BRUSH Specialized Company for FPD and Semi-Conductor

Company Profile

Confidential:

It is prohibited from disclosing this material for the causes other than the original purpose of usage or distributing them to a third party (including our company's production technology, standards, and process, etc.)

BRUSH BANK CO.,LTD

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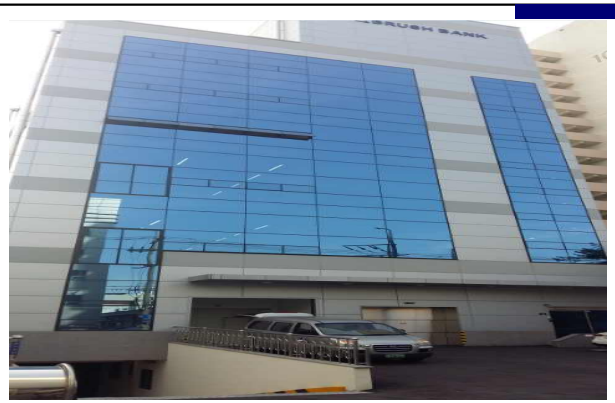
1-1. Company Overview



Location: 15 19-gil, Beoman-ro, Geumcheon-gu, Seoul, Korea

Location: 42 108-gil Seokpo-ro, Jangan-myeon, Hwaseong-si, Gyeonggi-do, Korea

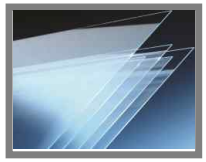
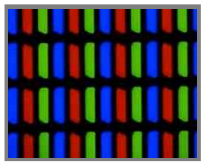
Main Office and Factory in Seoul

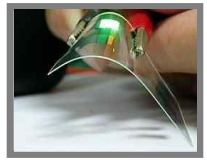
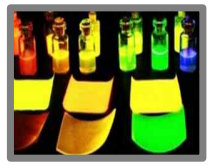
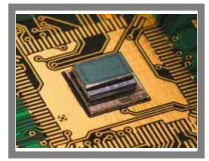
- Company name : Brush Bank Corporation
- Date of establishment : July 1, 1995
- Major item: FPD (Glass , Panel) and semi-conductor cleaning BRUSH (Nylon type)
- CEO: Seungjoo Park
- Homepage: www.brushbank.com
- Contact information: 02) 867-8204~5 FAX 02) 867-8540

Factory in Hwaseong, Gyeonggi-do

- Company name: Sponge Bank
- Date of establishment: July 1, 2009
- Major item: FPD (Glass , Panel) and semi-conductor cleaning BRUSH (PVA Sponge type)
- CEO: Seungjoo Park
- Homepage www.spongebank.com
- Contact information: 031) 358-0725 FAX 031) 358-0731

1-2. Business Scope


Glass Cleaning Brush | LCD Panel Cleaning Brush | Glass Returning Brush | Glass Cleaning Brush | OLED Panel Cleaning Brush | Semi-Conduct Cleaning Brush

BRUSH Specialized Maker with Technology and High Quality

- Thorough Quality Management
- \+ Continuous Technology Development
- \+ Complete Needs Of Customers
- \+ Secure Production Competitiveness Of Customers

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1-3. Company History

1967 ~ 2004

- 1967: Established Hankwang Brush Corporation
- 1995: Independent establishment of current CEO of Hankwang Special Brush
- 1996: Renamed to Brush Bank
- 1996: Initiated LCD glass cleaning brush development
- 2001: Commercialized entire LGD lines
- 2002: Received the entire orders of LGD 6G
- 2004: Developed SSD 7G brush

2004 ~ 2011

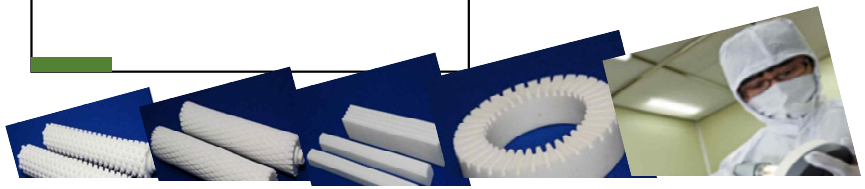
- 2004: Concluded technical advisory agreement with electronic materials engineering research lab in Hanyang University
- 2006: Relocated to new office in Geumcheon-gu
- 2006: Applied test and line of SSD belt brush
- 2009: Took over and started operating PvA sponge factory in Hwaseong-si
- 2010: Newly established research department
- 2011: Developed PVA sponge for 10G ~11G for the first time in the world

2014 ~ 2016

- 2014: Converted to Brush Bank Corporation
- 2015: Proceeded to develop 10.5G nylon brush
- 2016: Commendation granted to CEO from the Minister of Commerce, Industry, and Energy
- 2016: Provided/tested 10.5 brush sample

2017 ~ Present

- 2017: Took all the orders of cleaning devices BOE B9 10.5G D社,K社,S社 brushes in China
- 2018:
  - Obtained permission for construction of new factory
  - Expanded and relocated new factory
  - Newly established affiliated research office
  - Completed development of 10.5G deflection improving brushes (including shaft)



1-4. Current Status of Patent

No.	Patent registration number	Date of registration	Patent name
1	Patent 0481734	2005.03.30	How to manufacture shaft in channel brush roll
2	Patent 10-0914736	2009.08.24	Brush cleaning device for display glass
3	Patent 10-0622107	2006.09.01	Belt roller brush for display device cleaning
4	Invention I 300339	2007.09.01	用**来清洗**显示装置之玻璃面板的带状式滚筒刷 (Registered in Taiwan)
5	Patent 10-1059187	2011.08.18	Roller brush shaft for display glass cleaning
6	Patent 10-1336409	2013.11.27	Cleaning and transporting sponge roller and its manufacturing
7	Patent 10-1302808	2013.08.27	Cleaning and transporting sponge roller and its manufacturing
8	Patent 10-1307646	2013.09.05	PVA sponge manufacturing
9	Patent 10-1336535	2013.11.27	Cleaning and transporting sponge roller and its manufacturing
10	Patent D184174	2017.07.11	显示面板玻璃清洗用滚动刷用辊子 (Registered in Taiwan)
11	Design D184173	2017.07.11	显示面板玻璃清洗用滚动刷用辊子 (Registered in Taiwan)
12	Design 30-0881755	2016.11.11	Roller brush roller for display panel glass cleaning
13	Design 30-0881754	2016.11.11	Roller brush roller for display panel glass cleaning
14	Patent 10-1748493	2017.06.12	Cleaning disk brush unit
15	Design 30-0909628	2017.06.01	Roller brush roller for display panel glass cleaning

As of June 30, 2018, our company is in possession of 10 patents and 5 designs.

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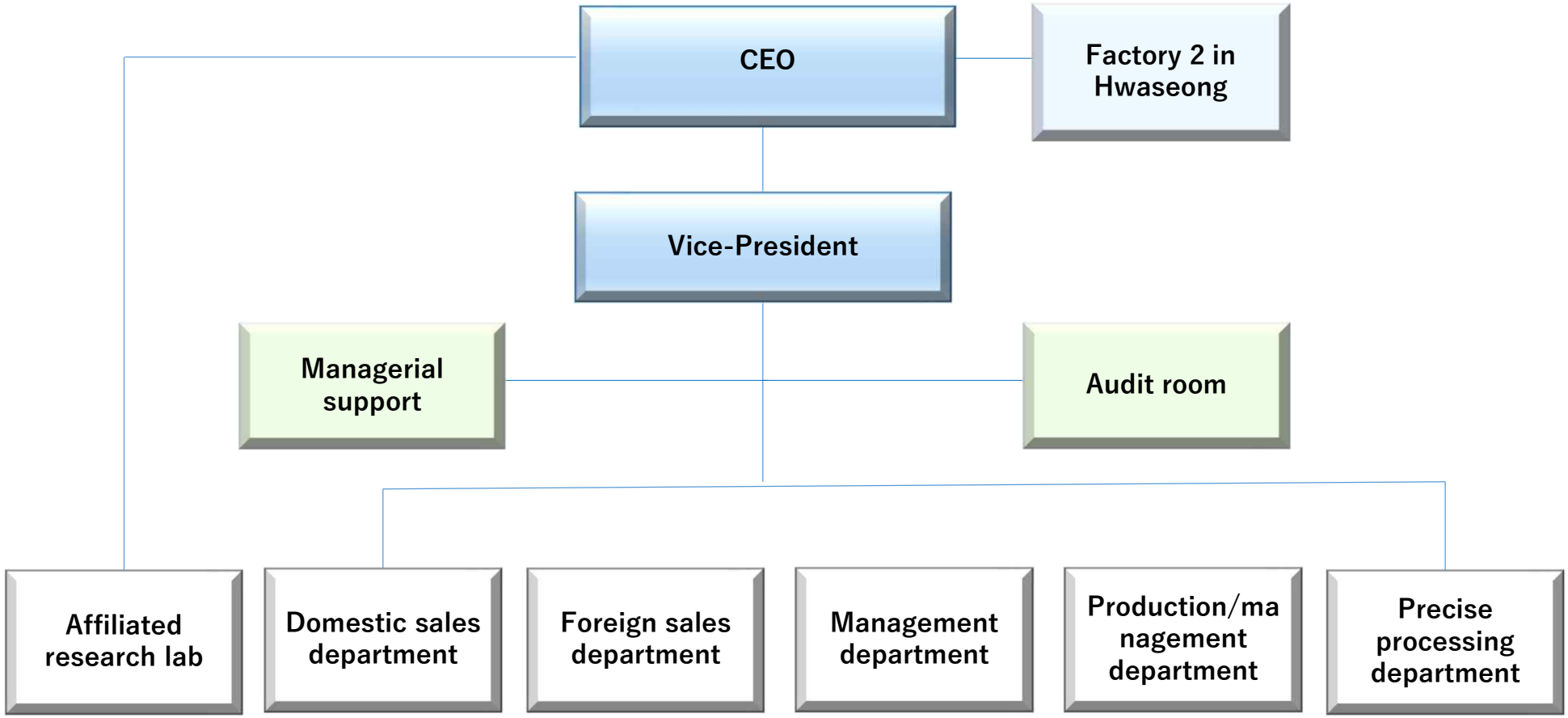
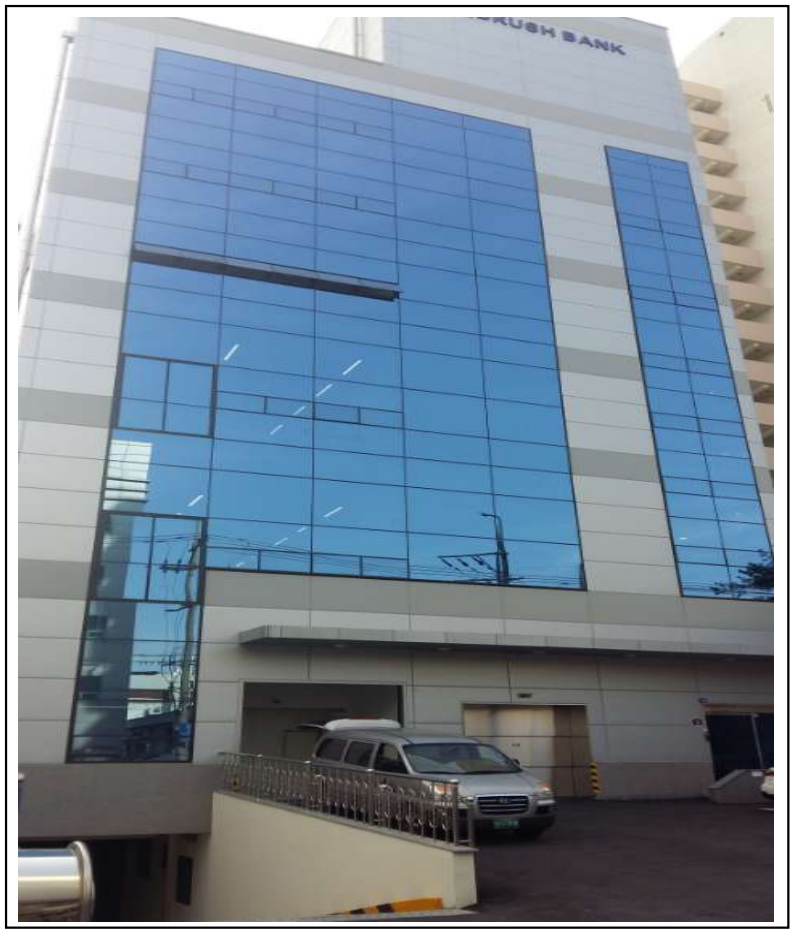
1-5. Organization of Our Company

