

**SERMA TECHNOLOGIES**

## FIB process optimisation for complex integrated circuits modification

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### FIB Process limitation in complex integrated circuits modifications

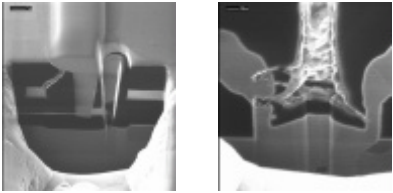
Limitations impacting yield:

- Problems on contacts to deep levels for technologies with more than 4 levels of interconnection. (Positioning, aspect ratio and electrical resistance).
- Problems of resistance and compliance limitations and time to process for long straps and analogs modifications.

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### FIB modification defects



Dielectric breakdown

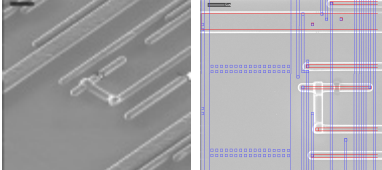
Bad planarisation of passivation making cleaning difficult

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### Fine positioning on planarized technologies

Working with CAO data :

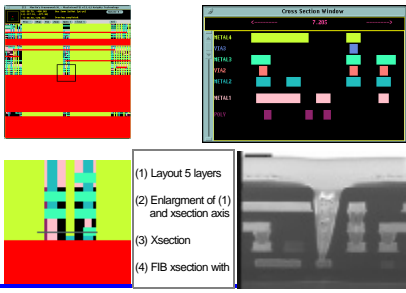


- Secondary electrons image only "see" top metal level
- CAO plots, superimposed on FIB image allow accurate positioning cuts or vias on lower metal levels.
- Best way to get high yields on > 3 metal levels

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### Example of FIB modification on 5 levels technology

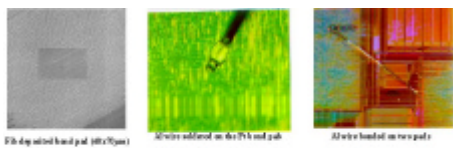


- (1) Layout 5 layers
- (2) Enlargement of (1) and xsection axis
- (3) Xsection
- (4) FIB xsection with

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### Long connexions : with Bond pad deposition and wire soldering.



Fib deposited bond pad (10x10µm)    Wire soldered on the 10x10µm pad    Wire bonded on wire pad

Example for a 2mm strap on 2 samples

FIB deposition	Wire bonding
- > 6 KΩ Resistance	- ~ 150 Ω resistance

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**SERMA TECHNOLOGIES** **LIMITATIONS IN FIB 'S STRAP RESISTANCE**

- Objectives:
  - Some straps could require greater current density than classically used for CMOS logic applications, this could be applied to the following cases:
    - All circuits with analogics part inside
    - All circuits in the case of straps between power supply

**SERMA TECHNOLOGIES** **Nickel chemical deposition on FIB modification**

Why Nickel?

- Electroless process
- Nickel adapted to platinumium and in some cases to aluminium.
- Resistivity better than FIB straps

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**SERMA TECHNOLOGIES** **Nickel chemical deposition on FIB modification**

Process

- use of commercial sodium hypophosphite
- Deposition at 80°C about 5 microns thickness in a quarter of hour.
- Electrical resistivity: 60 microhms/cm<sup>3</sup>

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**SERMA TECHNOLOGIES** **Nickel chemical deposition on FIB modification**

Experiments on packages and dies:

- Opening of vias with and without platinumium flash and deposit of thin straps (less than 0.1µm).
- Nickel deposition
- Electrical and physical characterisation

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**SERMA TECHNOLOGIES** **ELECTRICAL CHARACTERISATION OF FIB 's MODIFICATION**

Electrical measurements of contacts in a five levels technoly:

	Strap	M5	M4	M3	M2
FIB Pt	1170 ohm	70ohm/	100-200	250-400	400-600
	*	via	ohm/via	ohm/via	ohm/via
Nickel	5 ohm	open	13	25	NA
deposition	*	**	ohm/via	ohm/via	

\* 120 square (lenght: 600 µm / 5 µm width thickness: 1µm)  
 \*\*: corrosion

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**SERMA TECHNOLOGIES** **Nickel chemical deposition on FIB modification**

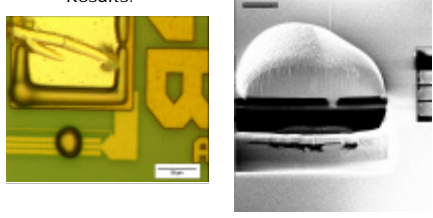
Results:

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**Nickel chemical deposition on FIB modification**

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Results:

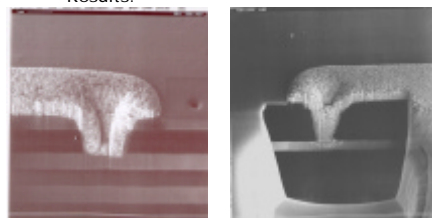


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**Nickel chemical deposition on FIB modification**

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Results:

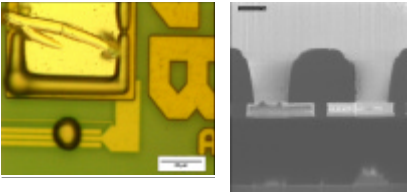


Metal 4 Metal3

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Connexion to metal 2

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**Nickel chemical deposition on FIB modification**

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Conclusions

- Process easy to applied for decreasing straps resistance
- Needs to be characterised on via with very high aspect ratio and with process adapted to deposition on aluminium.
- Next work: measuring yield and reliability

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