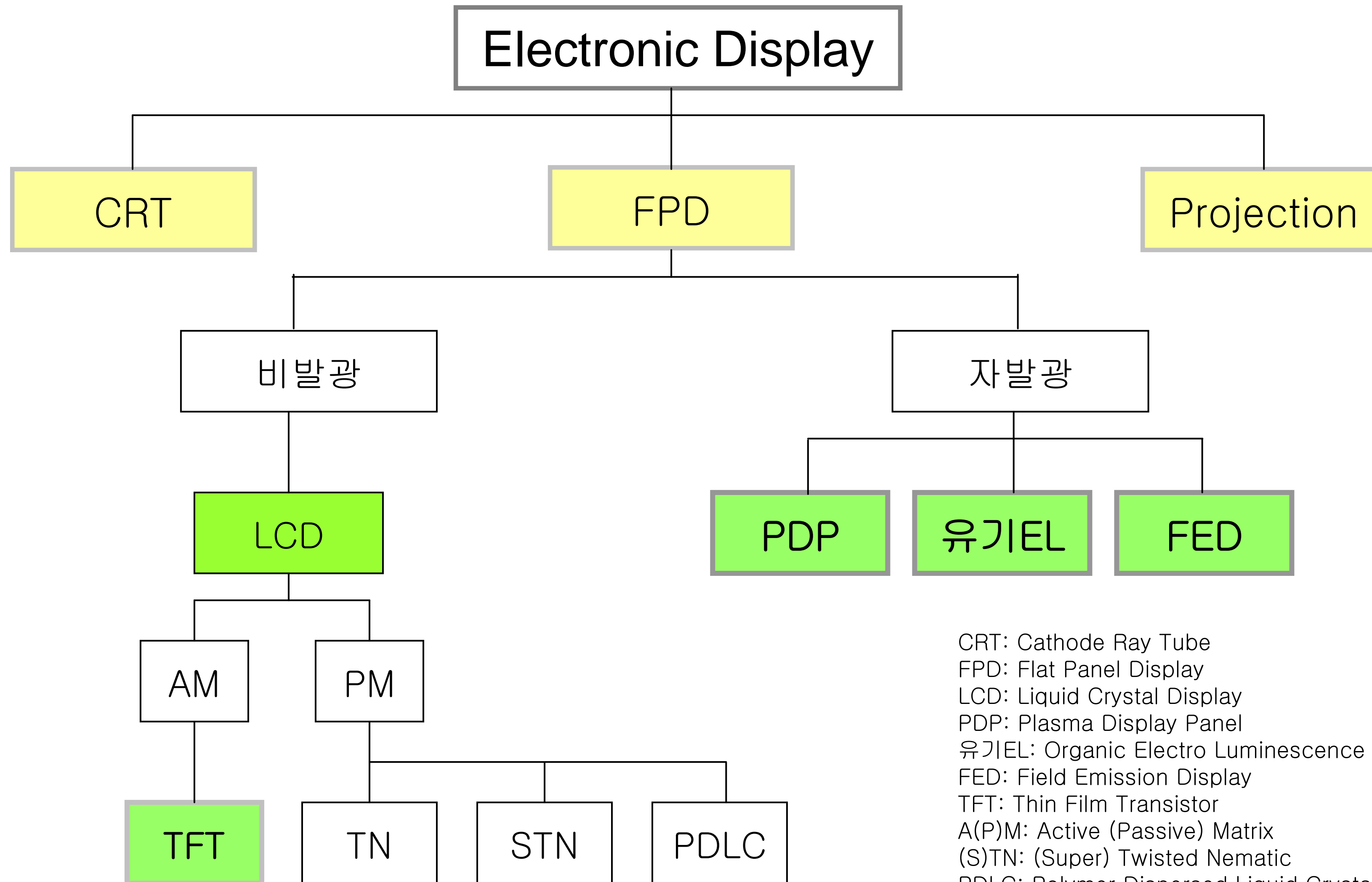
FPD 세정 공정

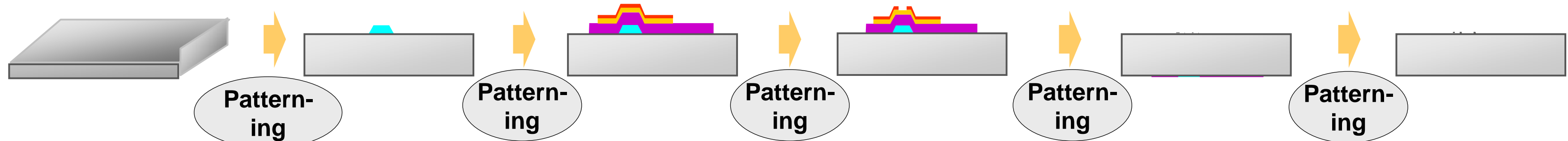
2006년 5월 3일

배재흠
수원대학교 화공생명공학과

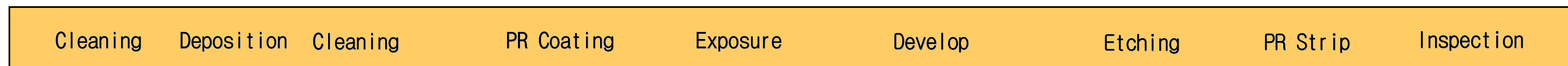
