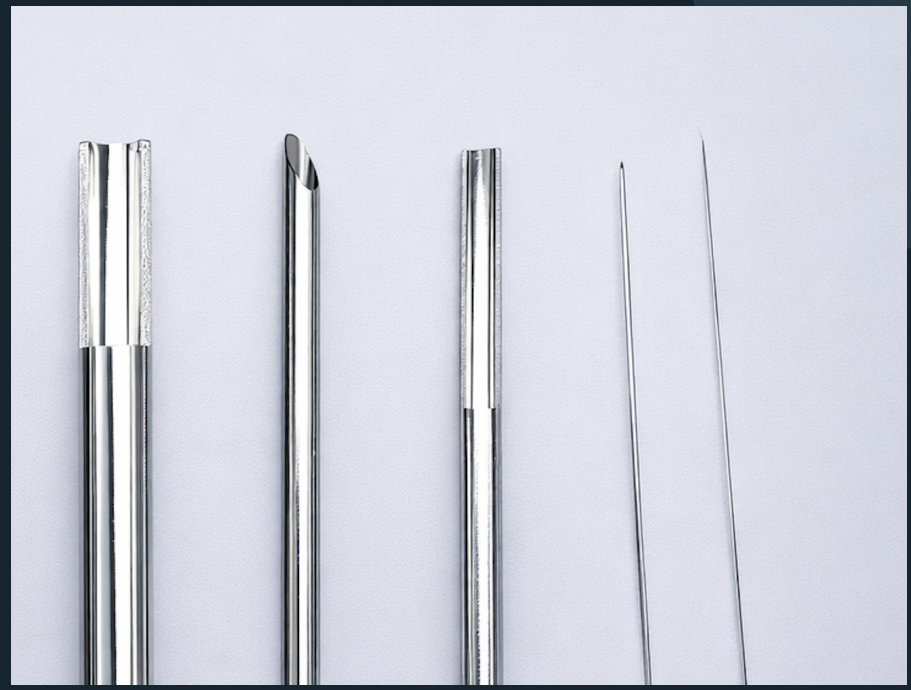
TECHNICAL BULLETIN / PRODUCT GUIDE

UHP Ultra-Fine Stainless Steel Capillary Tubing

Bores from ø0.1 mm (0.004″). Internal surfaces finished by chemical polishing.



A ø0.1 mm bore with a 100 mm length — 1,000 diameters deep.
That bore is chemically polished uniformly, end to end.

Purpose-built equipment, developed in-house for ultra-fine bores.

ø0.1
mm Minimum bore

1000×
Length-to-bore ratio

SEMI F19
Process verified by third-party analysis

KAMEHA Co., Ltd. | info@kameha-uhp.co.jp | kameha-uhp.com

Rev. November 2026

CAPABILITY

What chemical polishing can reach

Internal finishing of stainless steel capillary tubing is dominated worldwide by mechanical polishing methods. KAMEHA takes a chemical-polishing route instead — a process that requires neither an electrode nor a tool — which is what makes a ø0.1 mm bore accessible.

01

No electrode, no tooling required

Wherever the chemistry reaches, polishing proceeds — including ø0.1 mm bores and complex internal geometries such as bellows, which an electropolishing cathode cannot enter.

02

Acts on surface chemistry

Because material is removed by dissolution, the process raises the Cr/Fe ratio and promotes formation of a chromium-enriched passive layer.

03

Removes the surface itself

The work-affected layer, residual stress, and particles or hydrocarbons embedded in the bore are eliminated by dissolving the surface that contains them.

Where KAMEHA fits

The three points above are properties of chemical polishing as a process. The engineering problem is different: delivering uniform chemical action along a bore that is both ultra-fine and long.

KAMEHA specializes in exactly that regime and developed its own dedicated equipment for it — uniform, repeatable internal processing down to a ø0.1 mm bore, at production volume.

SPECIALTY

Uniform 100 mm down a ø0.1 mm bore

At ø0.1 mm × 100 mm, the length equals 1,000 times the bore diameter. Holding uniform chemical action over that entire length is not achieved by solution selection alone.

Solution renewal

Chemistry consumed by the reaction must be continuously exchanged within the bore.

Flow velocity

Through-flow is designed so that every point along the bore sees identical reaction conditions.

