamine

**[Analytical conditions]**
- Column: 5 μm; Size: 4.6 mm I.D., 150 mm L.
- Eluent: CH3CN/25 mM Phosphate buffer pH 7 (45/55)
- Flow rate: 1 mL/min; Temp.: 40°C; Detection: UV 220 nm
- Inj. vol.: 1 μL
- Sample: 1. Chlorpheniramine; 2. Diphenhydramine; 3. Diphenhydramine
  7. Promethazine

### Nucleobase

**[Analytical conditions]**
- Column: L-column3 C18; 5 μm; Size: 4.6 mm I.D., 150 mm L.
- Flow rate: 1 mL/min; Temp.: 40°C; Detection: UV 200 nm
- Inj. vol.: upper: 2 μL (50 mg/L), lower: 5 μL (10 mg/L)
  10. Adenosine
Application data

Alkaline eluent
A: 5 mM NH₃ in CH₂OH
B: 5 mM NH₃ in H₂O

Neutral eluent *
A: 5 mM CH₃COONH₄ in CH₂OH
B: 5 mM CH₃COONH₄ in H₂O
* Simultaneous test method for pesticides by the LC/MS (agricultural products)

Acidic eluent
A: CH₃CN
B: 5 mM HCOOH in H₂O

Agricultural chemicals

Quinolones

Alkaline eluent
A: CH₃CN
B: 5 mM NH₃ in H₂O

H₂ blocker

Okadaic acids

Neutral eluent *
A: CH₃CN
B: 5 mM HCOONH₄+50 mM HCOOH in H₂O
* Department of Food Safety, Standards and Evaluation Division Notification 0306 No. 4 and Department of Food Safety, Standards Bureau, Inspection Division Notification 0306 No. 2
UHPLC column

UHPLC (ultra-high performance liquid chromatography) is liquid chromatography provided at a higher speed with higher separation by using a column with fine particle packing materials in a particle size of about 2 μm. L-column3 with a wide selection range of pH values can select analytical conditions of detection sensitivity, peak shape, and elution order based on the intended purpose.

![Analysis time: 1/2](image)

**Eluent: 1/5**

- $r_t(4)$: Retention time (min), $N$: Number of theoretical plates

The decrease in particle size increases the linear velocity of the mobile phase (eluent) with height equivalent to a theoretical plate, and the change of that value is small within the wide range of the linear velocity. Therefore, UHPLC enables the analyses at a higher speed. In addition, the decrease of the inner diameter of the column and the length enables a reduction in the amount of eluent use.

**L-column series (2 μm):**
- Optimum flow rate range of inner diameter 2.1 mm: approx. 0.4 mL/min
- Optimum flow rate range of inner diameter 3.0 mm: approx. 0.8 mL/min

### Analytical conditions

**Column:** L-column3 C18

**Eluent:** A: CH$_3$CN, B: Aqueous solution

- A/B, A: 10:90-70:30 (0.5 min)
- A: B, 0:100-50:50 (0-10 min)

**Sample:**

- Flow velocity (mm/sec)
- Height equivalent to a theoretical plate

#### Standard test

- **Acidic eluent**
  - 5 mM HCOOH in H$_2$O

- **Alkaline eluent**
  - 5 mM NH$_3$ in H$_2$O

#### Antidepressants (SSRI)

- **Acidic eluent**
  - 5 mM HCOOH in H$_2$O

- **Neutral eluent**
  - 5 mM CH$_3$COONH$_4$ in H$_2$O

- **Alkaline eluent**
  - 5 mM NH$_3$ in H$_2$O

#### H$_2$ blocker

- **Acidic eluent**
  - 5 mM HCOOH in H$_2$O

- **Neutral eluent**
  - 5 mM CH$_3$COONH$_4$ in H$_2$O

- **Alkaline eluent**
  - 5 mM NH$_3$ in H$_2$O

**Sample:**
- 1. Famotidine, 2. Ranitidine, 3. Cimetidine
Metal-free column

The performance of packing materials is most important in the evaluation of metal-free column. Since the packing materials for the L-column series suppress the influence of metal impurities, the peak of the compounds that are easily subjected to metal coordination can be sharply detected. Furthermore, since the L-column metal-free column can be used in a wide range of pH values, an improvement in sensitivity and separation behavior can be expected.

