### **IPC Electronics Midwest 2010**

### **Reliable Solder Identification by X-ray Fluorescence Spectroscopy**

### Ron Glaser CMG Sales – Fisher Technology

### **Biography:**

Ron has worked with XRF technology and Fischer Technology for over 20 years. He has worked with many companies & government agencies to help solve their RoHS/High Reliability/ counterfeit components issues.

Fischer Technology, Inc. manufactures a complete line of hand held and bench top instrumentation including magnetic induction, eddy current, phase sensitive eddy current, x-ray fluorescence, beta backscatter, coulometric, hardness measurement, holiday detection, conductivity measurement and quality of anodic seals.

### **Executive Summary**

High reliability applications in the military and aerospace industry require reliable solder finish identification on components within the supply system of DoD, NASA, and many other organizations.

Consumer products and military/aerospace industry commonly share the same suppliers of electronic components. The RoHS regulation has forced those suppliers to provide lead free solder solutions. As a result, components with many different solder finishes are now available. Compatibility issues, among those various solder finishes such as melting temperatures, tin whisker formation, stress fracturing etc. create a serious reliability problem the military/aerospace industry is trying to overcome.

A new technique has been developed to reliably identify unknown samples or materials utilizing XRF instrumentation. The technique will help in identifying quickly and reliably bulk and surface finish solders of individual components as well as populated boards.

This new identification tool can be used for any application and is particularly helpful if suitable standards are unavailable. Fischer Technology will present practical examples for solder analyses. The method will also assist the user to identify the correct measurement application which can then be used to make a full quantitative analysis if desired.

#### **Contact Information:**

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### Reliable Solder Identification by X-ray Fluorescence Spectroscopy

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- High reliability applications in the military and aerospace industry require reliable solder finish identification on components within the supply system
- Consumer products and the military/aerospace industry commonly share the same suppliers of electronic components. RoHS regulations have forced those suppliers to provide lead free solder solutions. As a result, components with many different solder finishes are now available.
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## Expectations

- Reliable Identification of Solder Alloy
- Simple User Interface (Novice users)
- No Sample Preparation
- Short Measurement Times
- Reporting
- Solution:
  - X-Ray Fluorescence
    - Class of Material Identification

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### Solder Classes

Family	Alloys	Family	Alloys
SnPb	SnPb37 (eutectic)	Pb37 (eutectic) SnBi	
	SnPb10		SnBi10
	SnPb3		SnBi3
	SnPb1		SnBi1
SnCuAg (SAC)	SnCu0.5Ag1(SAC105)	SnCuAgBi	SnCu0.5Ag1Bi1
	SnCu0.5Ag1(SAC105)	(SAC+Bi)	SnCu0.5Ag4Bi1
	SnCu0.5Ag1(SAC105)		SnCu0.5Ag1Bi3
SnCuAgIn	SnCu0.5Ag1In1		SnCu0.5Ag4Bi3
	SnCu0.5Ag4In1	Sn (pure)	Sn
		SNIC	SnCu0.7Ni0.05
		SnAg	SnAg1
			SnAg4

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# **Class of Material Identification**

- Previous technique (Positive Material Identification)
  - is restricted to material samples which must have been measured before; variations of concentration or coating thickness are not included.
- New Class of Material Procedure
  - utilizes calculated spectra instead of experimental ones. The number of theoretical spectra is not limited. Therefore, it is possible to cover variations of parameters such as concentrations and/or coating thickness.

### Advantage for the user

 Does not have to measure test samples of the respective material. User only has to define which type of material he wants to identify. Pre-defined classes of material can be imported to the instrument and are ready for application







### Prerequisites for Class of Material Identification

- The realistic calculation of spectra (instead of measuring known samples) is the basis of the new class of material identification technique.
  - Utilizing software of energy dispersive XRF instruments used for the analysis of layers and material analysis (coating thickness & composition)
- The determination of the unknown thickness and/or concentration values can be interpreted as an evaluation of free parameters. The basic algorithm searches for a best fit of a calculated spectrum with the measured one. The best fit parameters (concentration and/or thickness values) are the solution to the measuring task. The theoretical calculation of the spectrum takes into account:
- Known Instrument Parameters
  - photo-excitation and absorption, secondary enhancement excitation, and primary the geometry of the experimental setup
  - the primary excitation conditions
  - the properties of the detector (response function)
  - In addition ,both beam scattering are taken into account.

