ACI-LeadFree Soldering Summit

SnPb Solder Analysis by X-ray fluorescence Spectroscopy

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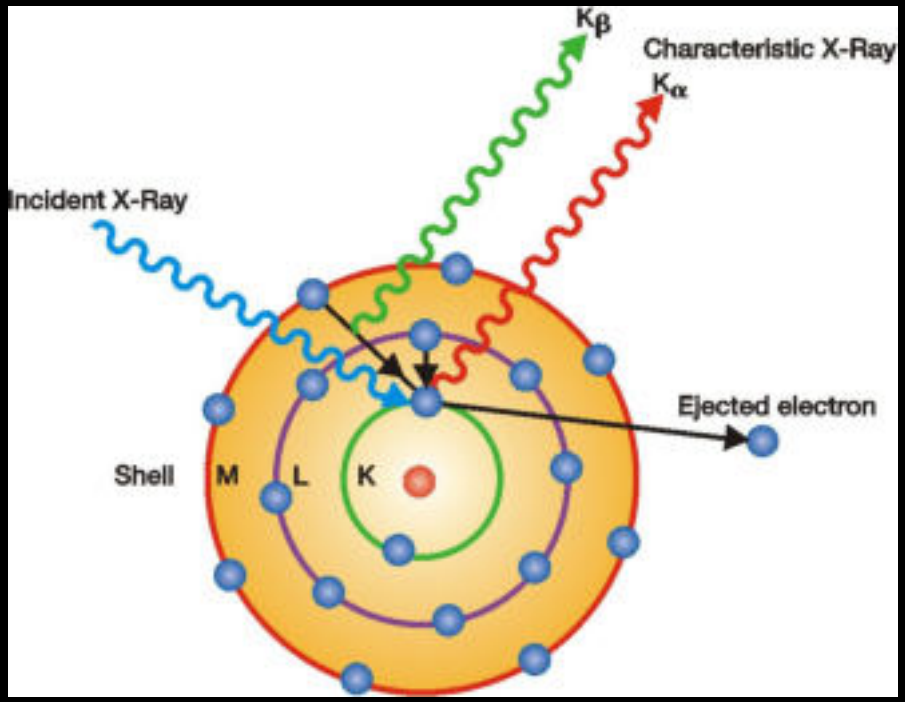
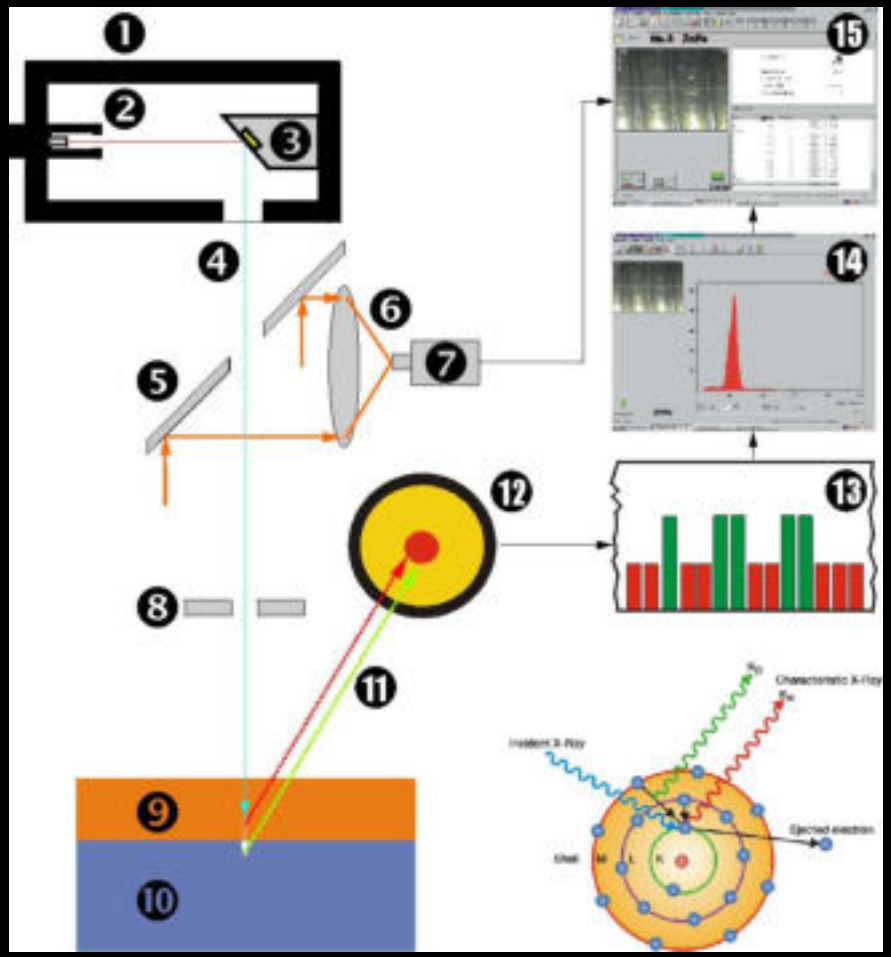
X-Ray fluorescence process