![Graph showing S/N ratio comparison between SUS column and Metal-free column for Acidic and Alkaline eluents.](image)

**Antibiotics (tetracycline)**

- **Analytical conditions**
  - Column: L-column3 C18, 3 μm; Size: 2.0 mm or 2.1 mm I.D., 50 mm L
  - Eluent: A: CH₂CN; B: 5 mM HCOOH in H₂O
  - Flow rate: 0.2 mL/min; Temp.: 25° C; Detection: ESI-MS/MS (+)
  - Inj. vol.: 1 μL (50 μg/L)

- **Sample:**
  1. Oxytetracycline (OTC); 2. Tetracycline (TC)
  3. Chlorotetracycline (CTC); 4. Doxycycline (DC)

- **Keto-enol tautomerism of CTC**

As the antibiotics of tetracycline base coordinates* with the metal ions at the β-diketone location in the structure, they are strongly influenced by the metal.

The tetracycline has keto-enol tautomerism, and the peak leading of CTC and DC occurs. This change can be suppressed by setting the column temperature low.

* Quoted from Standard Methods of Analysis in Food Safety Regulation, Animal Drugs and Feed Additives, Part 2003

**Modified peptides**

- **Analytical conditions**
  - Column: L-column3 C18, 3 μm; Size: 2.0 mm or 2.1 mm I.D., 50 mm L
  - Eluent: A: CH₂CN; B: Aqueous solution
  - Flow rate: 0.2 mL/min; Temp.: 40° C; Detection: ESI-MS/MS (+)
  - Inj. vol.: 1 μL (1 pmol/L 0.1% HCOOH in H₂O)

- **Sample:**
  1. Oxidized ACTH (1-10)
  2. Glycosylated EPO (117-131)
  3. Phosphorylated Angiotensin I
  4. Nitrated Angiotensin I
  5. Methyalted Substance P
  6. Acetylated Calcitonin (15-29)

- **S/N**: Signal to noise ratio

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**Precautions for use**

- In order to sufficiently achieve the potential performance of a metal-free column, change the materials of tubings and needles to non-metal materials for use in a metal-free system environment.
- Solvent that degrades PEEK cannot be used.
- The metal-free column has withstand pressure equivalent to that of general-purpose stainless-steel columns. Determine the column pressure in reference to the following maximum pressure as a guideline.

<table>
<thead>
<tr>
<th>Column Length</th>
<th>Particle size:</th>
<th>5 μm</th>
<th>3 μm</th>
<th>2 μm</th>
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</thead>
<tbody>
<tr>
<td>50 mm</td>
<td>10 MPa</td>
<td>20 MPa</td>
<td>40 MPa</td>
<td></td>
</tr>
<tr>
<td>100 mm</td>
<td>15 MPa</td>
<td>25 MPa</td>
<td>60 MPa</td>
<td></td>
</tr>
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<tr>
<td>250 mm</td>
<td>20 MPa</td>
<td>30 MPa</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

The hardware made of a PEEK lined stainless-steel tube installed with PEEK frits is designed so that it can be used up to pH 12.
Technical report

- Degradation mechanism of silica-based columns by alkaline solution
  Packing materials using silica as the base material have many types of bonded phases and particle sizes. The columns packed with them are general purpose. However, in an alkaline solution, hydroxide ion dissolves silica (Step 1). Furthermore, the vacant space produced by the dissolution of silica at the top of the column significantly deteriorates the performance of the column (Step 2). Therefore, the pH range of an eluent is limited.

- Advantage of using alkaline eluent
  “Capable of analysis when dissociation is suppressed”
  An ionic compound has the same concentration under dissociation and non-dissociation conditions when pH is the same as pKa. In propranolol as a basic drug, many propranolol ions exist at a pH lower than 9.5, and many propranolol molecules exist at a pH higher than 9.5. The retention by propranolol ions is weak, and the retention by propranolol molecules is strong.

