폴리실리콘 제조용 실리콘 석출공정

Silicon Deposition Process for Preparing Polysilicon

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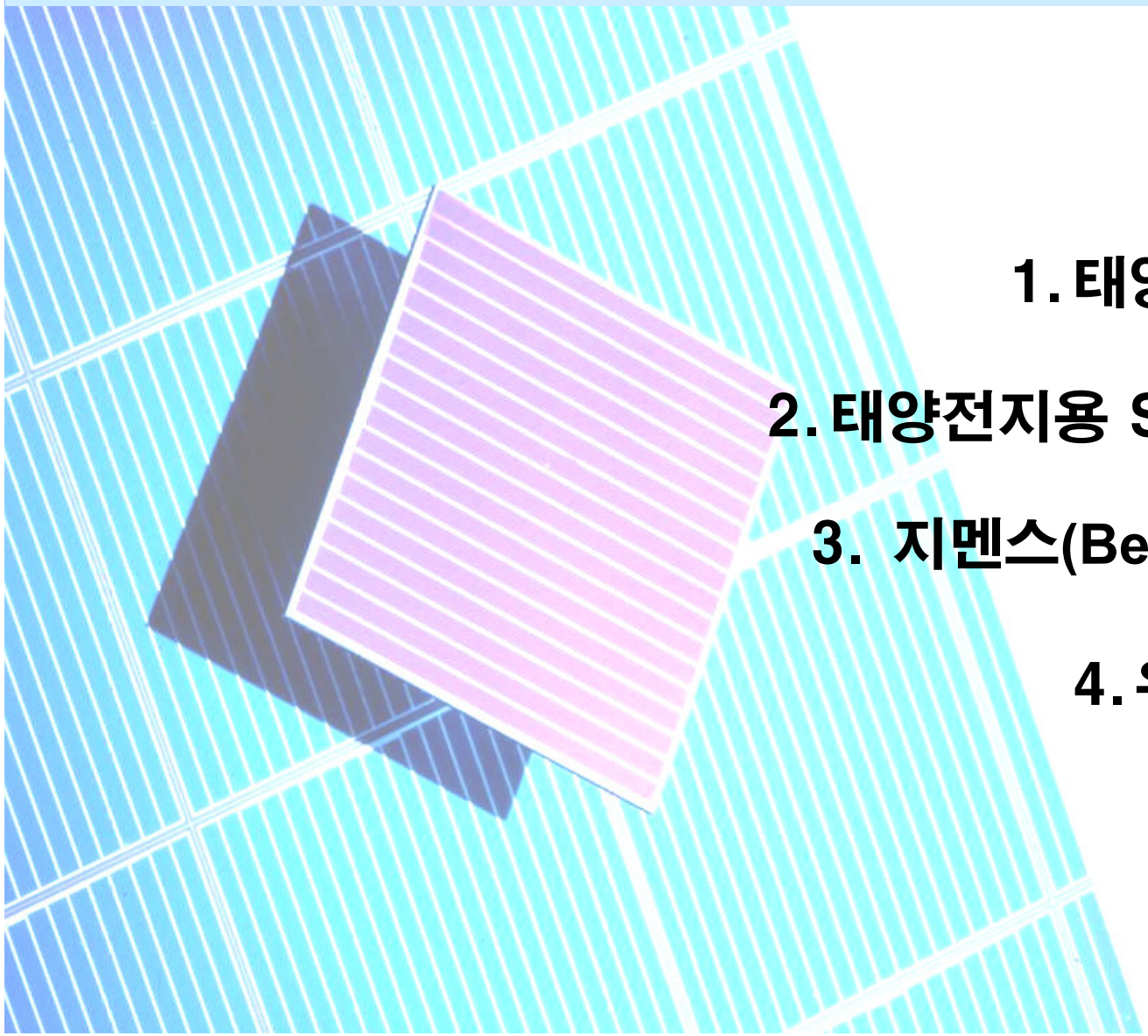
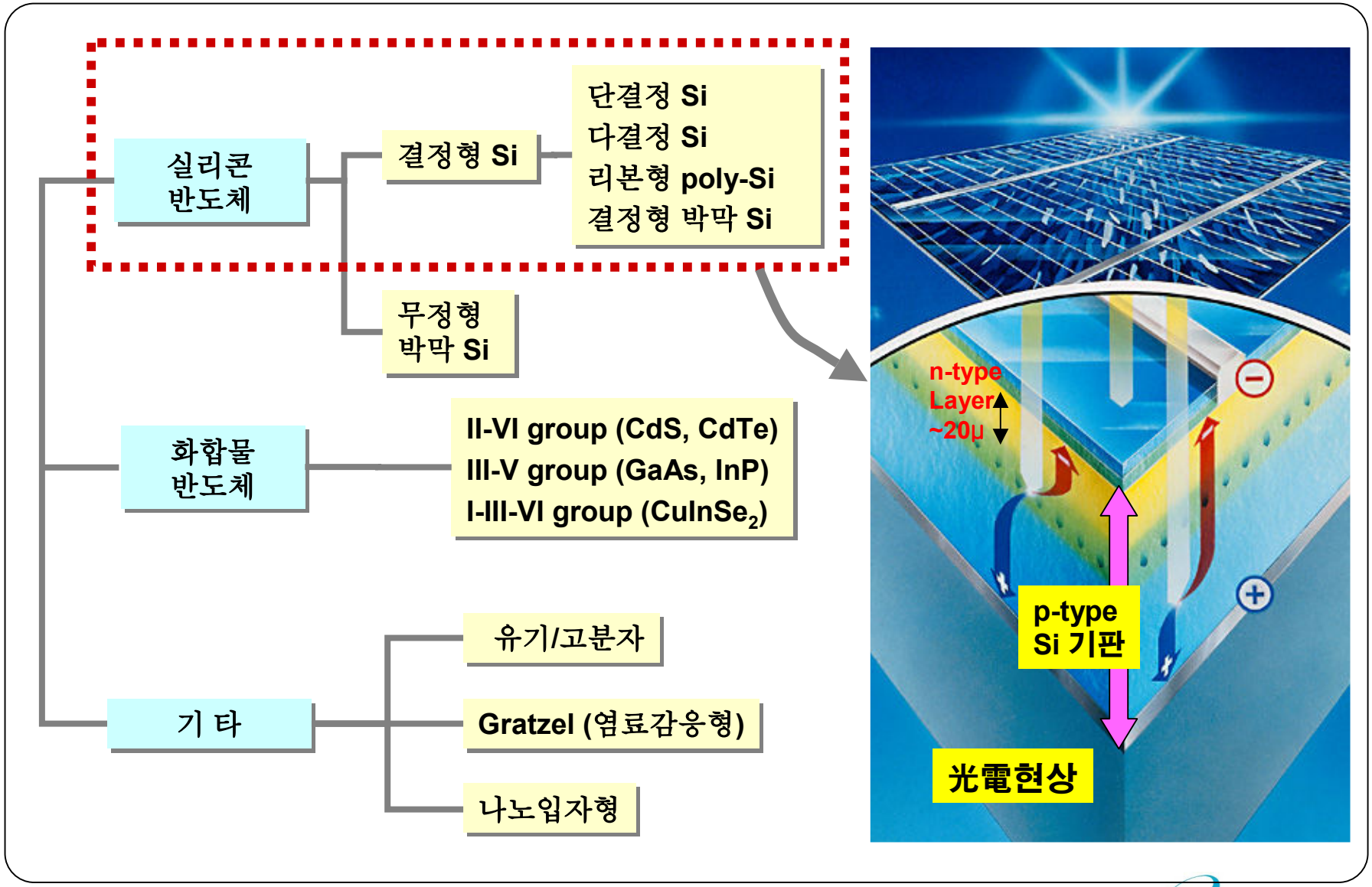
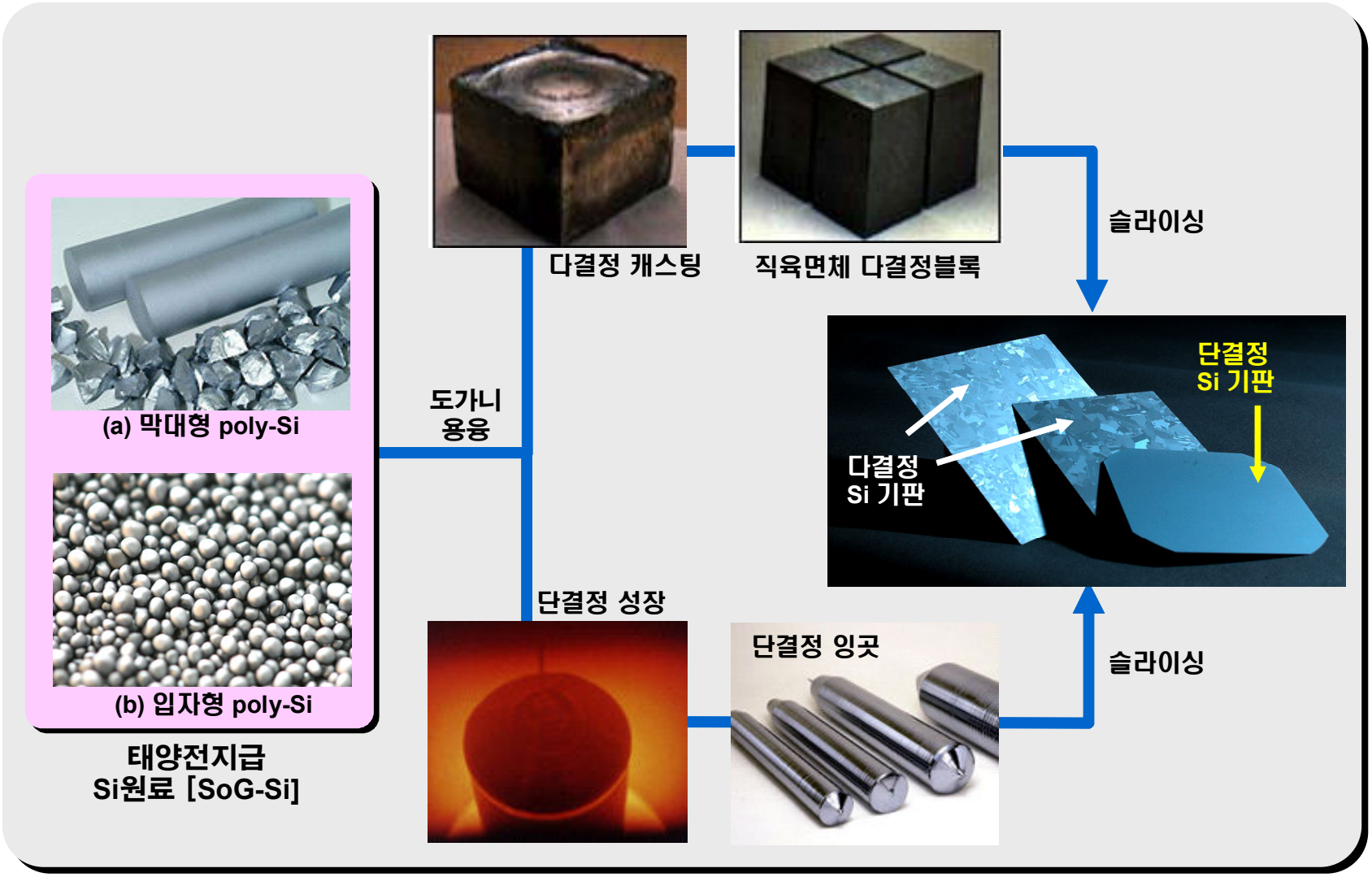
목 차



