



CONNECTED DEVICES

MACHINE LEARNING

SMART AUTOMATION

SMART AUTOMATION

AUTOMOTIVE ELECTRONICS

IoT

ARTIFICIAL INTELLIGENCE

ENABLING THE MANUFACTURE OF SEMICONDUCTOR DEVICES



Modernization of Metrology for Metallization Solutions with ICP – A Quality Control Requirement

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Introduction / Objective

- › Industrial progress pushes the boundary by applying established technology to new application. Trace metal analysis with detection limits to sub-ppm levels is required.
 - **Smaller tolerance** – Process is less forgiving. More parameters have to be monitored and with better performance.
 - **Faster dynamics** – Analysis by outside lab does not work any more. Analytical result is expected in minutes, if not seconds, to prevent colossal losses from operating process with wrong conditions for extended period of time.
 - **Improved economics** – Slim (low-margin) manufacturing processes require low cost metrology.
- › Traditional off-line wet metrology does not meet process control requirement of modern industry. There is a need for express on-line non-reagent metrology.
- › ICP-OES enables improved metrology for many technological processes by addressing these needs.

ICP enables multi-elements measurement in a parallel fashion!

13 Al aluminum 26.98	14 Si silicon 28.09	15 P phosphorus 30.97	16 S sulfur 32.07	17 Cl chlorine 35.45	18 Ar argon 39.95
31 Ga gallium 70.54	32 Ge germanium 72.58	33 As arsenic 74.92	34 Se selenium 78.96	35 Br bromine 79.90	36 Kr krypton 83.80

ECI ICP Analyzer (Online Monitoring System)

› Principle

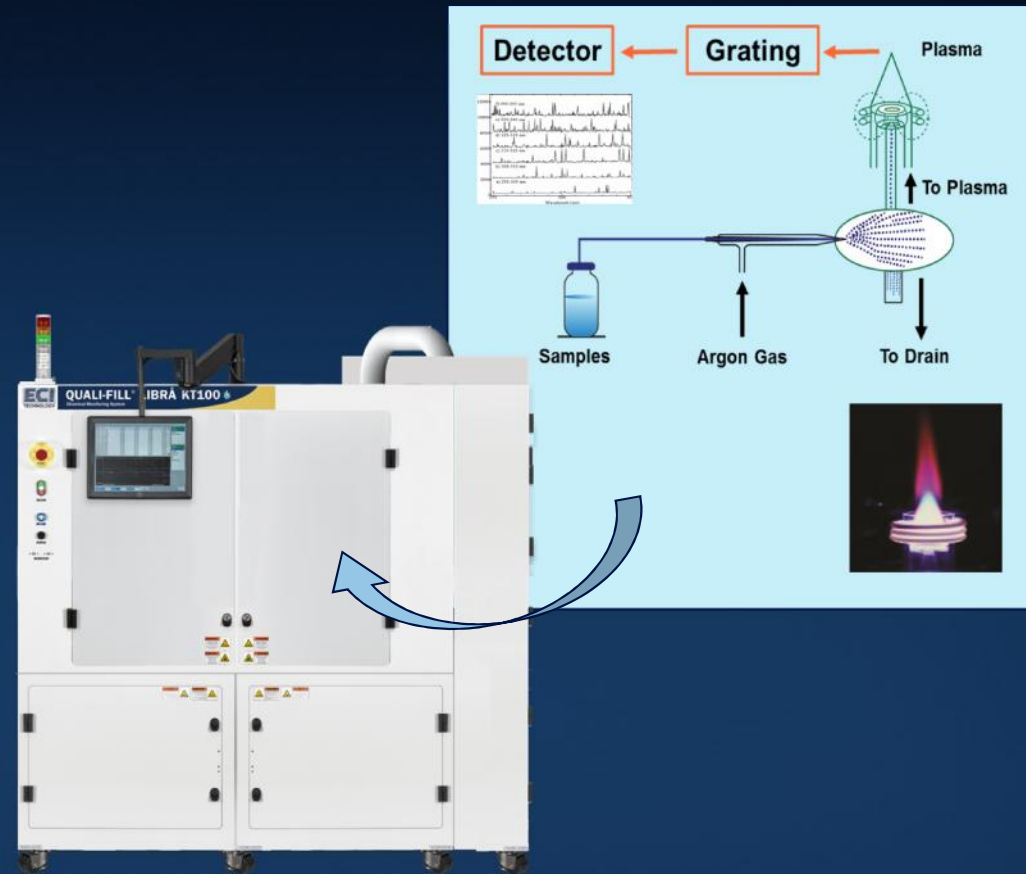
- Sample is ionized in plasma creating “glow.” Multiple elements can be measured based on the color of the glow.
- Method can be used for all metals and some non-metals – (multi-element advantage)