As of: 2018.12.31



Total number of employees: 52

1-6. Current Status of New Factory



- Construction size : 1 basement floor/6 floors on the ground

Site area	**994.4㎡(301 py)**	**Construction area**	**596.33㎡(181 py)**
Building-to-Land ratio	**59.97%**	**Floor area**	**4,213.53㎡(1,277 py)**
Manufacturing facility area	**3,203.83㎡(970 py)**	**Auxiliary facility area**	**1,502.75㎡(455 py)**

- Factory location :293-16 Doksan-dong, Geumcheon-gu, Seoul, Korea
- Date of construction completion: January 17, 2018
- Date of relocation: March 9, 2018
- Purpose of construction for new factory
  - Necessity for securing the shaft processing facilities for mass production of brush above 10.5G and supplement manpower
  - Necessity of clean room for improvement of product quality and stable mass production and the expansion of size in each process

1-7. Location of Each Floor in New Factory

6F Major materials warehouse

5F Research lab/gym space

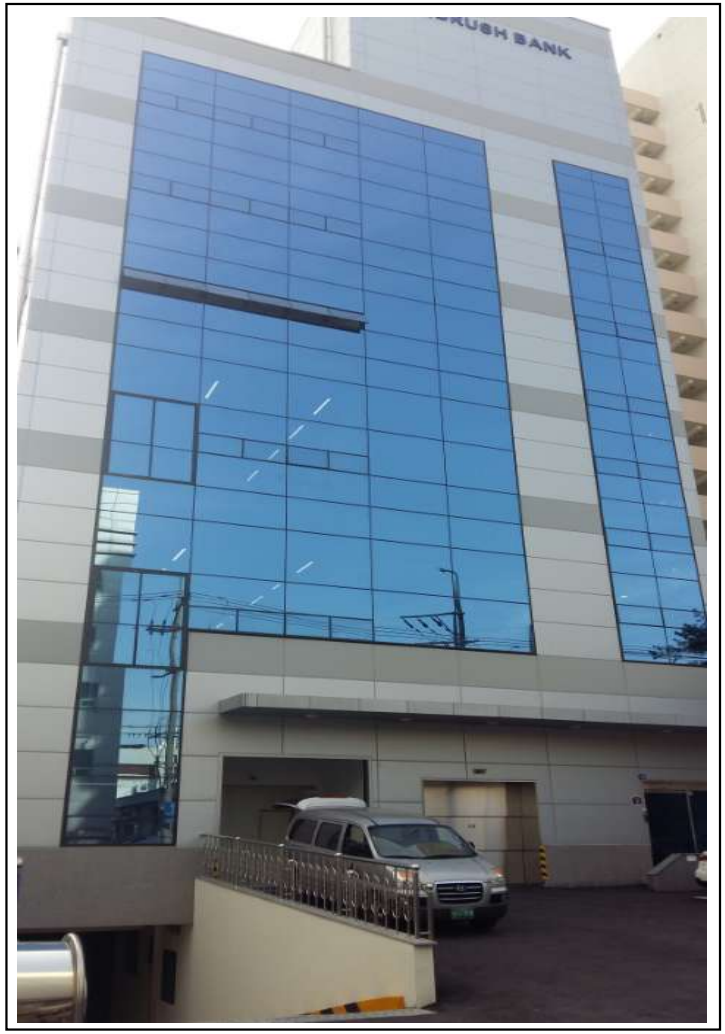
4F Office/meeting room/rest area for employees, etc.

3F Belt weaving, coating, and Channel Brush manufacturing process line

2F Brush Cutting, cleaning and packaging, and Punch&Disk manufacturing process line

1F Shaft precise process line

Base ment 1F Basement parking lot



1-8. Brush Manufacturing Capacity in New Factory/Raw Materials Suppliers

No.	Classification		Reference Spec'	Capa(EA/月)
1	Belt Type		10.5G/Ø80 X Ø110 X L36**(34**)	300EA/M
			8G/ Ø70 X Ø100 X L25**(22**)	400EA/M
2	Channel Type		10.5G/ Ø80 X Ø110 X L36**(34**)	300EA/M
			8G/ Ø65 X Ø100 X L25**(22**)	400EA/M
3	Disk Type		Ø70 X T30(L10)	10,000EA/M

- Expanded and reinforced facilities and devices to avoid problems on supplying brushes for 10.5G construction and mass production (LGD, BOE, CSOT, etc.) of clients of our companies with relocation of new factory in March, 2018 (Available to produce 800EA/month as of 8G specifications)
- There are two types of main raw materials; SUS Shaft and basic materials
  - -SUS Shaft: Seil STS (Origin: POSCO in Korea)
  - -Basic materials (Nylon/PFA Monofilament) : Toray (Origin: Japan) / DuPont (Origin: America)

2. Current Status of Main Global Clients

KOREA

LG Display
SAMSUNG
CORNING
C P M
LG化学
DMS
KCTECH
STI
SFA
JUSUNG ENGINEERING
TOP ENGINEERING
ILJIN

CHINA

BOE
华星光电 CSOT
TIANMA
CEC
中国电子 CHINA ELECTRONICS
东旭光电 Dongxu Optoelectronic
IVO
IRICO
GVO 国显光电
INESA 上海仪电
TRULY 信利

JAPAN

SHARP
IPS
SHIBAURA

TAIWAN

AUO
INNOLUX 群創光電股份有限公司

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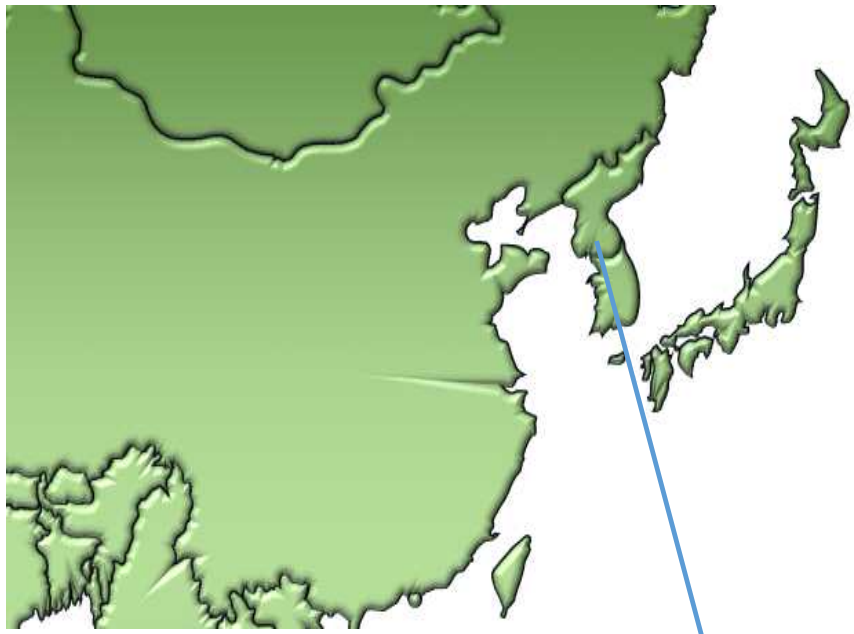
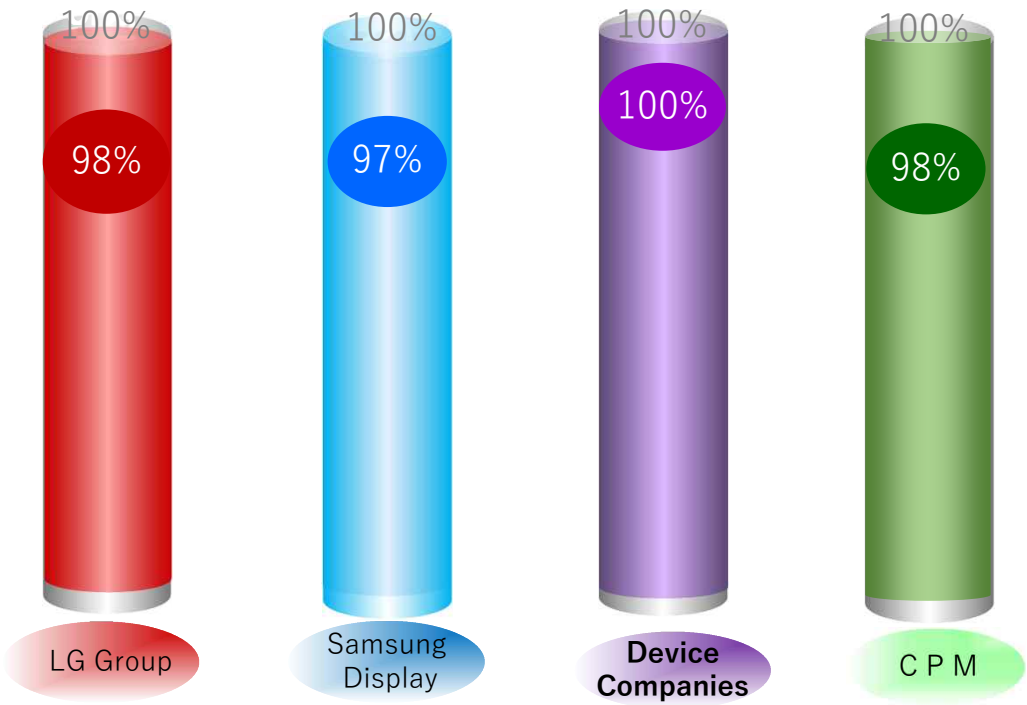
As of : 2018.06.30 in the first half of the year