1. 태양전지용 Si 기판 재료



1-1. 태양전지용 Si 원료와 기판

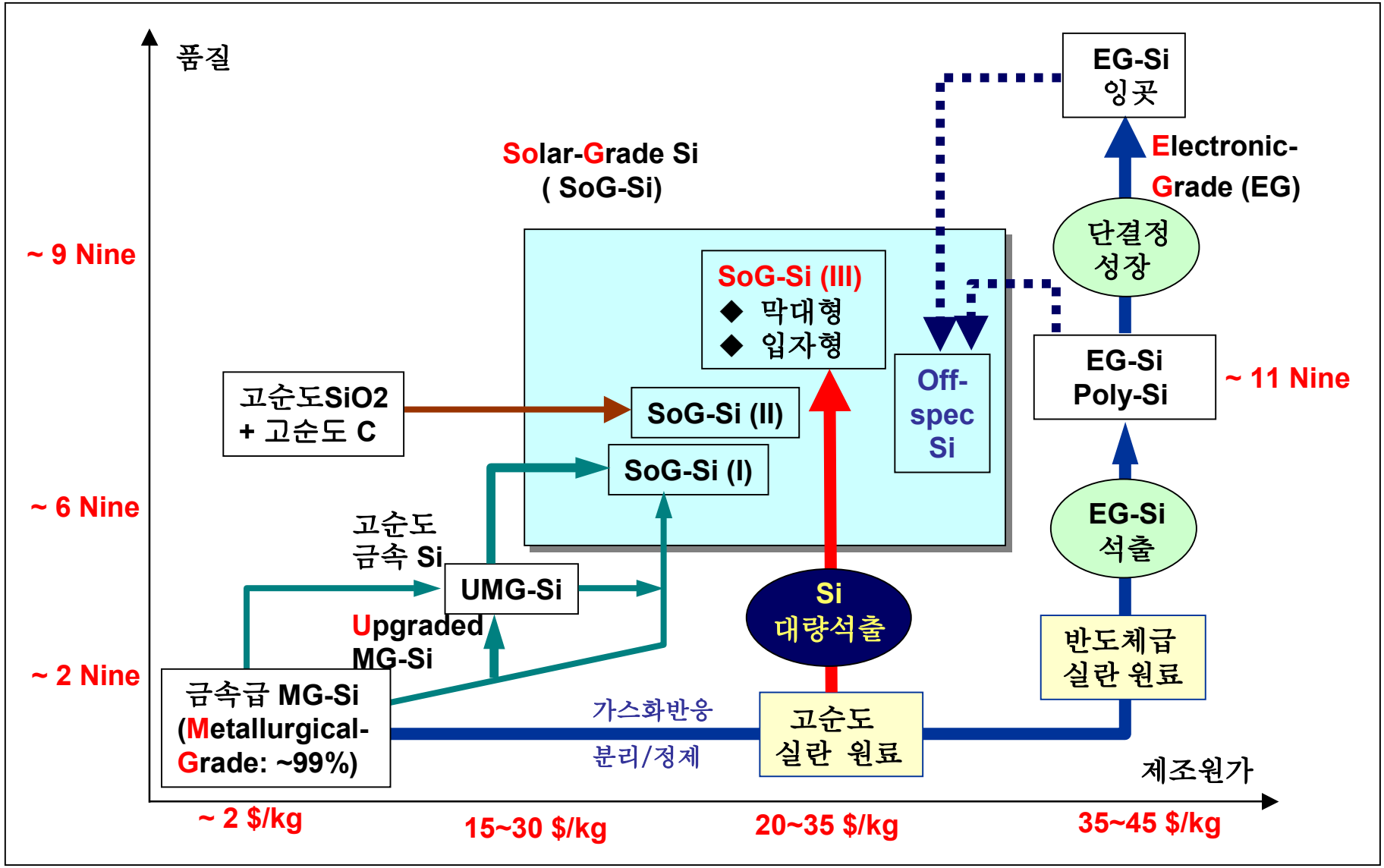


1-3. SoG-Si 시장 현황 및 전망(예)

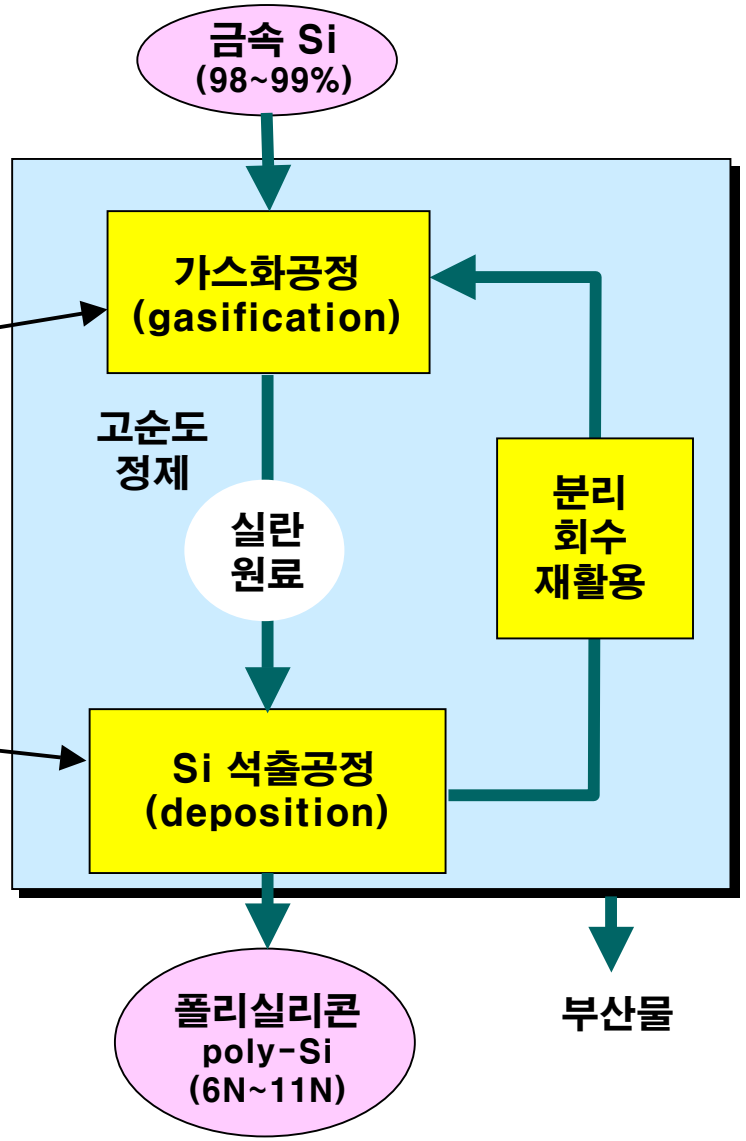
Year	Si수요 [모듈출하/PV산업] [+]	Si(g)/Wp (*)	Si가격($/Kg) (*)
2003	2.5만t (이하 EG+SoG)		~24
2004	2.7만t [1.2 GW]	13.0	
2005	3.2만t [1.7GW/12bn$]	11.5	~32
2006	4.1만t [2.6GW/20bn$] (#) 1.75 GW(installat'n)/2.20 GW(cell: 181 MW film)	10.5	~45
2007	5.0만t [4GW/30bn$] (#) 2.83 GW(installat'n)/3.44 GW(cell: 400 MW film)	9.5	60~80
2008	6.5만t [43bn$]	8.5	
2009		7.5	
2010	10만t [15GW/94bn$]	7.0	
2011	15만t [21GW/121bn$]		

(*) Rogol, M., "Silicon and the Solar Sector: Outlook through 2010," 3rd Solar Silicon Conference, Apr. 3, Munich(2006)
(+) Rogol, M., SOLA ANNUAL 2007-Big Things in a Small Package, Photon Consulting, Solar Verlag GmbH (2007).
(#) MarketBUZZ 2008: Annual World Solar Photovoltaic Industry Report (2008).

