Self-aligned Growth of Metallic Structures on Doped Semiconductors by Electrodeposition

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Motivation
Use selectivity advantage of ECD on p- or n-type semiconductors:
- light induced maskless, electroless ECD of Cu on p-Si
- self-aligned patterning Co on GaAs
- p-Si and n-Si selective side plating for nanowires

Experimental

Principle:
e- are photo-excited from V.B to C.B and contribute to the conduction process

Electroless deposition of Cu occurs only where laser shines on p-Si.

Light induced ECD of Cu on p-Si

Bulk + Surface charge carrier diffusion

Laser focus spot size 1 – 2 µm

Deposited Cu

Laser focus spot size 1 – 2 µm

Self-assembled Co on n-GaAs

Selective deposition on p-type GaAs and Si

Doping-induced electrodeposition

Self-assembled Co on n-GaAs

Side- plated Co on p-Si

Conclusions

- Light-induced ECD Cu on p-Si
  - Small structures down to 10 µm in diameter
  - Ion implantation helped reducing feature sizes
  - Shorter wavelength reduced feature sizes
  - Background plated Cu present

- Selective plating of Co on GaAs
  - Co was plated only on n-GaAs regions

- Selective side plating on cleaved p/n-Si
  - Co nanowires of 700 nm wide are observed only on n-Si layer by SEM
  - Thinner nanowires can be achieved by controlling n-Si layers thickness
  - Higher resolution SEM is needed for observing thinner nanowires

Experimental

Light induced ECD of Cu on p-Si

Light induced ECD of Cu on p-Si

Light induced ECD of Cu on p-Si

Effect of solutions

(a) no additives, (b) 0.01 M ascorbic acid but no NH₄F, (c) all additives, 0.0025 M NH₄F, (d) all additives, 0.01 M NH₄F, (e) all additives, 0.02 M NH₄F

(a) (b) (c) (d)

Effect of solutions

(a) no additives, (b) 0.01 M ascorbic acid and 0.005 M SPT but no NH₄F, (c) 0.01 M ascorbic acid, 0.005 M SPT and 0.0025 M NH₄F, (d) 0.01 M ascorbic acid, 0.005 M SPT and 0.02 M NH₄F in the CuSO₄/DW solution.

(a) (b) (c) (d)