Bath temperature

Dissolution rate is highly temperature-sensitive; the temperature profile inside the bore is held constant.

Cycle time

Set individually according to bore, length and the incoming condition of the tube blank.

The surface change produced by our chemical polishing process

Cr/Fe ratio **0.5 → 1.6**

Work-affected layer and embedded contamination removed. The indicator used to gauge surface corrosion resistance improves roughly threefold.

The following pages present the third-party measurement data behind this figure.

* Values above were measured on a different product in a different material. Measurement conditions are stated on the following page.

On the polishing chemistry

Our polishing solutions are supplied by a Japanese chemical manufacturer with a long track record in chemical polishing. The formulation is adapted to our application under a long-standing supply relationship.

What is proprietary to KAMEHA is the equipment and process design that makes that chemistry act uniformly on a ø0.1 mm bore over its full length.

CRITERIA

Ra alone cannot define internal surface quality

Ra is the parameter we are asked about most often. Ra describes the geometry of a surface. The chemical state of that surface requires a separate evaluation.

What Ra does tell you

- Average height of surface peaks and valleys
- Smoothness to the eye and to the touch
- An indication of physical resistance to flow

What Ra does not tell you

- Cr/Fe ratio of the surface (corrosion-resistance indicator)
- Presence of a work-affected layer or residual stress
- Embedded contamination — particles, hydrocarbons

What Ra evaluates is the geometry of the surface.

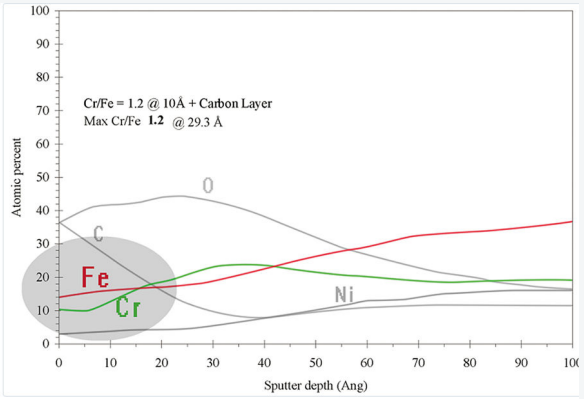
In flow meters, sensors and semiconductor fluid paths, what governs component life and reliability is the chemical state of the surface — the Cr/Fe ratio, the presence of a work-affected layer, and embedded contamination. KAMEHA reports these alongside Ra.

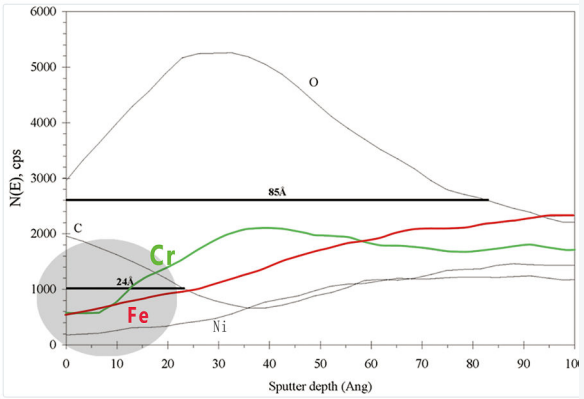
DATA 01

Surface chemistry — measured on our chemical polishing process

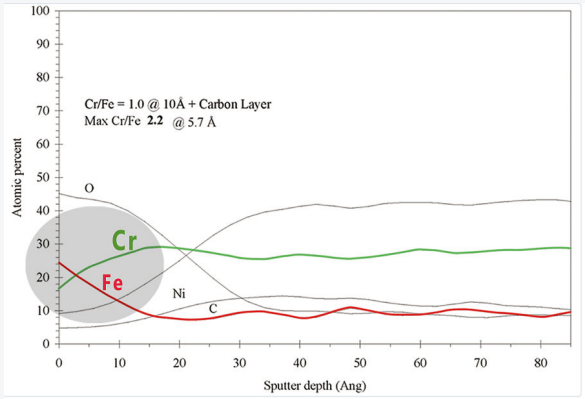
Chemical polishing is a dissolution reaction, so it acts on the chemical composition of the surface. Our process was submitted to an independent laboratory for analysis.

