A CONTAMINATION AUDIT by Dr Sheila Hamilton

With changing technologies and smaller features within electronic interconnections the influence that contamination has on yields has greatly increased. This in turn has led to many more processes being carried out in Cleanroom environments. However even within these environments defects attributable to contamination still occur in significant numbers. The Teknek Contamination Audit sets out to identify all the different types of contamination present in the Cleanroom together with the sources of the contamination. It also highlights remedial actions to reduce the amount of contamination and so improve yields. The process can also be applied to general production environments and often the audit covers every aspect of a production facility from Goods Inwards to Final Dispatch.

Cleanrooms are classified by the number and size of the particles in the air of the room and so traditionally this has been used as the way to identify how clean the area is. It has been thought that the airborne particles, ie those small enough to be picked up and redeposited by air currents, were the main risk to yields and that by simply monitoring them the integrity of the cleanliness of the Cleanroom could be assured. The effect of contamination present on surfaces within the Cleanroom is ignored. Our Audits, which monitor surface contamination, have shown considerable volumes of contamination are generated within the Cleanroom and that despite intensive control measures significant amounts of contamination are brought into the Cleanroom by people and on the parts and their associated storage and transportation.

Methodology

The Contamination Audit focuses on the contamination found on all surfaces within the Cleanroom such as workbenches, equipment cabinets, floors walls and even the parts themselves. Tote trays and cart wheels are also sampled.

Teknek's proprietary DCR (dust collecting) Rollers are used to pick up samples from the surfaces and transfer the contamination to DCR Adhesive Pads. These pads contain a special adhesive surface designed to remove the contamination from the DCR roller and to capture it permanently on the adhesive. The adhesive paper with the contamination is then overlaminated to prevent further contamination. The samples are numbered and identified with the area from which the samples are taken. A layout of each area is sketched and notes made about the process carried out. Potential contamination generators are highlighted.

Analysis

The main method of analysis uses an Optical Microscope with a camera attachment. Each sample is viewed and all types of contamination present on the sample are noted. A photograph is taken and also any unusual or dominant contamination.

The percentage of samples within each area which contains each specific type of contamination is calculated.

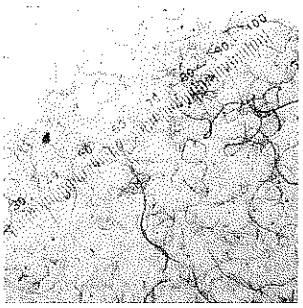
Results

The analysis results in a substantial report outlining the contamination found in each area with recommendations for improvements. A key feature of the report is the Contamination Matrix which shows a complete map of contamination found throughout the facility. A Sample Contamination Matrix is shown on page 8.

How to read the Matrix

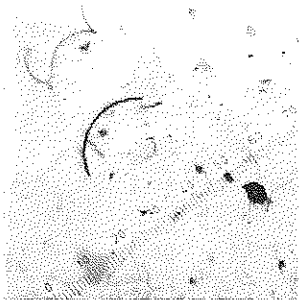
The **areas audited** are down the left side and the **contaminants grouped by type** are along the top. The numbers in the boxes indicate the risk level based on the percentage of samples with that contamination. The use of colour for the Risk Bands makes it easy to spot the key target areas for improvement.

The use of the this Matrix makes it easy to track the effectiveness of improvements as the Contamination Audit can be repeated after a period and the resulting Contamination Matrix overlaid on the original one to highlight changes in the pattern and level of contamination. The adjacent photographs are typical of the ones used in the report.



Sample 1

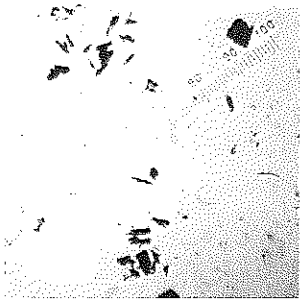
Sample 1 is taken from the top of equipment in a Cleanroom and shows large amounts of clothing fibres in spite of full gowning procedures.



Sample 2

Sample 2 is taken from inside a container used to transport PCB's (printed circuit boards) within a Cleanroom and shows a variety of contamination including metal fragments and beard hair.

Sample 3 is taken from an Exposure unit and indicates a wear issue in part of the mechanism.



Sample 3

Conclusion

The Contamination Audit is invaluable in identifying the amount and sources of different types of contamination present within a production process whether or not the process is carried out in a Cleanroom. Implementation of remedial measures based on the Contamination Matrix reduces contamination and increases yields significantly.

What to do next

See page 10 & 11 for information and a template of the grid.