- Incident X-ray Beam strikes sample
- Excitation of characteristic X-ray Fluorescence (photoelectric effect)
- Element Specific characteristic radiation is detected
- Software evaluates Spectrum
- Non-destructive and quick

Hardware Configuration



- 1. X-ray tube
- 2. Cathode
- 3. Anode
- 4. Primary Beam
- 5. Camera Mirror
- 6. Camera Optic
- 7. Video Camer
- 8. Collimator
- 9. Sample Top Layer
- 10. Sample Substarte
- 11. Fluorescence Radiation
- 12. Detector
- 13. Countrate
- 14. Spectrum
- 15. Measurement Results

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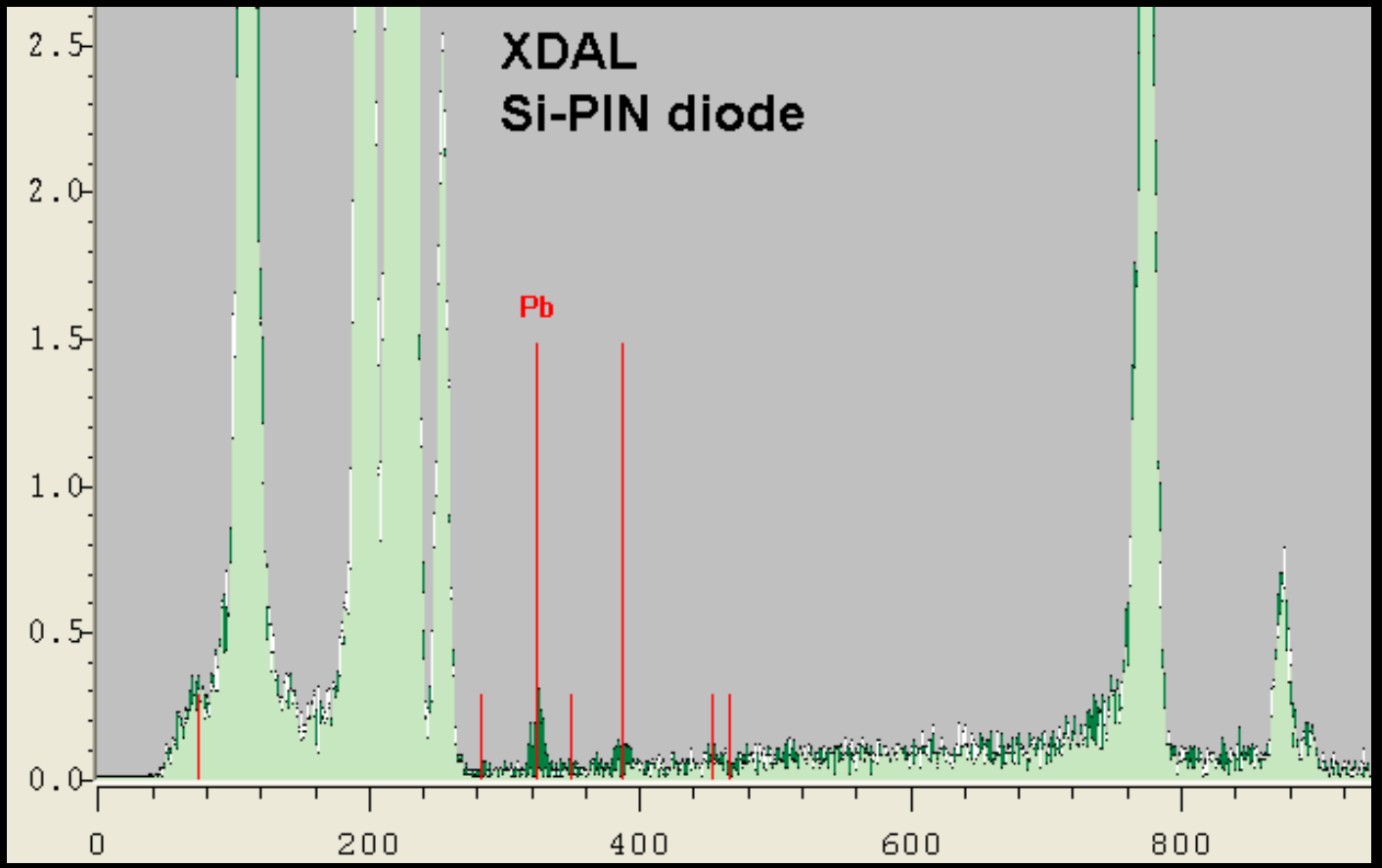
Fischerscope® X-Ray XDAL / XAN