디스플레이 분류

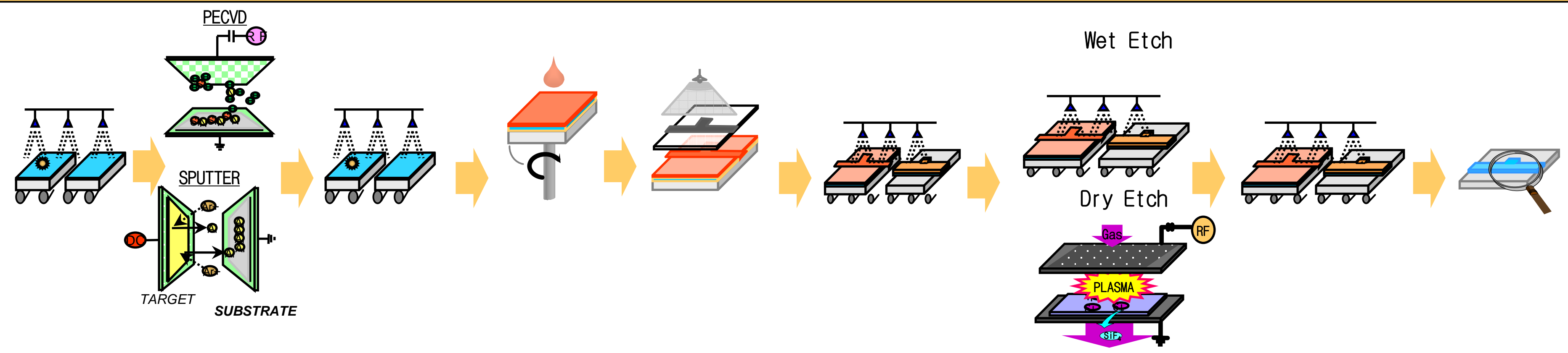


FPD Process Overview



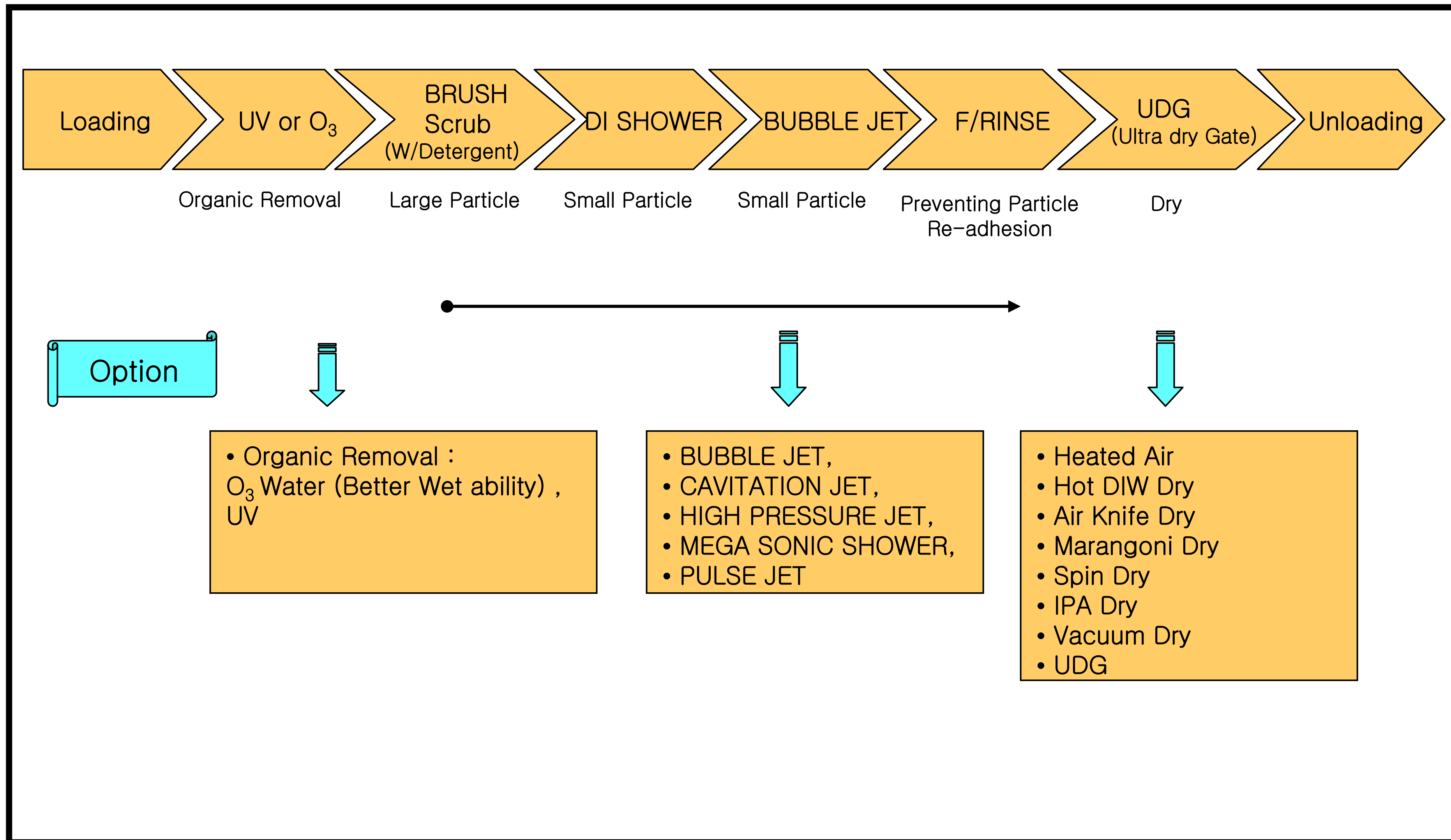
Deposition & Patterning Process in Detail