CONTAMINATION MATRIX - WORKED EXAMPLE

TYPE OF CONTAMINATION	Operator				Process						Resins										Miscellaneous																			
AREAS AUDITED	Clothes Fibres	Threads	Hair	Clear Fibres	Epoxy Resin	Epoxy Glass	Copper	Dry Film	Solder Mask	Red Emulsion	Clear	White	Yellow	Red	Blue	Green	Black	Grey	Amber	Orange	Plastic Film	Metal	Brass	Wallboard	Rust	Foam	Rubber	Non woven Fabric	Cellulose	Glass	Vegetable Matter	Stones	White Waxy Sub	Black Debris	Foam Mat	Coated Fibres	Skin	Insect	
Artmaster (Main)	3	3	2		1	1	2				1	3	1	3	3	3	1	1	3	1	1	3	1	1		1	2		3	1	1	2	3	3	2	1			
Artmaster (Lamination)	4	1	2				2				1	2	2	3	2	1	2		1	2	1	2		2	1		2		3	2	1	1	2	2		1			
Artmaster (Darkroom)	3	1	3	2			1			1	1	2	3	1		2	2	2	2	2		3	1		1		1		2		2		2	3	2				
Inner Layer Print	4	2	2	1		2	3	2	1		2	2	1	2	1	1	2	3	1	1	2	4	1	1	1		2	1	4	2	1	2	2	2	1	1	1	
Inner Layer A.O.L	4	2	2	1	1	2	4	2	2			1	1	1	1	1	2	1	1	1		3		1			2	1	2	1	1	1	1	2	2		1	1	
Stack Up	3	1	1	1	4	3	1					1		1	1		1	1	2	1	1	1	1		1			1	1			1	1	1			1		
Hardboard Print Dry Film Lamination	4	1	2	2	1	1	3	3			1	2	1	2	1	1	1	1	1	2	1	3	1	1	1		2	1		1		1	1	3			1		
Hardboard Print Manual Exposure	4	1	2	1			4	2			1	2	2	2	1		1	2	1	3	2	3	3				4		1	1		1	1	3			1		
Hardboard Print Auto Exposure	4		2	1	1	1	3	3			2	2	1	2	2	1	2	1	1	1	1	3	1		1		2		2	1	1	1	1	3	1	1	1		
Solder Mask Electrostatic Spray	3	1	2	1		1	2		3		1	2	1	1	2	1	2	1	1	1		2			1		1		3	1	1	1	2	2	1		2		
Solder Mask Auto Exposure Lines	4	1	2	1	1		3		4		2		2	2	2	1	2	2	2	1		4	1		1	1	2		3	2	1	1	2	3	1	1	1	1	
Solder Mask Auto Curtain Coating	4	1	2	1		1	2	1	4		2	2	1	1	1	1	2	1	1	1	1	2		1			3		1	1		1	1	2	1	1	1		
KEY	*76 - 100*			4		*51 - 75*			3		*26 - 50*		2		*1 - 25*		1																						

TYPE OF CONTAMINATION																																		
AREAS AUDITED																																		
KEY	76 - 100	4	51 - 75	3	26 - 50	2	1 - 25	1																										

A CONTAMINATION AUDIT - ACTION

This audit was designed by Dr Sheila Hamilton of Teknek Electonics Ltd for one particular work process. By removing the descriptive information from the coloured worked example we have created a template from the original one. This is on the opposite page.

Photocopy it and start using it in your own place of work. If you have any questions please contact her.

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MONITORING

Question 1 : In your practice, how often do you monitor the airborne particle cleanliness of cleanroom. [DE]

Answers:

[1] It depends on a lot of different factors. I strongly suggest you start by reading the new ISO standard (14644-2) that addresses this issue. [KG]

[2] We monitor our CR, 24 hours/day 7 days a week. We use a Lighthouse System for particle, Temp, RH, Diff-pressure, Ionizer and ESD. We always know how clean it is. [E]

Question 2: I'm using a handheld particle counter in monitoring the cleanliness of our cleanroom. Is there a standard how to use it? What should be the correct distance of isokinetic probe from the ceiling? [DR]

Answers:

[1] You will find lots of articles written on the subject but a good rule to follow is bench height or say 900mmm. Remember, the general idea is to prove the cleanliness in the working plane. [CP]

[2] To monitor the non-viable airborne particulate in cleanroom, a discrete particle counter with a distant sampling probe would be more accurate. Particles would be generated from technician when he make any movement around the sample location. To have a better and accurate result, try to place the handheld particle counter on a clamp-stand and sample at work height. [CN]

Question 3: Is there an international standard available that is equivalent to BS5295 that defines methods and sampling points for clean room environmental monitoring? [JB]

Answer:

[1] ...there isn't a standard re monitoring and sample positions since this is subject to your own risk assessment study. The number of sample points etc are up to you for general monitoring. The cleanroom specs only refer to validation of the room. [CP]

Source: S2C2 website www.s2c2.co.uk. Click on Forum on the Home Page to read questions and answers or post your own. Note that there is also an archive section which is worth checking. Somebody may have already answered your question.

FOR SALE OR LEASE

I have a mobile clean room for sale or lease if anyone is interested contact me at johnb@atgweb.com

Thanks

John Barlo, Oregon, USA [Oct 5, 2001] www.atgweb.com