

# Electrowinning

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# Electrowinning

## *What Is It?*

- An electroplating process used to remove metal ions from concentrated solutions.
- As in production plating, direct current is applied to an electrolytic cell and metal ions are reduced and deposited onto the cathode.

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## *Why Might It Be Useful?*

- Reduce Metal Concentrations in Process Solutions
  - Prolong bath life
- Reduce Metal Concentrations in Waste Streams
  - Lessens the burden on end-of-pipe waste treatment systems
- Recover Metals
  - Sell to a recycler
  - Reuse as electrodes in the plating process

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*Where Can It Be Applied?*

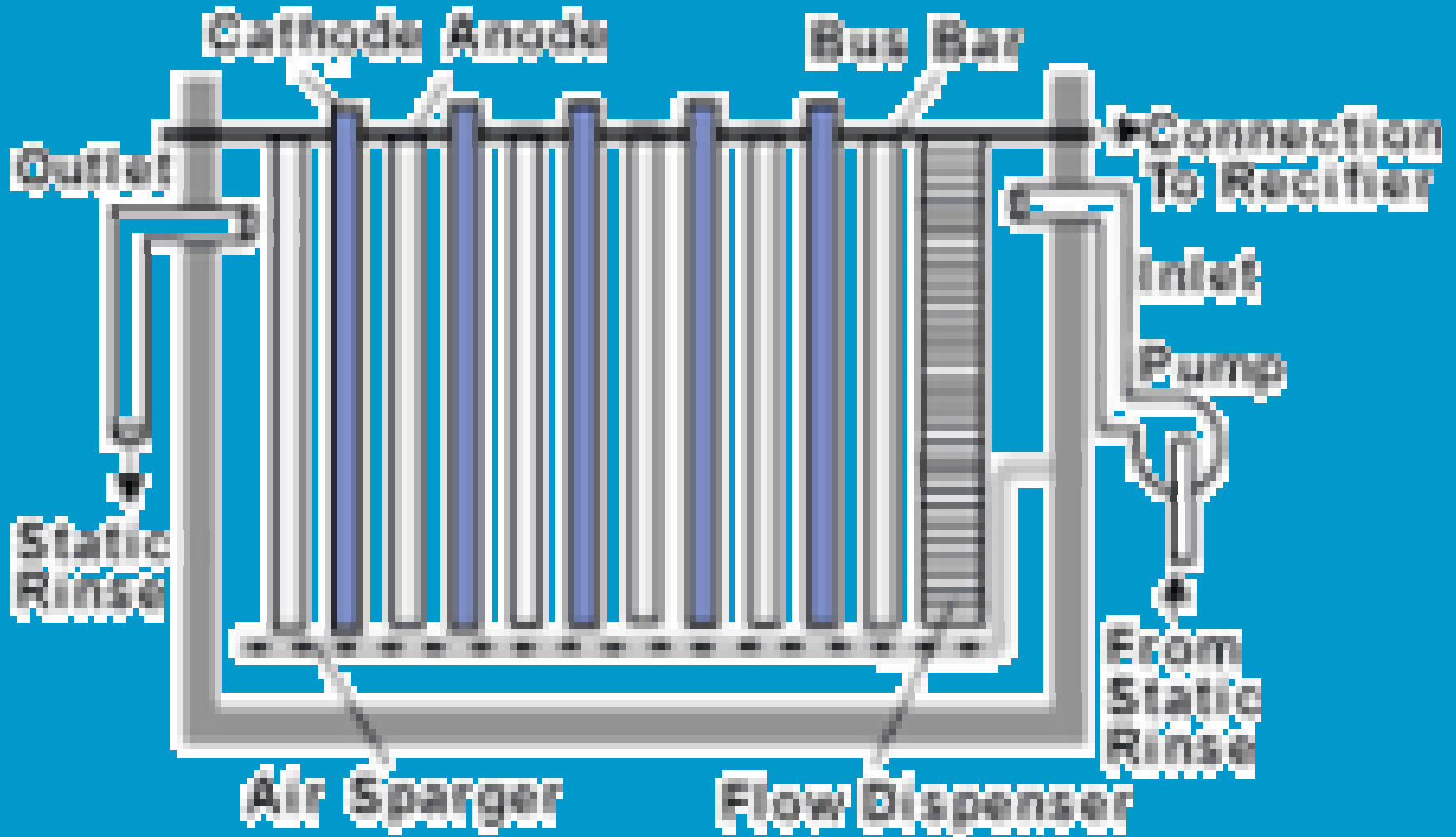
- Spent Plating Baths
- Dragout Recovery Solutions
- Highly Concentrated Rinse Waters
- Acidic Regeneration Solutions From Cation Exchange
- Plating Rinses With Relatively Low Metal Concentration
  - Use special cathode designs

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## *Process Components*

- Process Tank
  - Polypropylene or lined steel
  - Capacity: 10-1500 gallons
- Cathodes and Anodes
  - Cathode materials: stainless steel, metal coated foam, carbon fibers
  - Anode materials: titanium, niobium; coated with precious metal or metal oxides
- Transfer Pump
- Rectifier
- Electrolyte
- System Controls