FPD Cleaning Process

Process Sequence

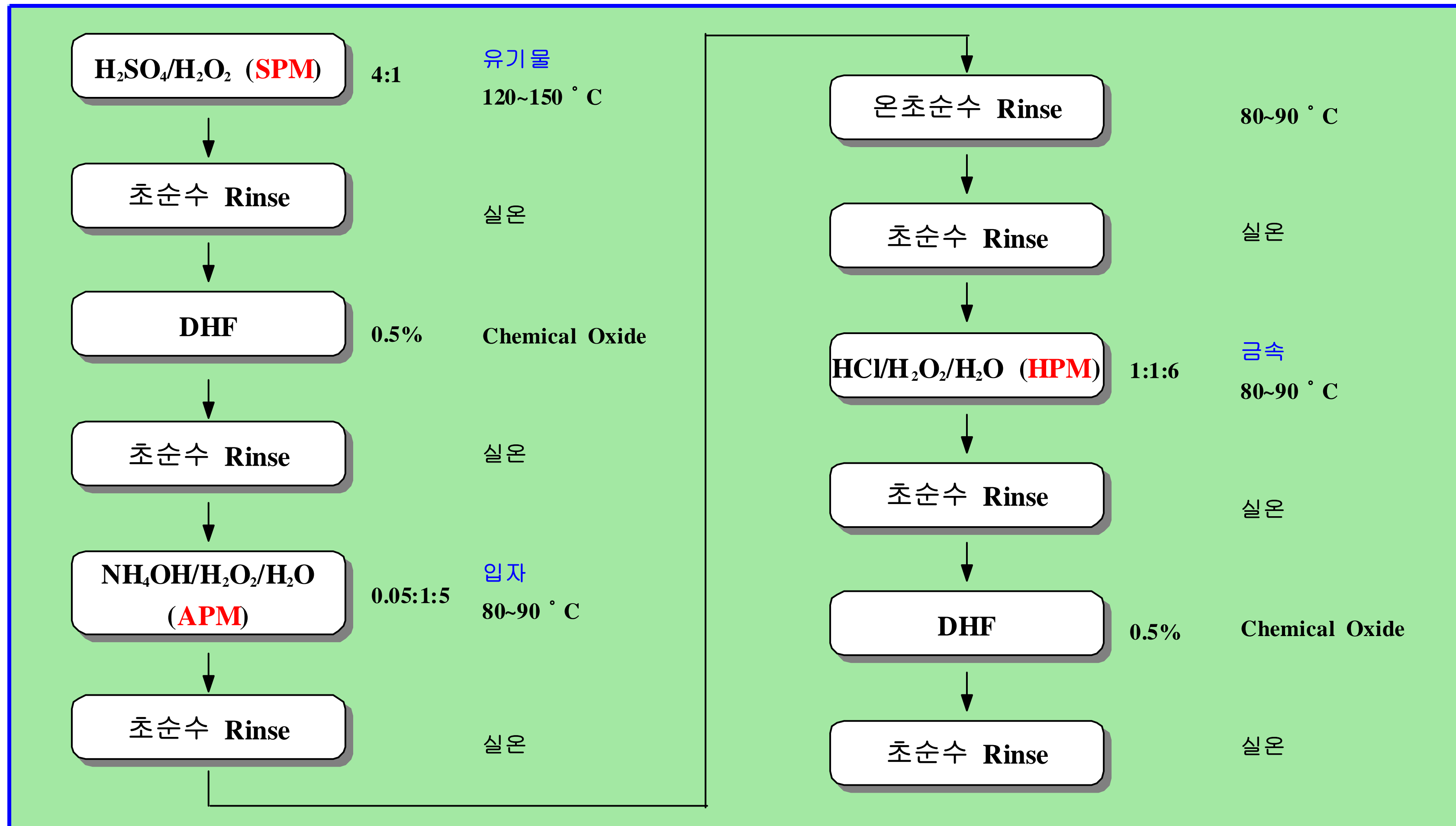


FPD Cleaning Technology Trend*

Cleaning Method	Trend				Target
	'94~96	'97~99	'00 ~		
Chemical Cleaning	Brush U/S M/S DI Shower	Bubble Jet High Pressure Jet Cavitation Jet	Pulse jet HPM/SJ VUV	**One Chamber / Multi Cleaning**	▪ **Floor-Space-effective** ▪ **Environment-friendly** ▪ **Performance Enhancement** ▪ **Yield-up** ▪ **Scalability** ▪ **Running-cost-effective** ▪ **Investment-cost-effective**
			Function Water – O_3 Water : Oxidative – H_2 water : Reductive – Elctrolyzed Water		
Dry Cleaning		UV Cleaner : Excimer, DUV CO_2 Cleaning Ice Particle Cleaning	LASER, Plasma		
Dry system	Hot Air → Hot DI → Spin Dry → IPA Dry → Air knife → UDG				

* 박영순, 태화일렉트론

Example of Semiconductor Cleaning Process



Conventional Wet Cleaning Process

분류	Cleaning Methods	Cleaning 목적 및 Mechanism	Comments
화학적 세정	APM, SC-1 ($NH_4OH/H_2O_2/H_2O$) 75~90 ℃	➢Light Organics, I/II 족 Metals, Particle 제거 ➢$2H_2O_2$ + C --> CO_2 +$2H_2O$ ➢M + H_2O_2 -->MO +H_2O, MO+$4NH_4OH$ -->$M(NH_4)^{4+}$	Metal Re-Adsorption (Alkali 계 Metal) due to low Redox potential Si- wafer micro-roughness
	HPM, SC-2 ($HCl/H_2O_2/H_2O$) 75~85 ℃	➢Metal(알칼리 이온, 중금속) 제거 ➢Ion Exchange : Na^+ +HCl --> NaCl + H^+ ➢Complex : M + H_2O_2 --> MO + H_2O MO +2HCl -->MCl_2+H_2O	Formation of thin hydrophilic chemical oxide film Difficult in maintenance of hardware due to high corrosiveness
	SPM ($H_2SO_4/H_2O_2/H_2O$) 90~130 ℃	➢Heavy Organic, Metal 제거 ➢H_2SO_4 +H_2O_2 --> H_2SO_5(CARO'S ACID) + H_2O ➢H_2SO_5 + Hydrocarbon --> CO_2 + H_2O +H_2SO_4	Formation of thin hydrophilic chemical oxide film Generation of SO_4^{2-} Residue on the substrate
	Dilute HF (HF/H_2O)	➢ Natural Oxide Film, Metal 제거 ➢6HF +SiO_2 --> H_2SiF_6 + $2H_2O$ ➢3HF + M --> MF3 +$3H^+$	Removal of surface oxide and metal in the metal oxide film by dilute HF solution Removal of noble metal by H_2O_2
	BOE ($HF/NH_4Cl/H_2O$/ 계면활성제)	➢Oxide Film 제거	Buffered oxide etchant HF/NH_4F=1:7

FPD와 Semiconductor의 세정 비교*

Classification	Semiconductor Process	Flat Panel Display Process
1. 세정의 대상	Wafer. ~ 300 mm dia.	*300*400mm(1st G)* Glass, ~ 1870*2200 mm (7th G)
2. 세정제	SC1, SC 2, SPM.. RCA cleaning.. *Acid & Base Mixture*	*1000(3G) ⇒12,000m³/day(6G)* Detergent, THAM**, 電解水
3. 세정 목적	Organics, Metal, Particle, Oxide	Organics, Particle, Water Marks, *Metal, Oxide*
4. 반송 단위	약 25 매/lot, Carrier	1 매, 연속 반송
5. 세정 방식	Dip, Bath	Shower, Spray
6. 세정 시간	about 10 min/each bath	Below 1 min /1 매, chamber *연속반송 1000 ~ 8000 mm/min*
7. 기타		얼룩 (Water Marks)

* 권정현, 삼성SDI ** tetra methyl ammonium hydroxide

Mechanism of Organic Removal

1. PRINCIPLE
   Remove an electron from organic molecules to oxidize and decompose them to CO_2, H_2O, and etc.

2. HOW TO REMOVE AN ELECTRON?
   To remove an electron by high ORP solutions such as H_2SO_4, HCl, HNO_3, etc. have been used.

