Direct metallisation on silicon
Plating and screen printing on porous silicon

nb technologies
consulting engineers

In a line of advanced metallisation concepts starting from multi-print of Ag and plating on screen printed Ag seed, direct plating on silicon has the potential for 20% **efficiency mono-Si cells** without selective emitter as well as **CoO reduction up to 0.10 Euro per wafer**, depending on approach and options.

NBT has identified and advanced on the crucial pieces for succeeding in direct plating concepts:

- screen printing of resist (HF compatible) as etch mask, nitride protection and plating mould
- wet-etch patterning of nitride
  (preferred to etch paste (cost and residue) and LASER ablation (cost and damage))
- patterned **porous silicon** on emitter for **thickness-limited Ni-silicide formation** at low temperature, enabling to **contact high-ohmic emitters without selective emitters**
- specialised Ni-**electro**plating solution **sunNiSi**
  for etching porous silicon and plating of Ni from a single bath at RT
- **solvent-free cleaning solution to remove resist** after the metal stack is completed
- aligned multiple screen prints **(sunstence® uni / sunstence® me)** usable for the combination of screen printed etch pastes, resists and Ag paste metallisation

Ask for your sampling!

Approaches

The wet processing steps are enabled by NBT's single-side/backside-dry **suncup®** plating tool concept (patents pending). Different approaches are possible:

1. Ag is plated directly on silicon after nitride patterning with superior adhesion (patented)
2. Porous silicon is formed (e.g. 5% HF) prior to plating Ni/Cu/Sn stacks in the screen printed resist serving as etching mask, nitride protection and plating mould. The Ni-silicide is formed at 350℃ and limited to the porous silicon thickness. In contrast to electroless Ni coatings on silicon, the electroplated Ni shows superior adhesion directly after plating (patent pending).
3. The patterned porous silicon is contacted with screen printed Ag paste. The benefit of porous silicon is the high contact area that is contacted directly without firing through the nitride (patent pending).

Standard mono-Si solar cell manufacturing steps without selective emitter

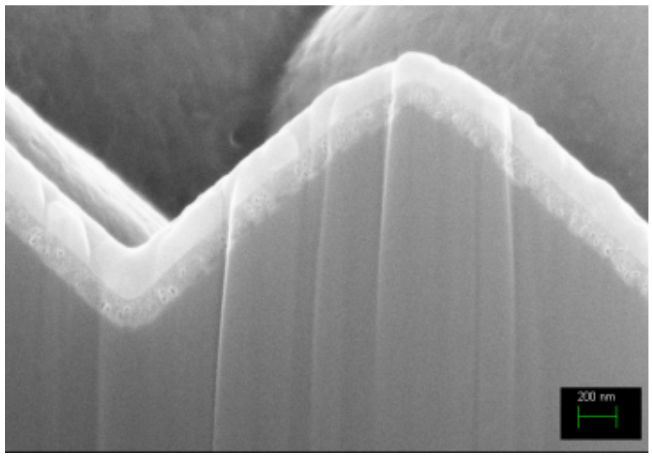
texturing, doping, ARC layer, backside AlAg screen printing + firing!

Front side metallisation

Process Step	Details	NBT product portfolio
Mask Deposit	Screen printing of HF-resistant resist	sunstence® uni screen + Maramask PV-HF resist
Nitride Patterning	- Etching with HF (20%) - Laser ablation + HF DIP (5%)	suncup® wet process tool
Porous Silicon Formation + Ni-Filling (single bath)	- Electrochemical porosification (20nm) - Ni electroplating in porous silicon	suncup® wet process tool + sunNiSi chemistry
Electroplating (final metallisation)	Ni Cu Sn or Ni Ag	suncup® wet process tool
Mask Removal	Peel resist from surface and filter solids (KOH-based solution)	
Nickel Silicide Formation	Firing at 250°C to 300°C (form NiSi in porous silicon)	

>20% efficiency mono-Si solar cell (without selective emitter)

Process flow of direct plating approach using porous silicon as limitation for the silicide formation



Electroplated Ni and uniform Ni-silicide formed less than 200nm deep in a layer of porous silicon

sunstence® uni and **sunstence® me** are distributed under the **sunstence®** family by Hans Frintrup GmbH.

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