

廠務技術研討會

半導體封裝研磨廢水回收技術與 矽泥再利用

Grinding Wastewater Reclaim Technology & Silicon Sludge Reuse for
Semiconductor Assembly Industries

彭柏頤

矽品精密工業股份有限公司

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OUTLINE

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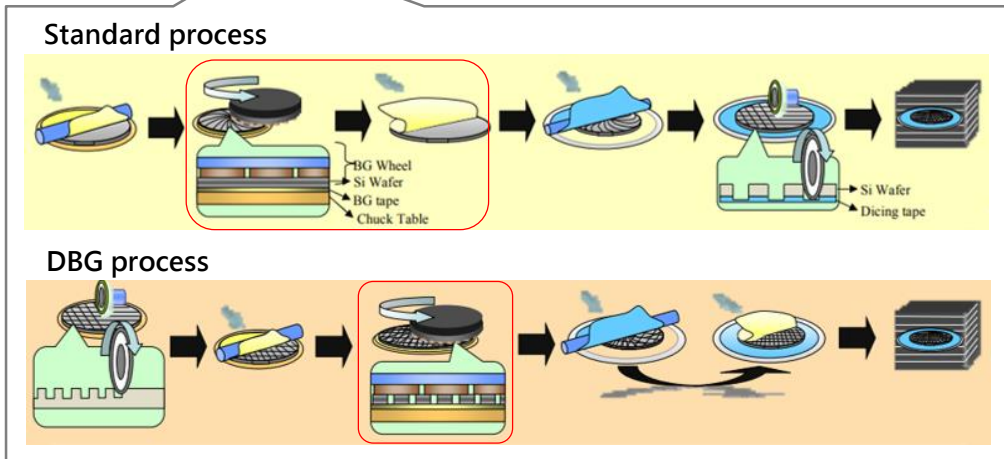
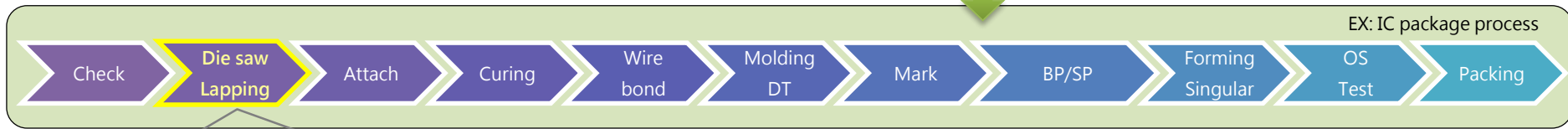
Introduction

Preface:

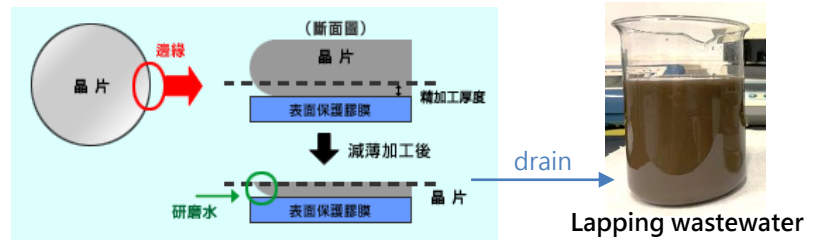
In semiconductor manufacturing, IC packaging is the final stage of semiconductor device fabrication, semiconductor material is encapsulated in a case that prevents physical damage and corrosion. The case, known as a "package", supports the electrical contacts which connect the device to a circuit board.



IC Design → Semiconductor Fabrication → **IC package & test** → PCB assembly



Lapping / Grinding ↓

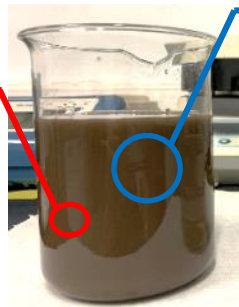


- IC card: Target Thickness 30~80um
- Stacked Package: Ultra thin die (Target thickness 25~50um)

Introduction

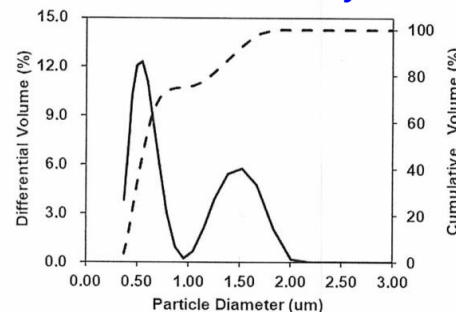
Lapping Wastewater Quality:

Conductivity: 3.0 $\mu\text{s}/\text{cm}$
Turbidity: 9600 NTU
Total Solids : 821 mg/L
Total Organic Carbon : 1.1 mg/L
Silicon dioxide : 125 mg/L
pH: 7.4



Particle diameter: 400~700 nm

Particle Size Analysis



Statistics Table

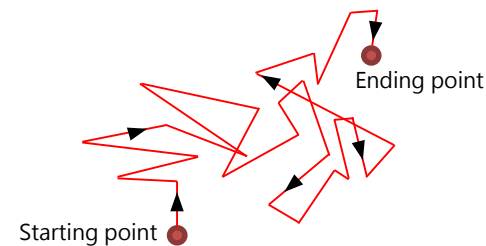
Size (nm)	Percent(%)	Accumulation
<300	3.80%	3.8%
400-500	17.00%	20.8%
500-600	24.41%	45.21%
600-700	19.78%	64.99%
700-800	8.84%	73.83%
800-900	1.20%	75.03%
1000-1500	12.14%	87.17%
1500-2000	12.62%	99.79%
>2000	0.21%	100%

→ How to do:

1. Check particle size of LP wastewater.
2. Choosing right method to remove turbidity or TS.

What's characteristic of lapping particle:

- a. Lapping wastewater particle diameter was analyzed, the results shown the size between 400nm and 700nm.
- b. Brownian motion and steady in liquid of lapping particles.
- c. Lapping wastewater is difficult to remove and separate by filter.



Brownian motion

Methods

Origin:

- Why don't we use the membrane filtration directly?
- ✓ Actually, We did, but that requires large amount of water for backwash.
- ✓ Most ultrafilter acceptable limit of turbidity is 300 NTU. (see table)

Items	LP Raw Water	DOW 2860	HYDRAcap MAX
Turbidity	9600 NTU	max < 300	max < 300
Total Solids (TS)	821 ppm	max < 100	-
Particle/Pore size	400-700 nm	30nm	80nm

Common methods :

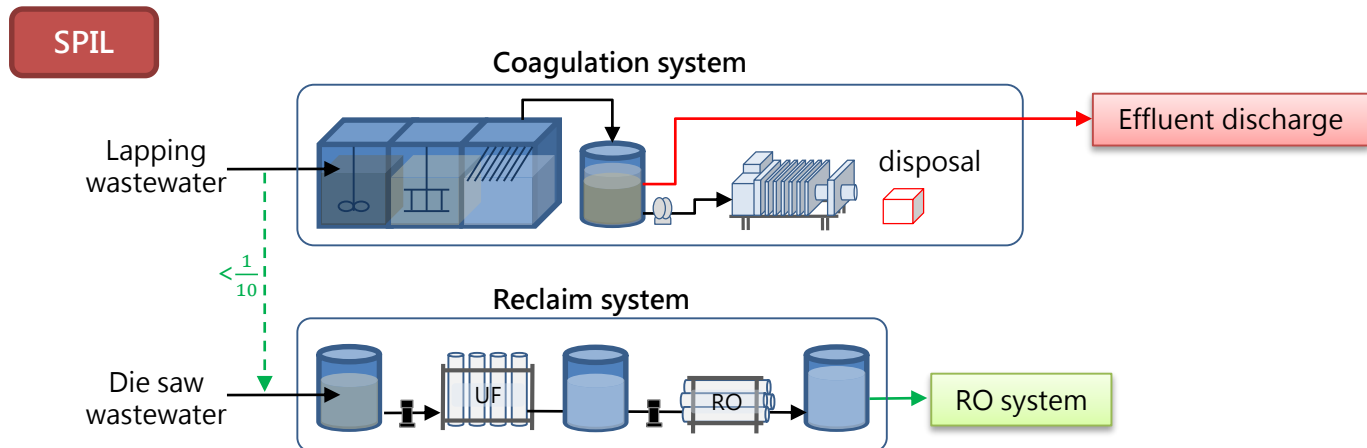
Methods	Reclaim	Slurry	Description
1. Chemical treatment	N	Y	traditional solution
2. Dissolved air flotation	N	Y	low specific weight
3. Membrane treatment (UF)	Y	Y	have limit & colloidal fouling
4. Filter treatment (candle)	Y	Y	similar UF & slurry out

Consideration

- Effective? Water quality?
- High concentration slurry ?
- Running & PM cost ?