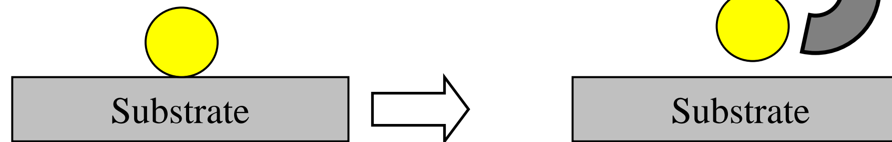
3. WHY OZONIZED WATER?
   ORP of ozonized water(DIW with a few ppm of ozone) is higher than those of H_2SO_4, HCl, HNO_3.

4. O_3 and OH^-(hydroxyl ion) in water generates OH*(hydroxyl radical) which promotes oxidation of organics.

5. Initiators such as high pH or UV radiation may be necessary for OH* reaction.

Mechanism of Particle Removal

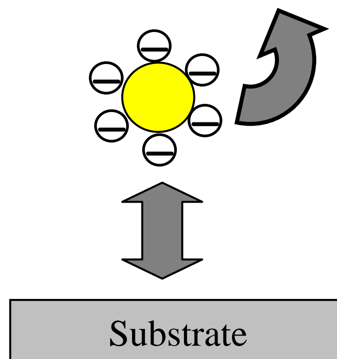
1. 1ST Step....lift off



⋆ Mechanical lift off
- Ultra sonic (MHz)
- Brush scrub

• Chemical lift off
- Substrate etching with alkaline and HF
- Use of H_2 Water : H radical generation
  ⇒ inactivation of soil or detachment of soil
- Particles are dissolved with HF or decomposed with O_3

1. 2ND Step....Prevention of re-adhesion

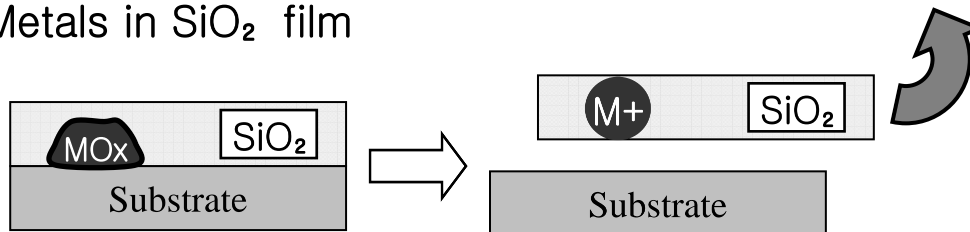


• Change of surface potential charge of particle and substrate
- Alkaline pH
- Negative potential may help the enhancement of negative charge.

⇒ Same polarity of Zeta potential between particle and substrate

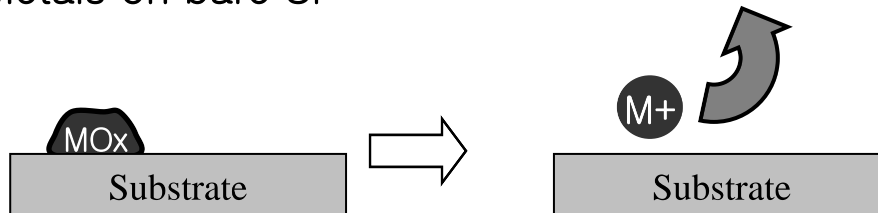
Mechanism of Metal Removal

1. Metals in SiO_2 film



* Metals are removed together with SiO_2 by etching with HF.

2. Metals on bare Si



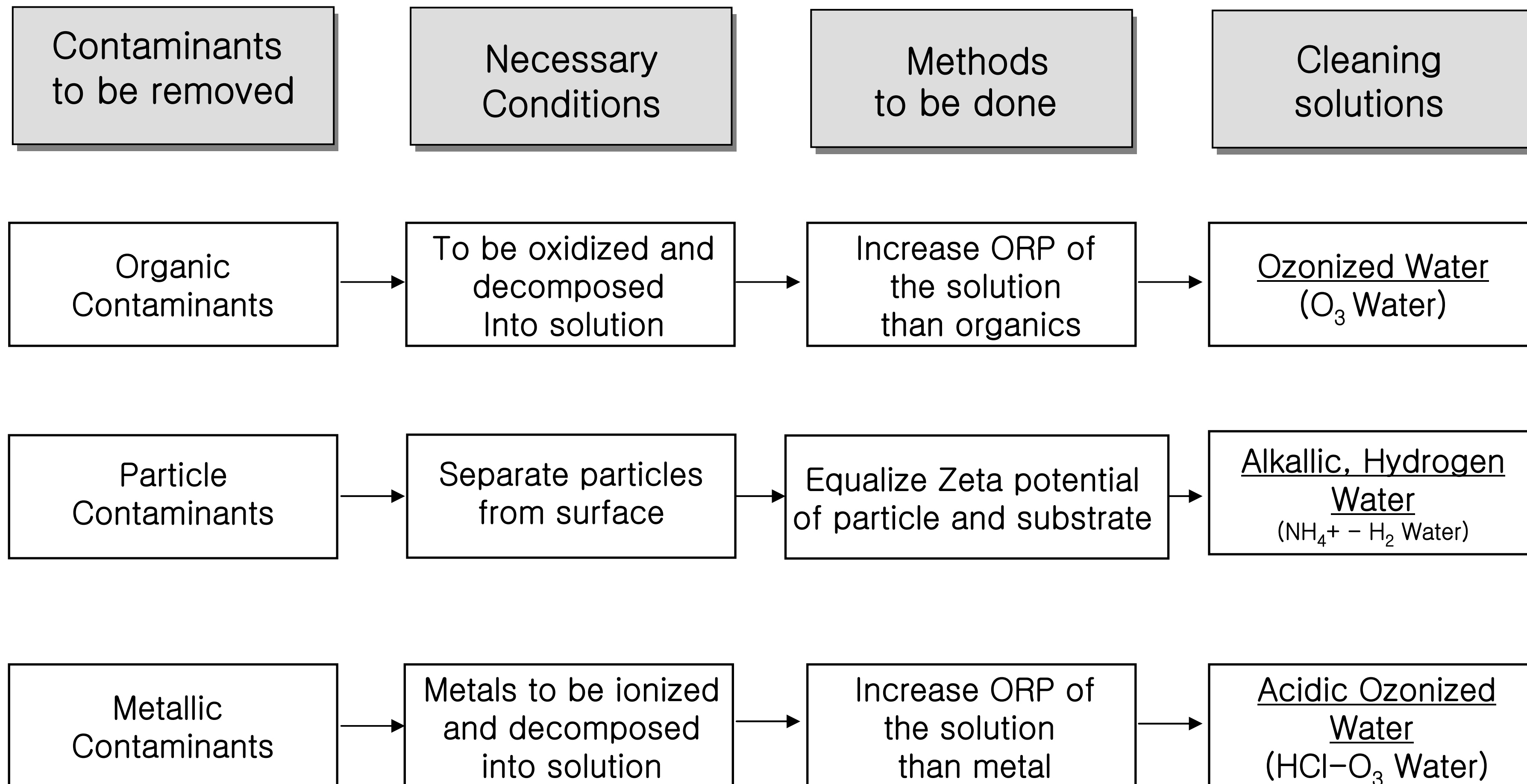
* Metals are ionized by acidic and oxidative solutions.