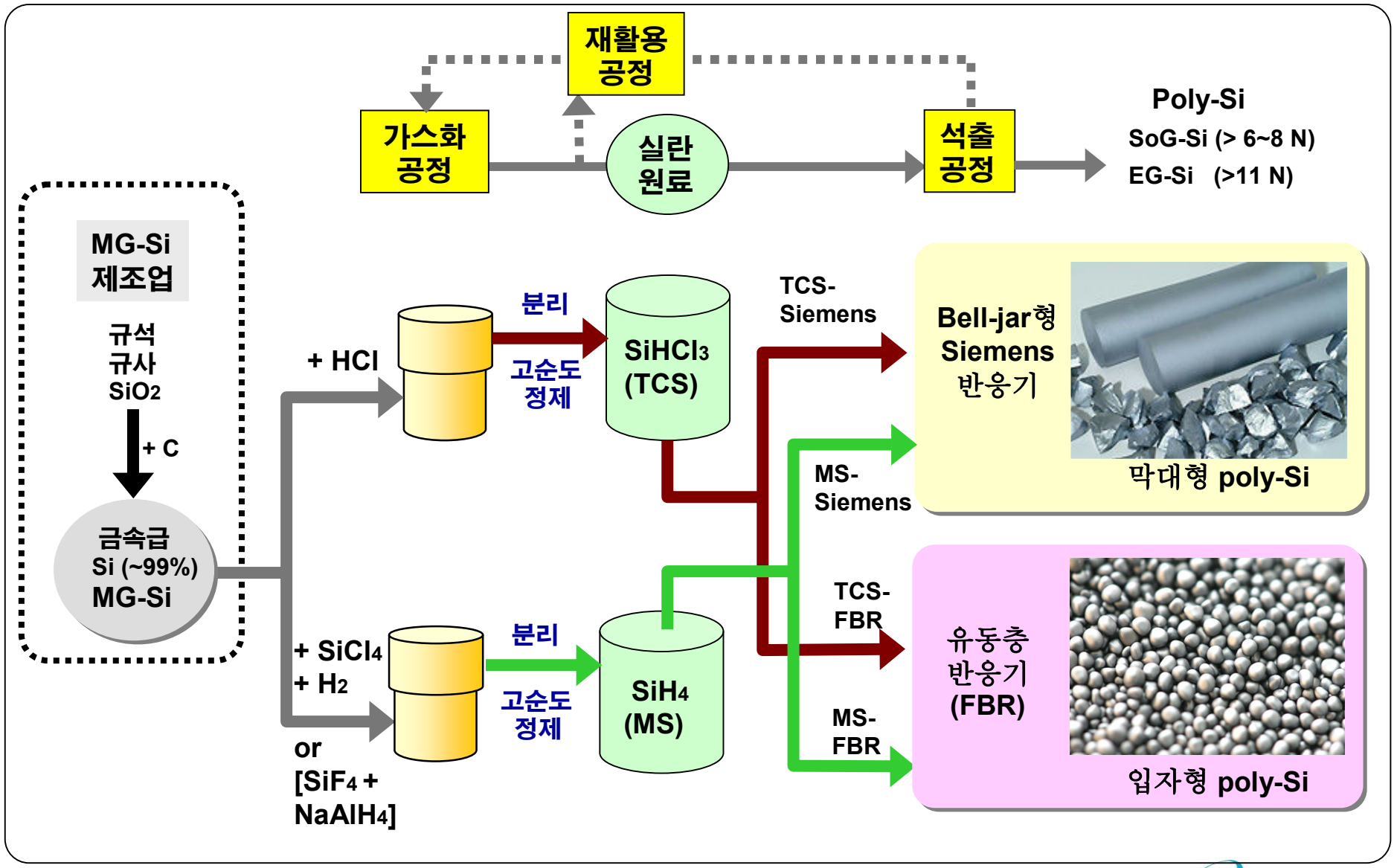
2. 태양전지용 Si원료(SoG-Si) 제조방법



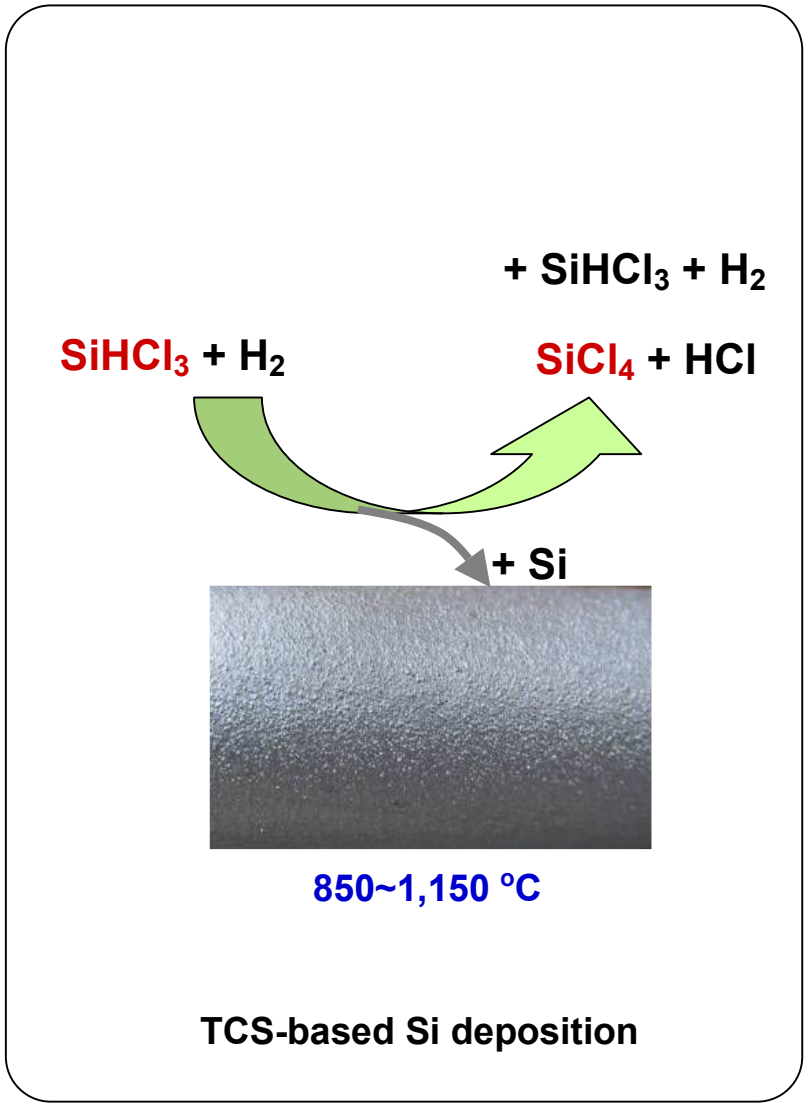
2-1. poly-Si 상업생산 공장 개요

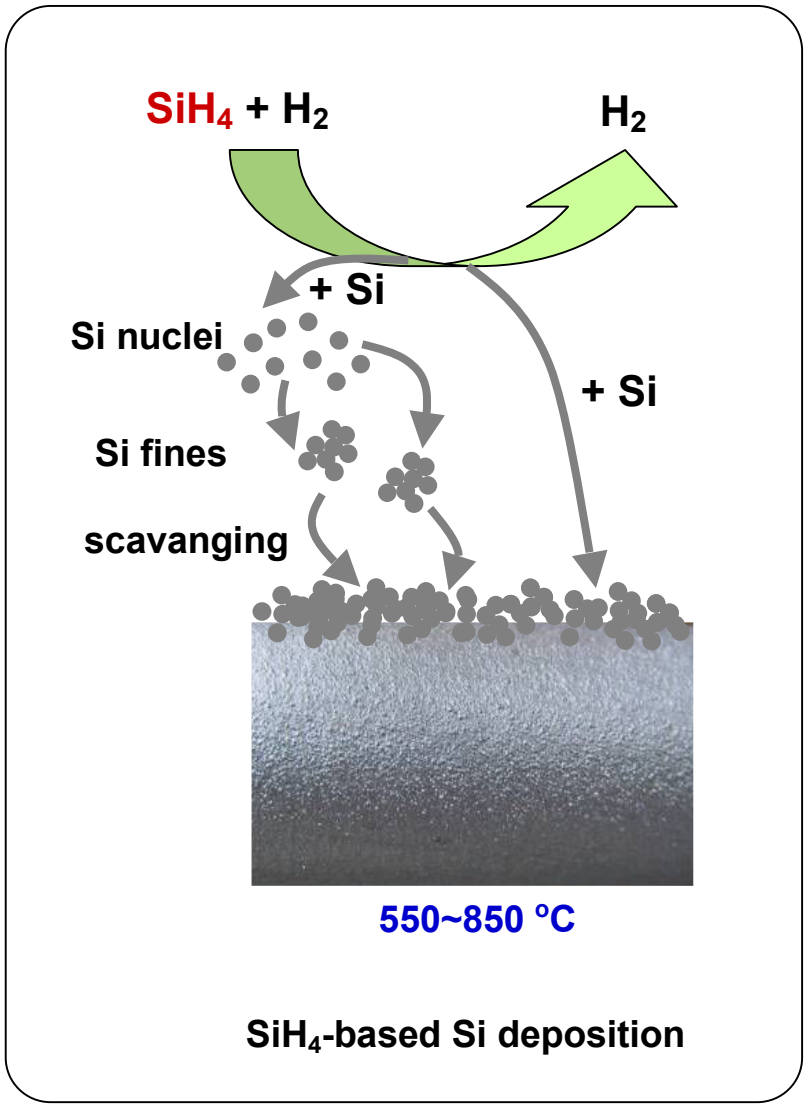


2-2. poly-Si의 4가지 상업생산 경로



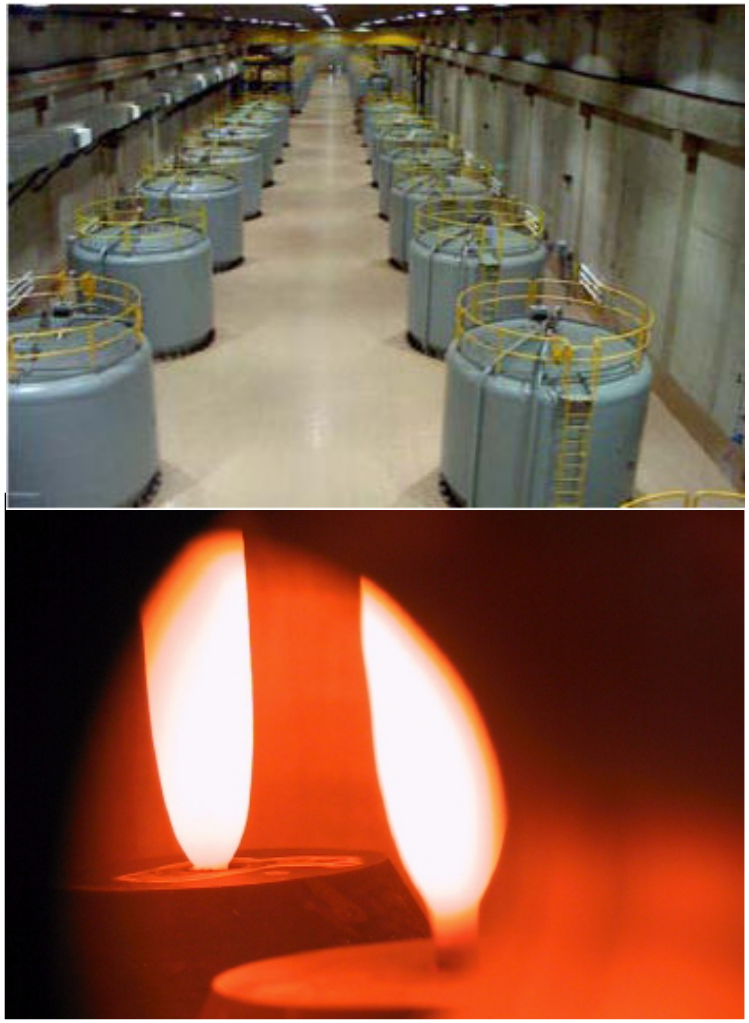
2-3. Si 석출반응