Need pretreatment



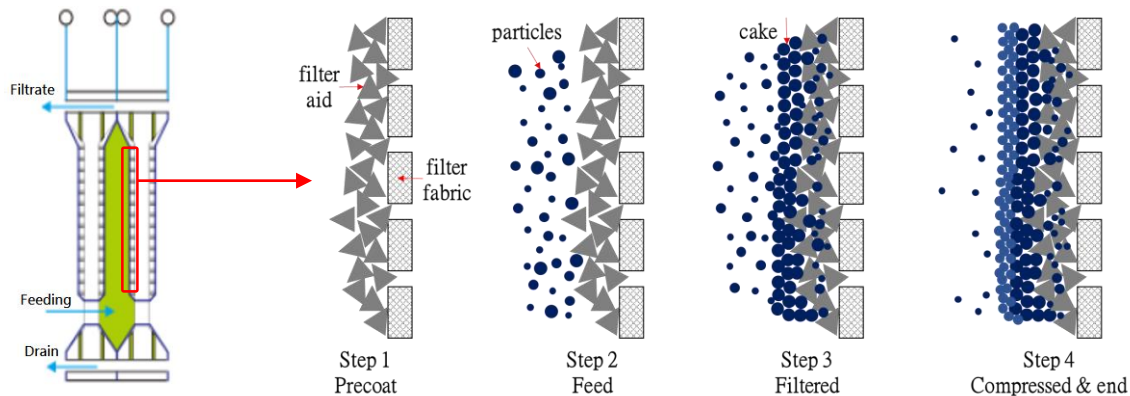
Methods

Pre-Treatment Technology : → Precoat filter aid + Frame filter

What ' s Filter aid?

→ filter aid pretreatment may improve filtration properties and efficiently remove the fine solids.

Principle of precoat:



The detailed tactics of this process is that we pre-coated the filter aid on filter fabric and build a filter bed by grind the particle in lapping wastewater to physically separate silicon particles.

© Types Of Filter Aids:

Diatomite, perlite and cellulose are the filter aids most frequently used in industry.

© Filter aid key properties:

- ✓ Consist of rigid, complex shaped
- ✓ Form a permeable, stable
- ✓ incompressible filter cake
- ✓ Remove fine solids at high flow rates
- ✓ Remain chemically inert
- ✓ Insoluble in the process liquid