Since general C18 silicas-based columns can only analyze by propranolol ions, retention should be enhanced by adding an ion-pair reagent (Fig. 3 (1)). Because L-column3 with a wide range of pH values use can analyze basic compounds under the condition of suppressed dissociation, sufficient retention can be obtained in a simple eluent composition (Fig. 3 (2)).

- Alkaline resistance of L-column3
  Recently, many manufacturers sell columns usable for an alkaline eluent. While L-column2 is usable for pH 1 to pH 9, L-column3 became usable for pH 1 to pH 12 (Fig. 2). The columns with durability in a wide range of pH values are very advantageous in the development of methods of analysis and from the economic viewpoint. The high durability is an important factor in the selection of columns.

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Fig. 1 Image of silica dissolved by alkaline solution

Fig. 2 Durability test of alkaline eluent (pH 12)

<table>
<thead>
<tr>
<th>Analytical conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column: L-column3 C18, 5 μm; Size: 2.1 mm I.D., 150 mm L.</td>
</tr>
<tr>
<td>Eluent: A: CH₃CN, B: 25 mM Phosphate buffer pH 2.5, 50:50</td>
</tr>
<tr>
<td>Flow rate: 0.2 mL/min, Temp.: 40°C; Detection: UV 255 nm</td>
</tr>
</tbody>
</table>

Fig. 3 Abundance ratio and retention time due to pH change (propranolol)
Technical report

"Changing separation behavior of ionic compounds by simultaneous multicomponent analysis"
Changing the pH of an eluent changes the retention behavior of the ionic compounds. Because L-column3 is usable within the range of pH 1 to pH 12, the pH of the eluent can be changed significantly. Changing the pH enables an improvement in separation.

"Improvement of peak intensity"
In the LC/MS often used for trace analysis, peak intensity is important. In the analysis of a basic compounds, higher pH values of an eluent enable the acquisition of sufficient retention and peak intensity. This is an advantage in the use of an alkaline eluent.
Fig. 4 shows the peak area ratio assuming the peak area to be "1" when formic acid is used as an eluent. The peak area of ibuprofen, an acidic drug, changes little even if the pH of the eluent changes. On the other hand, an increase in the pH of the eluent increases the peak area of amitriptyline.