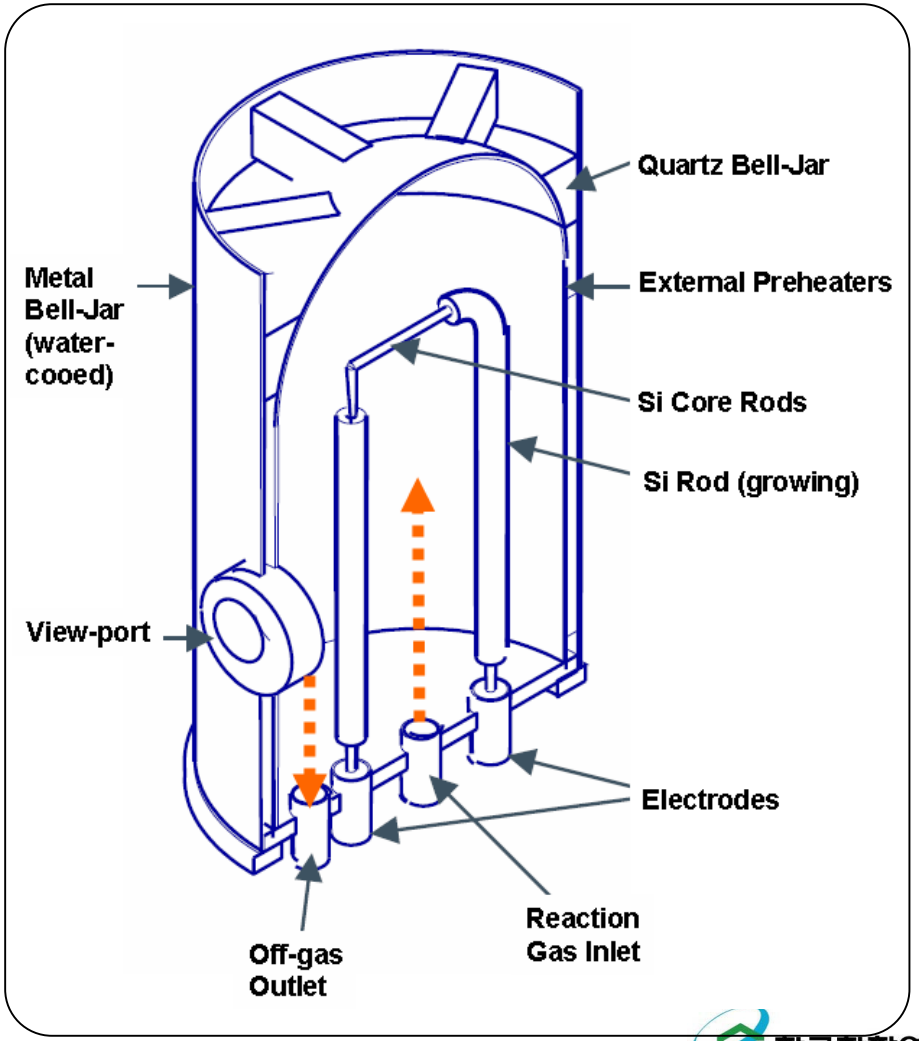
3. Siemens (bell-Jar) 석출기술

[Source: REC]



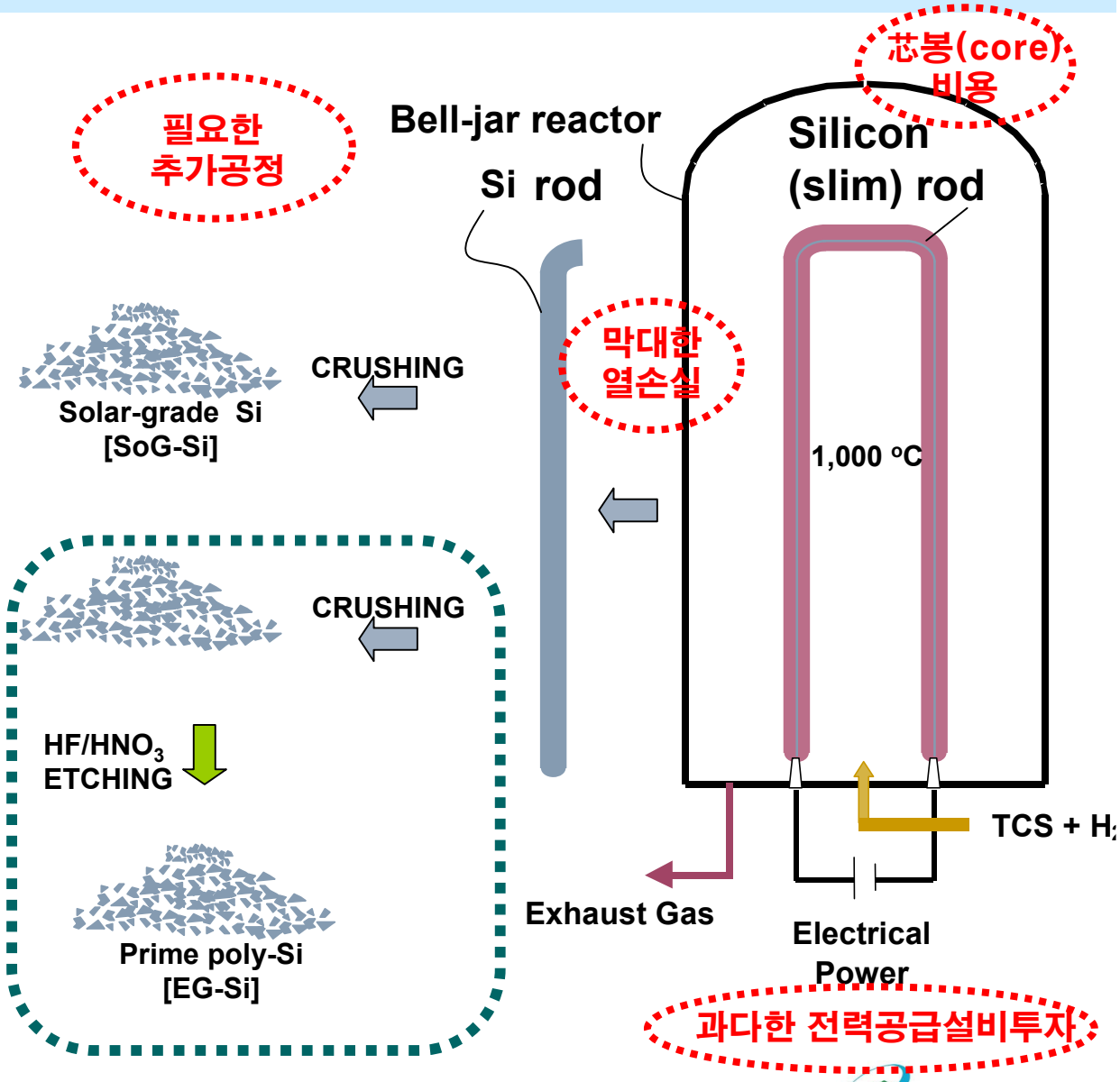
[Source: KRICT]

$89.5 Mio.$ (50%선금)/3,000 mt plant
$49.4 Mio.$(25%선금)/1,700(?) mt plant
2006년 계약분[GT Solar '06계약분, IPO자료]