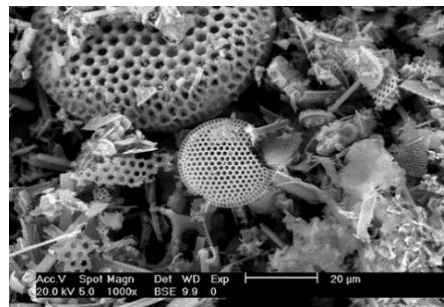


Figure1. DIATOMITE

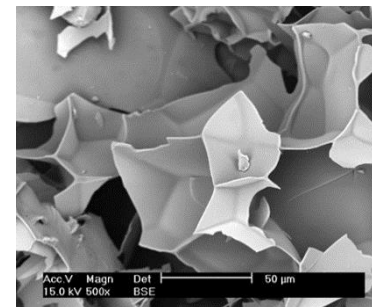


Figure2. PERLITE

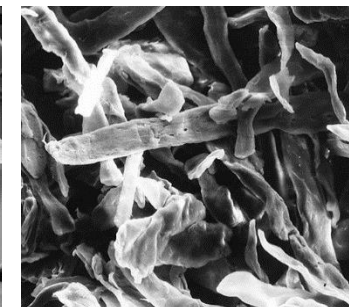


Figure3. CELLULOSE

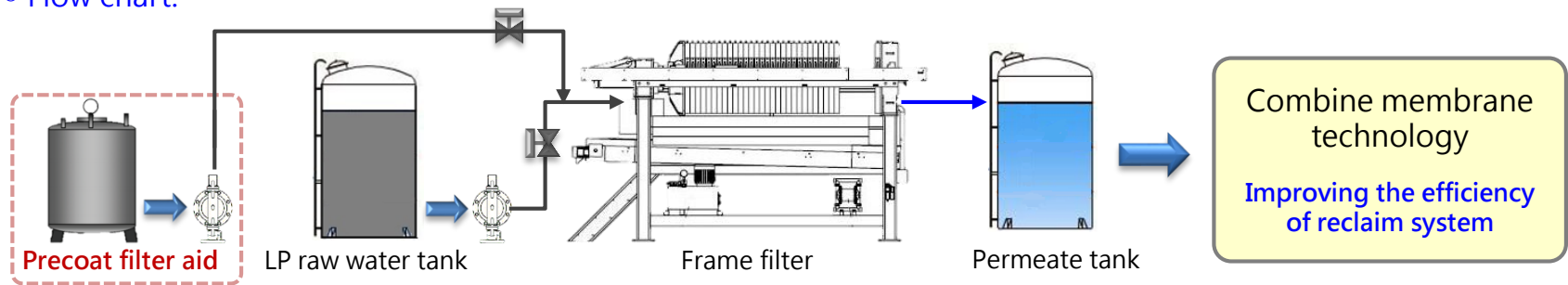
Methods

Pre-Treatment :

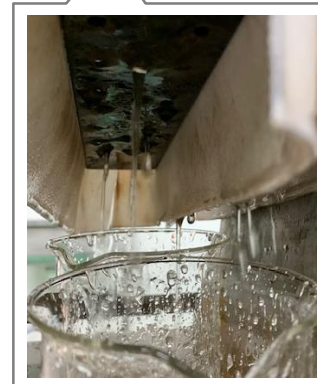
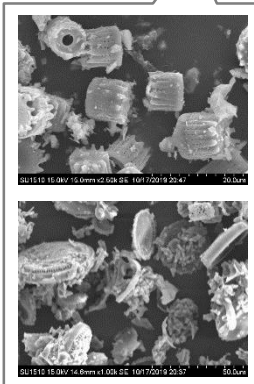
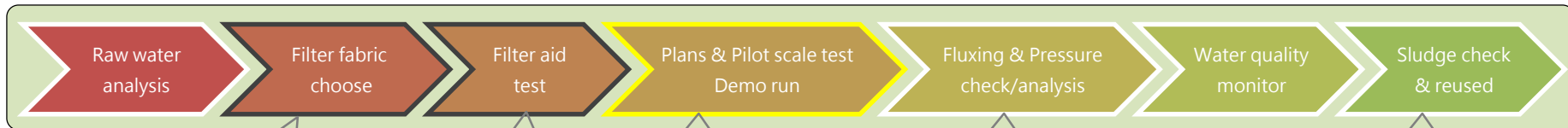
Target:

→ Total solids (TS) or turbidity removal rate >99% and ensure that permeate is not contaminated

© Flow chart:



Test design :



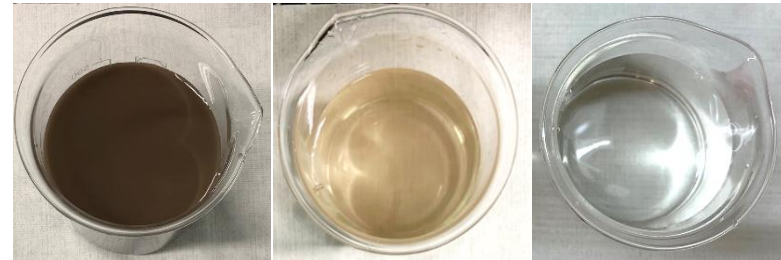
Test Result

Demo test result :

Water quality table:

Items	Raw water	Permeate	unit	Removal rate
Cond.	3	3	μs/cm	-
TOC	1.1	0.3	mg/L	72%
TS	>800	<7	mg/L	99%
Turbidity	9600	<20	NTU	99%
Cl ⁻	0.55	0.08	mg/L	85%
SO ₄ ³⁻	1.79	0.21	mg/L	88%
SiO ₂	125	23	mg/L	80%
pH	7.4	7.1	-	-