Pb – detection



- 4 µm Sn coating contaminated with 0.4% Pb on FeNi
- Detection limits of 0.01% possible

Market Requirements-Regulatory Driven

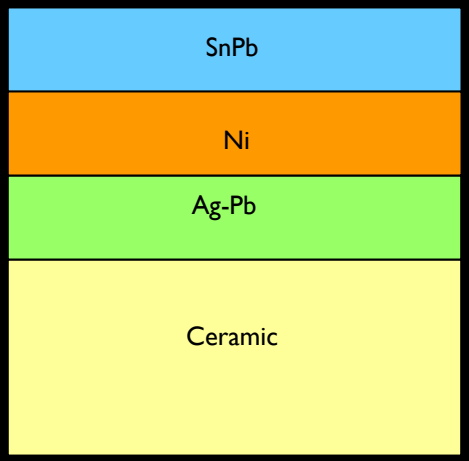
- Lead Free
  - **Directive 2002/95/EC (Final 27 January 2003)**
    - **R**estriction **o**f the use of **H**azardous **S**ubstances in electrical and electronic equipment
  - **Directive 2002/96/EC (Final 27 January 2003)**
    - **W**aste **E**lectrical and **E**lectronic **E**quipment
      - Prohibits certain materials in landfills, forces recycling
  - **Directive 2000/53/EC (Final 18 September 2000)**
    - **E**nd of **L**ife **V**ehicles
      - Mostly affects Automobiles, but includes language on automotive electronics

Market Requirements - Reliability Driven

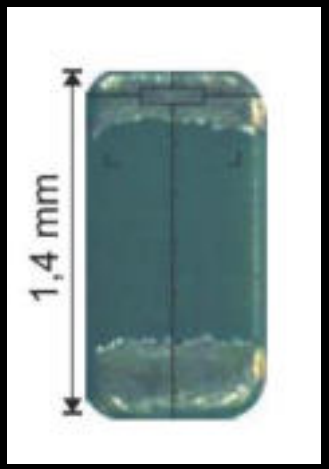
- Avoiding Lead Free - Minimum of 3 % Pb to reduce risk of Sn – Whiskering
- End users demand “not pure tin finishes”
  - Specifications
    - Boeing BQA-96-03
      - Requirements for Soldered/Plated Electrical, Electronic Assemblies/Harness/Cables/Components and Mechanical Items
    - Defense Supply Center Columbus
      - MIL-PRF-38534
        - » General performance requirements for hybrid microcircuits, Multi-Chip Modules (MCM)

Typical Sample

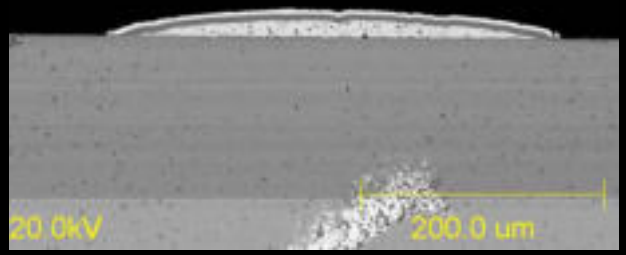
- Multi-Layered Chip Capacitor
  - Various Solder alloys
  - Ni or Cu – Barrier Layers
  - Various metallization alloys
  - Ceramic material with many doping elements