› Design Features

- Multiport valves: Sampling from different tanks
- Dilution channels with in-line mixer
- Sample loop for sample containment

› Integration to ICP

- In-line delivery pump for introduction to ICP
- Simplified software for data acquisition

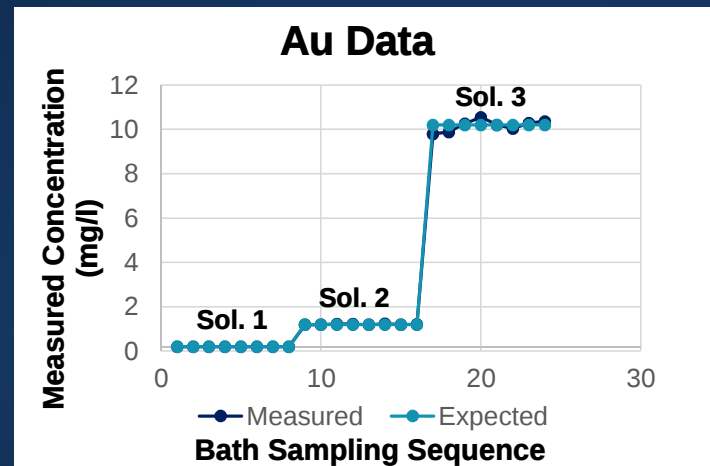
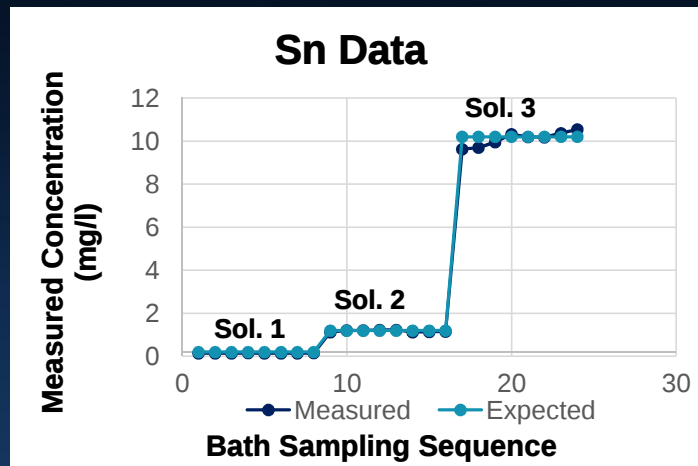
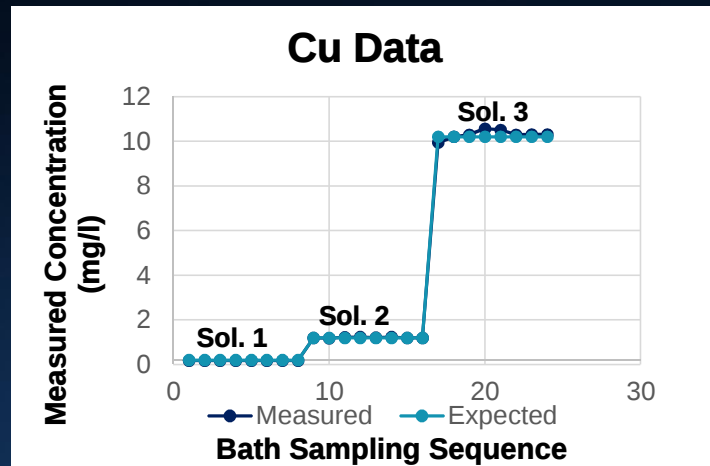