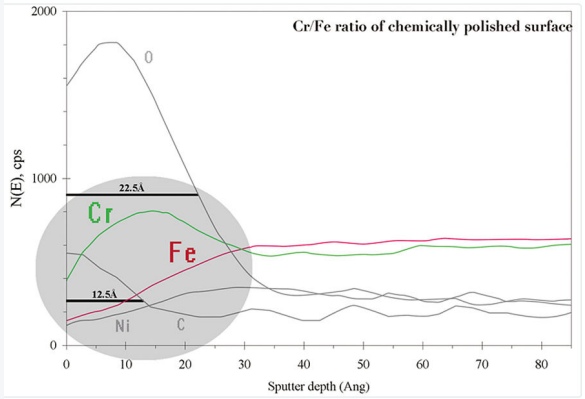
As-received (untreated)





After chemical polishing





Parameter	As-received	After CP	UHP criterion
Cr/Fe ratio (XPS)	0.5	**1.6**	> 1.5
CrOx/FeOx ratio (XPS)	0.6	**2.3**	> 2.0
Oxide thickness (AES) *	85 Å	**22.5 Å**	—

Both the Cr/Fe and CrOx/FeOx ratios meet the UHP-grade acceptance criteria of SEMI F19. These ratios describe the quality of the passive film that determines how readily a stainless steel surface corrodes — the higher the value, the lower the tendency toward corrosion and metallic ion release.

LABORATORY COMMENT

Oxide film thickness and Cr/Fe ratio are both comparable to the range typically observed on electropolished stainless steel.

Surface quality equivalent to electropolishing — inside bores that electropolishing cannot reach.

* Measured by RJ Lee Group (USA) in accordance with SEMATECH 90120403B / 91060573B. The test coupon (US-produced 316L stainless steel) was supplied by KAMEHA; chemical polishing was performed jointly with our partner facility.

* Oxide thickness values are reference figures. The test sample was a semiconductor gas pressure-gauge component, not capillary tubing. The data indicates the surface chemistry our chemical polishing process is capable of reaching. Values achieved on any given part depend on base material quality and process conditions.

DATA 02

Read the structure of the passive film, not its thickness

A passive film has a compositional depth profile, so a single ratio cannot tell you where in the film the chromium is concentrated. Put simply: what matters is less how thick the film is than what sits at its outermost surface. Whether the first layer a fluid touches is iron-dominated or chromium-dominated changes the corrosion behavior.

Parameter	As-received	After chemical polishing
Maximum Cr/Fe ratio	1.2	2.2
Depth at which the maximum occurs	29.3 Å below surface	5.7 Å below surface
Surface carbon contamination layer	24 Å	12.5 Å
Oxide film thickness (carbon-corrected)	61 Å	10 Å
Laboratory observation	Spalled Fe-O layer identified	—

A thick film is not necessarily a good film

An oxide film exists on the untreated surface as well, but it is a thick layer dominated by iron oxides. Chromium enrichment sits 29.3 Å below the surface, so the outermost layer actually in contact with the fluid remains iron-rich.

The outermost layer itself is replaced

After chemical polishing, the iron-oxide-dominated layer is dissolved away and the chromium enrichment peak moves to 5.7 Å from the surface. The layer that fluids and gases contact directly becomes chromium-oxide dominated.

Depth of the chromium enrichment peak

29.3 Å → 5.7 Å

The outermost layer contacting the fluid becomes chromium-oxide dominated.

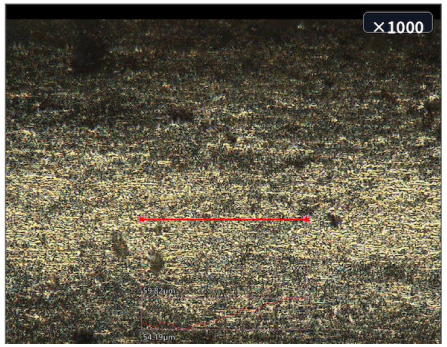
* Depth profiling by AES (Auger electron spectroscopy), measured by RJ Lee Group (USA). Reference values obtained on a different product in a different material; values achieved on any given part depend on base material quality and process conditions.

DATA 03

Measured internal roughness, before and after

Smoothness is not our point of differentiation — it is a precondition. Measured values are stated together with their measurement conditions.