The selection of the pH value of the eluent matching the purpose of the analysis is recommended.

```
<table>
<thead>
<tr>
<th>pH</th>
<th>Amitriptyline (pKa 9.4)</th>
<th>Ibuprofen (pKa 4.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

%PGDQW

Fig. 4 Comparison of peak area ratio

**Precautions when using an alkaline eluent**
Even when using some chemically stable columns, using the eluent with high pH is very severe conditions for the column. The selection of an eluent with the pH matching the purpose of the analysis is recommended. Strictly follow the operation manual for columns when using an eluent with allowable pH. Even allowable pH promotes deterioration of the performance of the column in the following cases:

- Ratio of organic solvent is low.
- High column temperature.
- Eluent is added in a high concentration.

Parts of the LC or LC/MS to be used may be replaced with those resistant to alkaline. Ask the manufacturer for further information. After use, wash the column and the flow channel with an eluent not containing additives.

<Supplement>
The method for preparing an eluent in this catalog is as follows:
Select the grade of reagent (for HPLC) based on the purpose of the analysis. Chemical change, pH change, and rotting by the microorganism may occur after the preparation. Completely use the eluent within one or two days.

- 0.1% formic acid solution
  Formic acid 1 mL
  Add water to prepare a total volume of 1000 mL

- 5 mM ammonium formate solution
  1 mol/L ammonium formate solution 5 mL
  Add water to prepare a total volume of 1000 mL

- 5 mM ammonium acetate solution
  1 mol/L ammonium acetate solution 5 mL
  Add water to prepare a total volume of 1000 mL

- 5 mM ammonium hydrogen carbonate (ammonium bicarbonate) solution
  Ammonium hydrogen carbonate (M.W = 79.06) 0.40 g
  Add water to prepare a total volume of 1000 mL

- 5 mM ammonium (ammonium hydroxide) solution
  28% ammonia water 334 μL
  Add water to prepare a total volume of 1000 mL

- 25 mM Phosphate buffer pH 2
  Phosphoric acid (85%) 1020 μL (equivalent to 15 mM)
  Sodium dihydrogen phosphate dihydrate 1.56 g (equivalent to 10 mM)
  Add water to prepare a total volume of 1000 mL

- 25 mM Phosphate buffer pH 7
  Potassium dihydrogen phosphate 1.36 g (equivalent to 10 mM)
  Disodium hydrogen phosphate nonahydrate 2.13 g (equivalent to 15 mM)
  Add water to prepare a total volume of 1000 mL

- 25 mM Phosphate buffer pH 11
  Dipotassium hydrogen phosphate 4.17 g (equivalent to 24 mM)
  Tripotassium phosphate 0.23 g (equivalent to 1 mM)
  Add water to prepare a total volume of 1000 mL

[Analytical conditions]
Column: L-column2 CDS 3 μm, Size: 2.1 mm i.d., 50 mm L.
Eluent: A: CH₃CN, B: Aqueous solution, A/B, Gradient elution
Temp.: 40°C, Inj. vol.: 5 μL
## Line up

Packing materials: *L-column3 C18* (USP category: L 1) (Octadecylsilanized silica gel for liquid chromatography)

<table>
<thead>
<tr>
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- Connection type: 1/16” Waters.

Packing materials: *L-column3 C8* (USP category: L 7) (Octylsilanized silica gel for liquid chromatography)

<table>
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- Connection type: 1/16” Waters.
About connection type (joint)

The connection type (joint and thread type) of column is divided into several types. The connection type is distinguished by different tubing lengths at the end of the ferule.

Always connect by using the same connection type for the LC tubing and the column or by using tough connectors and Pre-column filter to avoid the generation of dead volume.

The connection of L-column3 is the Waters type (unified fine thread No.10-32UNF, outer diameter of tubing 1/16”).
**Reference: About L-column series**

The *L-column* series appeared in 1990 and evolved corresponding to user needs with the concept of low adsorption, high durability, high resolution, and high reproducibility. We earned a very favorable reputation because of our untiring efforts for performance and quality and a consistent stable supply for many years.

<table>
<thead>
<tr>
<th>Packing materials</th>
<th>USP category</th>
<th>Particle Size (µm)</th>
<th>Pore Size (nm)</th>
<th>Micro column</th>
<th>Semi-micro and general-purpose column</th>
<th>Semi-preparation column</th>