Typical Applications of ICP in Advanced Packaging

Chemistry	Component Analyzable by ICP
Acid Copper Electrodeposition	Copper, Acid, Chloride, TOC, Trace Metals (Ni, Sn, Au), Accelerator Turnover
Nickel Electrodeposition	Nickel, Boric, Chloride/Bromide, TOC, Trace metals (Cu, Sn, Au)
Sn, SnAg Electrodeposition	Sn/Sn(IV), Ag/Bound Ag; Trace metals (Cu, Sn, Au)
Sulfite Au Electrodeposition	Au, Tl/As, SO ₄ , Trace metals (Cu, Sn, Ni)
Electroless Solutions	Main components, stabilizers, Pd catalyst, Boron/Phosphorous reducers

Complex matrix solution requires a robust ICP method and post analysis cleaning

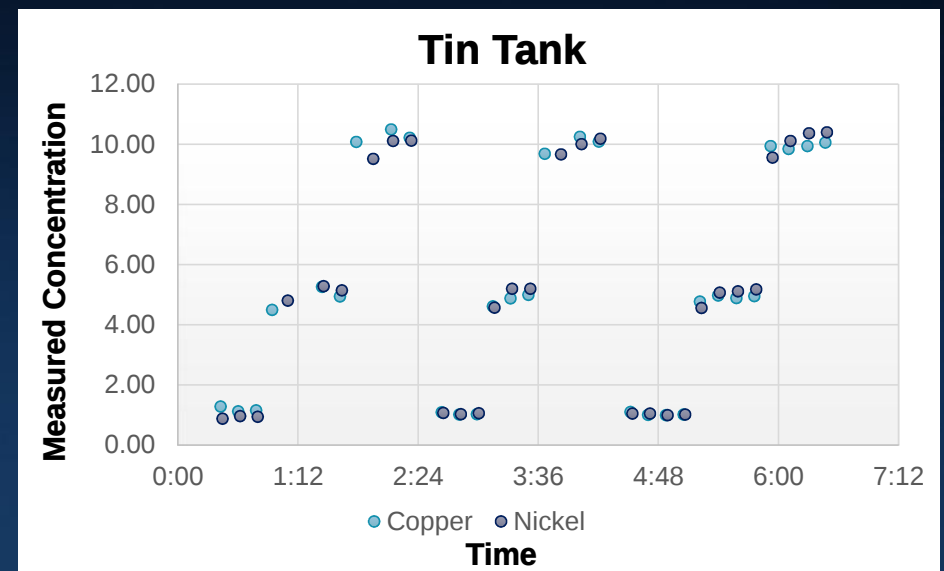
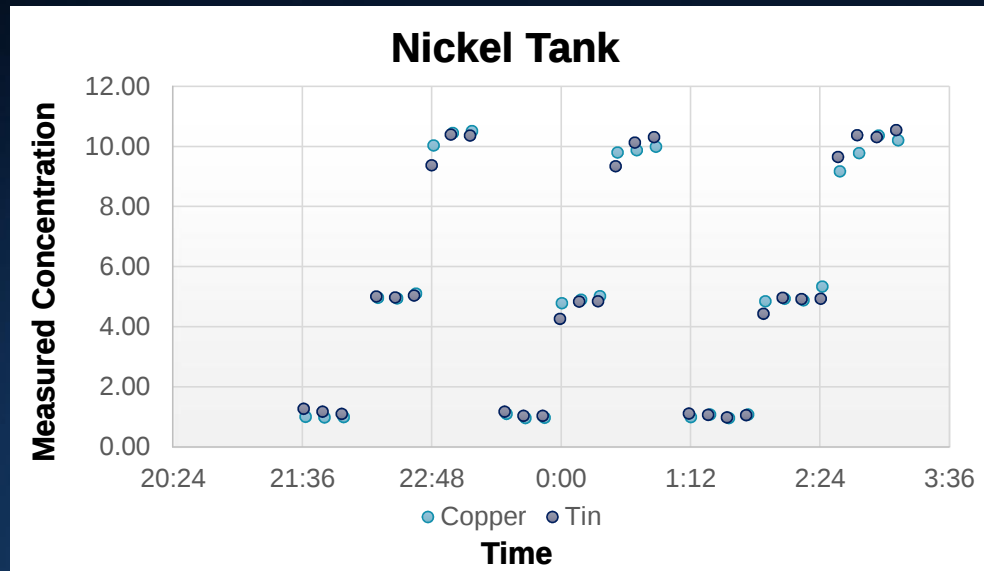
Comprehensive Monitoring of Metallization Solutions



- › Model example for Nickel Sulfamate Metallization Solution
- › Tanks have varied levels of simulated contaminants in Nickel Sulfamate
- › Contaminants measured with high precision!
- › No carry-over between tanks!