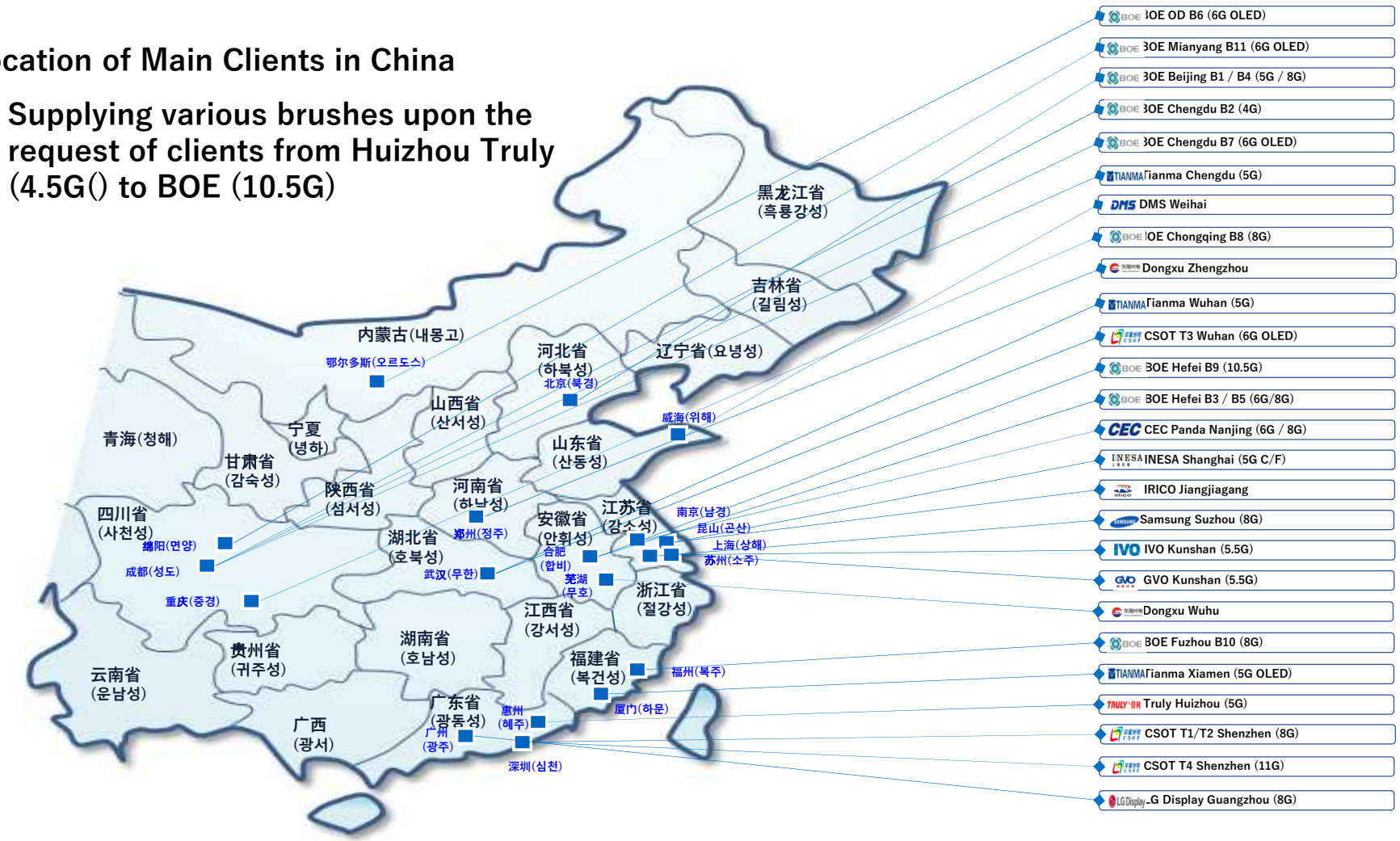
M/S of Main Clients for Direct Delivery in Korea





Location of Main Clients in China

- **Supplying various brushes upon the request of clients from Huizhou Truly (4.5G() to BOE (10.5G)**



3-1. Classification of Major Products

Belt Brush

- **Specialty and advantages**

Improve 10% of cleaning capability compared to current brush

Not left-overs on the objects compared to channel brush

Improved deflection phenomenon by making it light-weighted for more than 9% compared to existing brushes

Channel Brush

- **Specialty and advantages**

Seamless flow of cleaning fluid if cleaning

The most general Manufacturing type for production of existing brushes

Disk Brush

- Specialty and advantages

Conveniently removed vertical and horizontal particles

Inconvenient to attach and exchange due to attachment of many brushes

Punch Brush

- Specialty and advantages

Convenient manufacturing of various forms of Objects to be cleaned

Available to cope with cleaning environment on objects with curves

PVA Sponge

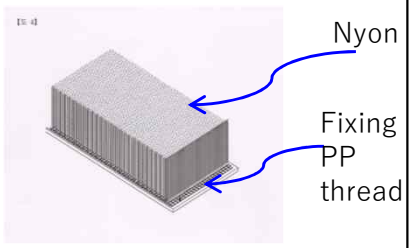
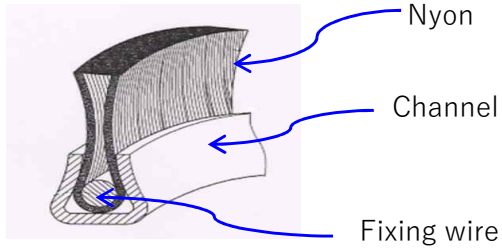
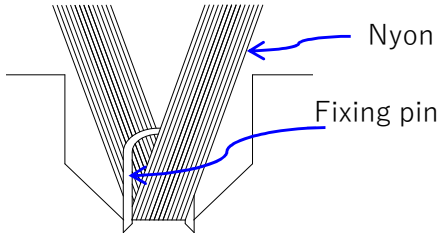
- Specialty and advantages

Brush with the most outstanding cleaning power among the current brushes

Short exchanging period (High adhesive power of foreign substances from strong absorbing power)

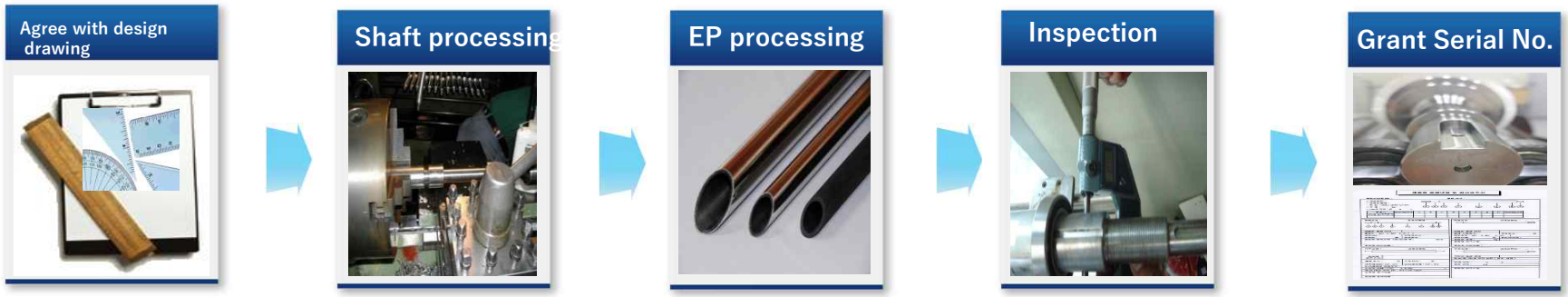
3-2. Types of Roll Brush Products

Comparison of Each Roll Brush Manufacturing

Classification	BELT TYPE	CHANNEL TYPE	PUNCH TYPE
Basic structure			
Advantages disadvantages	* High density * Decrease in weight from removal of SUS channel	* Available to manufacture with high density * Available to apply fine Nylon • Remove left and right of proceeding direction of foreign substances	• Remove foreign substances in front and rear direction of proceedings • Available to manufacture various materials, shapes, and structures
Notes			

3-3. Roller Brush Production Process

Shaft Production Process



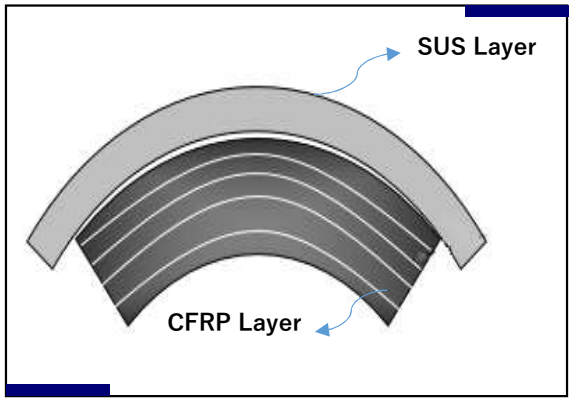
Brush Production Process

Clean Room

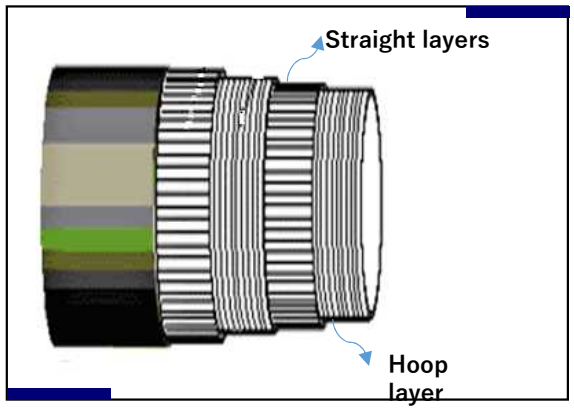
3-4. CFRP Applied Shaft Structure

CFRP (Carbon Fiber Reinforced Plastic) Structure Overview

Shaft Cross Section Structure



CFRP Cross Section Structure

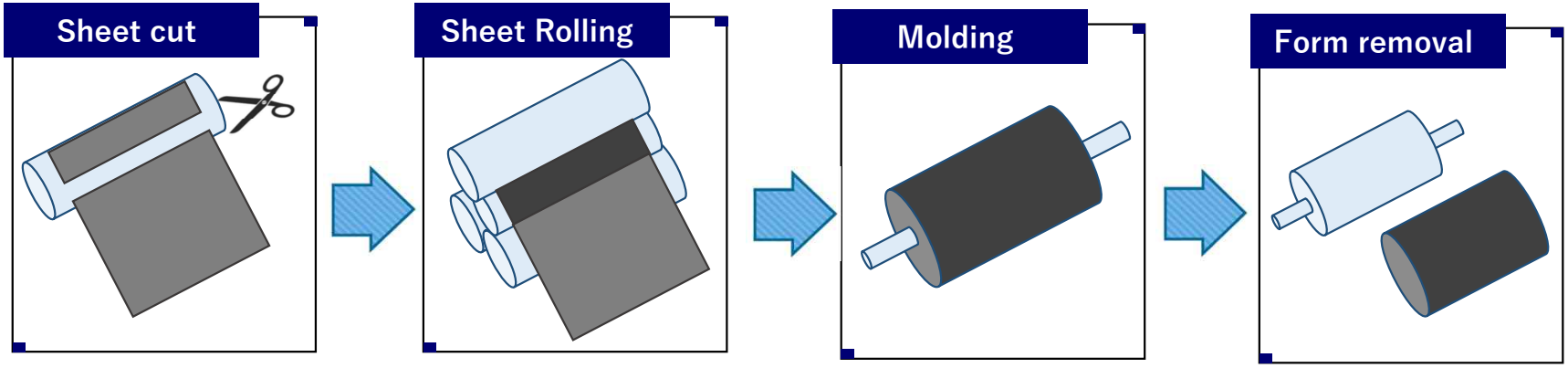


CFRP(Carbon Fiber Reinforced Plastic)

Carbon fiber made with carbon fiber reinforced plastic is classified into PAN and Pitch type depending on the materials and how they are made and also into CFRP, CFRM, CFRC, and CC depending on the reinforcing agent, Matrix Resin. As for industries where it is applied, there are space and aviation materials, electricity, electronics, civil engineering, construction, bio-medicine, vehicles, and sports materials in a wide range of application.

