Halogen Free Solder Paste

A Truly Zero Halogen Approach

Gavin J. Jackson, Ian J. Wilding
Henkel Ltd, Hemel Hempstead, United Kingdom
Gavin.jackson@henkel.com
Ian.wilding@henkel.com

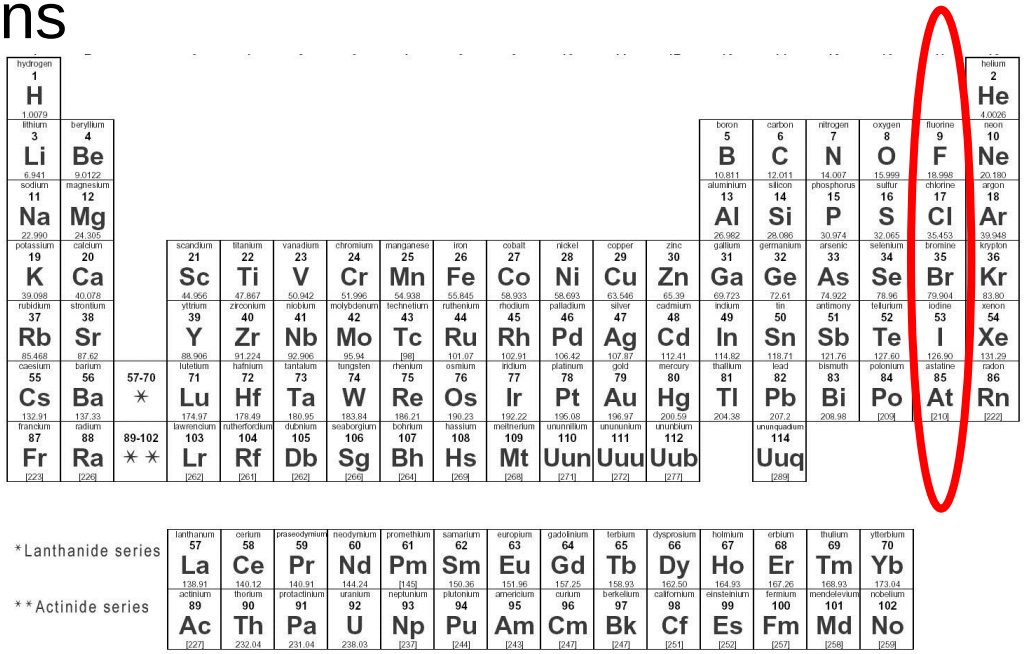
Mark Currie
Henkel Electronic Materials LLC, Irvine, CA
Mark.currie@henkel.com

Contents

- What is a halogen?
- Impact on the environment
- Halides and halogens
- Halides in electronics
- Halogens in electronics
- Definition of halogen free
- Technical challenges to remove halogen
- Current ‘State of the Art’
- Summary and conclusions

What is a halogen?

- The elements occurring in Group 17 of the periodic table (fluorine, chlorine, bromine, iodine & astatine)
- Widely used in all manners of industrial and consumer applications
  - Toothpaste
  - Disinfectants
  - Lighting
  - Film photography
  - Drug manufacturing
  - Food production
  - Etc……