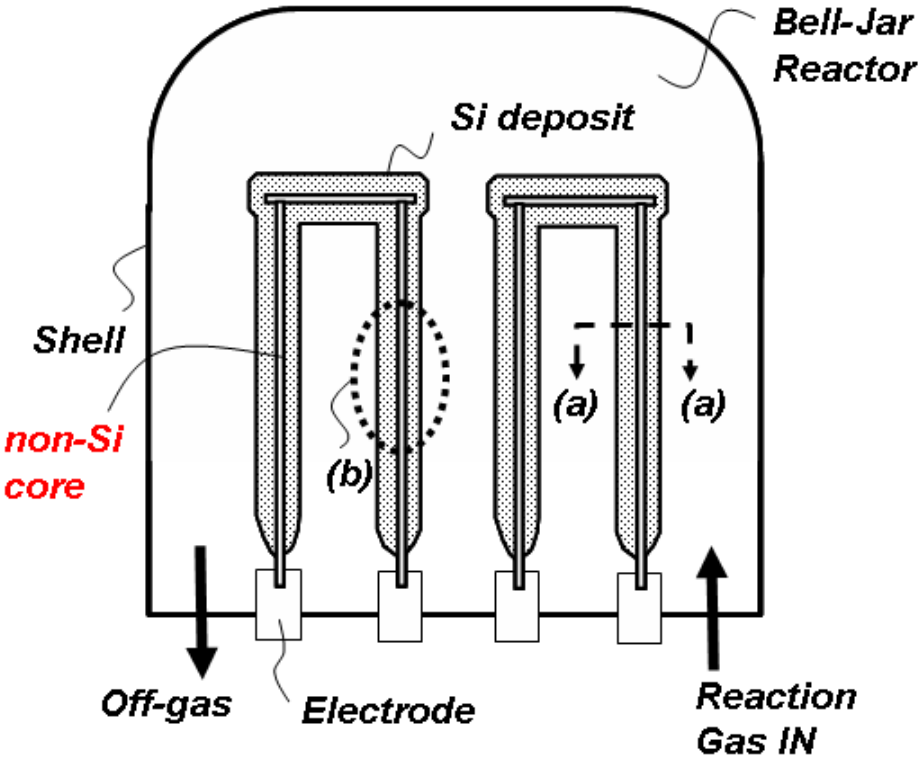


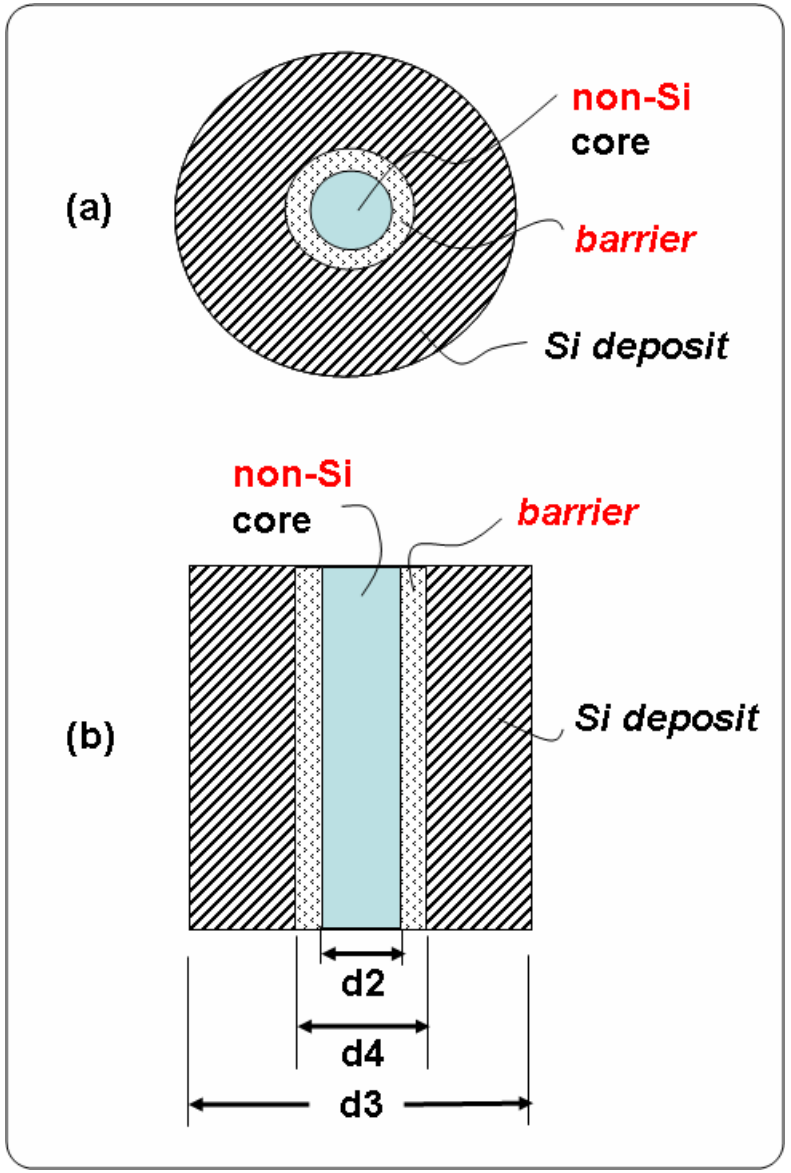
3-1. Siemens 석출공법의 특징

[Source: Wacker's Presentation]



3-2. KRICT Bell-Jar Process (i): non-Si core material

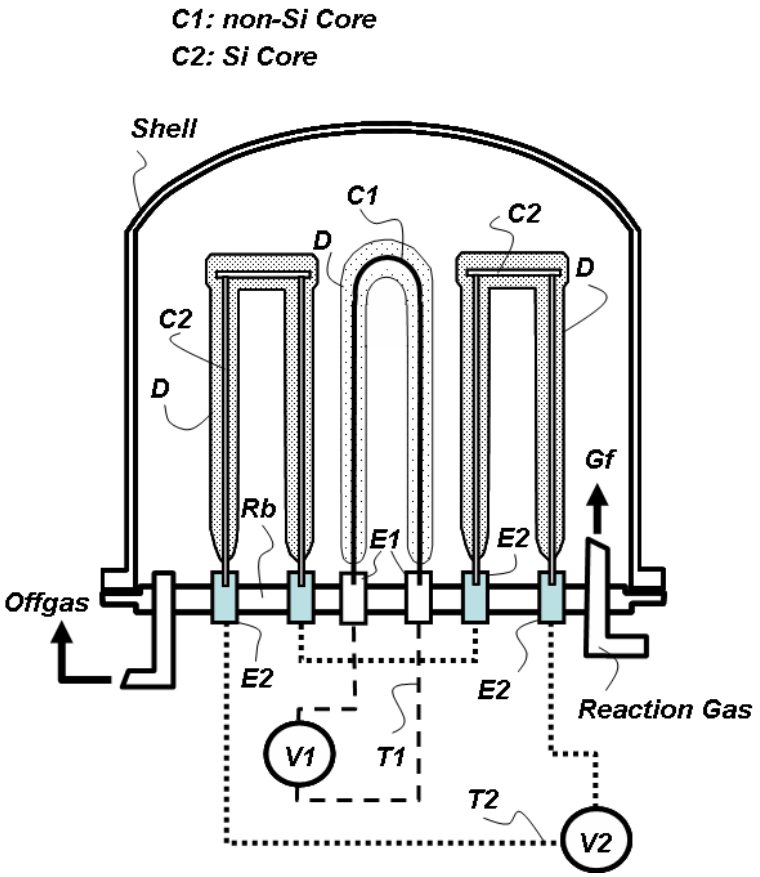




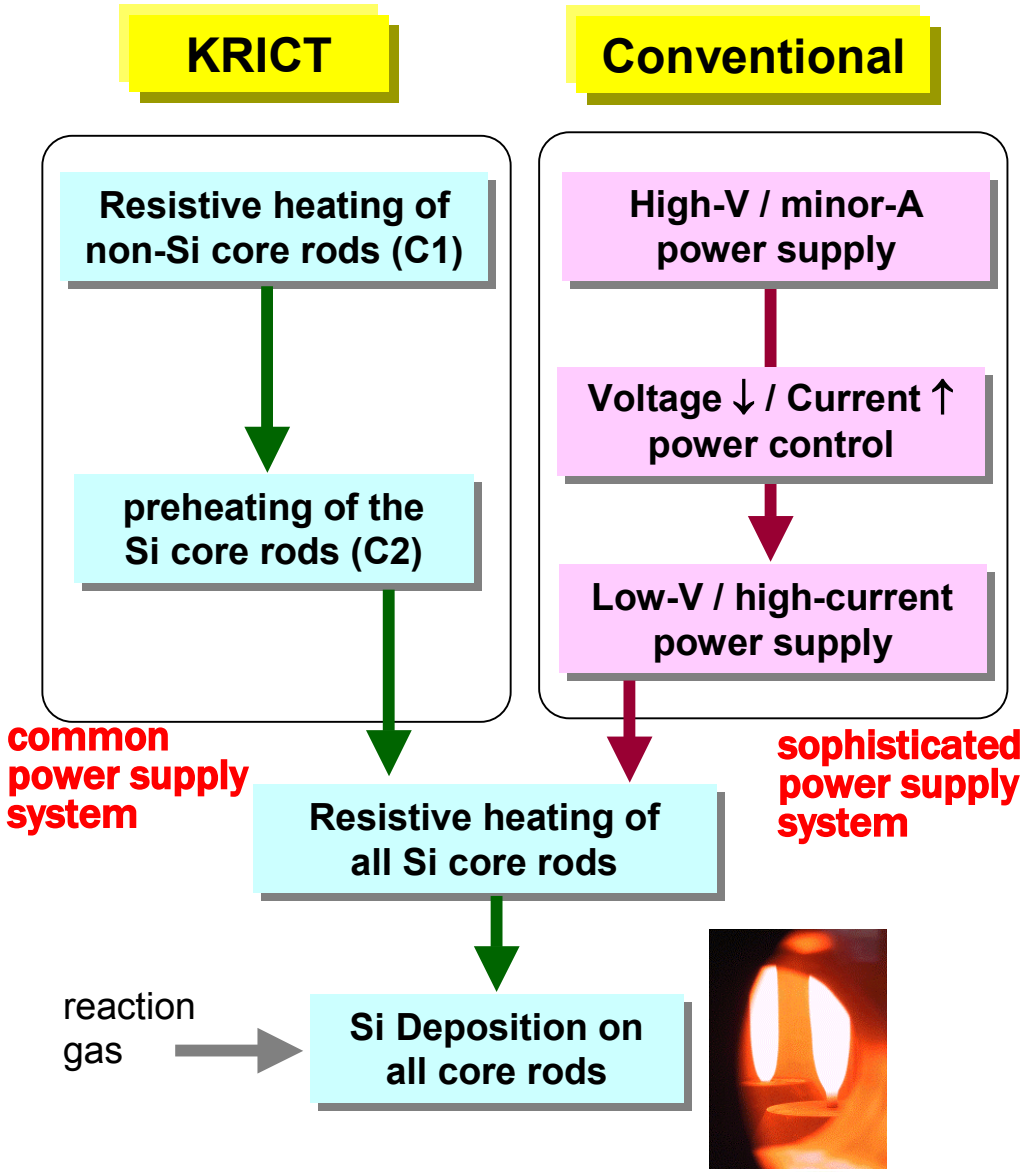
non-silicon core filament covered with a barrier layer against impurity diffusion

[KR 0768148 (3007) / WO2007136209]