<th>Metal-free column</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-column</td>
<td>L-column ODS</td>
<td>L 1</td>
<td>3, 5</td>
<td>12</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>L-column ODS-P</td>
<td>L 1</td>
<td>5</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>L-column C8</td>
<td>L 7</td>
<td>5</td>
<td>12</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>L-column2</td>
<td>L-column2 ODS</td>
<td>L 1</td>
<td>2, 3, 5</td>
<td>12</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>L-column2 C8</td>
<td>L 7</td>
<td>3, 5</td>
<td>12</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>L-column2 C6-Phenyl</td>
<td>L 11</td>
<td>3, 5</td>
<td>12</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>L-column3</td>
<td>L-column3 C18</td>
<td>L 1</td>
<td>2, 3, 5</td>
<td>12</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>L-column3 C8</td>
<td>L 7</td>
<td>3, 5</td>
<td>12</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Classification by inner diameter cited from JIS K 0124:2011

The silica-based reversed phase columns are created by modifying the bonded phases on the surface of the silica and end-capping silanol groups. Although end-capping is performed using different methods depending on manufacturers, the complete elimination of the silanol groups is difficult. Therefore, the peak of the analyte is subjected to tailing because of the interaction with the silanol groups or metal impurities.

The *L-column* series eliminated the secondary interaction (interaction with silanol groups and metal impurities) of the silica base reversed phase column to the utmost limit by applying unique end-capping technology and pursued the separation mechanism of an original column. Since the *L-column ODS* entered the stage in 1990, the columns have continually evolved.
The **L-column series** may present a different separation pattern in a simultaneous multicomponent analysis even when using the same C18 (ODS) column because the manufacturing method for the packing materials is different.

<table>
<thead>
<tr>
<th>L-column</th>
<th>L-column2</th>
<th>L-column3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base material</td>
<td>Fully porous high purity silica</td>
<td>Fully porous high purity silica</td>
</tr>
<tr>
<td>End-capping</td>
<td>High temperature gas phase end-capping</td>
<td>Advanced end-capping</td>
</tr>
<tr>
<td>Usable pH range</td>
<td>pH 2 - pH 9</td>
<td>pH 1 - pH 9</td>
</tr>
<tr>
<td>Features</td>
<td>You can use without worry because this has been stably supplied since 1990. The influence of the silanol group was eliminated to the utmost limit. It offers an abundant lineup, such as the phenyl column, micro column, and nano column with inner diameters less than 1 mm. Metal free columns (glass lining) are also available.</td>
<td>When comparing the L-column and the L-column2, retention is weaker, and stereoselectivity is a little lower. The inert level of packing material is high, and it has low adsorptivity equivalent to that of the L-column2. Not only the alkaline resistance but also the durability in an eluent with high water ratio were dramatically improved. Metal free columns (PEEK lining) are also available.</td>
</tr>
</tbody>
</table>

### Characteristic test

<table>
<thead>
<tr>
<th>Cat.No. 622070</th>
<th>Cat.No. 722070</th>
<th>Cat.No. 822070</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column: C18, 5 μm</td>
<td>Column: C18, 5 μm</td>
<td>Column: C18, 5 μm</td>
</tr>
<tr>
<td>Size: 4.6 mm I.D., 150 mm L.</td>
<td>Size: 4.6 mm I.D., 150 mm L.</td>
<td>Size: 4.6 mm I.D., 150 mm L.</td>
</tr>
</tbody>
</table>

#### Hydrogen bond property

- 1. Uracil
- 2. Caffeine
- 3. Phenol
- 4. Butylbenzene
- 5. o-Terphenyl
- 6. Amylbenzene
- 7. Triphenylene

- Hydrogen bond property: $k_{(Caffeine)} / k_{(Phenol)}$  
  - This is the value representing the influence of the hydrogen bond of the silanol group of packing materials and the samples as represented by the ratio of the retention factors of caffeine with high hydrogen bond property and phenol with low hydrogen bond property. The larger the value of "hydrogen bond property", the hydrogen bonds are easy to occur between analyte and packing materials.

#### Hydrophobicity

- Hydrophobicity: $k_{(Amylbenzene)} / k_{(Butylbenzene)}$  