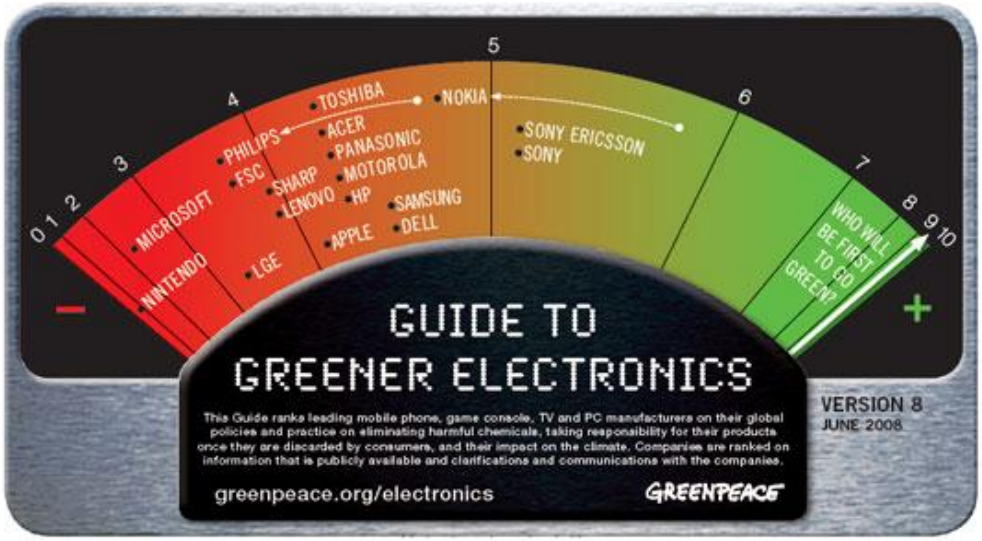


Impact on the Environment

- CFC's and ozone layer depletion
- Certain brominated flame retardants (RoHS directive)
- Persistence in the environment
- Potential to form dioxins
- The complete removal of halogens is currently not legislation driven

Impact on the Environment

- Halogens do not cause harmful effects to humans in the forms used in electronics manufacturing
- The concern is the unregulated disposal of waste electronics and electrical equipment via incineration
- This can potentially release harmful (to human health and the environment) by-products



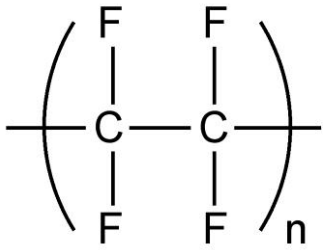
Halides and Halogens

- **Halides**

- Ionically (weakly) bonded ‘salts’
- Negatively charged halide neutralised by a positively charged cation
- Generally hydroscopic and under certain conditions electrically conductive
- E.g. NaCl (table salt)

- **Halogens**

- Covalently (strongly) bonded halogen in an organic molecule
- No ionic charge when bonded into the molecule
- Structure will determine the ease of evolution of the halide
- E.g. Teflon



Halides in Electronics (Solder)

	Halide Free			Halogen Free	
Drivers for Classification	High reliability interconnects International standards			REACH Non-government organisations (NGOs)	
Definition	No flux corrosivity or dendritic growth detection Specific requirements to give ROL0 classification			No intentional halogens added to flux Comply to international standards (see below)	
Test Procedures	Well-established Chloride and Bromide halide test measured by titration			New – O_2 bomb on flux Ion chromatography on flux	
International Standards	IPC J-STD-004B IPC-TM-650	Fluoride Test	None detectable	JPCA-ES-01-1999	Bromine 900ppm max Chlorine 900ppm max Total halogen 1500ppm
		Chlorides and Bromides	<0.005%	IEC 61249-2-21	
				IPC-401B	

Halogens in Electronics (Bis-A Resins)

- The main use of halogens in the electronics industry is flame retardants in laminate manufacturing
  - Polybrominated biphenyls and polybrominated diphenyl ether have been largely covered by the RoHS directive
  - Careful disposal of electronics (limiting impact of TBBPA) has also been covered by the WEEE directive in Europe
- Halogens are added to fluxes (cored solder wire, liquid fluxes, solder pastes) to improve solder performance