<u>acidic and oxidative solutions.</u>

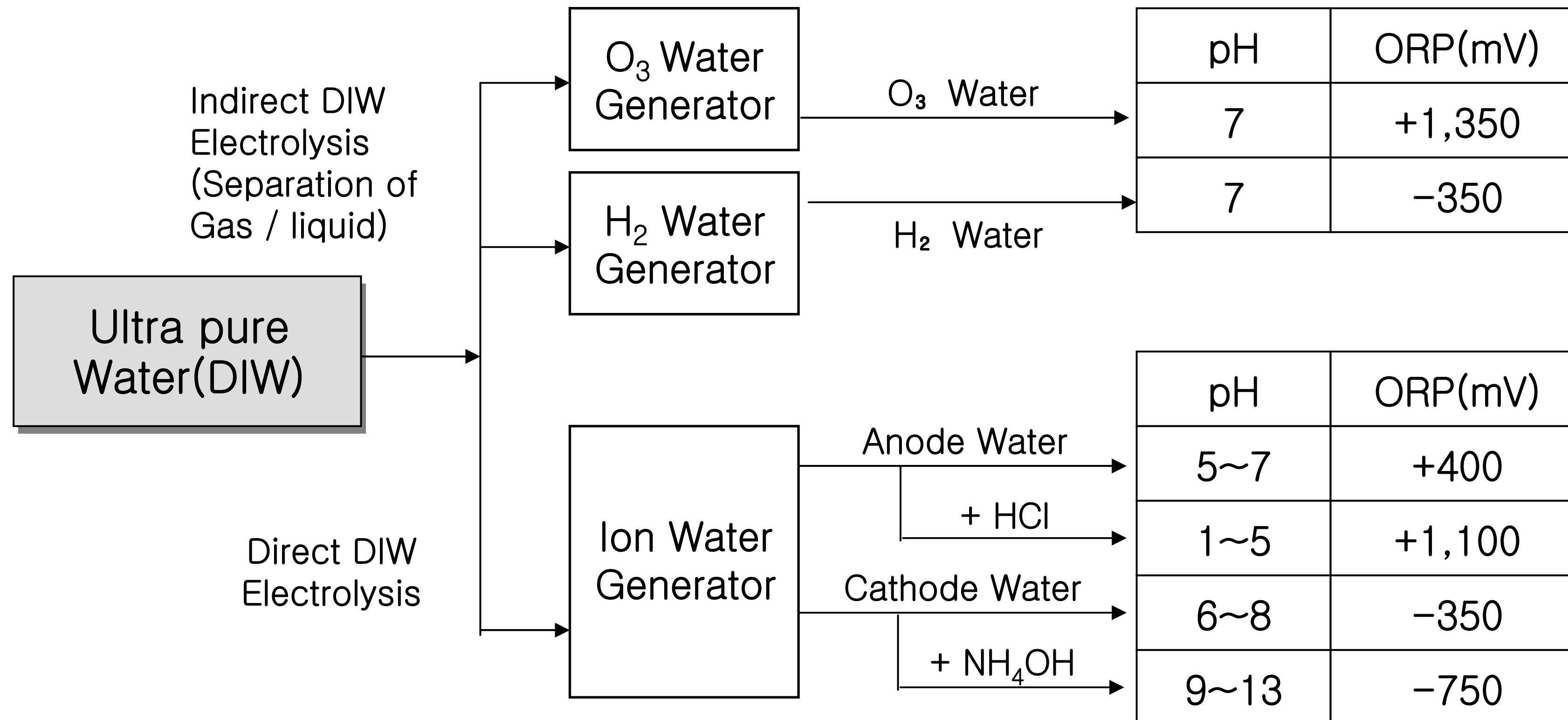
Conventional : Acid & oxidizer at Hot temp & High conc.

Activated UPW : Diluted acidic oxidative solutions(HF/O_3 or HCl/O_3 solution)
→ ORP of Ozonized water is higher than those of H_2SO_4, HCl, HNO_3 etc.

Cleaning Principles



Functional Water



Electrolyzed water (EW)

- □ The controlled water in terms of pH and oxidation-reduction potential (ORP) by the electrolysis

- □ Easy to control pH/ORP in wide range with only current /voltage changes

- □ Oxidation-reduction potential (ORP, E)