  - This is the value representing the magnitude of the retention force of packing materials as represented by the ratio of the retention factors of amyl benzene and butyl benzene. The larger the value of hydrophobicity, the higher the hydrophobicity of the packing materials and the longer the retention time.

#### Stereoselectivity

- Stereoselectivity: $k_{(Triphenylene)} / k_{(o-Terphenyl)}$  
  - This is the value representing the plane recognition ability as represented by the ratio of the retention factors of triphenylene with a plane structure and o-terphenyl with a three-dimensional structure. The larger the value of stereoselectivity, the stronger the retention of a compound with a plane structure.

### Adsorptivity (SSRI)

<table>
<thead>
<tr>
<th>Cat.No. 622070</th>
<th>Cat.No. 722070</th>
<th>Cat.No. 822070</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column: C18, 5 μm</td>
<td>Column: C18, 5 μm</td>
<td>Column: C18, 5 μm</td>
</tr>
<tr>
<td>Size: 4.6 mm I.D., 150 mm L.</td>
<td>Size: 4.6 mm I.D., 150 mm L.</td>
<td>Size: 4.6 mm I.D., 150 mm L.</td>
</tr>
</tbody>
</table>

#### Paroxetine

1. Paroxetine
2. Citalopram
3. Fluoxetine

#### Uracil

1. Uracil
2. Caffeine
3. Phenol
4. Butylbenzene
5. o-Terphenyl
6. Amylbenzene
7. Triphenylene

- **$S_{(3)}$: 1.58**  
  - In case the bonded phase is C18 (ODS)

- **$k$: Retention factor, $S$: Symmetry factor**
**Reference: Line up L-column, L-column2**

**L-column2**

<table>
<thead>
<tr>
<th>Packing materials</th>
<th>Particle size</th>
<th>Inner diameter</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 µm</td>
<td>2.1 mm Cat.No.</td>
<td>30 mm</td>
</tr>
<tr>
<td>L-column2 ODS (USP category: L 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.1 mm</td>
<td>713630</td>
<td>60,000</td>
</tr>
<tr>
<td></td>
<td>3.0 mm</td>
<td>723650</td>
<td>65,000</td>
</tr>
<tr>
<td></td>
<td>4.6 mm</td>
<td></td>
<td>721150</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 µm</td>
<td>2.1 mm Cat.No.</td>
<td>711630</td>
</tr>
<tr>
<td></td>
<td>3.0 mm</td>
<td>721650</td>
<td>47,000</td>
</tr>
<tr>
<td></td>
<td>4.6 mm</td>
<td></td>
<td>721150</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 µm</td>
<td>1.5 mm Cat.No.</td>
<td>712130</td>
</tr>
<tr>
<td></td>
<td>2.1 mm</td>
<td>712130</td>
<td>44,000</td>
</tr>
<tr>
<td></td>
<td>4.6 mm</td>
<td>722150</td>
<td>40,000</td>
</tr>
<tr>
<td>L-column2 C8 (USP category: L 7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 µm</td>
<td>2.1 mm Cat.No.</td>
<td>711631</td>
</tr>
<tr>
<td></td>
<td>3.0 mm</td>
<td>721651</td>
<td>47,000</td>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 µm</td>
<td>2.1 mm Cat.No.</td>
<td>712141</td>
</tr>
<tr>
<td></td>
<td>4.6 mm</td>
<td>722151</td>
<td>40,000</td>
</tr>
<tr>
<td>L-column2 C6-Phenyl (USP category: L 11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 µm</td>
<td>2.1 mm Cat.No.</td>
<td>711636</td>
</tr>
<tr>
<td></td>
<td>3.0 mm</td>
<td>721656</td>
<td>52,000</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 µm</td>
<td>2.1 mm Cat.No.</td>
<td>712146</td>
</tr>
<tr>
<td></td>
<td>4.6 mm</td>
<td>722156</td>
<td>44,000</td>
</tr>
</tbody>
</table>

- Connection type: 1/16” Waters.

**L-column2 Metal-free column**

<table>
<thead>
<tr>
<th>Packing materials</th>
<th>Particle size</th>
<th>Inner diameter</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 µm</td>
<td>2.0 mm Cat.No.</td>
<td>50 mm</td>
</tr>
<tr>
<td>L-column2 ODS (USP category: L 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0 mm</td>
<td>731140</td>
<td>77,000</td>
</tr>
<tr>
<td></td>
<td>5 µm</td>
<td>2.0 mm Cat.No.</td>
<td>732140</td>
</tr>
</tbody>
</table>

- L-column2 Metal-free column is made from the combination of a glass lined stainless steel tube and polymer frits.
- Connection type: 1/16’’ Waters.
### Reference: Line up *L-column*, *L-column2*

#### *L-column*

<table>
<thead>
<tr>
<th>Packing materials</th>
<th>Particle size</th>
<th>Inner diameter</th>
<th>30 mm</th>
<th>50 mm</th>
<th>75 mm</th>
<th>100 mm</th>
<th>150 mm</th>
<th>250 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>L-column ODS</em></td>
<td>3 μm</td>
<td>2.1 mm</td>
<td>611630</td>
<td>611140</td>
<td>611640</td>
<td>611170</td>
<td>611020</td>