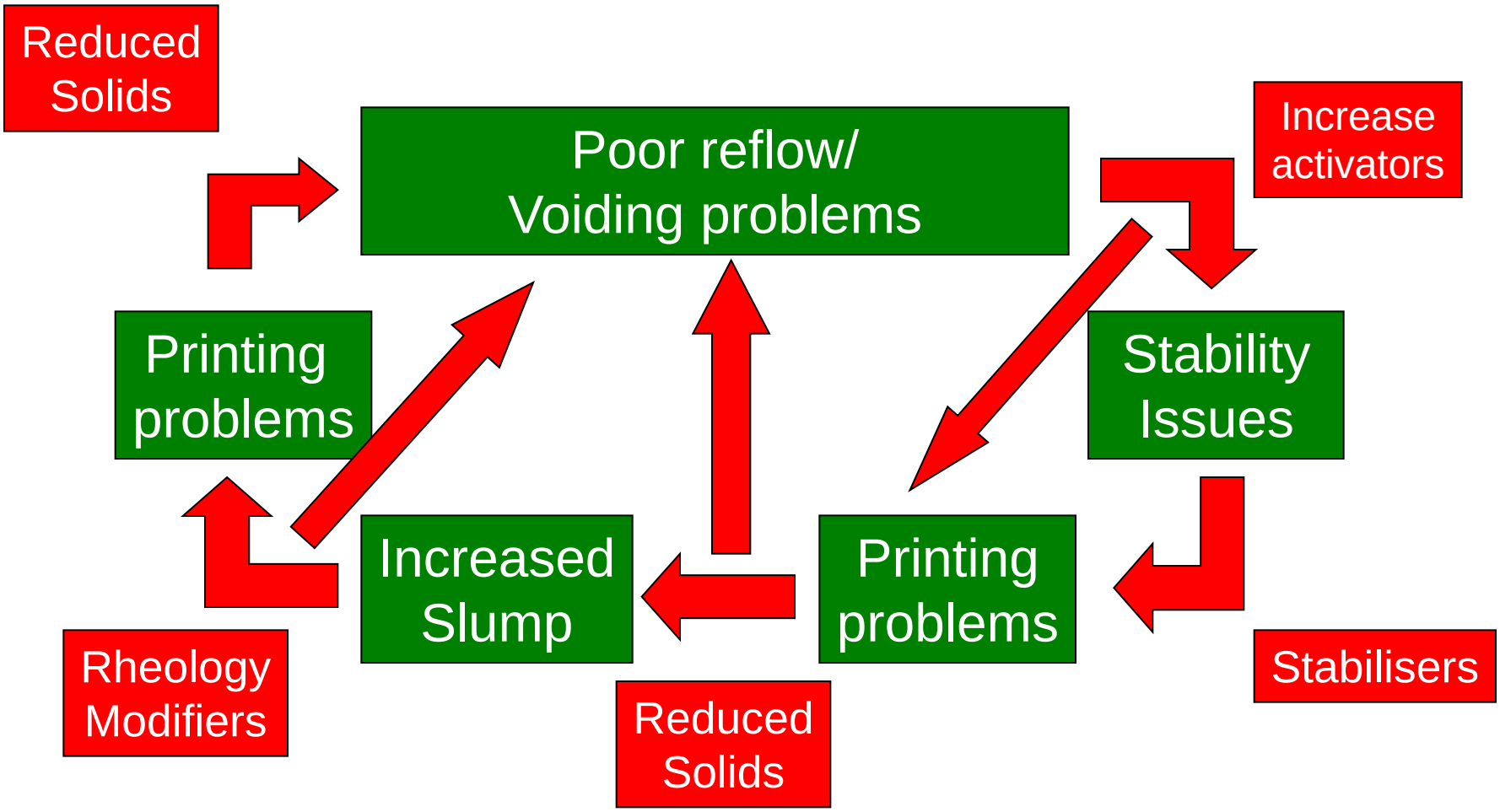
Halogens in Electronics

- Greenpeace initially pushed the effort
- Consumer (handheld) producers have lead the way
- Automotive now following with demand for Halogen free solder paste

Definition of Halogen Free

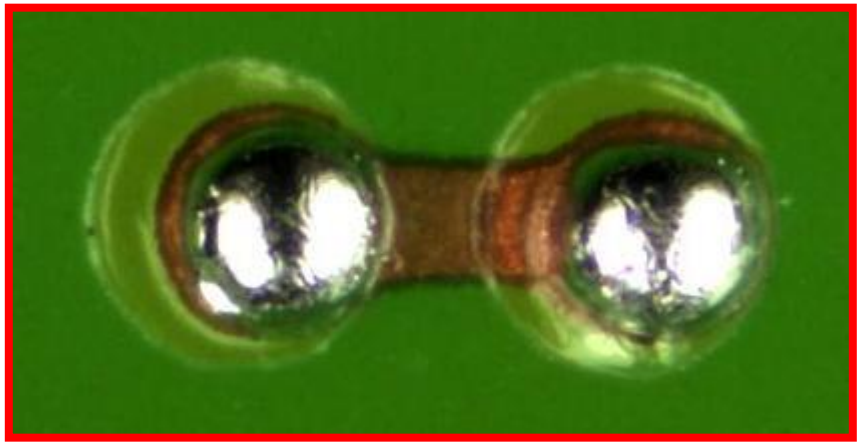
- Current definitions (JPCA, IEC, IPC) are all very similar
  - <900ppm Chlorine
  - <900ppm Bromine
  - <1500ppm combined (total) halogens
- The term halogen free does not necessarily mean **zero** halogen
  - Is it technically possible to go zero halogen?