As-received · Before — Ra 0.45 µm (17.7 µin)

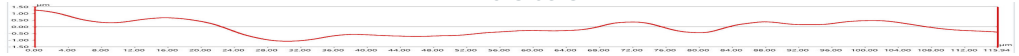


Bore surface · ×1000

Ra	0.45 µm
Rz	2.34 µm
RzJIS	1.18 µm

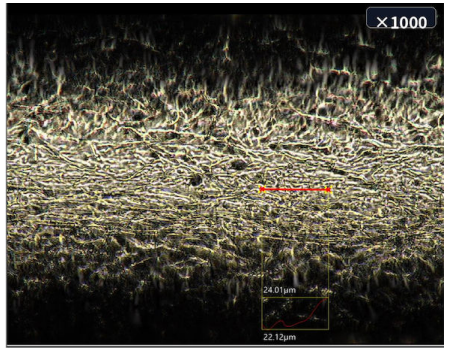
Evaluation length 115.94 µm

Laser microscope
Sample: ø0.2 mm capillary, sectioned to expose the bore



Roughness profile · vertical scale ±1.50 µm

Chemically polished · After — Ra 0.17 µm (6.7 µin)



Bore surface · ×1000

Ra	0.17 µm
Rz	0.57 µm
RzJIS	0.45 µm

Evaluation length 46.29 µm

Laser microscope
Sample: ø0.2 mm capillary, sectioned to expose the bore



Roughness profile · vertical scale ±1.50 µm

Full roughness parameter set

Parameter	Ra	Rz	RzJIS	Rp	Rv	Rc	Rt	Rq	Rsk	Rku	RSm	RΔq
Before	0.45	2.34	1.18	1.26	1.08	1.18	2.34	0.53	−0.34	2.30	42.44	0.09
After	**0.17**	**0.57**	**0.45**	**0.26**	**0.31**	**0.45**	**0.57**	**0.19**	**−0.69**	**1.58**	**21.28**	**0.06**

All values in µm except Rsk, Rku and RΔq (dimensionless).

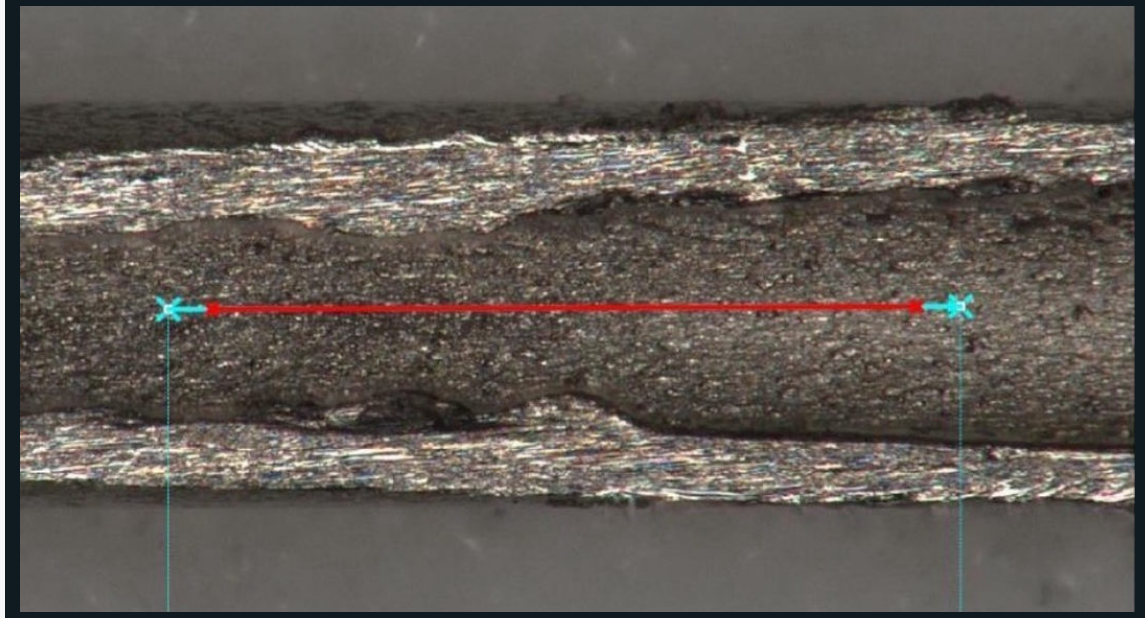
* Evaluation length: 46.29 µm after polishing / 115.94 µm before polishing (evaluated within the microscope field of view). Values vary with geometry, dimensions, base material and finish grade.
* Measurement is outsourced to a third-party laboratory and to our partner facility. Measurement data is supplied together with samples. Inspection certificates (dimensions, appearance, Ra) are supplied as standard.