Lapping raw water → Permeate water

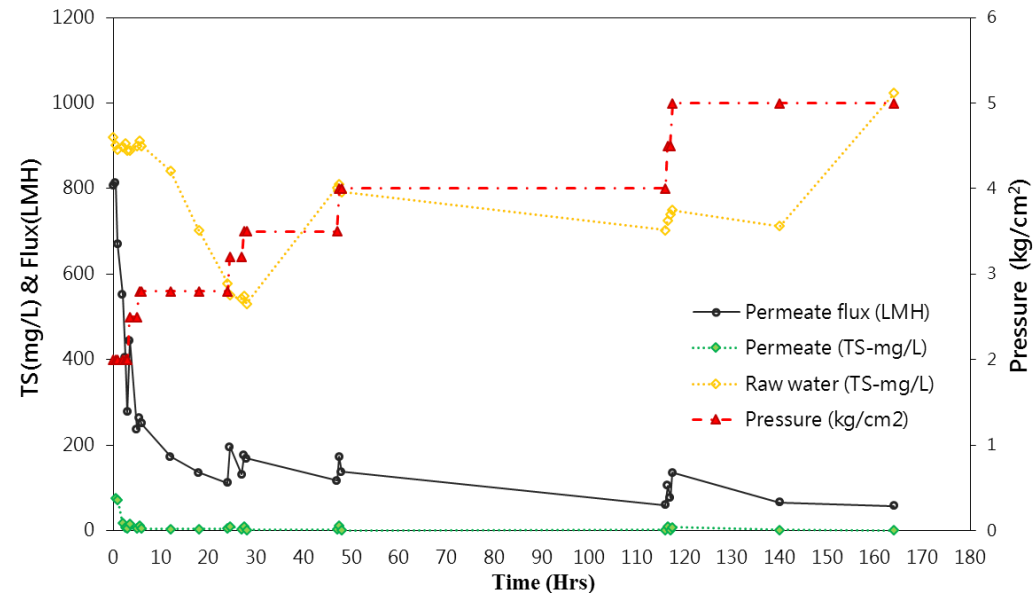


→ The removal rate of total solids & turbidity can be reach to 99%.

Graph of pilot scale result:

- ✓ Have good performance of testing result.
- ✓ Concentration variation not effect the result.
- ✓ The turbidity is main parameter of water quality.
- ✓ Pressure should be control by flux.
- ✓ The Pressure need to fine adjustment.
- ✓ Steady permeate term between 2.5 to 4.5 kg/cm².
- ✓ Flux a. Initial >300, b. Steady=100-200, c. End <100 LMH.

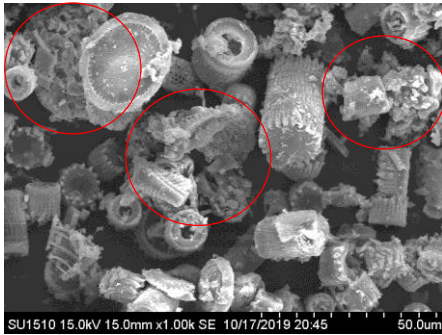
→ This is good method as pre-treatment.



Test Result

Demo test result :