Technical Challenges

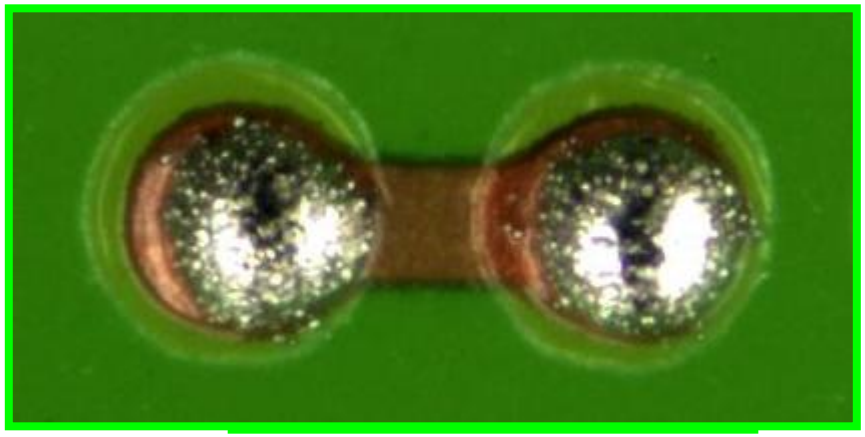


Technical Challenges Reflow

- The removal of halogen from a flux formulation is not simple
- Halogens are exceptionally efficient at removal of oxide from solder surfaces
- Fluxes have to be formulated from first principles