(Expanding the scope of application with advantages such as high intensity, high flexibility, and light weight, etc.)

3-5. CFRP Molding Process



- Rolling process applied by or company is to attach the carbon fiber on the mold rolling it by giving pressure on them. This is the most historical and stable process for manufacturing CFRP on the hollow shaft.
- Compared to other processes, it is easy to realize the progress of straightness. However, straightness of product is achieved after molding that it is important to manage cycle between molds. This process has a short amount of time for preparation among manufacturing methods of CFRP and simple to apply. Therefore, it is very economically profitable and outstanding in mass production with short cycle time.

Number of possessed molds : 100PCS,cycle time: 2.5hrs ,1day/3cycle (8 hours)
Number of daily production : 60pcs/1day, ref.) 2,000pcs/1month

3-6. Purpose of Application of Light Weighted CFRP Shaft and Effect Analysis

Main purpose of light-weight of shaft

Effect of light-weighted brush

- **Significantly reduce the weight compared to existing hollow shaft**

Effect of preventing brush from being deflection

- **Significantly improve the deflection phenomenon on the brush with outstanding pressure load intensity**

- **Necessity of long brush from Large panel (7G, 8G, 11G)**
- **Oxidized and corroded bearing Realize to reduce (rust)**
- **Realize to minimize the deflection by the weight in case of rotation**
- **Realize to make it convenient when managing and replacing brush**

3-7. Purpose of Application of Light Weighted CFRP Shaft and Effect Analysis

Comparison of weight of shaft between existing SUS Shaft and CFRP applied shaft

Classification	SUS Shaft		Light-weighted Shaft	
Applied shaft materials	SUS 304		SUS 304 + CFRP	
Total length of shaft	2357 mm	2997 mm	2357mm	2997mm
Shaft diameter (external diameter)	Ø 48.6	ø 54	ø 48.6	ø 54
Shaft weight	17.2 Kg	19.8 Kg	8.4 Kg	10.4 Kg
Total weight (Brush included)	22.40 Kg	28.9 Kg	13.6 Kg	18.5 Kg
Weight reducing rate of shaft compared to existing SUS shaft			Reduced by 51.2%	Reduced by 47.5%
Reduction rate of total weight of brush compared to existing SUS shaft applied brush			Reduced by 39.3%	Reduced by 36.0%

3-8. Shaft Concentricity & Deflection Management (TEL 向 in Japan)

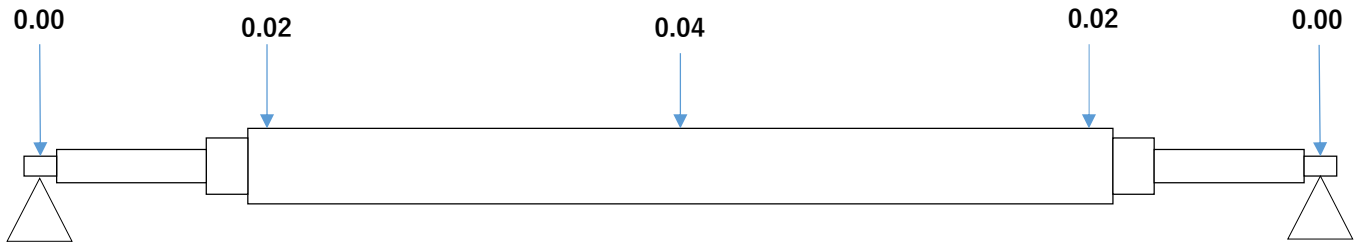
Concentricity management scope

L2990 concentricity measuring Data

· Measuring devices: Commercial shelves 3000 x 600
- Dial gauge
- Balance correcting device

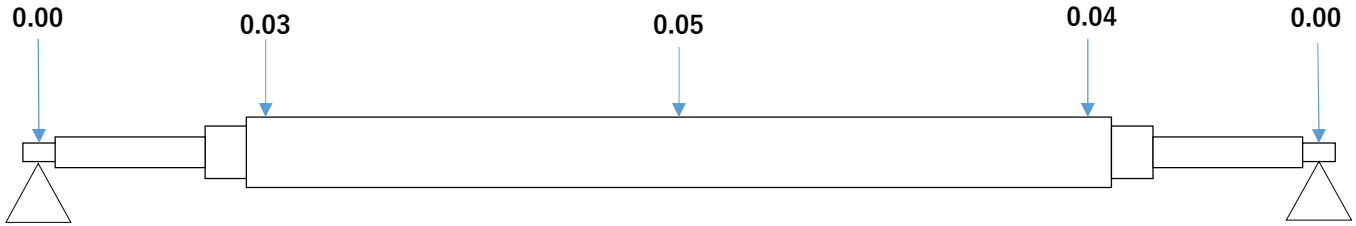
· How to measure : Measure 5 points including bearing (Measurement error: Based on the middle area in the range of ±0.03)

Manual rotation

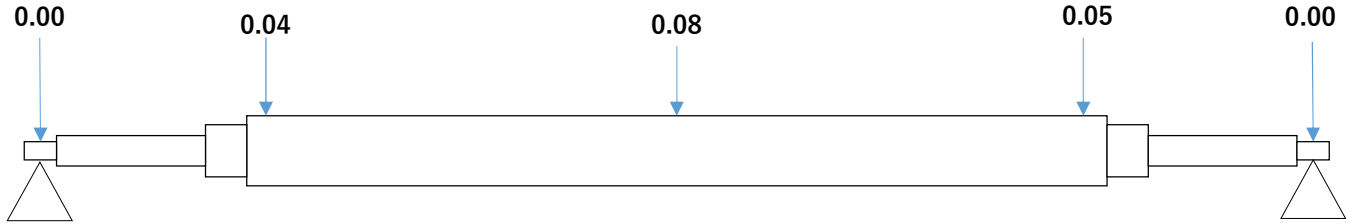


3-9. Shaft Concentricity & Deflection Management (TEL 向 in Japan)

- **In case of 500 RPM rotation**



- **In case of 700 RPM rotation**



- Reference : **It is difficult to identify accurate measures due to causes such as slight movement of shaft in case of 700rpm high speed rotation and shaking of digital gauge sensor. Therefore, average value is recorded.**

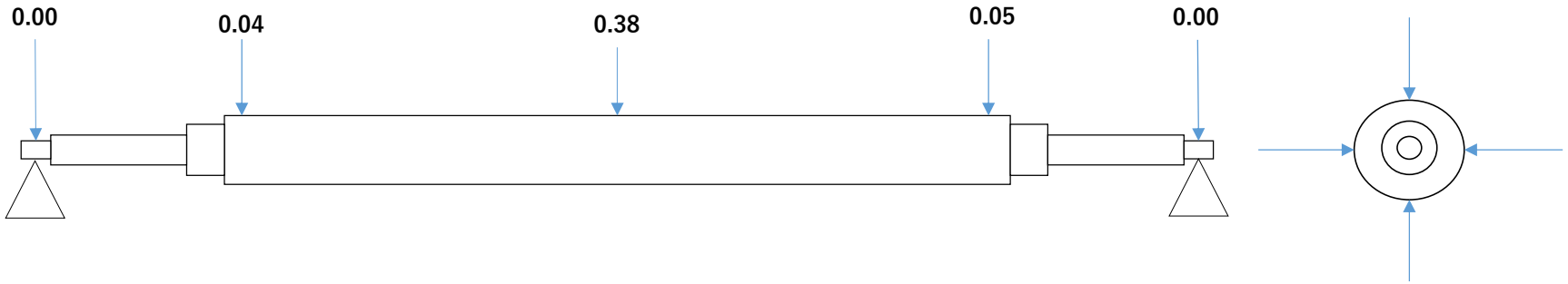
3-10. Shaft Concentricity & Deflection Management (TEL 向 in Japan)

Deflection Management Scope

L2990 Concentricity Measuring Data

- **Measuring Device : Granite surface plate 3000 x 600**
  Dial gauge

- **How to measure : Measure top fixed part in V block (Measurement error: ± 0.05 from middle area)**
  Measure 4 points in straight line

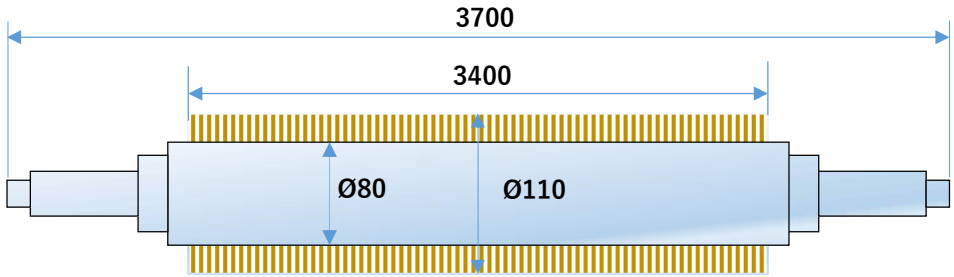


Reference: Deflection increases due to the weight of SUS coil and brush after winding brush,. As for the criteria of analysis in our company, there is deflection in about 0.7 to 0.8mm in case of completed goods.

