Metallization of nanostructures by High Power Impulse Magnetron Sputtering

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Aim

- Metal deposition inside high aspect ratio structures
- Exploring High Power Impulse Magnetron Sputtering (HiPIMS) for ionized PVD

Previous work: HiPIMS for Ni silicides:

Metallization for 3D integration

3D integration – scaling in 3rd dimension, multiple device layers

The challenge:

- Vias to connect the layers
- Small diameter, 20-100nm
• Electron beam lithography
• 250 nm deep holes
• Diameter from 60 to 200 nm
• Cu used for filling tests
Experimental

- High Power Impulse Magnetron Sputtering (HiPIMS)
- High ionization of the sputtered Cu

**HiPIMS**
- On time 50 μs
- 100 Hz
- Peak current 2.3 A/cm²
- Average power 60 W
- 0.5 Pa

**Bias**
- Unipolar pulsed DC
- 10 μs on, 5 μs off

Discharge and substrate current waveform, target Ø 5cm.
Typical DC current ~150 mA
Results: DC sputtering

DC sputtering = Neutral deposition flux

- Very little deposition inside the holes
- Bias has no impact
HiPIMS: bias

Filling improved with increasing bias
HiPIMS: Aspect ratio

Ø 200 nm

Bias of 400 V

Aspect ratio still limited!
Discussion

• A.R. ~1...OK
• A.R. ~2 ....pinch-off

Two factors:
• Resputtering
• Flux directionality
HiPIMS: Deposition rate

Deposition rate on a flat surface

Efficient resputtering above 200eV
~70% ionization estimated
Deposition simulations?

- Using SIMTRA*
- Angular distribution and gas transport
- No resputtering or plasma consider
- At present, only preliminary results!

Conclusions

- HiPIMS suitable for I-PVD
- Pulsed bias effective
- Limited aspect ratio at present
- Modelling - ongoing