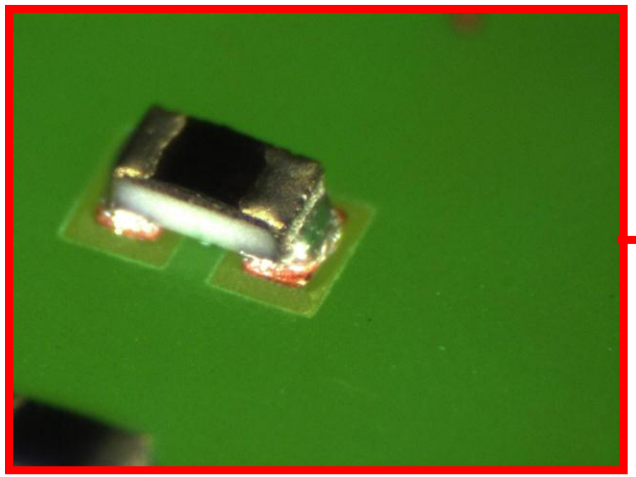
Typical halogen containing formulation

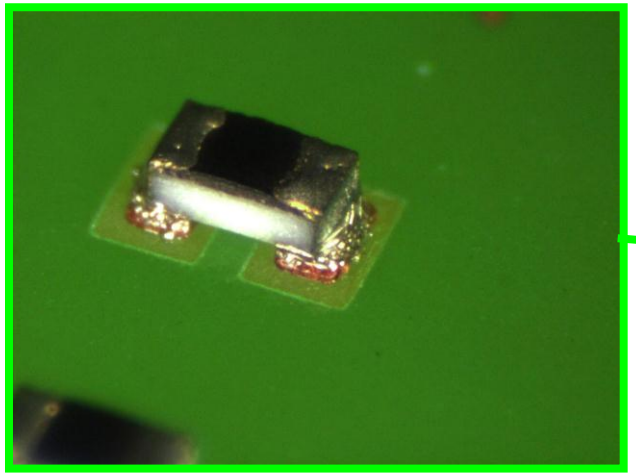


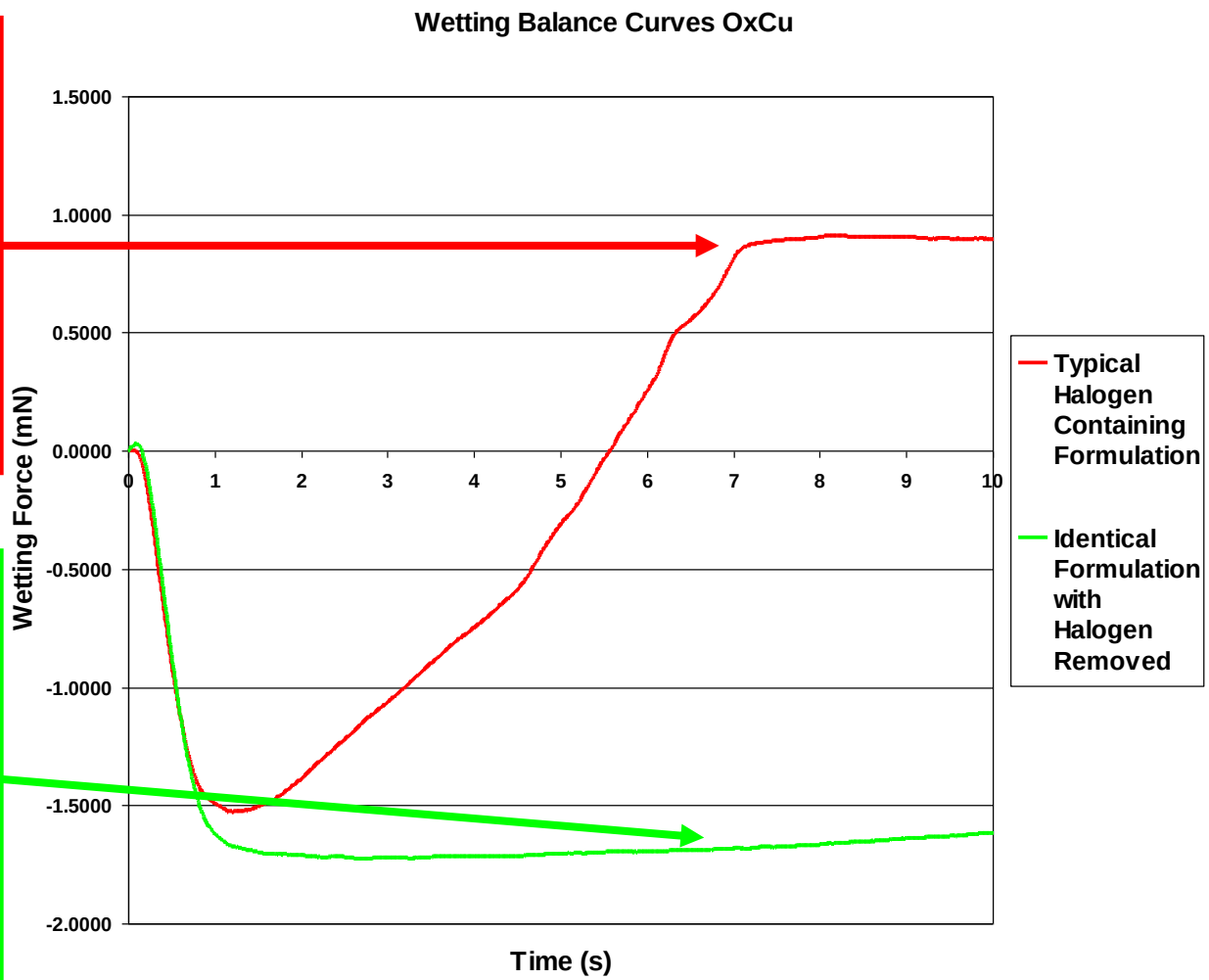
Identical formulation with halogen removed