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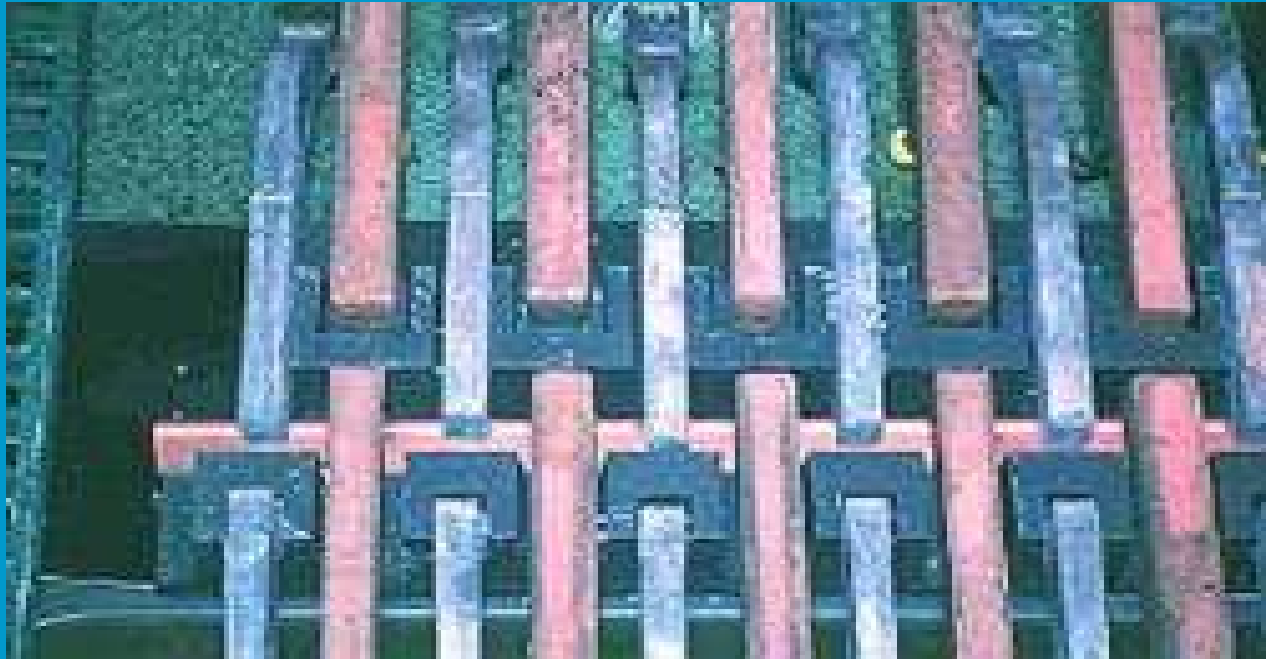
# Electrowinning

*Photo courtesy of L & T Technologies Incorporated*



# Electrowinning

*Photo courtesy of Straits Resources Limited*



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## *Process Parameters*

- Metal Ion Concentration
  - High: 1000-20,000 mg/L
  - Medium: 100-1000 mg/L
  - Low: <100 mg/L (use HSA, HMT cathodes)
- Surface Area and Type of Cathode
- Current Density (CD)
  - Range: 10-5000 amps (CD in amperes per sq. ft. )
- Electrolyte Agitation
- Species of Metal Ion
- Temperature

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## *Cathodes*

- Flat Plate
  - 1-100 sq ft. or more
  - Gross metal recovery
- Wire Mesh & Expanded Metal
- Reticulated
  - Made of metal coated carbon fibers
- High Surface Area (HSA)
- High Mass Transfer (HMT)

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## *Limitations*

- Usually Not a Stand Alone Technology
  - Combine with ion exchange, for example
- Less Efficient at Low Metal Ion Concentrations
  - Apply to higher concentration solutions (1-5+ gm/l)
- Applicability & Effectiveness Varies With Metal
  - Position in Electromotive Series
  - Theoretical Rates: 1.09 to 7.35 g/amp-hour (gold)
  - Aluminum near bottom of series
  - Nickel requires close pH monitoring
  - Does not work for chromium
- In General Used to Remove Cations (Not Anions)

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## *Cost Factors*

- Determine Capacity
  - Amount of metal to recover
  - Deposition rate
- Refer to “*Process Parameters*”
- Capital Costs (NCMS/NAMF: Cushnie, 1994)
  - 1000 amperes - \$32,000
  - 2000 amperes - \$48,000
  - 3000 amperes - \$65,000
  - 4000 amperes - \$75,000
- Operating Costs
  - Labor, electrode replacement, maintenance, energy

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## *Case Studies*

- Plating Shop:  
[www.pfonline.com/articles/010005.html](http://www.pfonline.com/articles/010005.html)
- Printed Wiring Board/Reclaiming Etchant:  
[www.epa.gov/opptintr/dfe/pubs/pwb/case\\_stu/case2/](http://www.epa.gov/opptintr/dfe/pubs/pwb/case_stu/case2/)