The Origin of Background Plating

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Outline

Motivation

- Why plating?
- Relevant questions
  - Texture
  - Cleaning
  - Mechanical stress

Experiment

- Sample preparation
- Results

Summary
## Motivation

### Why plating instead of Ag screen printing?

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Challenges</th>
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<tbody>
<tr>
<td>- Less shading</td>
<td>- Adhesion</td>
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<tr>
<td>- Higher conductivity</td>
<td>- Shunting</td>
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<tr>
<td>- Low contact resistance</td>
<td>- <strong>Background plating</strong></td>
</tr>
<tr>
<td>- Lower series resistance</td>
<td></td>
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<tr>
<td>➤ Higher efficiency</td>
<td></td>
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</tbody>
</table>

- Higher efficiency

![Image](100 µm)
Motivation

Questions:

- Are there texture dependant effects?
- Is wafer cleaning important?
- Can wafer handling cause problems?
Sample size 5x5 cm² cut out of 6 inch wafers by laser
Sample Preparation

Texture

Cz-Si

KOH / HBA

Piranha

HCl

Cleaning

NaOH Etch

HF Clean + 50 Ohm/sq Emitter Diffusion

PSG Removal + SiN$_x$:H Deposition

Inkjet Masking + selective SiN$_x$:H Opening

Mask Removal in KOH Solution
Sample Preparation

Texture
- KOH / HBA
- Piranha
- HF Clean + 50 Ohm/sq Emitter Diffusion
- PSG Removal + SiNₓ:H Deposition
- Inkjet Masking + selective SiNₓ:H Opening
- Mask Removal in KOH Solution

Cleaning
- NaOH Etch
- HCl

Mech. Stress
- Ultrasonic Bath
- Cofiring + Ni Deposition + Sintering
- Cu Electroplating
Sample Preparation

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- KOH / HBA
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Cleaning
- NaOH Etch
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SEM/FIB
1. Search for unintentional plating on SiN$_x$:H surface
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2. FIB milling into the surface
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3. FIB milling cross sections in 12 nm steps
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2. FIB milling into the surface
3. FIB milling cross sections in 12 nm steps
4. Stopping FIB and starting EDX investigations

EDX diameter ~1 µm
Results on Surface

Round copper depositions on surface

Texture
Cleaning
Mech. Stress

KOH/HBA
NaOH
HCl
No
No background plating when Piranha cleaned
Results on Surface

Copper “worms” and round depositions found on surface

Texture
Cleaning
Mech. Stress

KOH/HBA
HCl
Piranha
Yes
Effect No. 1

KOH/HBA
HCl
No

Only detected on HCl cleaned sample
Effect No. 1

Results - FIB

Texture
KOH/HBA
HCl
Mech. Stress
No

Only detected on HCl cleaned sample
Effect No. 1

Disruptions by **impurities**

- Insufficient cleaning

**Texture**

- KOH/HBA

**Cleaning**

- HCl

**Mech. Stress**

- No

Only detected on HCl cleaned sample
Effect No. 1

Disruptions by impurities

- Insufficient cleaning

Texture

KOH/HBA

Cleaning

HCl

Mech. Stress

No

Only detected on HCl cleaned sample
Effect No. 2

Detected on HCl cleaned and mechanically treated sample.
Effect No. 2

Detected on HCl cleaned and mechanically treated sample

Texture
Cleaning
Mech. Stress
KOH/HBA
HCl
No
Yes
Effect No. 2

**Silicon particles** located in valleys of pyramids

Ni was detected underneath the particle by EDX

- Insufficient cleaning
- Mechanical stress

Detected on HCl cleaned and mechanically treated sample
Results - FIB

Effect No. 3

Only detected on mechanically treated sample
Results - FIB

Effect No. 3

<table>
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<tr>
<th>Texture</th>
<th>KOH/HBA</th>
<th>HCl</th>
<th>Piranha</th>
<th>Mech. Stress</th>
<th>Yes</th>
</tr>
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</table>

Only detected on mechanically treated sample
Effect No. 3

**Cracks** in the silicon wafer
Ni was detected in crack
Contact between base and emitter ➔ Shunting

➡️ Mechanical stress

Only detected on mechanically treated sample
Summary

- No texture dependence was found

- Sufficient cleaning is necessary, Piranha clean is suitable

- No/low stress avoids background plating

Effect No. 1
Impurities

Effect No. 2
Si Particles

Effect No. 3
Cracks
Thank you for your attention!

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