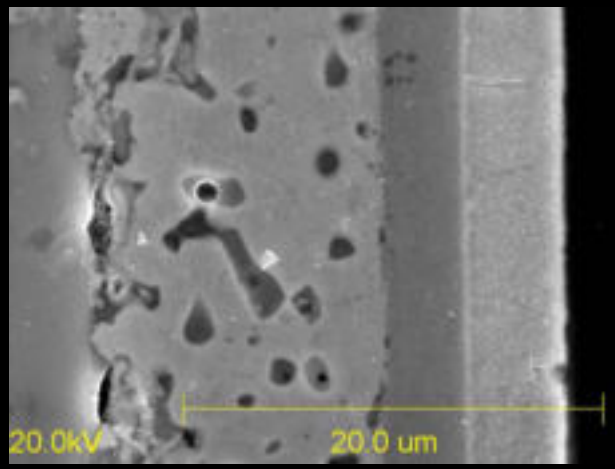


- SnPb Solder Terminations
- Ni-Barrier Layer on Terminations
- Ag-Pb-metallization layers
- Ceramic materials



Typical Sample - MLCC's



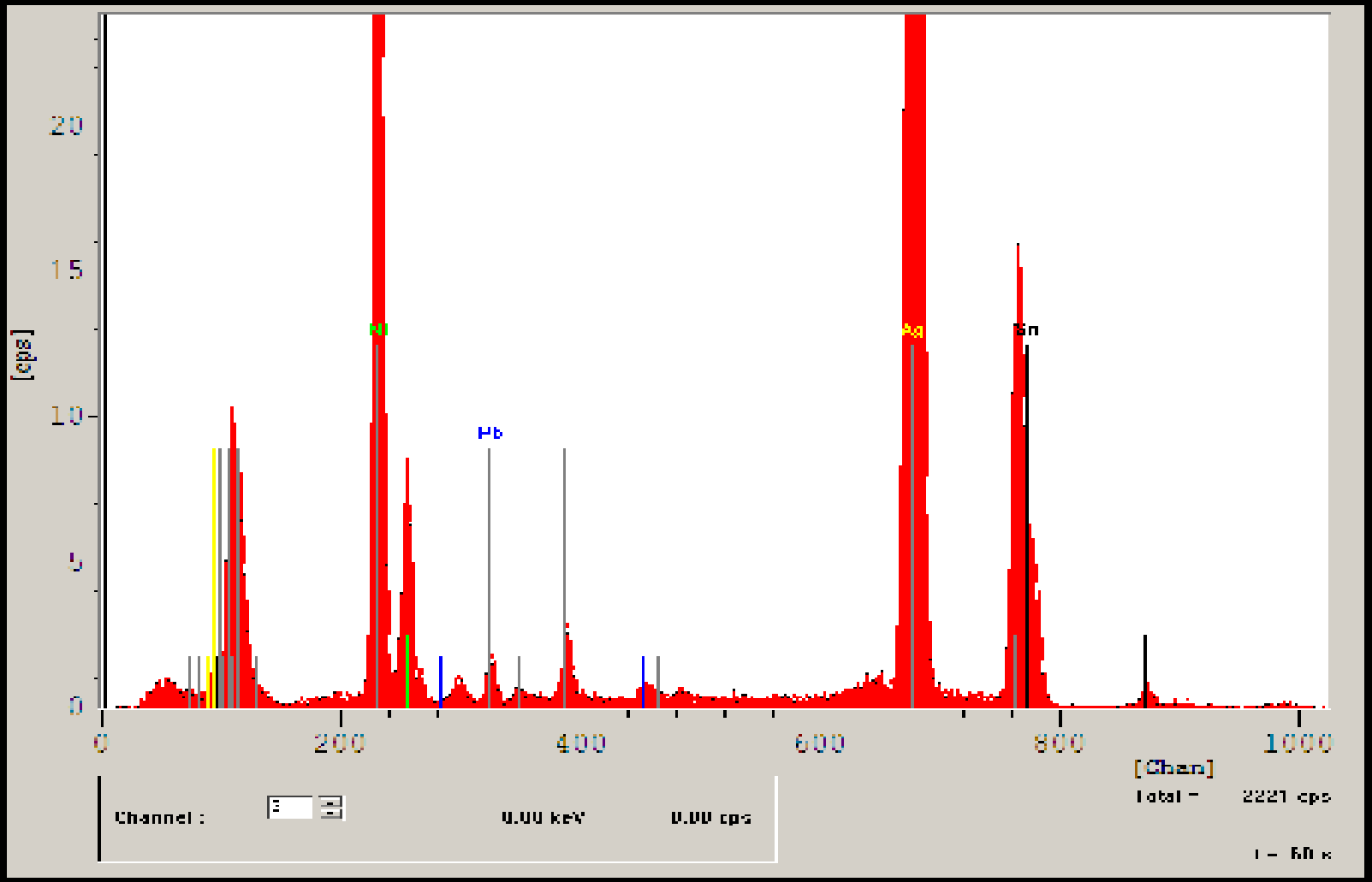


- MLCC 'S (MultiLayerCeramicCapacitors)
  - Ceramic Base Material
    - Contains many elements Pb,BiAg.
  - Ag in Solder and Paste/Frit
- Application needs to be treated as a layered system
- Any other setup will yield wrong results with potential wrong classification of parts
  - Pure Sn- treated as containing > 3% Pb, Bi, Ag