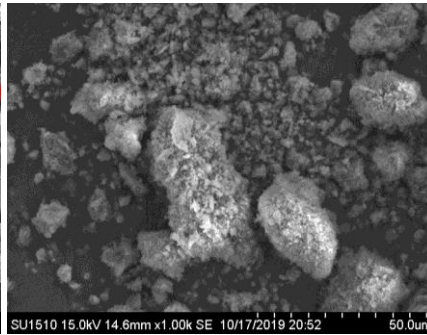
New Methods



SU1510 15.0kV 15.0mm x1.00k SE 10/17/2019 20:45 50.0um

Precoat filter sludge

Traditional Methods



SU1510 15.0kV 14.6mm x1.00k SE 10/17/2019 20:52 50.0um

Coagulation sludge

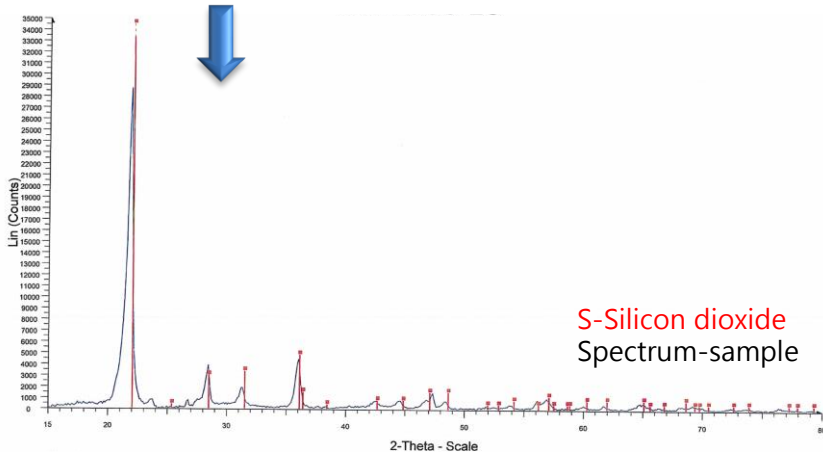
◎ Sludge analyze table:

Items	Sludge	unit
pH.	7.5	-
Solid content	51.5	%
Moisture content	48	%
Organic content	<0.5	%
Residual	20	%
Si-dry basis	38	%
Fe	180	mg/L
Cu	N.D.	mg/L
Cd	N.D.	mg/L
Pb	N.D.	mg/L
Al	268	mg/L
As	N.D.	mg/L
Hg	N.D.	mg/L
Se	N.D.	mg/L

◎ Assessment results:

- ✓ The spectrum shown is most likely of silicon dioxide.
- ✓ Most metals were not detected in sample.
- ✓ Moisture content less than 50%.
- ✓ Coagulation sludge: friable and disrupted.
- ✓ Precoat filter sludge: durable and close.
- ✓ Sludge mainly contains silicon dioxide and a part of silicon element.

→The sludge has great potential for reuse.

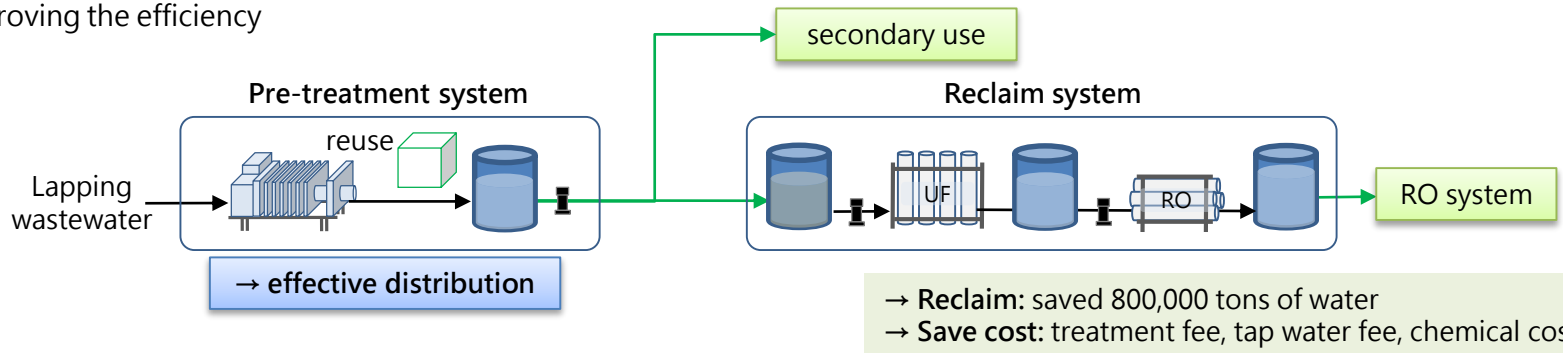


Conclusion

Plan to series system:

Reclaim system of SPIL

- ✓ Successful separation of lapping wastewater
- ✓ Improving the efficiency



Assessment of reuse potential for sludge:

Potential of Si-sludge

- ✓ The high purity silicon dioxide sludge (SiO_2) can be recycled for further, like green building materials, rubber products or paint.
- ✓ Due to emission treatment norm, the sludge is currently disposed as waste, and then recycled into silicon dioxide by contractor.
- ✓ We are trying to recycle the sludge for market use by new SPIL protocol.
- ✓ In the future, we will continue to study methods for separating silicon and silicon dioxide to increase the value of sludge.





Thank you
Q & A