High-Conductivity Metallic Layers for by Electrodeposition

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**Motivation**

- Fabrication of low-resistivity materials for use as interconnects in electronic chips
- ECD is a particularly suitable process:
  - low energy → avoid interdiffusion, clean interface
  - high quality, epitaxial films can be produced
- To grow epitaxial Ni and Cu films with superior electric and electromigration properties

**Transport Properties of Ni(111) films**

Fuch’s model:

\[ \rho(t) = \rho_\\infty + \frac{3}{8} (1 - p) \rho_\\infty \frac{L_\\infty}{t} \]

- \( t \) - film thickness, \( \rho_\\infty \) - bulk resistivity, \( L_\\infty \) - bulk electron mean free path and \( p \) - specularity parameter which is the fraction of electrons specularly reflected at the film interfaces.

**Experimental**

- **Galvanostat**
  - MeSO₄ 0.5 M, pH 2.5
  - EG&G 273A Galvanostat
  - Room Temperature
  - Graphite counter electrode

**Growth**

- Substrate: n-GaAs (110)
- Back contact: Ga/In eutectic
- EG&G 273A Galvanostat
- Room Temperature
- Graphite counter electrode

- 0.5 M CuSO₄
- 1M H₂SO₄
- 1.5 mM Cl⁻
- 500 ppm polyethylene glycol MW 3400
- 2 µM 3-mercapto-1-propane sulfonic acid sodium salt
- Pulsed plating

**Conclusions**

- Bulk resistivity of Ni(111) is essentially zero at low temperatures
- Cu films are structurally comparable to the Ni films …
- Electrical properties of Cu films are under investigation.
- Electromigration failure for defined defects will be studied on such films.
- One puzzle: Why are Ni(111) films conducting so much better than similar Ni(100) films [by a factor 100]?