High Reliability Industry View

- Mil/Aero not required to change by RoHS, but very much affected due to component termination change to 100% Tin
- Tin Whiskers are a real threat to high reliability electronics
- Mitigation of 100% Tin after it sneaks in is far too expensive. Costs will increase, need to be passed on to customers
- Can keep SnPb by working with suppliers and by adding the right equipment
- Flow down requirements to manage 100% Tin are coming soon.
- Can be turned into a competitive advantage

XRF Spectrum of a MLCC



Measurement Results

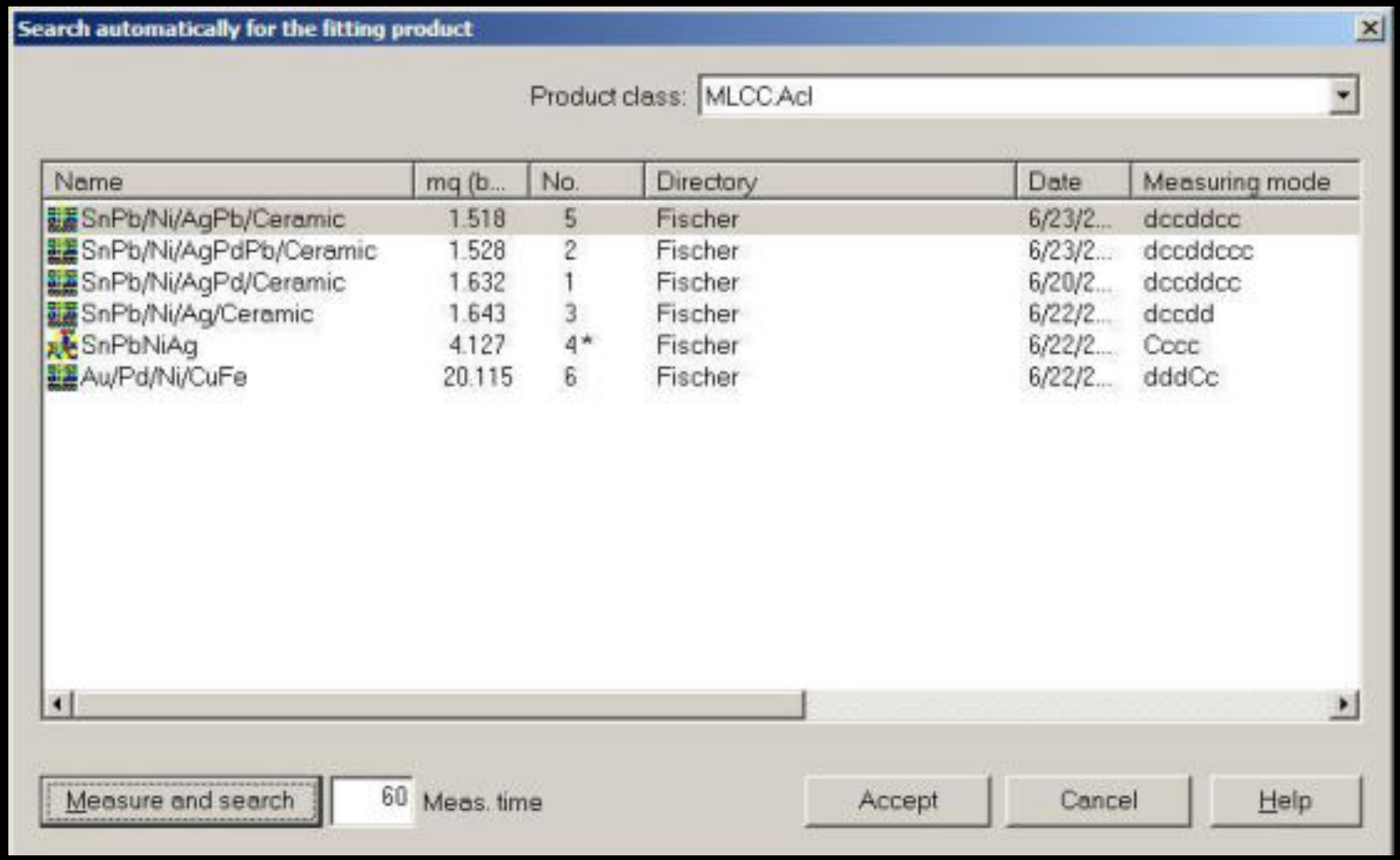
Application	SnPb[µ"]	Sn [%]	Pb [%]	Ni [µ"]	AgPb[µ"]	Ag [%]	Pb [%]
SnPb/Ni/Ag/Ceramic	97.1 ± 1.52	94.5 ± 0.18	5.48± 0.18	68.2±1.1	1313±11.4		
SnPb/Ni/AgPb/Ceramic	74.0 ± 1.43	100.00±0.02	-0.02± 0.02	53.5±0.34	1300±18.5	98.3±0.05	1.74±0.05
		Sn 1[%]	Pb 1[%]	Ni 1[%]		Ag 1 [%]	
SnPbNiAg		12.8±0.17	1.61±0.05	22.3±0.07		63.3±0.20	