KRICT Bell-Jar Process (ii): mixed core rods

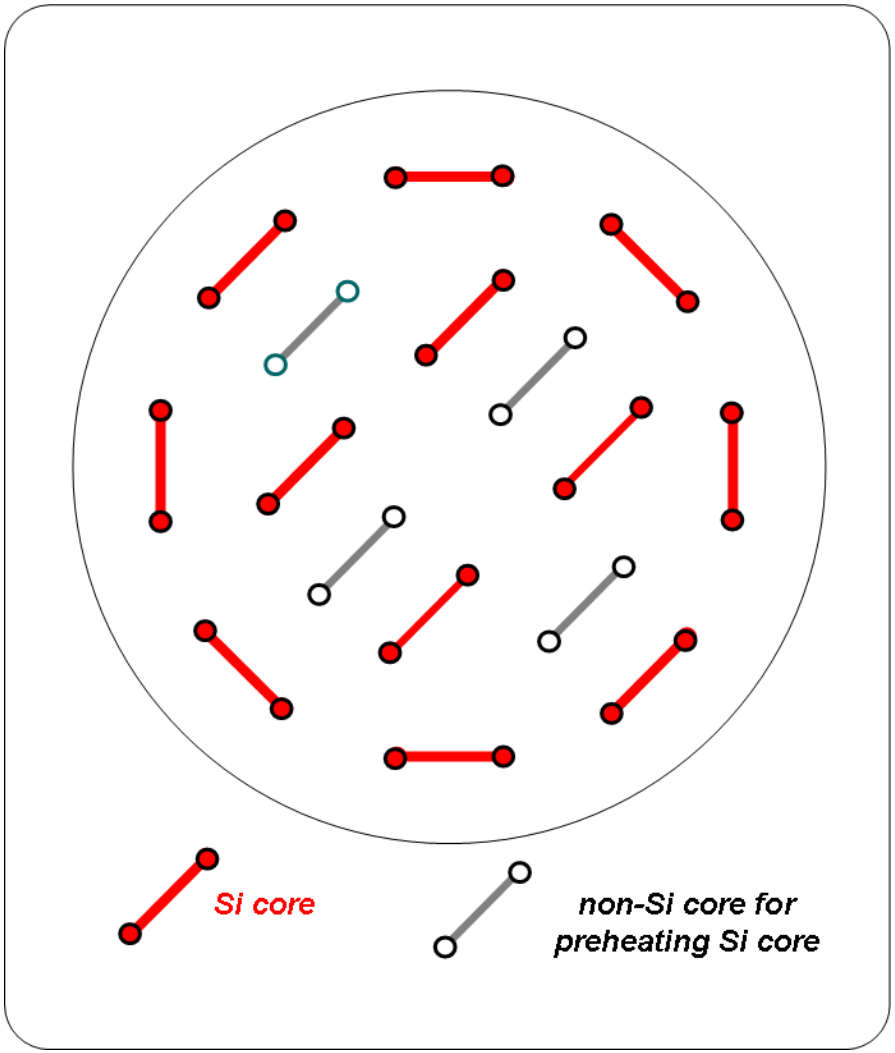


[KR 0768147 (3007) / WO2007133025]



Advantageous Non-Si Core and Mixed Cores

- contamination by diffusion barrier
- very cheaper power supply system
- easier preparation of core material
- cheaper core material
- easy operation and rapid core heating
- easy separation of non-Si core and Si deposit



[KR 0768147 (3007) / WO2007133025]

4. 유동층(流動層; FBR)석출공법

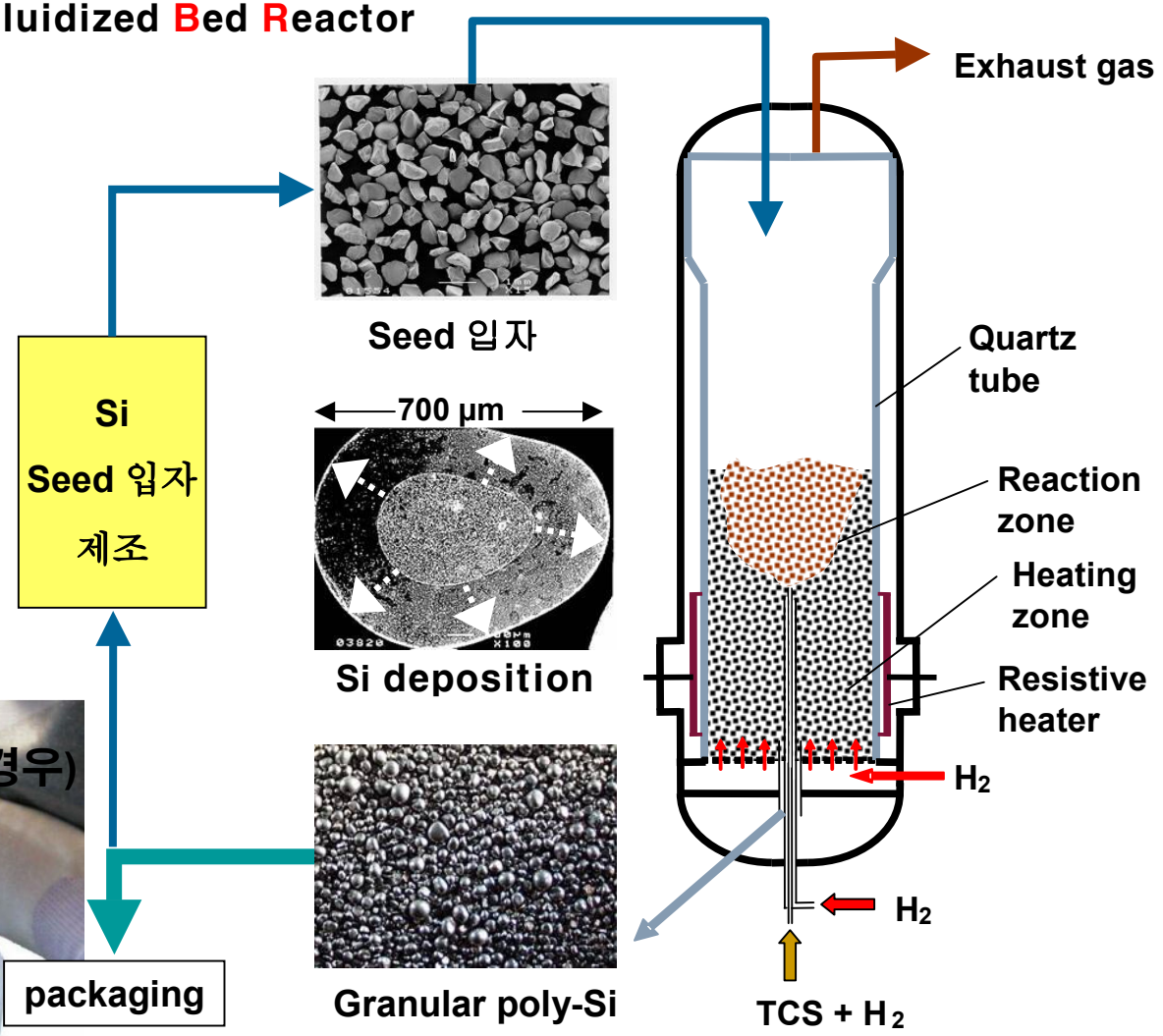
장 점

- 연속대량생산 가능
- 높은 반응수율
- 전력소모 대폭 절감

低價 생산 가능

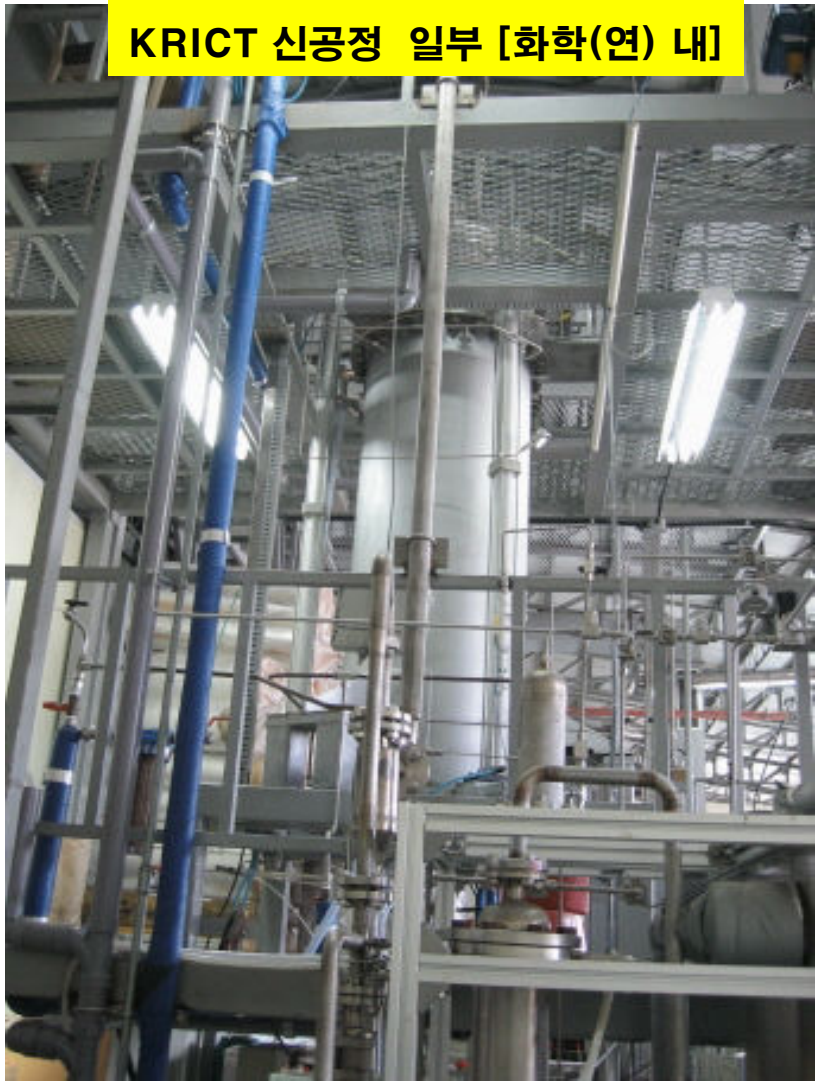
문 제 점

- 入자加熱 기술 필요
- 넓은 표면적 (오염 위험)
- 잔유 성분 (Cl/H) 제거 필요
- 粉末생성 문제 (SiH_4 원료의 경우)