3-11. Development of 10.5G or Higher Super-Light Shaft

- M/Glass Size:2900 x 3320

- Brush Spec' for development of 10.5G or higher: Ø80 x Ø110 x 3700(3400)



- **In need of long brush**
  → Necessity of long brush Corresponding to M/Glass Size (長面 3340mm or above)

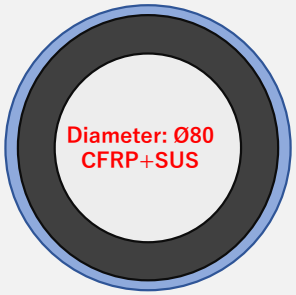
- **In need of expanding shaft external diameter**
  Improve stability in environment of using brush (Improve shaking/deflection of brush)

- **In need of light-weighted shaft**
  → Improve deflection from weight with light-weight

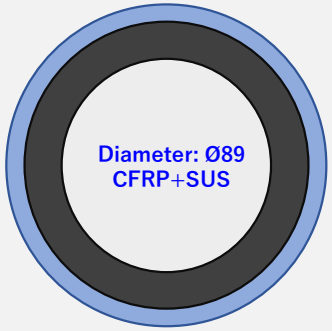
Existing Light-Weighted Shaft + Development and Application of Super Light-Weighted Shaft
(One Body for CFRP / Improve concentricity, straightness, and deflection)

3-12. Comparison and Analysis of 10.5G or Higher Super Light-Weighted Shaft Vs. Light-Weighted Shaft

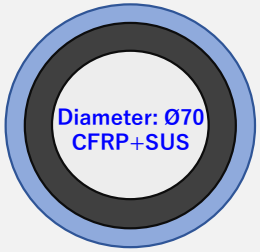
For exclusive development of 10.5G



For delivery of 10.5G to Demo



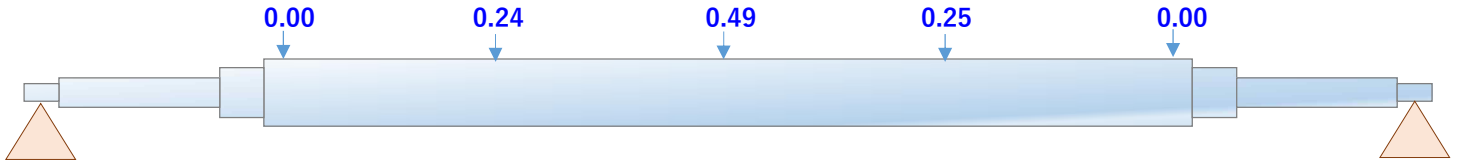
For delivery of 8.5G



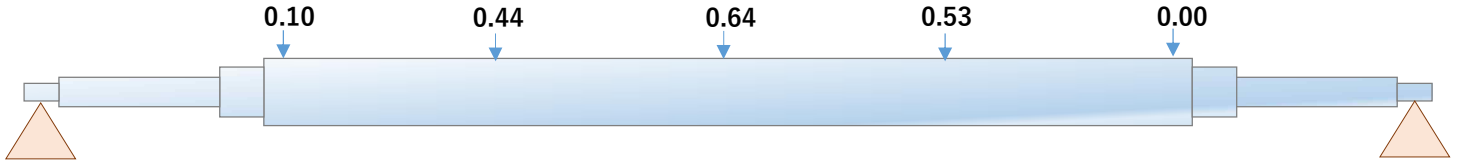
Classification	Ø80 x 36**(34**)-10.5G	Ø89 x 36**(34**)-10.5G	Ø70 X 25**(22**)-8.5G
Applied shaft materials	Super Light-Weighted SUS+CFRP	SUS+ CFRP	SUS + CFRP
Total length of shaft	36**(34**)	36**(34**)	25**(22**)
Shaft weight	17.5Kg	27Kg	14Kg
Total weight(Belt Brush)	25.5Kg	35KG	18Kg
Total weight (Channel Brush)	36.3Kg	47.3Kg	25Kg
Notes	• Super light-weighted shaft has innovatively improved concentricity and straightness with the process development of forced application of SUS pipe and CFRP as well as realization of one body of CFRP and also the deflection with light-weighted body while enhancing the stability of brush shaft.		

3-13. Comparison of Deflection of Super Light-Weighted Shaft Vs. Light-Weighted Shaft

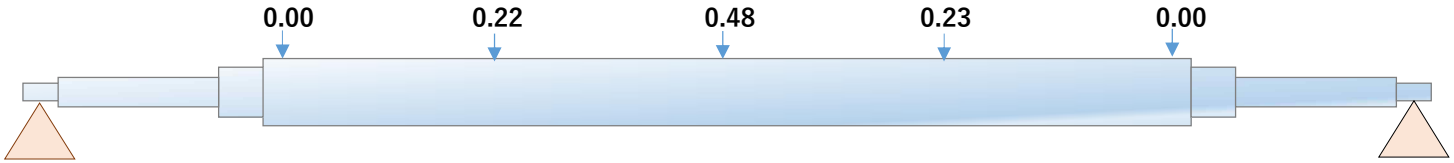
- **Super-lighted weight Shaft 10.5G for exclusive development Ø80 x 36**(34**)**



- **10.5G Product for demonstration Ø89 x 36**(34**)**



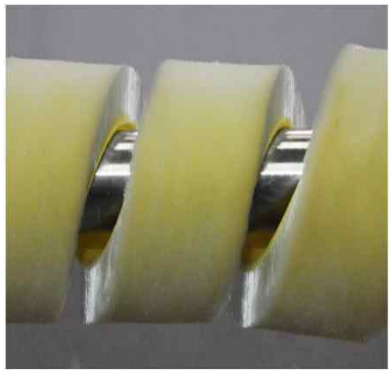
- **For delivery of 8.5G Ø70 x 25**(22**)**



※ Super light-weighted shaft is shorter in the length by 1,178mm compared to 25 for 8.5G, while the diameter of shaft increases by Ø10. Therefore, Ø80 has been applied. However, the Shaft weight increased by about 3.5kg, and deflection of shaft had almost the same result of data.**

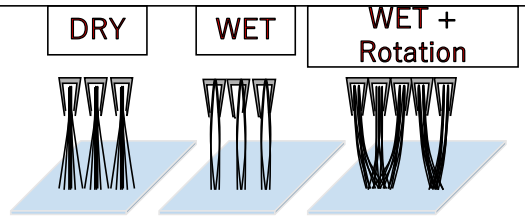
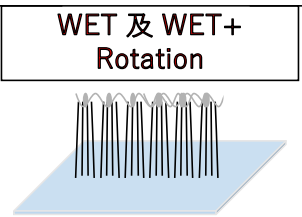
3-14. Brush Comparison between Belt type and channel type

Comparison of Each Winding Type

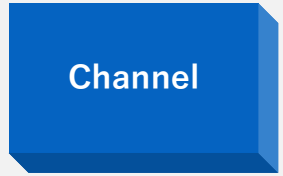
Classification	Channel Brush		Belt Brush	
Product image				
Winding image				

3-15. Brush Comparison of Belt Type and Channel Type

Comparison of Basic Materials When Cleaning

Classification	Channel Brush	Belt Brush
WET suspended status		
WET Rotating status (300 rpm)		
Fur materials status		

测量视频



测量视频

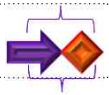
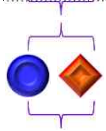
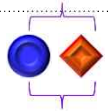
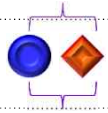
3-16. Brush Comparison of Belt Type and Channel Type

Comparative Analysis of Same Specifications

Classification		Channel Brush	Belt Brush	Difference
毛材	Diameter	0.05mm	0.05 mm / 0.1 mm	Same
	毛長	13 ~ 14mm	5 ~ 15 mm	Available to manufacture the lowest length of 毛長 up to 5mm
	種類	Nylon	Nylon 610, PP	Same
Shaft		Ø65 (SUS + CFRP)	Ø70 (SUS + CFRP)	Based on L2520
Winding conditions	Width	5 mm	10 ~ 60 mm	Prevent from falling down with smaller width compared to channel type. Increase of density. Relieve pressure between channels
	材質	SUS304 COIL	PP thread file	Reduce weight and prevent rust
毛's 密度		- 平均:190ea/㎟ - Channel 중 密度 : 276ea/㎟	251ea/㎟ (Based on Ø0.05)	Consistent fur density (Spec' management on density)
Deflection (SHAFT)		0.2 ~ 0.3 (Ø65)	0.15 ~ 0.25 (Ø70)	Brush 外徑 : Ø100, L= 2520 – Same conditions
Deflection (BRUSH)		0.5 ~ 0.6 (estimates)	0.35 ~ 0.45 (estimates)	Brush 外徑 : Ø100, L= 2520 – Same conditions
重量 (based on 8 generations)		* If changing existing Ø65 x Ø100 channel standards to belt specifications		
		Ø65 x Ø100 (CHANNEL)	Ø65 x Ø95 Reduced by 8.3 kg	External diameter: Based on 15mm毛長
			Ø70 x Ø100 Reduced by 6.2 kg	

3-17. QC List in Each Process

Explanatory Mark: :Inspection :process :Mobilization :Movement

No	Process name	Process	Measuring unit/Device	Management Items	Management Criteria	Management Cycle	Number of Sample	Managerial Method	In charge of	Actions in case of abnormal condition	Notes
1	▪ Material warehousing and import inspection		- Micro-meter - Vernier calipers - Dial gauge, etc.	-Foreign substances, appearance, physical properties, length, weight, and thickness	-Import inspection criteria	1 time/Lot	Total inspection	-Import inspection -Grade report	Materials	-Improvement measures after reporting	
2	▪ SUS process		- CNC - Shelves - Welder, etc.	.-Manufacturing drawing	-Manufacturing drawing criteria (clients)	1 time/Lot	Total inspection	-Standard work management criteria	Worker		
3	▪ EP process		- Outsourcing process	-Form, foreign substances, and surface, etc.	-Import inspection criteria	1 time/Lot	Total inspection	- Import inspection	Materials	- Improvement measures after reporting	
4	▪ Concentricity adjustment and measurement		-Pneumatic machine - Micro-meter - Dial gauge	-Concentricity: 0.05mm or less - Bearing allowance: ±0.02	-Standard work management criteria (In-company management criteria)	1 time/Lot	Total inspection	Standard work management criteria	Worker		-Process inspection grade report (Concentricity)
5	▪Planting/winding process		- Planting equipment - Loom	- Manufacturing drawing	- Manufacturing drawing - Standard work management criteria	1 time/Lot	Total inspection	-Standard work management criteria	Worker		
6	▪ Cutting process		-Cutting machine - Micro-focus	-Normal cutting rate : 90% or above	-Standard work management criteria (In-company management criteria)	2 times/Lot	Total inspection	-Standard work management criteria	Worker		-Process inspection grade report
7	▪ Cleaning process		- Cleaning room -Cleaning detergent - Dry room	- Foreign substances and appearance	-Standard work management criteria	2 times/Lot	Total inspection	-Standard work management criteria	Worker		
8	▪ Package process inspection		- Clean/package room	-Foreign substances, appearance, and Spec, etc.	-Standard work management criteria	1 time/Lot	Total inspection	-Standard work management criteria	Worker		-Final report -Grade report
9	▪ Release		- Difference						Materials		

Release Inspection Grade Report (Manufacturing Complete)

ROLL BRUSH 出厂报告书

CUSTOMER			
PART NO	71C07110000009	HS.CODE	9603.5
SPEC	Ø65X(Ø100XL2240(2520) Nylon 612 0.07mm		
P/O. NO	4500095604	TEST DATE	30-Apr-2018
QUANTTY	4EA	CHARGE	Kim Jae Min

检验项目	材质规格 (检查基准)	检查工具	检查结果	
1. SHAFT 材质	SUS 304	Electro Polishing Grinding IPA Washing	检验完毕	合格
2. NYLON 材质	NYLON 612	品质保证书	检验完毕	合格
3. FILAMENT 厚度	ø0.05	Micro-meter	检验完毕	合格
4. BRUSH 成品外径	Ø100 ± 0.15	DIGITAL VERNIER CALIPERS	检验完毕	合格
5. SHAFT 外径	ø65xL2530 EP	数码显微镜	检验完毕	合格
6. SHAFT 同心度	管理偏差 0.05 (平均检查0.03~0.05)	DIAL INDICATOR	参考 检查表	合格
7. BRUSH毛密度	见本限度	肉眼检查	检验完毕	合格
8. BRUSH 清洗度	1次. 洗净剂+ 过滤水清洗 2次. 过滤水清洗	数码显微镜	检验完毕	合格
9. 毛切单面状态	见本限度	数码显微镜	检验完毕	合格
10. 出货(包装)状态	PVC BOX 聚丙烯 BOX ACETATE 包装	肉眼检查	检验完毕	合格
综合判定	合 格			