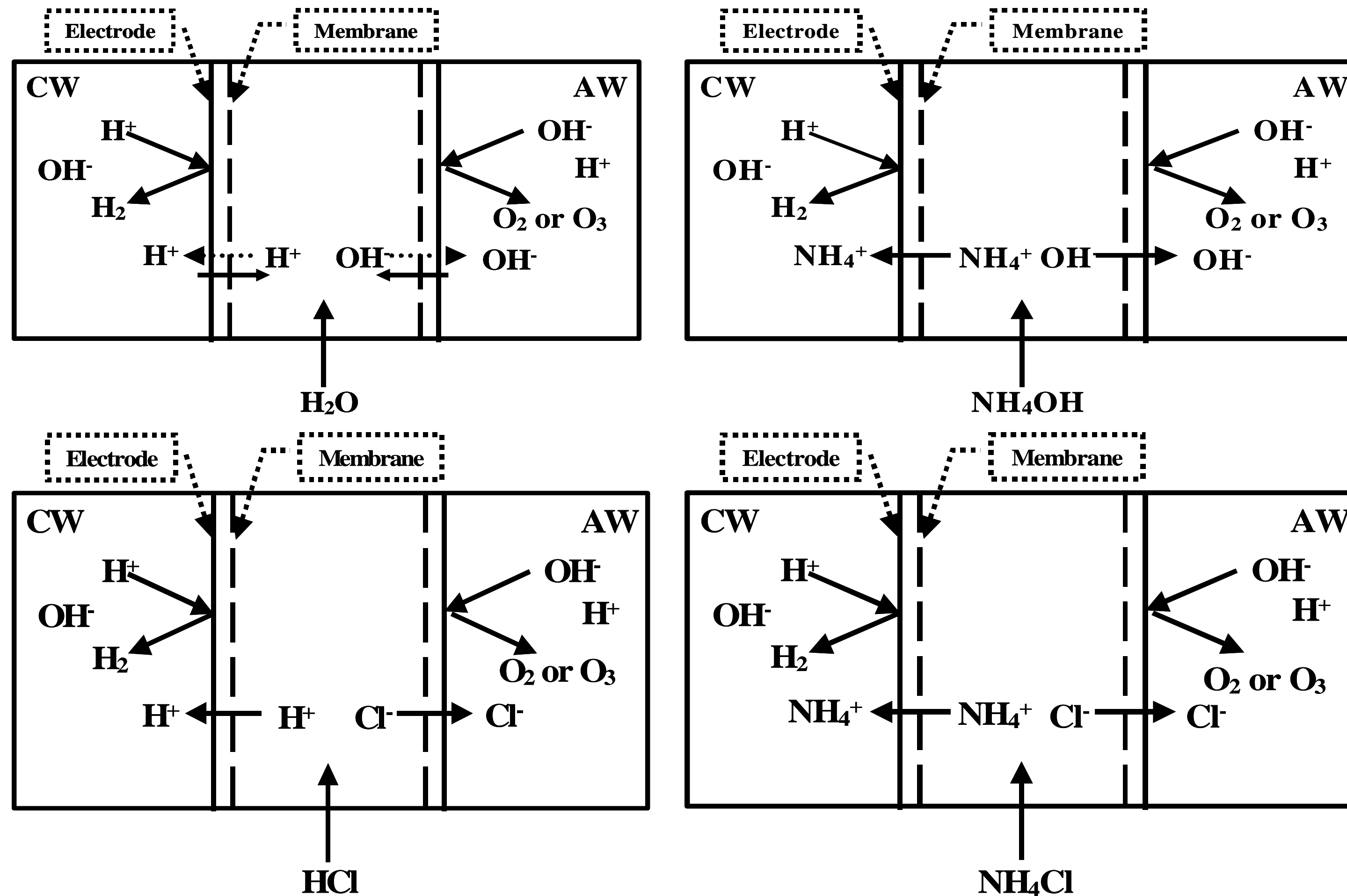
$$O_x + ne = R_{ed} \quad (1)$$

$$E = E_o - RT/(nF) \log (C_{red}/C_{ox}) \quad (2)$$

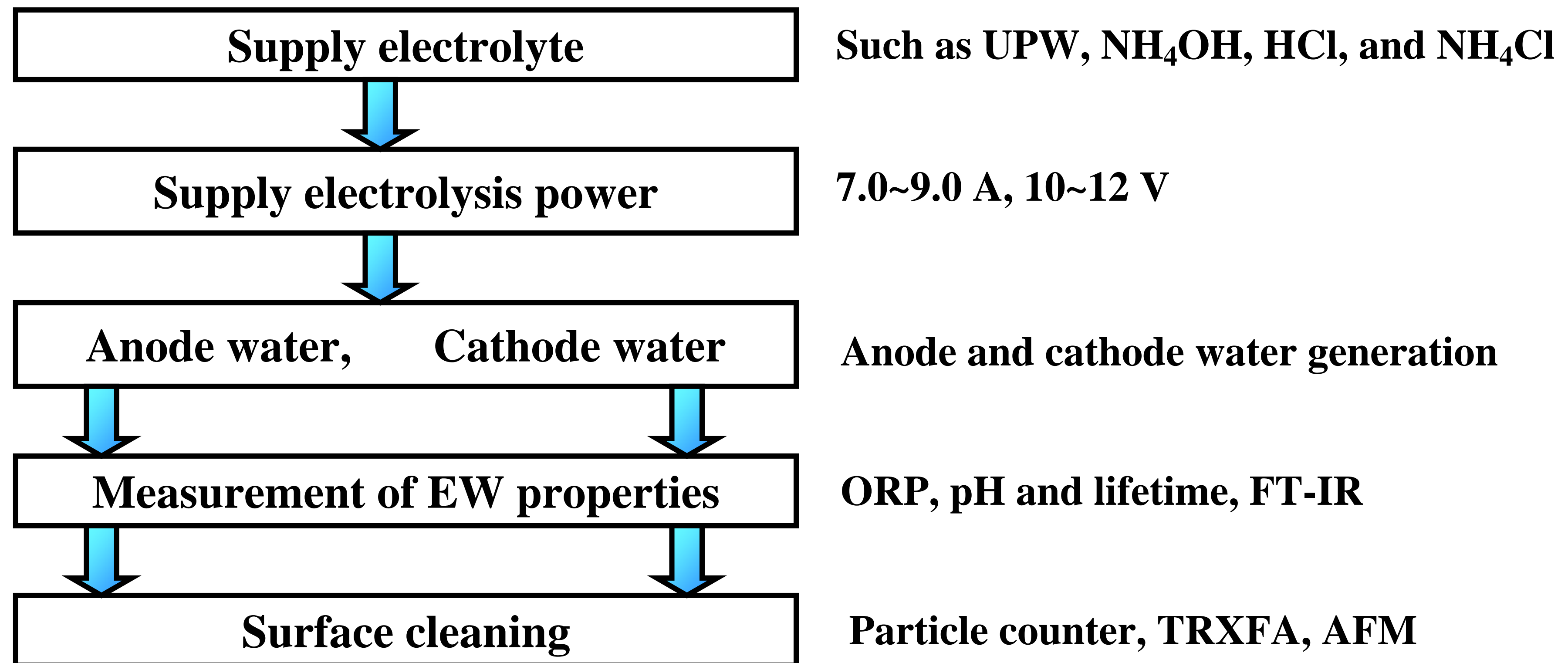
at $C_{red} > C_{ox}$, ORP is negative value (reductive water)

at $C_{red} < C_{ox}$, ORP is positive value (oxidative water)