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## Definition of Solder Class SnPb3%

eate class of materials with product no.=9899997, name=STK Artikel, directory=Fischer							
Def.MA of class of material:							
Label: COM solder/PCB	Label: COM solder/PCB						
Thickness Concentration      • μm   • %   • Μ   • Μ   • Μ	Bezeichnung und Param Name: SnPb3, 3-12 µm /PCB	eter von / bis From	To	Create			
Notizblock: d1 [µm]: 3.00 - 12.00	d1 [µm] Cu 1 [%]	3.0000 <del>8.0000</del>	12.0000				
Sn 1 [%]: 96.00 - 97.00 Pb 1 [%]: 3.00 - 4.00 Cu 2 [um]: 5.00 - 50.00	Ag 1 [%]	0.0000	0.0000	Others No. of spectra =			
	Bi 1 [%]	0.0000	0.0000	1000			
	ln 1 [%]	0.0000	0.0000	Store all spectra			
	Sn 1 [%]	96.0000	97.0000	With boundaries From/To			
	РЬ 1 [%]	3.0000	4.0000	Help			
	Cu 2 [µm]	5.0000	50.0000				
×	C 3 [%]	5.0000	80.0000				
<u>N</u> otizblock füllen	•			Ōĸ			

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## Definition of Solder Class Sn 100%

Create class of materials with product no.=9899997,	name=STK Artikel, o	lirectory=Fischer		×
Def.MA of class of material:				
Label: COM solder/PCB	Def. <u>M</u> A			
Thickness ⓒ μm ⓒ nm ⓒ nm ⓒ nm ⓒ o/oo ⓒ mils ⓒ μ" ⓒ Concentration ⓒ % ⓒ o/oo ⓒ ppm ⓒ μ" ⓒ Concentration ⓒ % ⓒ o/co ⓒ yan ⓒ van ⓒ va	Bezeichnung und Paran Name: pure Sn, 3-12 µm-oo 15	PCB	To	Create
Notizblock:	d1 [µm]	3.66990	12.0000	
d1 [µm]: 3.00 - 12.00	Cu 1 [%]	0.0000	0.0000	
Sn 1 [%]: 100.00 - 100.00 Cu 2 [μm]: 5.00 - 50.00	Ag 1 [%]	0.0000	0.0000	Others No. of spectra =
	Bi 1 [%]	0.0000	0.0000	1000
	In 1 [%]	0.0000	0.0000	Store all spectra
	Sn 1 [%]	100.0000	100.0000	With boundaries From/To
	РЬ 1 [%]	0.0000	0.0000	Help
	Cu 2 (µm)	5.0000	50.0000	
<b>X</b>	C 3[%]	5.0000	80.0000	Cancel
<u>N</u> otizblock füllen	•			<u>o</u> k

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### Search class of materials

		Directory	Solder_PCB		•		1
Name / Notes		Ident.No.	Class of materials	Date / create	Date / modify	Residual	
		0.89	SnPb3, 3-12 µm /PCB	19.12.2008	19.12.2008	0.26	
	~	3.65	pure Sn, 3-12 µm-oo/PCB	19.12.2008	19.12.2008	0.61	
		3.70	SnBi1-4, 3-12 µm /PCB	19.12.2008	19.12.2008	0.55	
		24.50	Sn/CuFe2	19.12.2008	19.12.2008	8.75	
		26.39	pure Sn, 1-2 µm/ PCB	19.12.2008	19.12.2008	0.72	
		128.69	Eutectic SnPb, 10 µm-oo /PCB	19.12.2008	19.12.2008	0.48	
		185.61	pure Sn, 20 µm-oo/PCB	19.12.2008	19.12.2008	0.65	
		213.07	SAC 105-405+3Bi, bulk	19.12.2008	19.12.2008	10.04	
		214.61	SAC 105-405+1Bi, bulk	19.12.2008	19.12.2008	9.82	
		216.22	SAC 105-405 bulk	19.12.2008	19.12.2008	10.07	
		216.91	SAC 105-405+1In, bulk	19.12.2008	19.12.2008	10.65	
		270.89	SnCu bulk	19.12.2008	19.12.2008	9.62	
		417.13	Eutectic SnPb, 3-15µm /PCB	19.12.2008	19.12.2008	0.93	
		423.18	Immersion Ag finish /PCB	19.12.2008	19.12.2008	10.82	
	× .	5546.77	pure Sn, 3-12 µm/ FeCoNi	19.12.2008	19.12.2008	78.46	
	. >	6284.77	SnPb 7-13Pb bulk	19.12.2008	19.12.2008	83.25	
		6315.71	SnPb 2-4 Pb bulk	19.12.2008	19.12.2008	83.44	
	1	6326.55	SnPb0.5 - 1.5 , bulk	19.12.2008	19.12.2008	83.49	
Measure and identify		6360.58	SnBi 7-40 bulk	19.12.2008	19.12.2008	83.73	
		6402.14	SnPb eutectic bulk	19.12.2008	19.12.2008	83.82	
		6613.88	SnBi 1-4 bulk	19.12.2008	19.12.2008	85.29	
Compare / display spectra		7861.78	SnPb3, 3-12 µm/ FeCoNi	19.12.2008	19.12.2008	92.66	
compare / display spectra		10811.53	SnBi1-4, 3-12 µm/ FeCoNi	19.12.2008	19.12.2008	107.97	
		13825 53	Futertic SnPh 3-12 um/ F	10 12 2008	10 12 2008	121 55	
Help	Produ No.	ct Lab	el:	Directo	ry:	-	