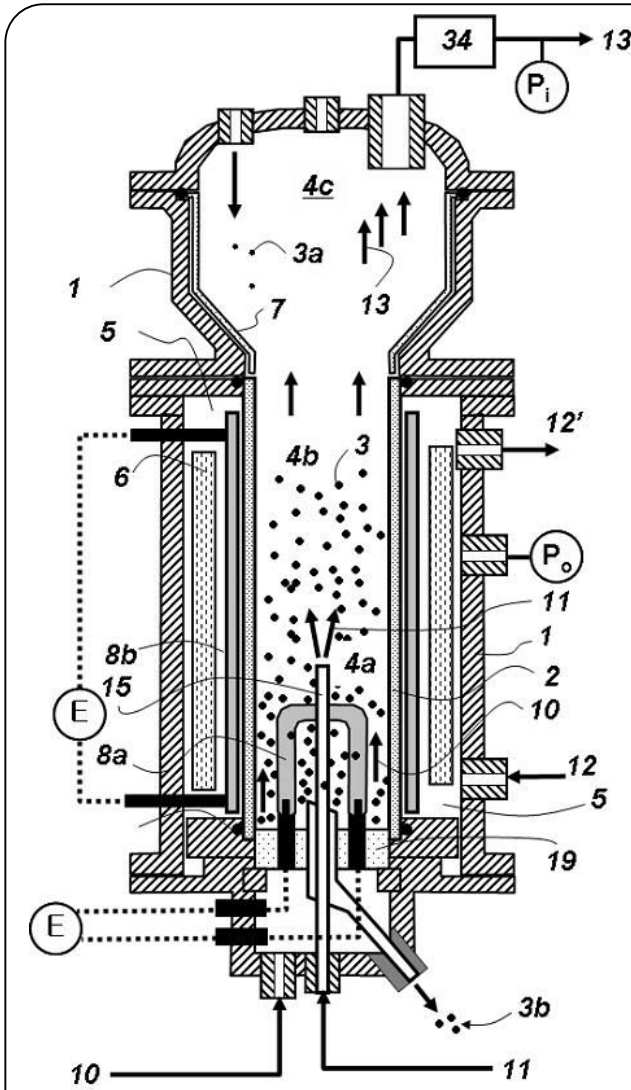


[Source: Wacker's Presentation]

4-1. 화학(연) KRICT-FBR (New-Version)



KRICT 신공정 일부 [화학(연) 내]

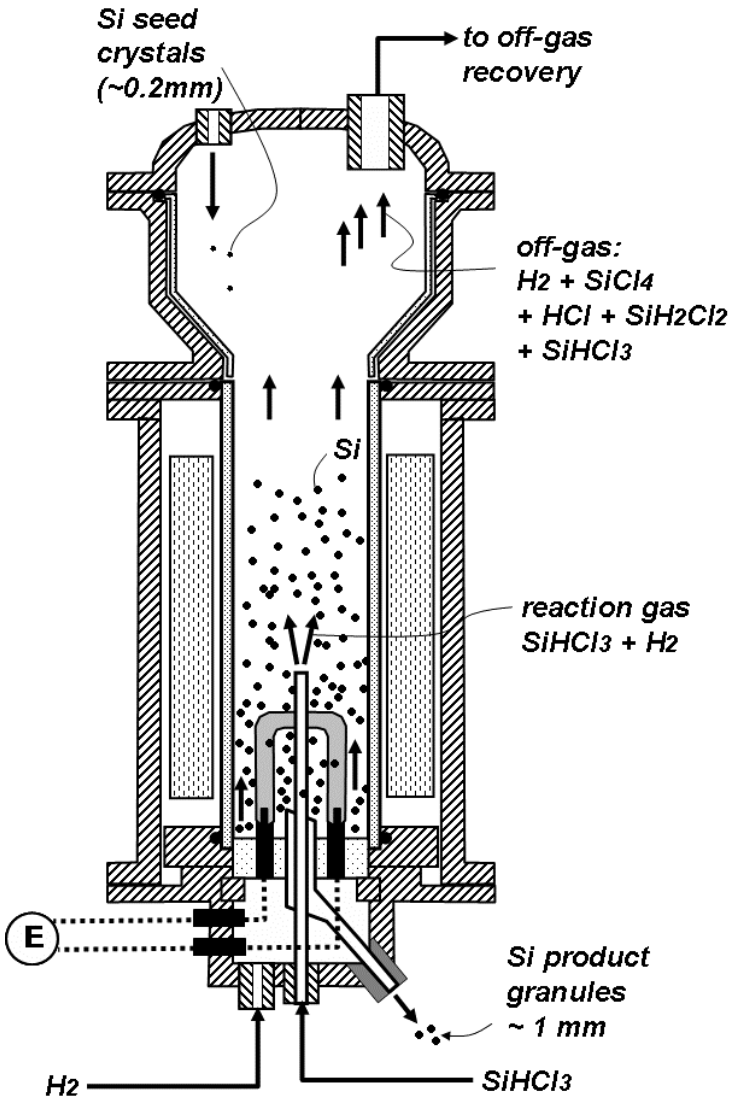


1: 반응기 셀
2: 반응관
3: Si입자
4: 내부영역
5: 외부영역
6: 단열재
8a, 8b: 가열기
10: 유동가스
11: 반응가스
12: 불활성가스
13: 배출가스
15: 반응가스 노즐
19: 가스분산공급부
E; 전력공급원
Pi: 내부영역압력
Po: 외부영역 압력

KRICT 신공정 [세계 유일의 高壓석출공정]

4-2. New KRICT FBR 특징

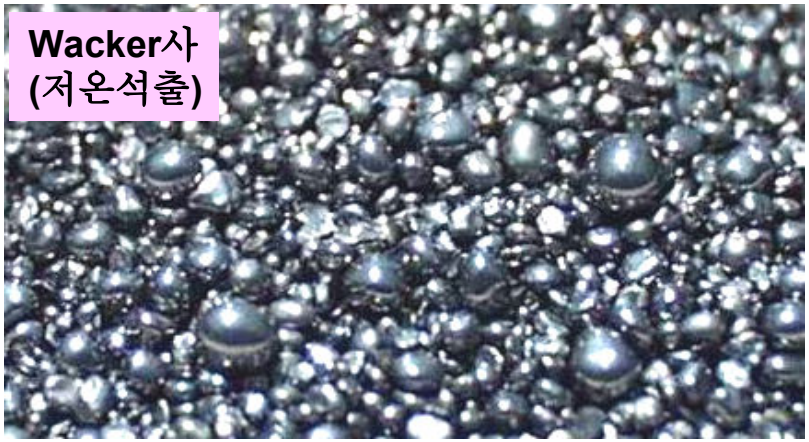
- ❖ 세계 유일의 高壓 석출구현[생산성 극대화]
- ❖ 高壓 운전 가능 單純한 구조 [수월한 材料選擇]
- ❖ 高品質 제품 [낮은 *Cl, H2* 잔류농도]
- ❖ 유동층 內部의 선택적 직접가열 실현
  [Heating Zone 도입→ 高壓에서도 반응온도 유지]
- ❖ 충분한 保溫→ 電力소모 극소화 *(world record*지양)
- ❖ 반응관 內壁에서의 Si석출 최소화 가능
  [Hot Wall개념에 기초한 선진국 FBR과 차별]
- ❖ 반응관 해체 없는 연속적 운전: 세계 최초실현
  [벽면에서의 Si석출물 *in situ* 제거기술 구현]
- ❖ 활용범위가 확대중인 粒子형(*granular*) 製品
- ❖ 모든 실란원료 [SiH_4 및 $SiHCl_3$(TCS)] 에 활용 가능
  [기존 Siemens반응기 교체 가능]
- ❖ 광범위한 산업재산권(특허) 확보