BRUSHBANK Co., LTD

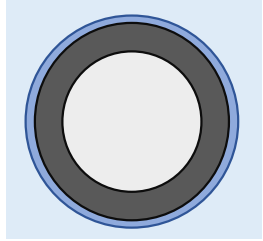
- Proceed inspection according to QC items in each process and prepare for manufacturing history card in each serial number
Check the final release grade report and issue based on the inspection grade report in each report

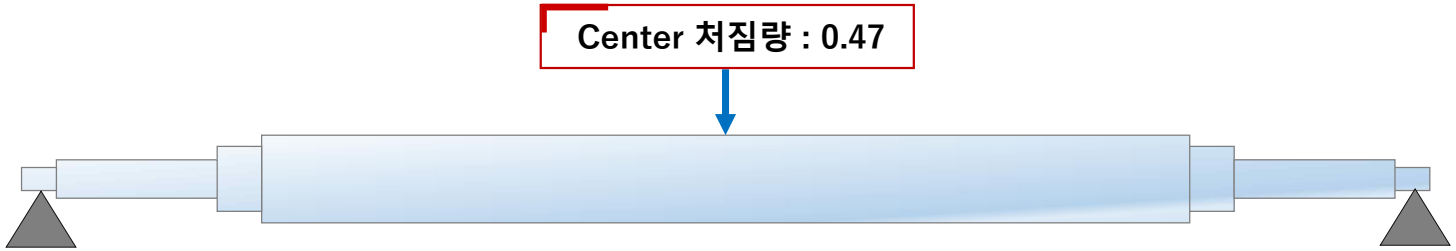
3-18. New Materials/Technologies Applied in 10.5G Brush

10.5G Improvement of deflection from application of CFRP High Ton

- Test Shaft Spec': Ø80 x 32** (SUS/CFRP-**24ton**)

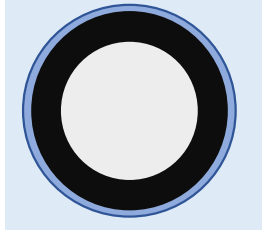
CFRP 24 ton

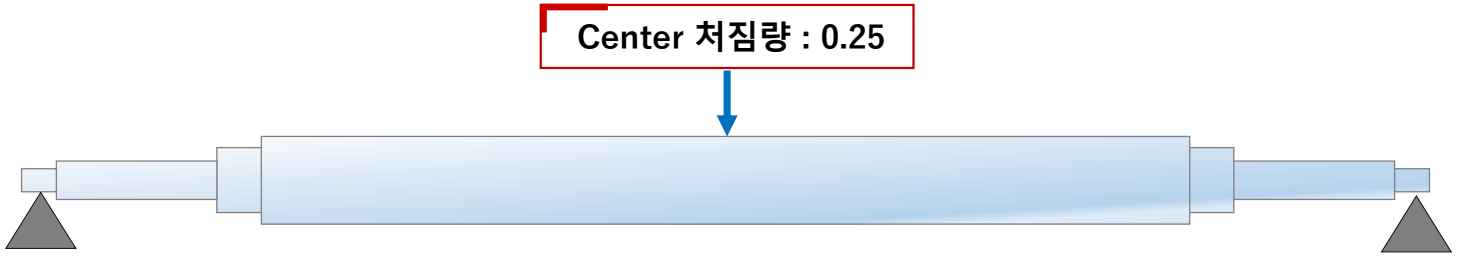




- Test Shaft Spec': Ø80 x 32** (SUS/CFRP-**30ton**)

CFRP 30 ton





- Results of test for improvement of deflection : Deflection was improved according to the results of measurement through mold-application of CFRP incorporated with 30 ton P.PREG and measurement of deflection of the same Spec' Shaft
- If you present the standard numerical value of brush's deflection which wraps the shaft , we can adjust and figure the deflection with you company's brush manufacturing technology.

Others (Q & A)

Confidential

E-Mail contents for response of Belt式 Brush Test results by Company S in Japan

サンプルブラシ評価に関して

받은 날짜 09분 20초
보낸 사람 @sharp.co.jp> 주소추가 | 수신차단
받는 사람 卓 様<brushbank0@empal.com>

BRUSHBANK
卓 様

シャープ亀山1工場、プロセス技術部の西宮です。
お世話になっております。

サンプルブラシですが洗浄装置への取付が完了したところです。

取付け後のパーティクル検査の結果では既存ブラシに対して約３０％
の洗浄効果アップを確認しました。

現時点で御社のブラシによる副作用等の品質トラブルもなく弊社での
使用が可能であることも確認できています。
パネル単位での評価を現在実施しており最終判断は8月頃になると思い
ます。

既存ブラシに対して御社ブラシは価格面でもメリットがあり今後の
展開についても前向きに考えたいと思っています。
その時はご協力をお願いします。

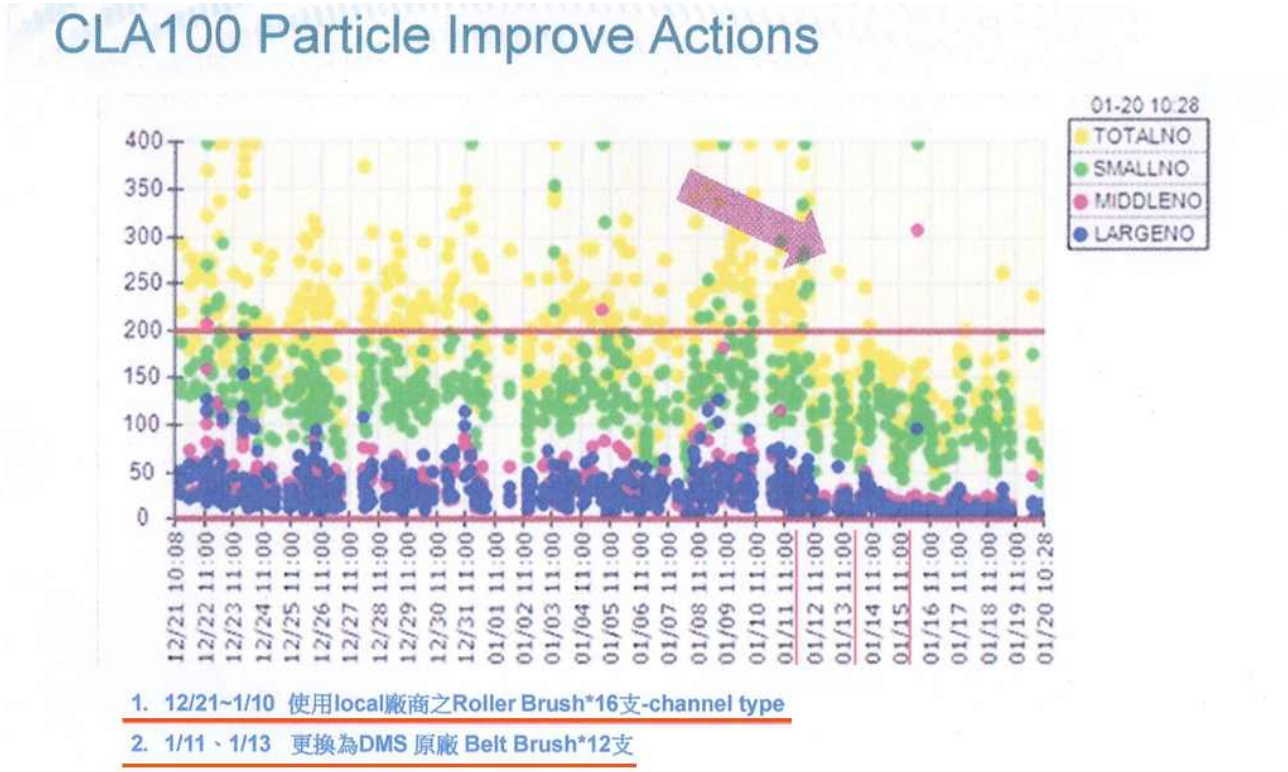
****
シャープ株式会社　ＡＶＣ液晶事業本部
　ＡＶＣ液晶第1事業部　プロセス技術部

- Notification of test results to be sent to Kameyama Factory of Company S in Japan

  - Cleaning power has improved by about 30% compared to existing brush, and there is no side effect or trouble by brush.

Others (Q & A)

Contents of Belt式 Brush Test results by台湾 A社

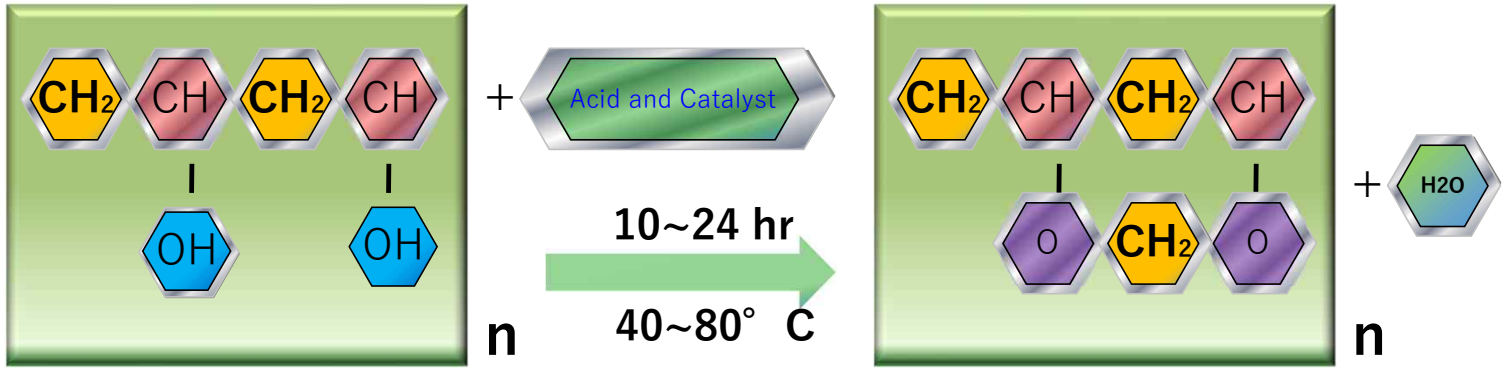


- **According to the results of**

Confirmation of cleaning power after applying Belt Brush 12EA from our company since January 11, 2015, after using Channel Brush 16EA up to January 10, 2015, there was a significant decrease in the number of particle on the Particle Counter Data.

4. PVA Sponge Product Overview

What is PVA Sponge ?



PVA RESIN
(Polyvinyl Alcohol)

PVA Sponge

What is PVA Sponge? : PVA sponge indicates an object made with open cell that is dense and consistent with the ingredient of polyvinyl alcohol and can be applied to various industrial fields through the colorization, formation, and process depending on the purpose of using.