EVIDENCE

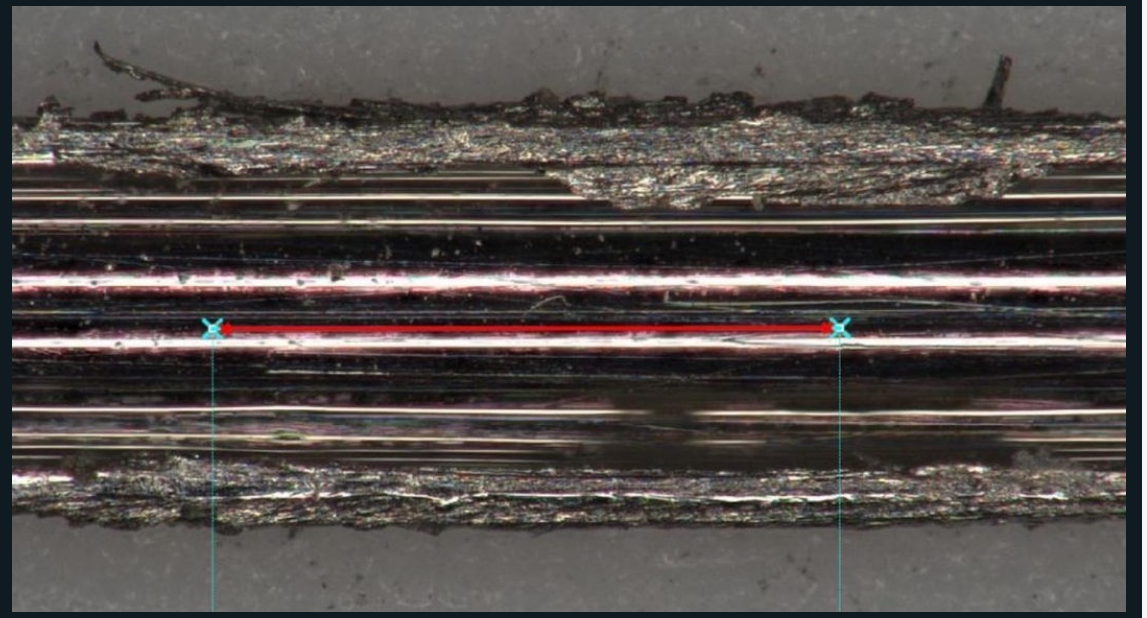
Bore cross-section, before and after — ø0.2 mm capillary

The same sample, imaged under identical conditions. The work-affected layer has been removed, revealing a smooth, specular bore.

BEFORE POLISHING



AFTER POLISHING



ø0.2 mm ultra-fine stainless steel capillary tubing · bore surface · identical sample

* Imaging magnification ×1000. The horizontal banding visible in the after-polishing image is specular reflection, not scratching.

PROCESS

An 11-step integrated process

Starting from BA (bright annealed) or MP (mechanically polished) tube blanks, every step — cleaning, chemical polishing, passivation, multi-stage rinsing, nitrogen drying and cleanroom packing — is managed as one controlled sequence in-house.

01 **Load capillaries**	02 **Ultrasonic degreasing**	03 **Rinse**	04 **Chemical polishing**	05 **Rinse**	06 **Passivation**
07 **Hot-water rinse**	08 **Ultrasonic cleaning**	09 **UPW final rinse**	10 **Nitrogen drying**	11 **Cleanroom packing & shipping**	

Additional fully automated line under installation

Automated transfer together with closed-loop control of bath temperature and immersion time removes operator dependence and secures lot-to-lot repeatability.

Finish grades

BA-based tube blank → Standard UHP grade
MP-based tube blank → Super UHP grade

Process transparency

Process conditions and equipment details can be disclosed as required during technical discussions. Factory visits can be arranged.

SPECIFICATION

Specifications

The following are representative specifications. We welcome inquiries on requirements outside this range.