Comprehensive Monitoring of Metallization Solutions

Multi-components, multi-tanks and multi-chemistry monitoring of different metallization solutions

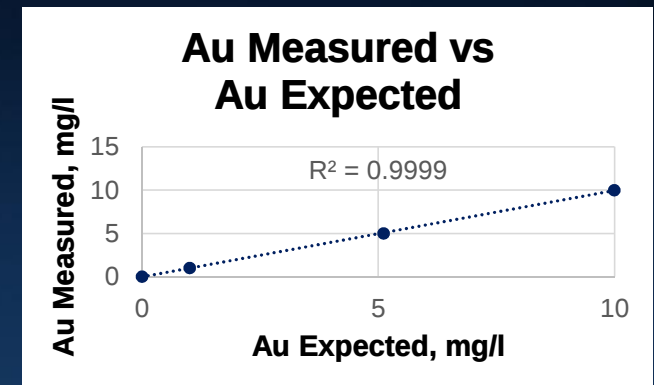
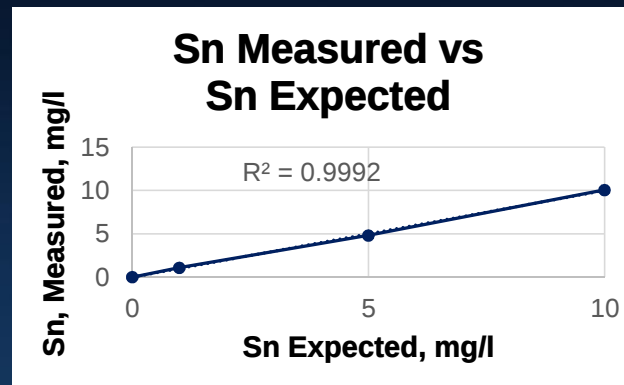
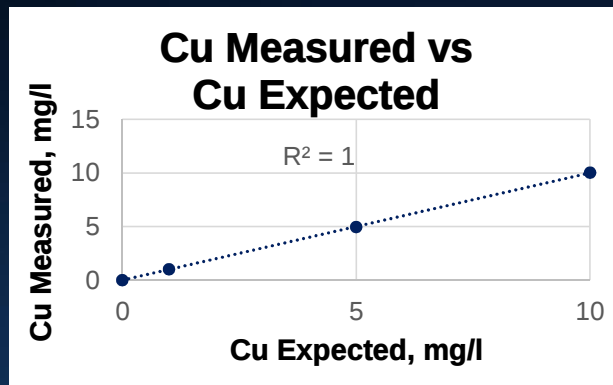


- Three different metallization solutions measured in series: Nickel solutions, Copper solutions and Tin solutions; 3 Tanks for each metallization solution
- Data shown for Nickel metallization solutions and Tin metallization solutions

**No evidence of carry-over between metallization solutions.
A single analyzer can monitor multiple chemistries!**

Comprehensive Monitoring of Metallization Solutions

Calibration Plots



Performance Specifications

	Nickel Tanks		Copper Tanks		Tin Tanks	
	Cu	Sn	Ni	Sn	Cu	Ni
Accuracy, ppm	0.5	1	0.5	1	0.5	0.5
Repeatability, ppm	0.5	1	0.5	1	0.5	0.5

Excellent linearity and dynamic range!

SUMMARY



Ability to analyze and monitor elements at sub-ppm level for most metals in different chemical matrixes



Provide excellent linearity for all elements/metals



Superb dynamic range; Excellent repeatability and accuracy



Rapid analysis of full range elements in periodic table



We Keep Your Chemistry Right™



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