4. PVA Sponge Product Overview

General Advantage and Specialty of PVA Sponge

I. Spiracles is comprised of Open-Cell

▪ Unlike existing Sponge products, it is comprised of open cell that more than 90% of volume is made of air holes

II. Possess outstanding characteristics of hydrophile property

▪Capable of absorbing water that is ten times of its weight

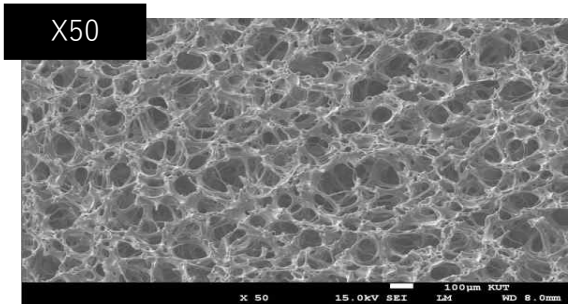
III. Possess outstanding characteristics of flexibility.

▪ No damage or scratch on the objects to be cleaned

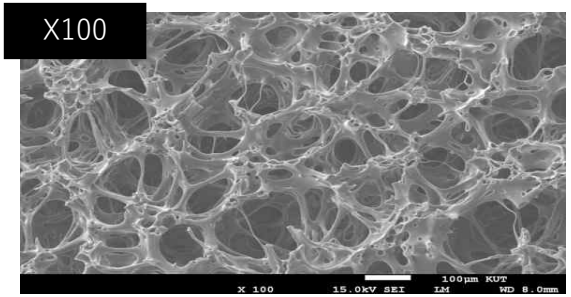
IV. Possess outstanding characteristics of cleansing power.

▪ Outstanding anti-corrosion and chemical resistance and available to use in cleaning process that requires precise cleaning

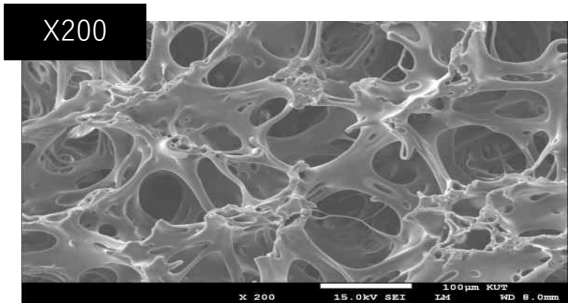
X50



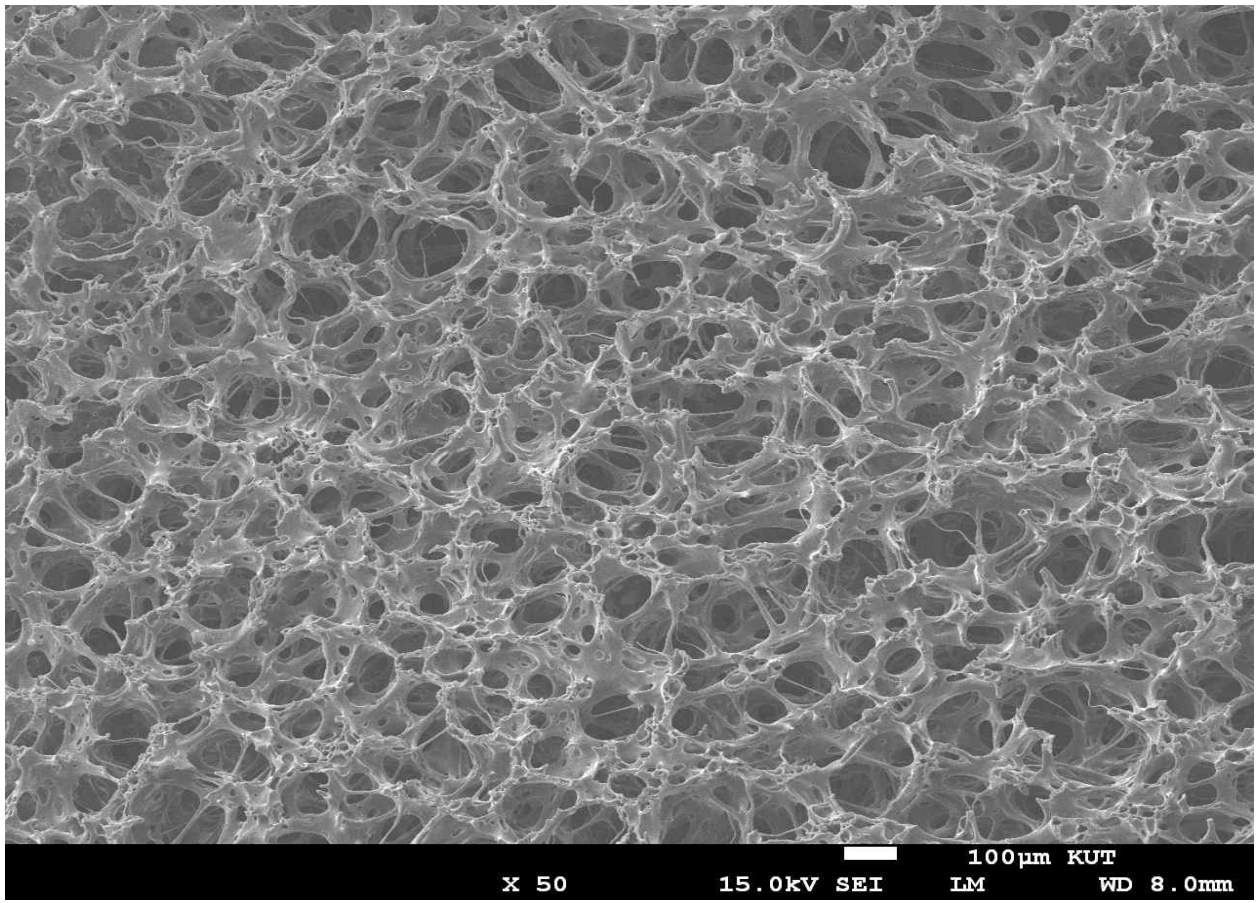
X100



X200



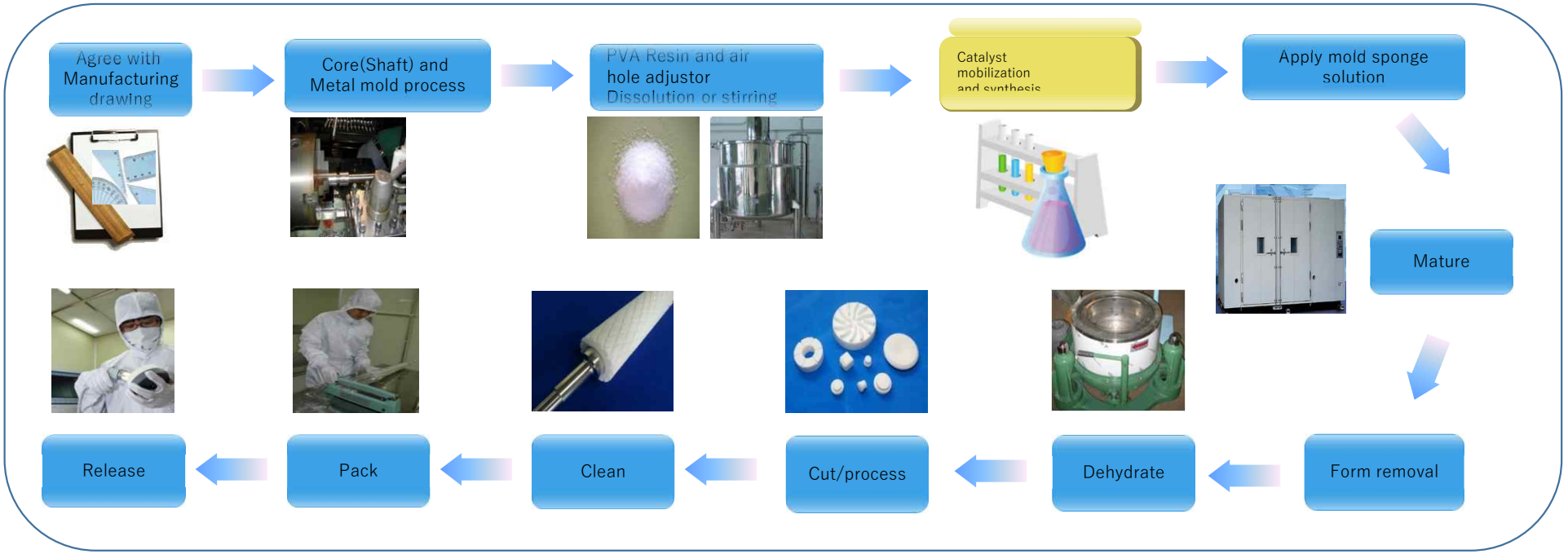
4. PVA Sponge Product Overview



Above is the photo in scale of SEM X50 on the brush surface with long part of Embossing Type (based on 8G).

4. PVA Sponge Product Overview

PVA Sponge Manufacturing Process



- Among the aforementioned process, agreement with drawing and process for mold manufacturing are omitted. As for long part (based on screw type), it is possible to cope with up to 3800mm without limitations on the specifications.
- PVA sponge products of our company have been made in the factory at Hwaseong-si, Gyeonggi-do. However, roll shaft has been processed in the factory In Seoul (Outsourcing for electrolytic polishing)

4. PVA Sponge Product Overview

PVA Sponge Production Technology by Brush Bank

• Matured release of sponge
Secure diversity in technology

Water tank maturing by the warm water and oven maturing type from heat as a part of knowhow.

Super precise shaft processing and secure PVA surface processing technology

Secure surface processing technology with the most stable processing technology in 0.05mm of shaft concentricity and the 3800mm concentricity of PVA sponge for ±0.15mm of surface processing technology

• Established joint R&D N/W with prestigious universities in Japan and professional companies abroad

- Concluded MOU with prestigious universities in Japan such as H大,C大,Y大 and also the affiliation for technology with Company F in Japan to realize the efficiency of technical development
- 3 patents in PVA sponge roller and 3 applications for patent

Matured release technology	Adhesive technology	Processing technology	Eco-friendly production technology	Secure R&D N/W

• Secure adhesive technology for perfect adhesiveness of SUS Shaft + synthetic resin film + PVA sponge

Use the adhesive of SUS Shaft + synthetic film + urethane to mature and fix PVA sponge (same as Aion Company in Japan)
-> Possess many other methods

• Secure eco-friendly production technology for fulfilling 100% of legal environment criteria

- Develop the alternative catalyst that reacts with PVA solution without using substances regulated with legal environment and apply them in production
- Bio-process of waste water from production process
- Bio-toxic test (water flea)

4. PVA Sponge Product Overview

PVA Sponge Roll Development Background

Increase of needs on display with high resolution for end users

- Realize 3800mm length for the first time in the world
  - **Available to cope with existing scratch occurring process**
  - **Develop long type roller brush of screw type and diamond for the first time in the field**
  - **One body beyond connected parts**

- Development History
  - **-Period:2010.6~2011.10**
    (Took 1 year and 4 months)
  - **-Number of people :7 (including cooperation of academic-industrial association in University C)**
  - **-Expense :1.5 hundred million KRW (facility, materials, Jig costs, etc.)**