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### **XRF Sample Spectra**



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## **Solder Class Identification**

earch class of materials						
lasses of materials Import-Export	Refresh (	Options End				
	Directory	Solder_PCB		•	8 8	
Name / Notes	Ident.No.	Class of materials	Date / create	Date / modify	Residual	<u> </u>
	0.89	SnPb3, 3-12 µm /PCB	19.12.2008	19.12.2008	0.26	
	3.65	pure Sn, 3-12 µm-oo/PCB	19.12.2008	19.12.2008	0.61	
	3.70	SnBi1-4, 3-12 µm /PCB	19.12.2008	19.12.2008	0.55	-
5um SnPb3/Cu/PCB	24.50	Sn/CuFe2	19.12.2008	19.12.2008	8.75	
	26.39	pure Sn, 1-2 µm/ PCB	19.12.2008	19.12.2008	0.72	
	128.69	Eutectic SnPb, 10 µm-oo /PCB	19.12.2008	19.12.2008	0.48	
	185.61	pure Sn, 20 µm-oo/PCB	19.12.2008	19.12.2008	0.65	
	213.07	SAC 105-405+3Bi, bulk	19.12.2008	19.12.2008	10.04	
	214.61	SAC 105-405+1Bi, bulk	19.12.2008	19.12.2008	9.82	
	216.22	SAC 105-405 bulk	19.12.2008	19.12.2008	10.07	
	216.91	SAC 105-405+11n, bulk	19.12.2008	19.12.2008	10.65	

Search class of materials						×
Classes of materials Import-Export	Refresh (	Options End				
	Directory	Solder_PCB		•	8 8	
Name / Notes	Ident.No.	Class of materials	Date / create	Date / modify	Residual	~
	0.00	pure Sn, 3-12 µm-oo/PCB	19.12.2008	19.12.2008	0.39	
	4.59	SnBi1-4, 3-12 µm /PCB	19.12.2008	19.12.2008	0.34	
4 um Sn/Cu/PCB	24.34	Sn/CuFe2	19.12.2008	19.12.2008	8.88	
	26.03	SnPb3, 3-12 µm /PCB	19.12.2008	19.12.2008	0.37	
	35.97	pure Sn, 1-2 µm/ PCB	19.12.2008	19.12.2008	0.56	
	140.41	Eutectic SnPb, 10 µm-oo /PCB	19.12.2008	19.12.2008	0.71	
	160.99	pure Sn, 20 µm-oo/PCB	19.12.2008	19.12.2008	0.63 🔸	_
	203.35	SAC 105-405+3Bi, bulk	19.12.2008	19.12.2008	11.12	
	205.12	SAC 105-405+1Bi, bulk	19.12.2008	19.12.2008	10.74	
	208.11	SAC 105-405 bulk	19.12.2008	19.12.2008	11.10	
	211.01	SAC 105-405+1In, bulk	19.12.2008	19.12.2008	12.06	

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## **Analysis Results**

Fischerscope® Product: 9 / SnPb/ Application: 94 / Sr	XRAY XE Cu/PCB Dir 1Pb/Cu/PCB	)AL : SnPb 3CAL		В	lock: 1	I			
	0.1	inch							
n SnPb1[µm]	Sn 1[%]	Pb 1[%] Cu	3[µm]						
1 5.080	96.54	3.460	24.60						
Mean	<b>5.080</b> μm		96.54	00	3.460	00	24.60 µm		
Number of reading	S	1	1		1		1		
Min. reading	5.080 µm		96.54	8	3.460	8	24.60 µm		
Max. reading	5.080 µm		96.54	୫	3.460	8	24.60 µm		
Measuring time		10 sec							
	a. 4.00.04 DM								
Date: 1/6/2009 TIM	e: 1:28:31 PM								
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# Conclusion

- Huge concern in high reliability industry looking for a solution
- XRF Material Class Identification provides answers
  - No measured sample library required
  - Applicable for any material class identification
  - Solder Family Identification
  - Solder Alloy Analysis within Solder Family
  - Non-destructive
  - No sample preparation
  - Quick analysis (30-60 s)
  - Small spot size capability
- XRF software requires multi layered sample measurement capabilities

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