Technical Challenges Wetting

- Wetting properties of the fluxes are also affected by the removal of halogens

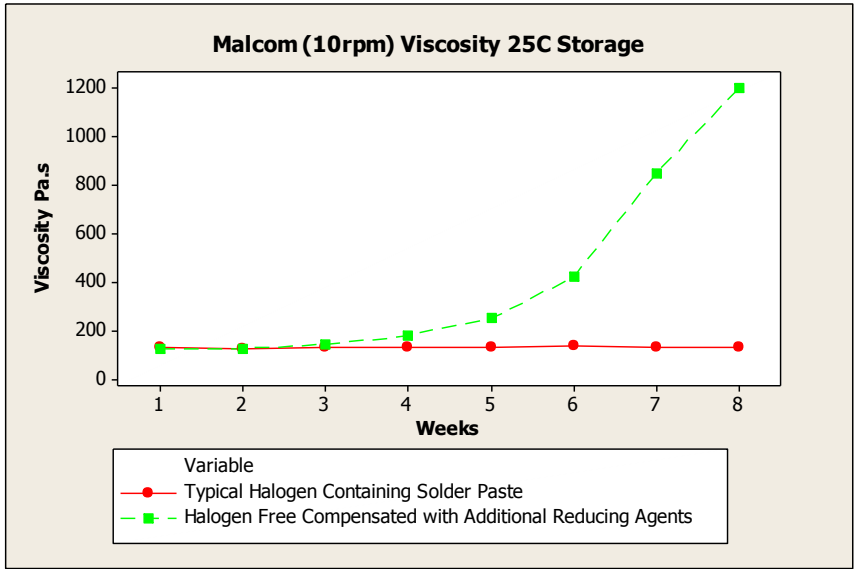






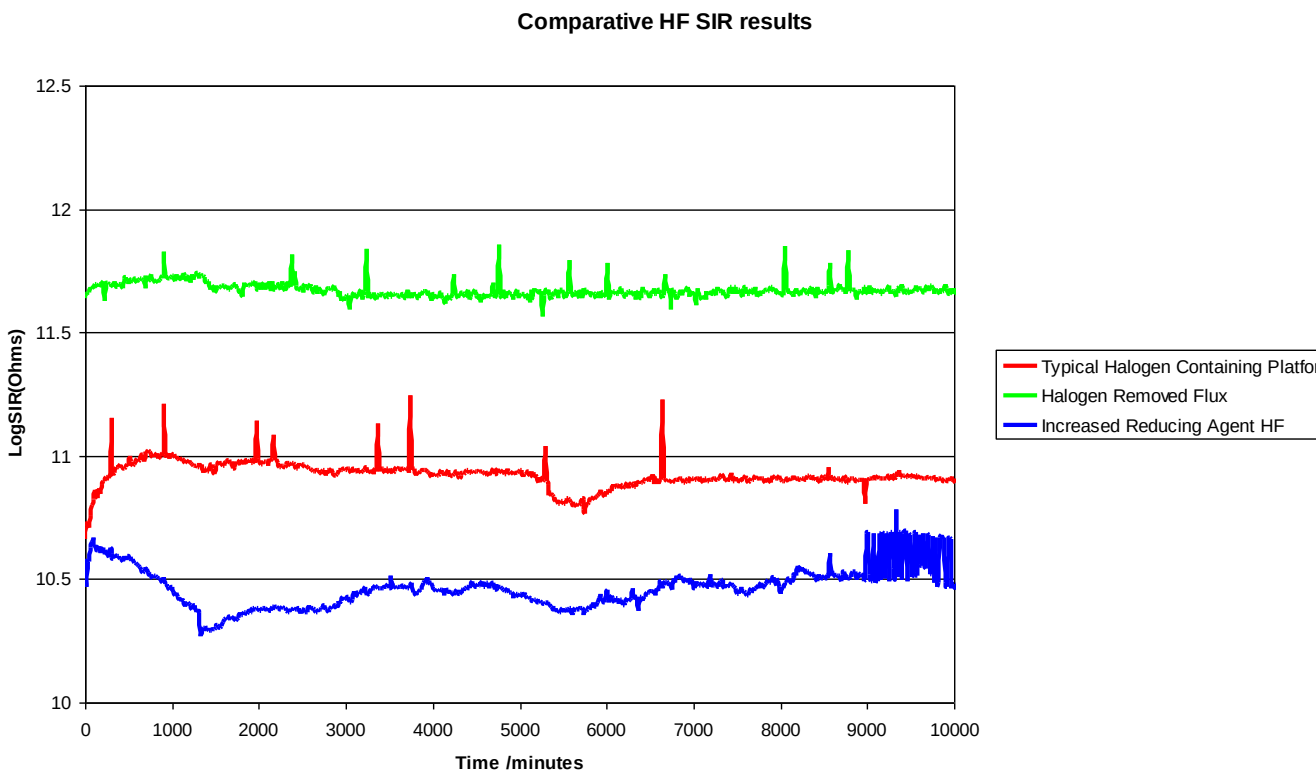
Technical Challenges Stability

- Compensating for the removal of halogen requires the addition of other materials that have reducing properties with regards to metal oxides
- This can also in some cases have a detrimental affect on stability of the product



Technical Challenges Reliability

- Increasing the non-halogen reducing agents can also compromise reliability
- The removal of halogen typically improves electrical reliability
- It's a balance