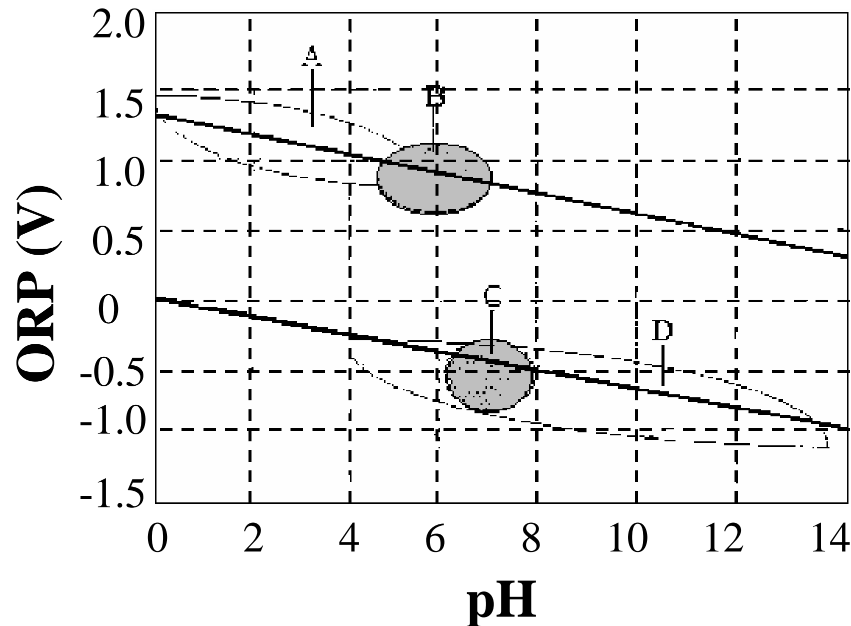
Principle of EW Generation



Procedure for Generating Electrolyzed Water



EW Properties



A : Anode water with electrolyte

B : Anode water by UPW

~ Effective for removal of metal ions

Oxidative water, High H^+ Conc.

Similar to properties of O_3 water

C : Cathode water by UPW

D : Cathode water with electrolyte

~ Effective for removal of particles

Reductive water, High OH^- Conc.

Similar to properties of H_2 water

Normally used with NH_4OH

국내 전해이온수 공급업체

1. 마이크로뱅크 (http://www.micro-bank.co.kr ; 031-905-3420)
   - 산업자원부의 청정생산기술과제 수행(Hynix와 공동수행)
   - 반도체/LCD 세정용 3조식 전해장치 제조기술 개발 및 응용 (금속오염물, 유기물, SiO_2 미립자, SO_4^{2-} 이온제거)
   - Redox를 이용한 산업공정에서의 일반세정기술 개발 및 응용 (하드디스크, PCB, 광학렌즈 등)
   - 전해 산성수에 의한 살균 소독 시스템 개발
   - 음용 이온수기 개발: ㈜한국세라스톤에 알카리성 이온수기 공급

2. 맥스산업㈜ (02-716-6883~4)
   - 직류전원에 의하여 산성/알칼리성 전해수(pH 2.0~12.0, ORP±1000mV이상)
   - 응용 : 반도체, LCD 및 PCB 기판 세정
   - 각종 배관라인의 세정 및 살균

3. ㈜서양에이아이 (http://www.seoyang.co.kr ; 02-488-8444)

일본 전해이온수 공급업체

1. REIKEN, INC. (http://www.reikeninc.co.jp)
   - Dynakleen.D
     - 고주파(30~34 kHz) 전기분해
       : 부식 예방 및 스케일 제거, 화학 물질 미사용
     - 3조 시스템(+, -, earth)
       : 이물질이 전극에 미부착 - 전극 유지용이, 자체 세정 효과
     - 활성수 : 살균 및 악취제거, 유지비저렴(ROI = 1~1.5 year)

2. Nissin seiki Co., Ltd. (http://www.nissin-seiki.co.jp)
   - 강알칼리 이온 세정수 생성시스템(NEWSEW-01-RO)
     - 강알칼리 이온수 생성(pH 12~12.5)
     - 순수 세정 장치가 있어 알칼리수와 순수를 별도로 생산가능
     - 전해질로 $CaCO_3$ 사용
     - 피세정물의 산화 및 부식 방지, 악취 제거 및 살균 효과

3. NITTO KOSHIN CO., Ltd.
   - 전해수 생성 unit
     - 본체에 수돗물을 직접 연결하여 연수와 알칼리성 전해수 생성(전해질 사용)
     - 연수기의 재생은 완전 자동
     - 응용 사례 :
       i) 액정 유리의 최종 세정
       ii) Al 가공유 세정에서 탄화수소계 세정제 대체