<td>611220</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.0 mm</td>
<td>621650</td>
<td>621490</td>
<td>621600</td>
<td>621330</td>
<td>621260</td>
<td>621320</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>45,000</td>
<td>50,000</td>
<td>50,000</td>
<td>55,000</td>
<td>67,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.6 mm</td>
<td>621150</td>
<td>621460</td>
<td>621180</td>
<td>621070</td>
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<td>45,000</td>
<td>48,000</td>
<td>53,000</td>
<td>65,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 μm</td>
<td>2.1 mm</td>
<td>612140</td>
<td>612170</td>
<td>612020</td>
<td>612220</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td>42,000</td>
<td>47,000</td>
<td>52,000</td>
<td>60,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.6 mm</td>
<td>622150</td>
<td>622180</td>
<td>622070</td>
<td>622080</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>38,000</td>
<td>43,000</td>
<td>48,000</td>
<td>60,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>L-column ODS-P</em></td>
<td>5 μm</td>
<td>2.1 mm</td>
<td>612147</td>
<td>612177</td>
<td>612027</td>
<td>612227</td>
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<tr>
<td>(USP category: L 1)</td>
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<td>45,000</td>
<td>50,000</td>
<td>55,000</td>
<td>67,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.6 mm</td>
<td>622157</td>
<td>622187</td>
<td>622077</td>
<td>622087</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td>48,000</td>
<td>53,000</td>
<td>65,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>L-column C8</em></td>
<td>5 μm</td>
<td>2.1 mm</td>
<td>612141</td>
<td>612171</td>
<td>612021</td>
<td>612221</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(USP category: L 7)</td>
<td></td>
<td></td>
<td>42,000</td>
<td>47,000</td>
<td>52,000</td>
<td>60,000</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>4.6 mm</td>
<td>622151</td>
<td>622181</td>
<td>622071</td>
<td>622081</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>38,000</td>
<td>43,000</td>
<td>48,000</td>
<td>60,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Connection type: 1/16" Waters.

#### Nano column / micro column with 0.075 mm I.D. - 0.3 mm I.D.

<table>
<thead>
<tr>
<th>Packing materials</th>
<th>Inner diameter</th>
<th>3 μm</th>
<th>0.1 mm</th>
<th>0.2 mm</th>
<th>0.3 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>L-column ODS</em></td>
<td>0.075 mm</td>
<td>711410</td>
<td>711390</td>
<td>713290</td>
<td>713270</td>
</tr>
<tr>
<td>(USP category: L 1)</td>
<td></td>
<td>711420</td>
<td>711400</td>
<td>713300</td>
<td>713280</td>
</tr>
<tr>
<td></td>
<td>0.1 mm</td>
<td>711410</td>
<td>711390</td>
<td>713290</td>
<td>713270</td>
</tr>
<tr>
<td></td>
<td>0.2 mm</td>
<td>711400</td>
<td>711400</td>
<td>713300</td>
<td>713280</td>
</tr>
<tr>
<td></td>
<td>0.3 mm</td>
<td>711400</td>
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<td>713300</td>
<td>713280</td>
</tr>
<tr>
<td></td>
<td></td>
<td>710000</td>
<td>710000</td>
<td>710000</td>
<td>710000</td>
</tr>
</tbody>
</table>

* Connection type: Valco

#### Trap column (cartridge type)

<table>
<thead>
<tr>
<th>Packing materials</th>
<th>Particle size</th>
<th>Inner diameter</th>
<th>Length</th>
<th>Specification</th>
<th>Cat.No.</th>
<th>Price (JPY)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>L-column ODS</em></td>
<td>5 μm</td>
<td>0.3 mm</td>
<td>5 mm</td>
<td>Cartridge (3 pcs)</td>
<td>752450</td>
<td>66,000</td>
</tr>
<tr>
<td><em>L-column ODS</em></td>
<td>5 μm</td>
<td>0.3 mm</td>
<td>5 mm</td>
<td>Cartridge (3 pcs)</td>
<td>652450</td>
<td>64,000</td>
</tr>
<tr>
<td>Holder</td>
<td></td>
<td>For 0.3 mm I.D.</td>
<td>(1 pc)</td>
<td></td>
<td>652452</td>
<td>24,000</td>
</tr>
</tbody>
</table>

* Connection type: 1/16" Waters.
LC column catalog
L-column3
Ver. 02

Chemicals Evaluation and Research Institute, Japan

- The product specifications are as of January 1, 2020. Please note that they may be changed without prior notice.
- For questions about part prices or ordering, please contact the Chromatography Department of CERI or a nearby agency. Details are provided on the page for the Chromatography Department of our website. Please use them as a reference.