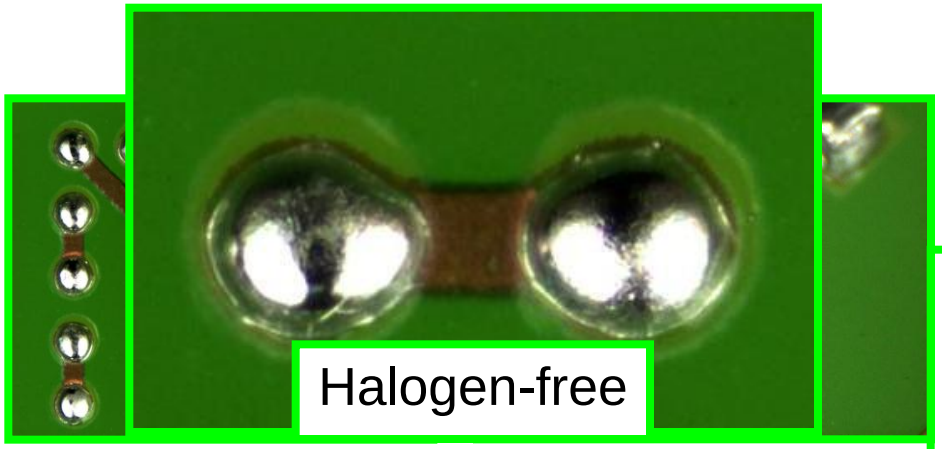


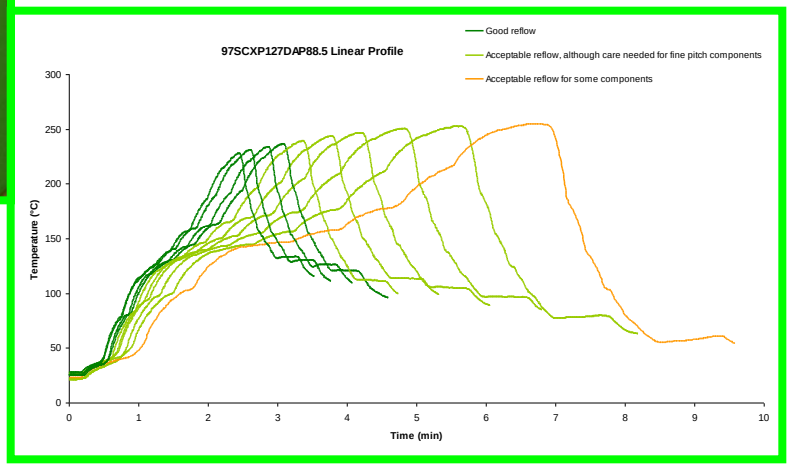
Current 'State of the Art'

- Extensive resource has been dedicated to the development of completely halogen free solder paste formulations
- Production of electronics assemblies is now possible with consumables containing no intentionally added halogens

Current 'State of the Art'