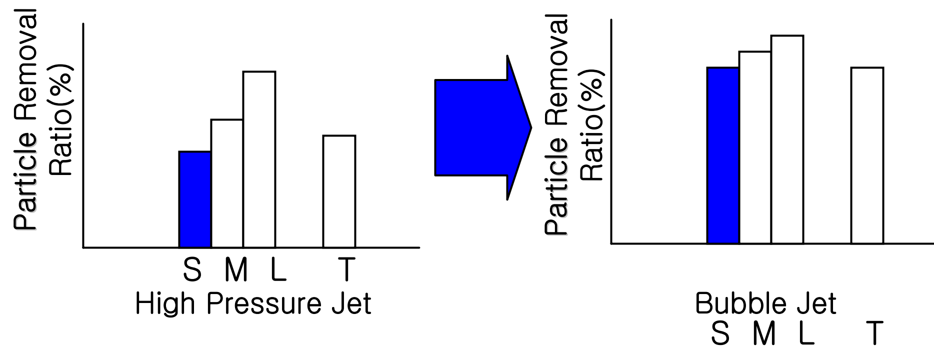
Applications of Functional Water

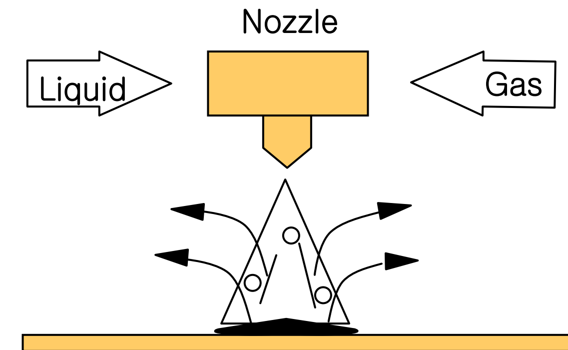
Classification	FPD	Semicon	Wafer
O_3 Water Organic Removal	1. Pre-Cleaning 2. Pre-Deposition 3. Post-Deposition 4. P/R Strip	1. Post-SPM Rinse 2. Pre/Post-CMP 3. Post-Ashing 4. P/R Strip	1. Growth of Protective Oxide
H_2 Water Particle Removal	1. Clean bare glass 2. Rinse after etching	1. Post-CMP	1.Rinse after Chemical Bath
Electrolyzed Water	Removal of Metal & Particle	1. Post-CMP	1.Removal of Metal, Particle & Organics 2. SO_4^{2-} removal after SPM cleaning

Bubble Jet Technology*

1) Principle

2) Performance



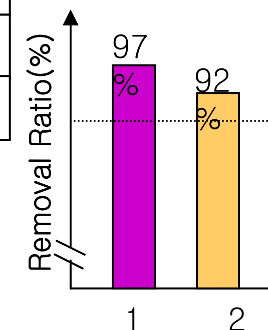


(Initial Particle : 1000−3000ea

S≒1~3㎛, M≒3~5㎛, L≒5㎛, T≒≥1㎛)

3) TEST : BM Pre−deposition

NO	Item	O_3 Water	Roll Brush	Bubble Jet	Shower(M/S)	Di Shower	Aqua knife	Air knife	Avg. Particle Residue
1	W / BJ	●	●	●	●	●	●	●	66EA
2	W/O BJ	●	●		●	●	●	●	170.3EA



Note : 1. Avg. Initial Particle : 2166EA

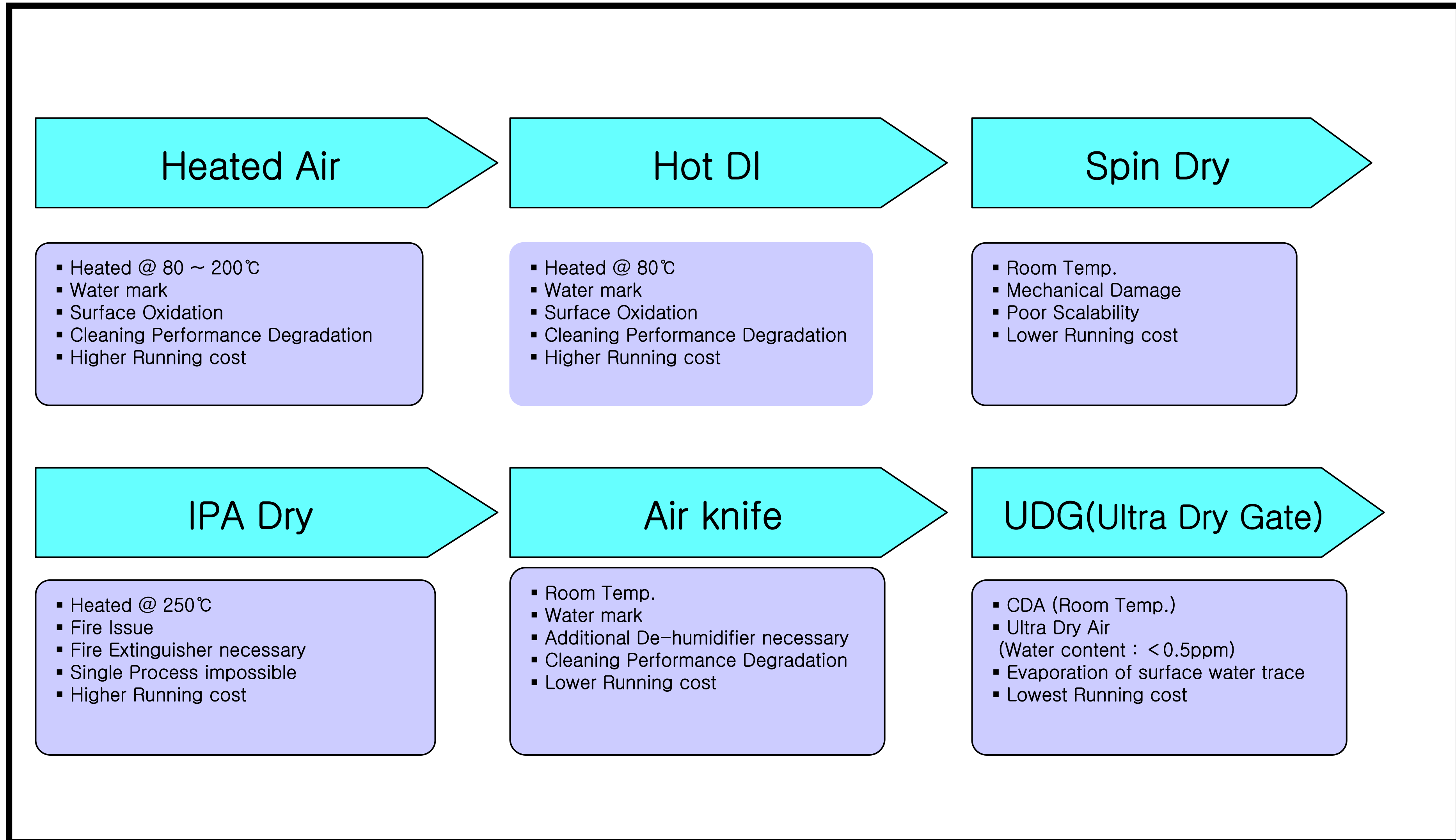
2. Sample Size(N) : 3Pcs, Each

3. Particle Counter : ≥**1**㎛ (Hitachi : GI−4700)

4. Glass Size : 590 * 670

* 박영순, 태화일렉트론

Dry Systems*



* 박영순, 태화일렉트론