Material	316L stainless steel (VIM + VAR, double vacuum melted) VIM + VAR = vacuum induction melting followed by vacuum arc remelting — an exceptionally clean grade with very low non-metallic inclusion content.
Bore (ID)	ø0.1 mm – ø1.0 mm (0.004″ – 0.039″) ø0.1 mm is the minimum bore we process.
Representative size	ø0.4 × ø0.2 × 100 mm (OD 0.016″ × ID 0.008″ × L 3.94″)
Length	ø0.1 mm bore: up to 100 mm (3.94″) per piece Cut to final length on the customer side.
Internal roughness	Ra 0.17 µm (6.7 µin), measured
Finish grade	Standard UHP grade / Super UHP grade Selected according to application.
Supply unit	Per piece; lot supply
Surface chemical analysis	Outsourced to an independent laboratory (RJ Lee Group), measured to SEMI standards

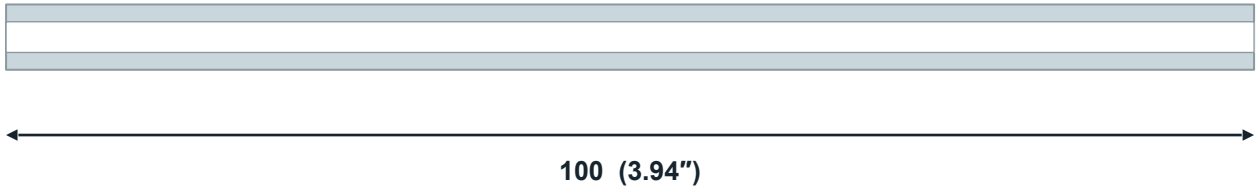
Prototype quantities are welcome. Minimum order quantity and lead time vary with specification and volume-please feel free to ask.

DRAWING

Reference drawing — ø0.4 × ø0.2 × 100 mm

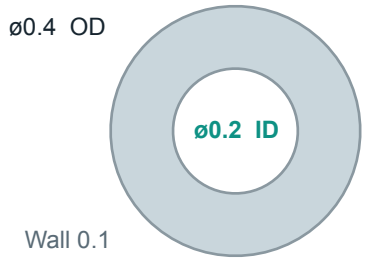
Units: mm / Reference drawing only — a formal drawing is issued on order.

SIDE VIEW



Bore surface: Ra 0.17 µm (6.7 µin), chemically polished finish

SECTION (ENLARGED)



Not to scale

* Proportions are not to scale (an outside diameter of 0.4 mm against a length of 100 mm). Tolerances are agreed individually according to the application.

Discuss your part with us

Bore, outside diameter, length, application — please contact us to discuss your requirements.

info@kameha-uhp.co.jp

APPLICATION

Geometries and conditions we handle

- ✓ Ultra-fine tubing bores from ø0.1 mm and up
- ✓ Complex internal geometries such as bellows, where an electrode cannot be inserted
- ✓ Flow-path components where a mechanically induced work-affected layer is a problem
- ✓ Internal surfaces requiring defined Cr/Fe ratio and cleanliness for UHP service

Typical application fields

Semiconductor equipment

UHP gas and liquid flow paths, mass flow controllers, connection tubing for pressure and flow sensors.

Analytical instruments

Chromatography and mass spectrometry micro-flow lines, where low adsorption and low carryover are required.

Medical & diagnostic devices

Micro-flow components in clinical and immunoassay analyzers, where corrosion resistance and a low-adsorption bore are required.

Toll polishing (customer-supplied material)

We accept internal chemical polishing of customer-supplied tubing. Because the surface chemistry achievable depends on the base material, we commit to the improvement our process delivers and agree final target values accordingly.

CONTACT

Get in touch

For any questions about our capillary tubing, please feel free to contact us. Physical samples can be provided on request.

Email info@kameha-uhp.co.jp

Website kameha-uhp.com (English) / kameha-uhp.co.jp (Japanese)

Location Tokyo, Japan



About KAMEHA Co., Ltd.

KAMEHA Co., Ltd. is a technical trading company specializing in UHP-grade internal finishing of ultra-fine and geometrically complex bores. Using chemical polishing equipment developed in-house, we produce smooth, clean internal surfaces in ø0.1 mm capillary tubing and bellows — geometries electropolishing cannot reach. Our technical base dates back to the establishment of our Shanghai operation in 2005, and the company is run by a team with more than twenty years of accumulated chemical polishing experience.

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