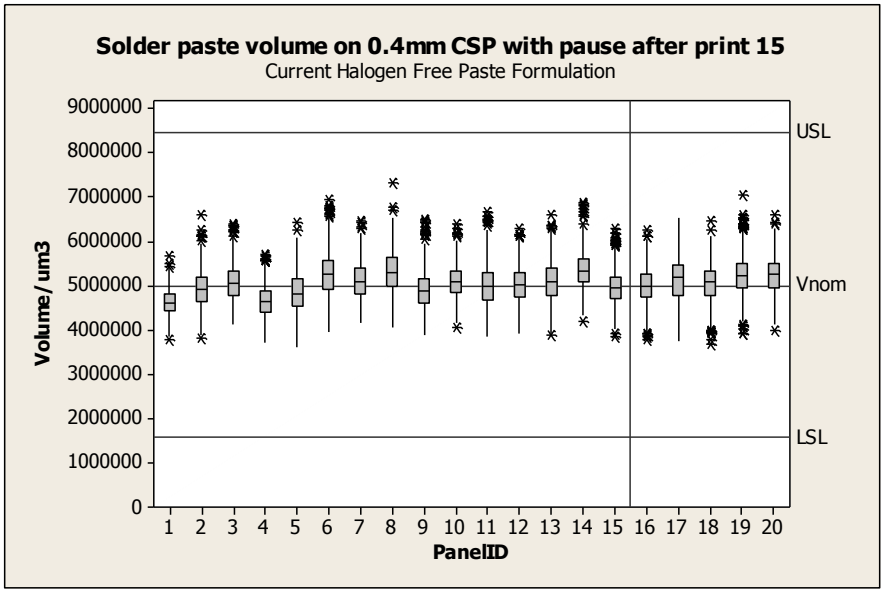
- Reflow Performance

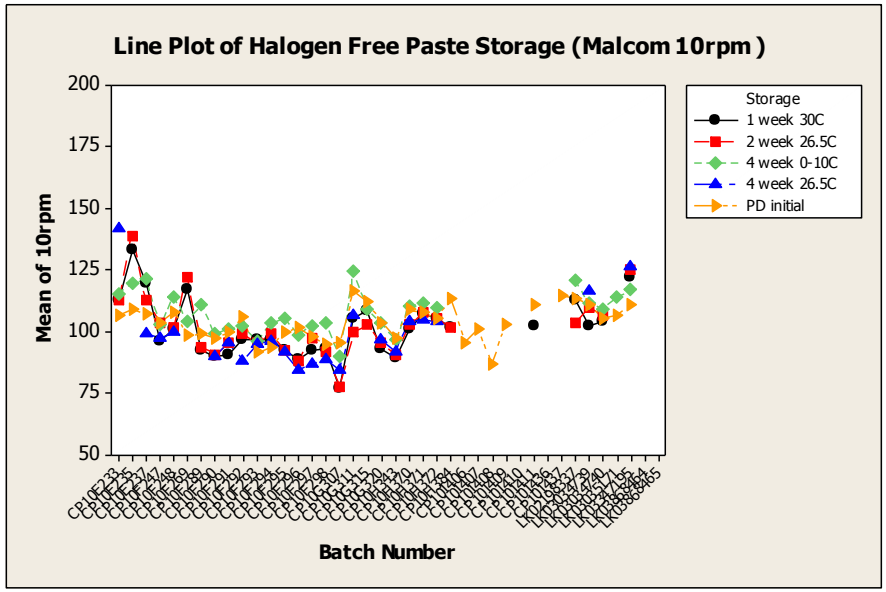




Current 'State of the Art'

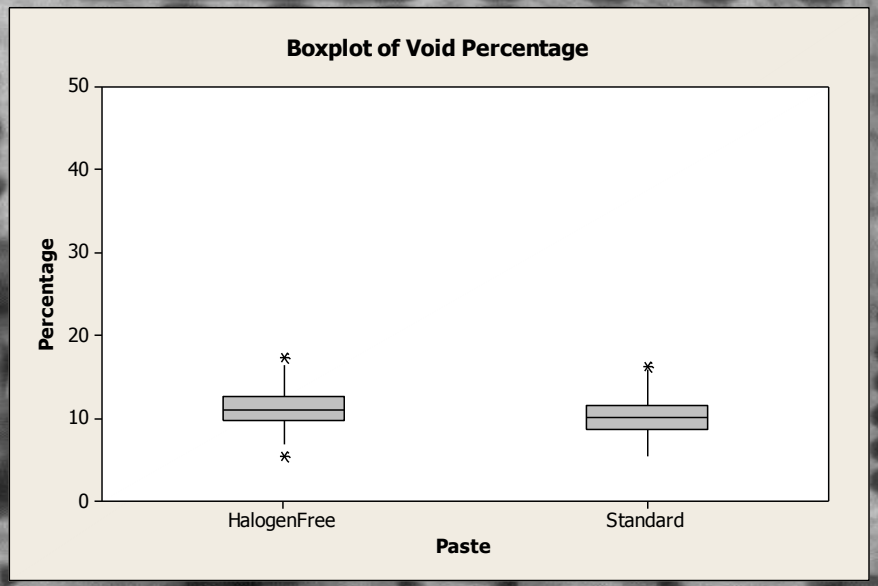
- Printing and Stability

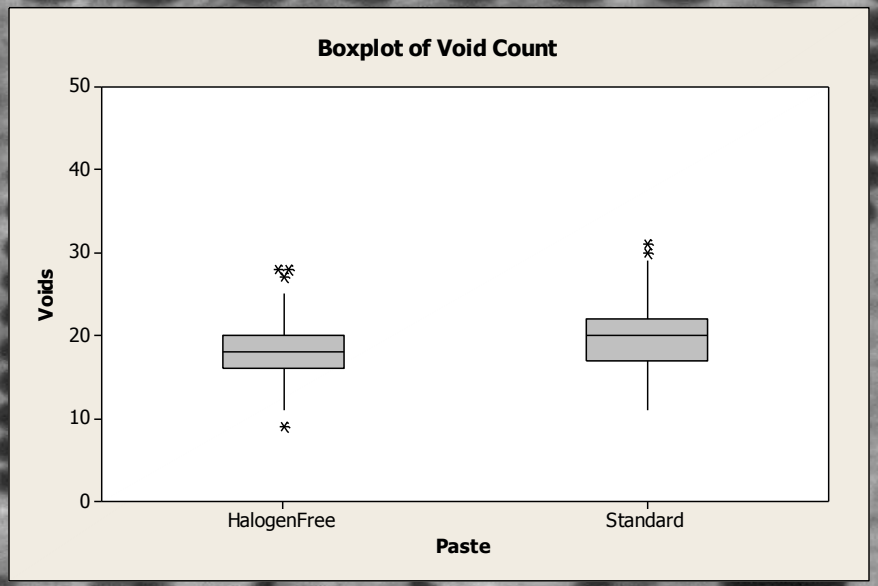




Current 'State of the Art'

- Voiding





Summary

- HF solder paste offers the following:
- Reduced environmental impact
- Attractive end-user perception
- Zero Halogen reduces risk
- Zero added Halogen Solder Pastes are now a technical possibility

Thank you for Listening

Any Questions?