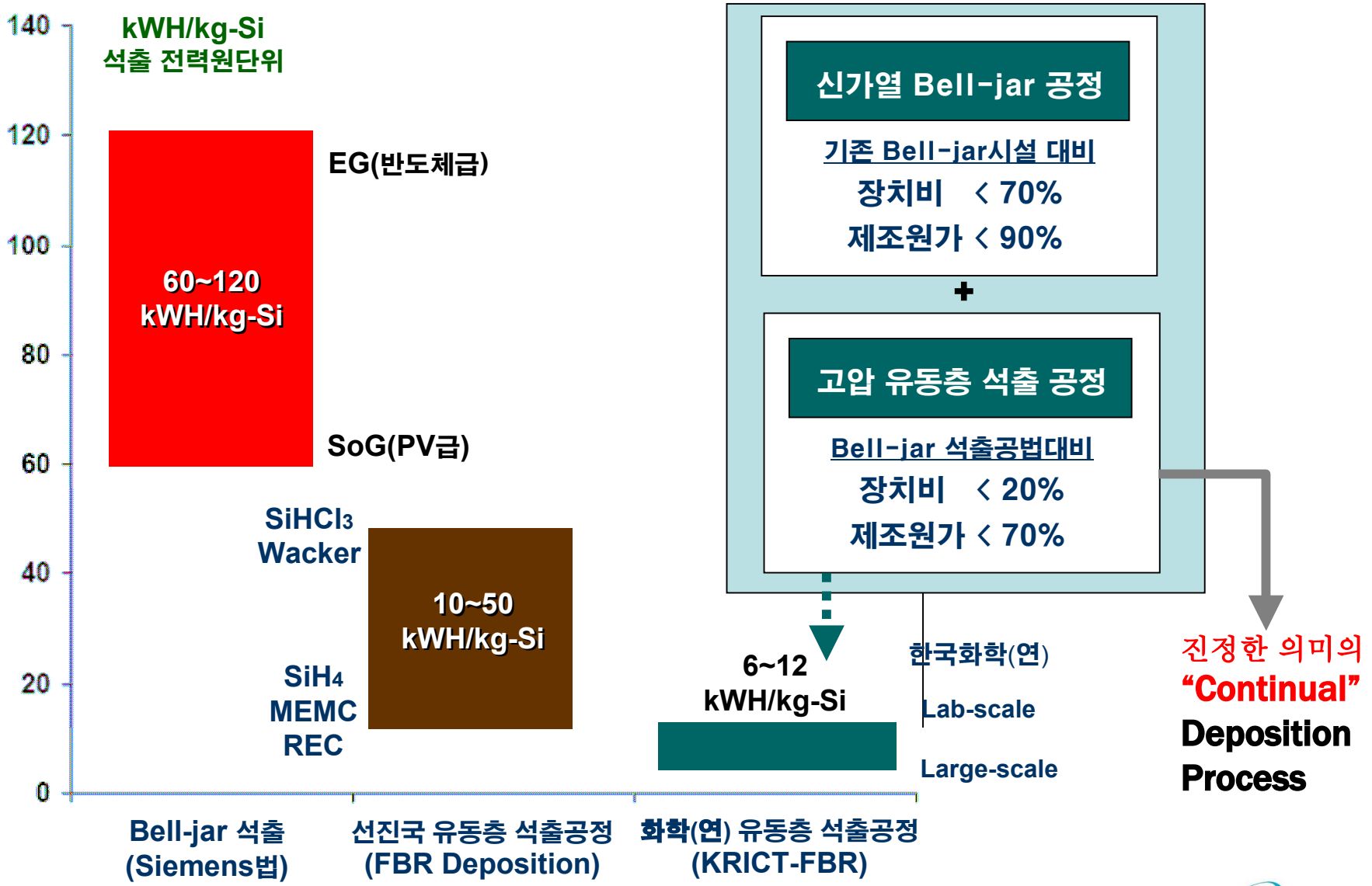
4-3. 입자형 poly-Si 시제품 비교

SiH_4 석출제품

$SiHCl_3$ 석출제품



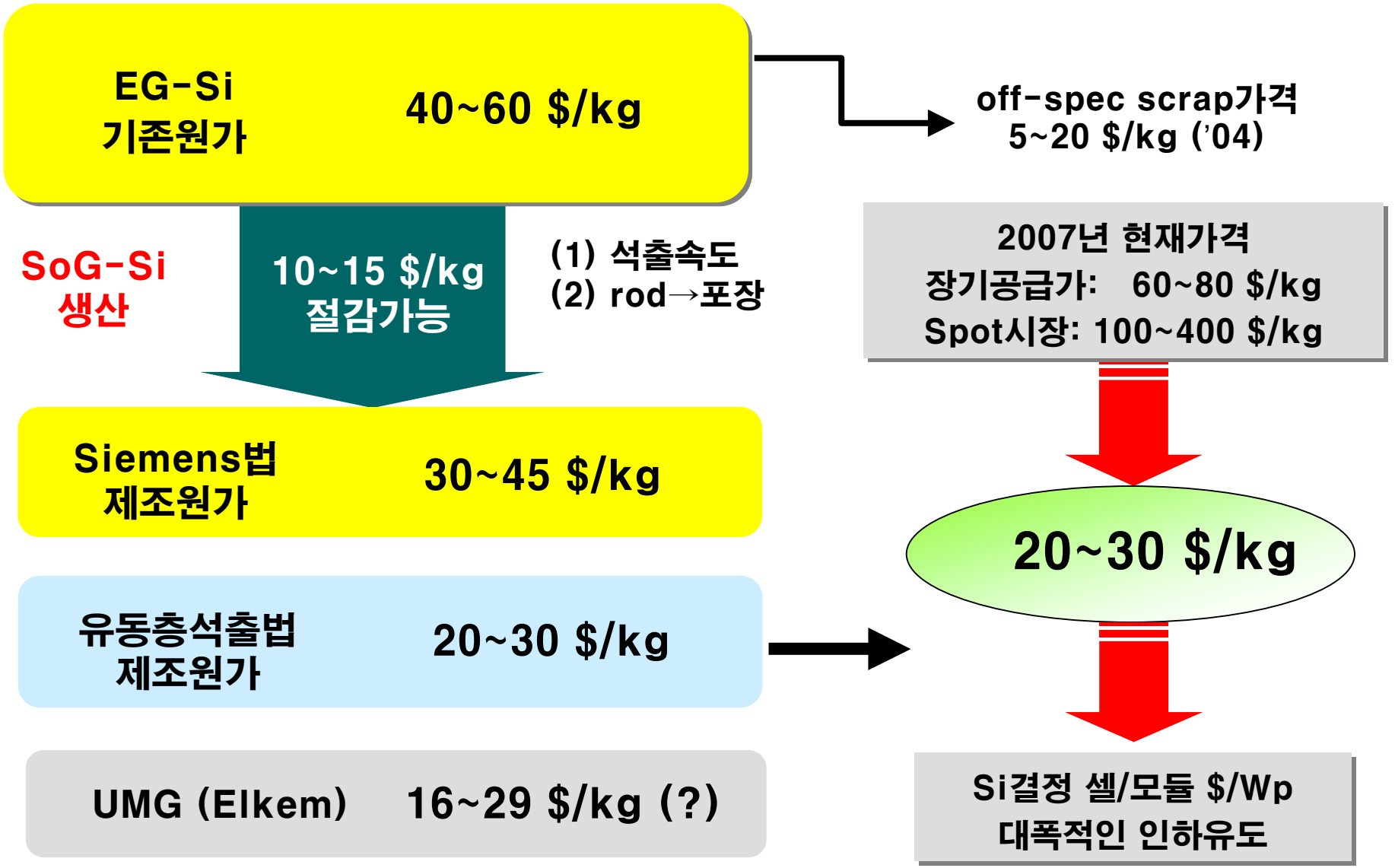
4-3. 석출공정 KWH/kg-Si 비교 (2008. 02. 현재)



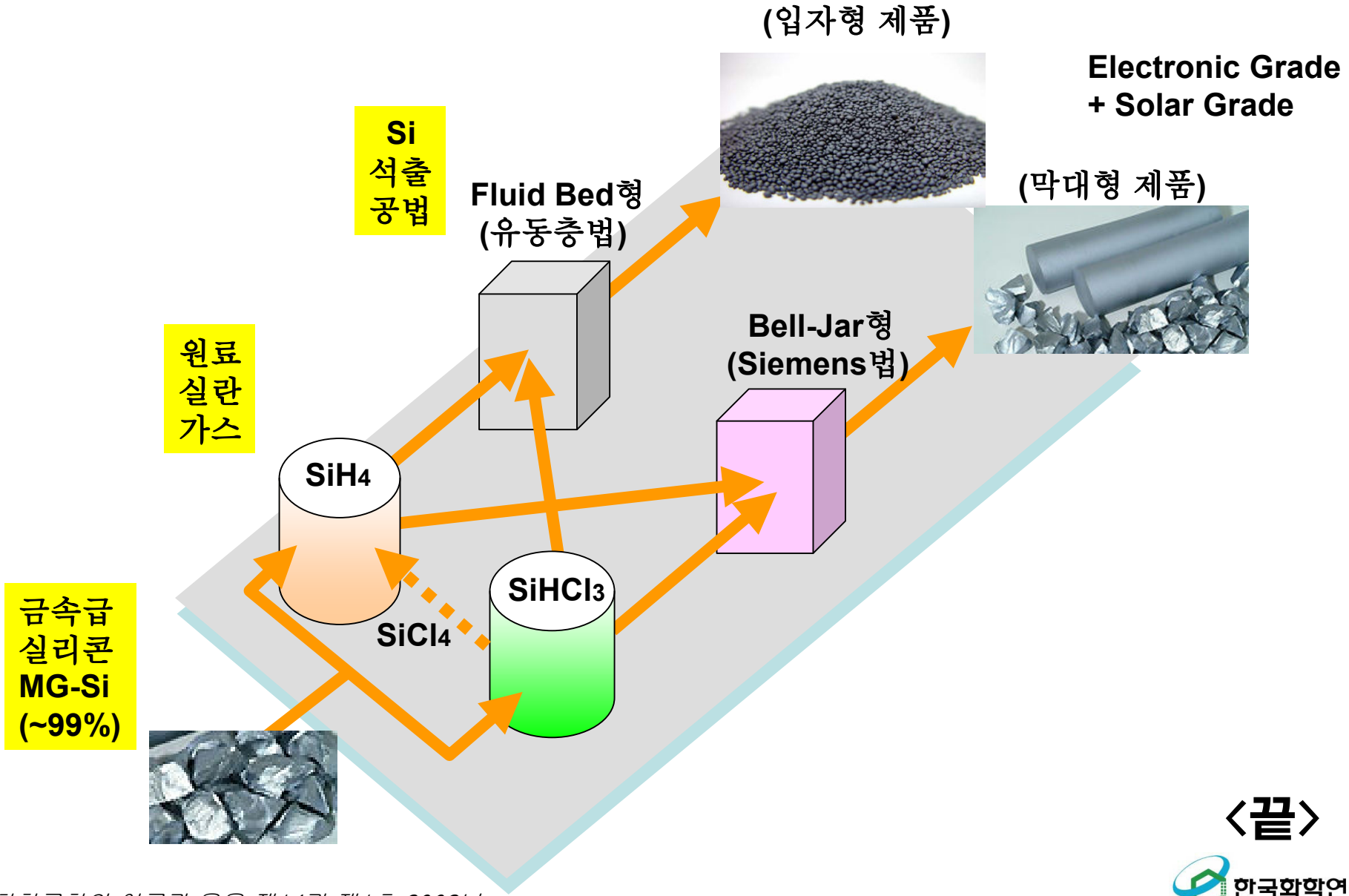
5. 향후전망: SoG-Si 종류별 활용범위

Cell공법 / Si소재종류	응용전망	다결정 mc-Si ★★★	단결정 sc-Si ★★★	EMC법 다결정 ★	리본형 Si결정 ★★★	球입자 셀 ★	후박형 thick film ★	박막형 thin film ★★★
(1) Upgraded MG Si (uMGS) (야금법에 의한 고순도 Si)		O	Δ	Δ	Δ	O	X	X
(2) 폴리실리콘 Poly-Si	Bell-jar (Siemens 법 석출): 막대(봉)형	O	O	Δ	Δ	X	X	X
	유동층(FBR) 석출: 입자형(granule)	O	O	O	O	O	O	X
(3) Si 분말	SiH_4 열분해	X	X	Δ	Δ	X	Δ	X
(4) 박막증착용 실란가스	$SiHCl_3$, SiH_2Cl_2	X	X	X	X	X	O	X
	SiH_4 gas	X	X	X	X	X	O	O

5-1. 제조원가 목표



5-2. 국내 poly-Si 제조업의 장기비젼



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