Needs of panel manufacturer

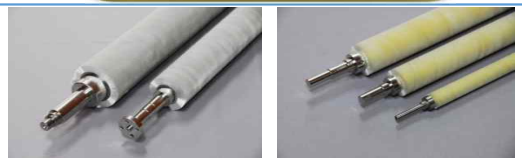
- In need of brush
  That can clean particles
  With size less than 0.5㎛
  →Not available to fulfill needs with existing nylon 毛材
  (In need of complete cleaning For manufacturing high Resolution panel)

- Nylon**毛材**Brush manufacturing technology
  PVA Sponge manufacturing technology combined
  →Small size particle cleaning
  Develop brush that can cope with them
  Recognize necessity

Brush Bank Infrastructure

4. PVA Sponge Product Overview

Nylon Vs PVA Comparison

Classification	Nylon Type Brush	PVA Type Brush
Brushing Concept		
Image and Cleaning Tool	 Tool: Wipe and clean particles based on the tension of nylon by adjusting 毛材 diameter and 毛長 of nylon (monofilament) (Nylon diameter:0.05/0.0635/0.08/0.1/0.2mm등)	 Tool: Wipe and clean particles based on the sponge surface by adjusting air hole size and types of surface of PVA sponge (embossing, flat type, screw type, and diamond type) (PVA air hole Size: Average120㎛)
Advantages/ Disadvantages from cleaning mechanism	Cleaning power: Effective in cleaning particles on objects with particles that exceed middle size → Not enough to completely clean fine particles less than middle size → →Replacement period: 3~6 months (Might be different depending on the belt criteria and environment)	Cleaning power: Effective in cleaning fine particles less than middle size and appropriate for process requiring stable and precise cleaning as 'no damage' and 'no scratch' on objects →Replacement period: 2~4 months (Might be different from brush management and environment of usage)

4. PVA Sponge Product Overview

PVA Sponge Roller (Screw Type)

PVA Sponge Roller (Diamond & Embo Type)

Purpose :Realized long axis for the first time in the world (10.5G用)

- Shaft is available for custom-manufacturing depending on the request of customers including SUS, PP, and PVC, etc. As sponge is directly applied to the shaft, squeezing or deviating phenomena of sponge are minimized in the use.
- With precise processing and manufacturing with less than 0.5mm of shaft concentricity and less than 0.15mm of the entire concentricity, it is possible to clean for display panel manufacturing process requiring precise cleaning and stably cope with them.

-LCD, OLED Panel manufacturing process: TFT Array , C/F, Cell process, etc.

- After increasing and attaching mask (Gate, S/D, metal, etc.), it is possible to stably use the process with scratch when cleaning with nylon fur brush
- Available to produce in the brush external diameter and length relevant to 3G – 10.5G (realize long axis for the first time in the world)
- Developed screw type sponge brush for the first time in the field and secured manufacturing technology such as diamond type and embo type

→Embossing type is manufactured with one body manufacturing type instead of connecting type

-LCD Panel Glass plate manufacturing process

Available to be used for cleaning process in need of more precise cleaning without causing damage or scratch on the plate in initial cleaning and rinsing process on the glass plate

Available to produce in corresponding with brush external diameter and length relevant to 3G to 10.5G

4. PVA Sponge Product Overview

PVA Sponge Roller (Flat Type)

Physical Characteristics :

Classification	Unit	Scope
Porosity	%	90~92
Average air hole	μ	100~140
Elasticity	kg/㎠	10~25
Density	g/㎠	0.1~0.13
Absorbing rate (dry)	%	900~1000
Absorbing rate (dehydrating)	%	400~450
Hot water limit Tmp : Max 70°C		

Purpose

- LCD,OLED panel Glass cleaning and processing
- Available for glass cleaning, solution, and absorption
- If solutions are different in each process, it is possible to use to distinguish the boundary of solutions
- Available to produce in corresponding with external diameter and length for 3G-10.5G
- No damage on the objects to clean by precise processing and manufacturing within 0.2mm of the entire brush concentricity in shaft

- Used for PCB circuit plate cleaning/solution/absorption

-LCD Panel process

• Effective in using in the cleaning process that can easily cause damage or scratch

- Available to use for solution or absorption

4. PVA Sponge Product Overview

PVA Sponge Roller (Disk Type)

Physical characteristics :

Classification	Unit	Scope
Porosity	%	90~92
Average air hole	μ	100~140
Elasticity	kg/㎠	10~25
Density	g/㎠	0.10~0.13
Absorbing rate (dry)	%	900~1000
Absorbing rate (dehydrate)	%	400~450
Hot water limit Tmp : Max 70°C		

Purpose :

-LCD Glass plate manufacturing process

• Available to maximize the
Cleaning effect with set on the process in need of cleaning
With Embossing Roller Brush if cleaning glass

-Semi-conductor: If processing Wafer CMP and cleaning.

•Available to manufacture with disk type and size
Corresponding with the wafer size of cleaning and cleaning environment

-LCD Panel process

• Cleaning process in various forms
In the cleaning process in need of strong cleaning in various areas

Production specifications: Available to produce with request of customers

4. PVA Sponge Product Overview

Non-adhesive PVA Roller Brush

Problem of existing adhesive method

• Use in the high-temperature cleaning environment (Use 40 to 70℃ DI Water)

-> Degrade cleaning power and cause the second particle from the possibility of chemical foreign substances in the adhesive

• Clean with continuous rotation for brush (300 to 600rpm)
->Degrade adhesive power of adhesive that anchored the core (shaft) part and PVA sponge part from cleaning in the rotation and causes gap and deviation of PVA sponge

→Cause degrade cleaning efficiency and destruct objects with degraded contact of objects by brush (glass and panel)

Solution

• In need of development of anchored and close brush to be used regardless of cleaning envvronment without using adhesive for cleaning core (shaft) and PVA sponge part

Grasper部 development + Sponge manufacturing

Develop non-adhesive PVA Sponge Brush

Resolution of issues

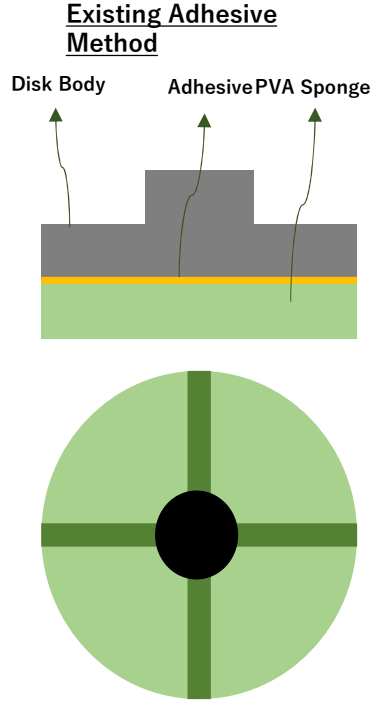
1. Zero foreign substances by adhesive
2. No second particles from adhesive
3. No deviation or gap of PVA sponge from high speed cleaning in rotation
4. Improve contact part of objects to be cleaned with unified brush (core + PVA sponge)

※ 註 : Grasper part of our company configures core (shaft) part as well as net (use PET type synthetic resin net) and anchored screw to make PVA sponge liquid completely absorbed on the net prior to releasing sponge to unify the Brush without using adhesive.
In addition, technology such as the manufacturing concept of this non-adhesive PVA sponge roller is based on the “patent application Number: 10-2012-0027716” as our company’s exclusive technology.

4. PVA Sponge Product Overview

Non-adhesive PVA Disk Brush

1) Configuration and Problems of Existing Disk Brush



Configuration and Problems of Existing Disk Brush

• Configuration: Disk Body部 + adhesive 部 + PVA Sponge部

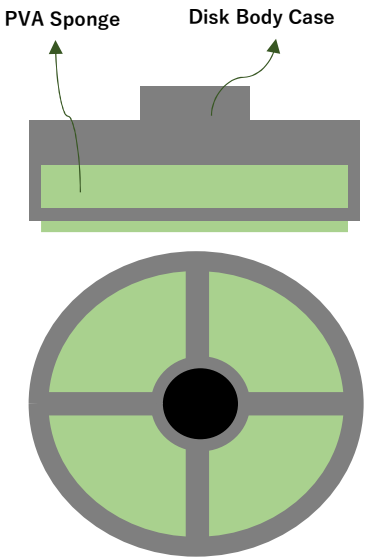
• Problems from cleaning environment (high temperature DI water/high speed cleaning

-> Cause second particles and degrade in cleaning power from possibility of emission of foreign chemical substances from adhesive
-> Degrade in adhesive power in adhesive with body part and PVA sponge part in Disk brush from cleaning in high speed rotation causing gap and deviation of PVA sponge
-> Degrade in contact power of objects to be cleaned with brush (glass and panel, etc. causing degrade in cleaning efficiency and destruction of objects

4. PVA Sponge Product Overview

Non-adhesive PVA Disk Brush

Non-adhesive method of our company



Resolution of Problems of Disk Brush

1. Zero foreign substances from adhesive

2. Does not cause second particle from adhesive

3. No gap on sponge or deviation from high speed rotation

4. Improve the manufacturing production cost competitiveness
- Semi-permanent use of disk body case
- Replace brush and reduce attachment/detachment time
- Reduce cost only by replacing PVA sponge if replacing brush after using

5. Eco-friendly products
- Reduce wastes with body case recycle
- Minimize environment pollution from not using adhesive

Image of completed good

Body Case surface (bottom)

Conclude top and bottom of body case

Body Case top/ Sponge

Body Case+Sponge connected

4. PVA Sponge Product Overview

PVA Sponge Chemical ResistanceTest

No.	Chemicals	Effect(Results)
1	Acetic Acid 1%>	Available
2	Ammonium Hydroxide 5%>	Available
3	Ammonium Hydroxide Conc.	Hardened
4	Acetone	Expanded
5	Acetone 20%>	Available
6	Alkali 5%>	Available
7	Benzene	Available
8	Chloroform	Intruded
9	Cresol	Intruded
10	Citric Acid 5%>	Available
11	D.M.F	Intruded
12	DMSO	Intruded
13	Ether	Available
14	EDTA 10%>	Available
15	Ethanol 10%>	Available
16	Ethanol 10%<	Intruded
17	Ethyl acetate	Available
18	Freon solvent	Available
19	Hydrofluoric Acid 5%	Available
20	Hydrogen peroxide 3%>	Available
21	Hydrochloric Acid 2%>	Available

No.	Chemicals	Effect(Results)
22	IPA 8%>(Isopropyl Alcohol)	Available
23	IPA 8%<(Isopropyl Alcohol)	Intruded
24	Mineral oil	Available
25	Methanol 20%	Available
26	Methanol 99-100%	Available
27	Methanol 20-80%	Intruded
28	M.E.K	Expanded
29	Ozone	Intruded
30	Oil and Fats(,油脂)	Available
31	Phosphoric Acid 5%>	Available
32	Phenol solvent	Intruded
33	Sodium hydroxide conc.	Hardened
34	Sodium hydroxide 5%>	Available
35	Sulfuric acid 5%>	Available
36	Tetrahydrofuran	Available
37	Toluene	Available
38	Trichloroethylene	Intruded
39	Tetrachloroethylene	Intruded
40	Trichloroethane	Available

- Evaluation on chemical resistance test above are the results by applying in each chemical
- Since results of test on chemical resistance are subject to be different depending on conditions, make sure to test before using.

5. Q & A

THANK YOU!

BRUSH BANK CO.,LTD