- 3 Different Applications
  - Ignoring Pb in Ag-paste/Ceramic
  - Define Pb in Ag-paste/Ceramic
  - Ignore layered structure of MLCC- measured as bulk

Measurement Results

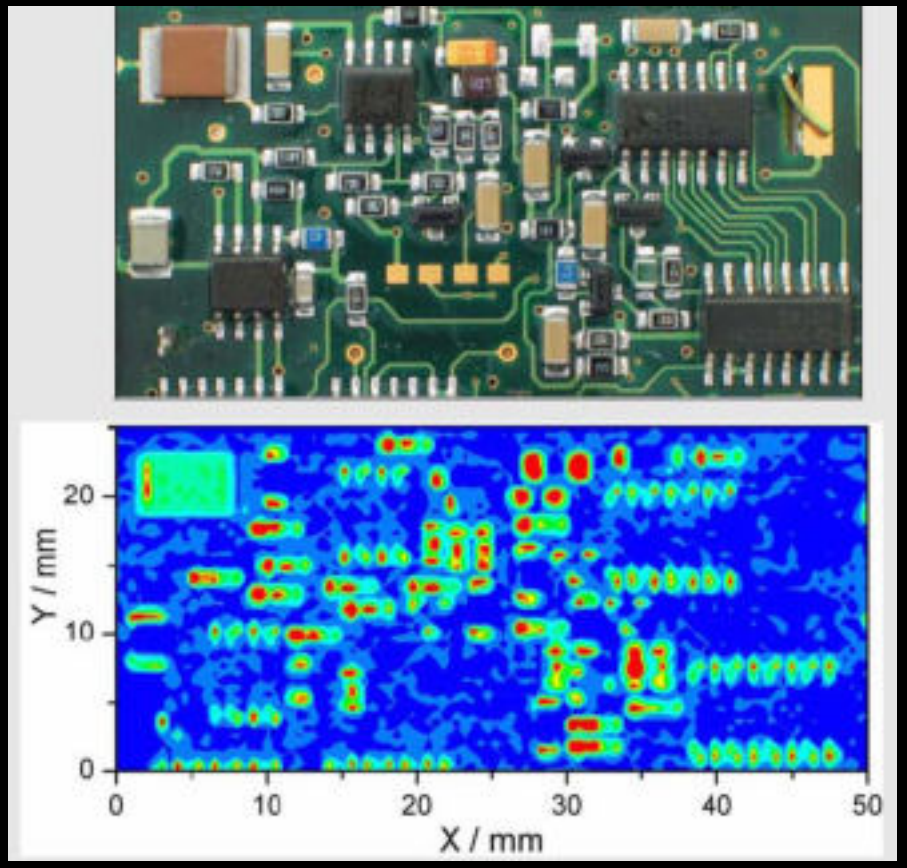
- Importance of taking layered structure into account
- Significant differences for different applications
- Pure Sn finishes could pass as containing > 3% Pb, Ag etc
- Bulk analysis not possible for layered samples

Automatic Product Search



Elemental Mapping of PCB-Board

- Scanning Capabilities with programmable XY-Stage
- Determination of Pb-presence
  - Relevant for RoHS-compliance



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Conclusion

- Huge concern in high reliability industry - looking for a solution
- XRF provides a solution
  - Non-destructive
  - No sample preparation
  - Quick (30-60 s)
  - Scanning capabilities
  - Automated Product identification
- XRF requires layered sample measurement capabilities