Insituware Application Note

Process Control of Solder Paste

Background

Current quality assurance standards for solder paste (such as J-STD-005 section 3.5) call for a viscosity measurement at a single shear rate; however, this practice is well known to be error-prone and have a high false positive rate. Therefore, solder paste is widely used in manufacturing processes without prior inspection or quality control despite over half of assembly and reflow soldering defects originating from the stencil printing process.

The Vision MARK-1 is an innovative tool for the non-destructive inspection and process control of solder pastes both before and during use. To accomplish this, the Vision MARK-1 uses a technique called electrochemical impedance spectroscopy (EIS).

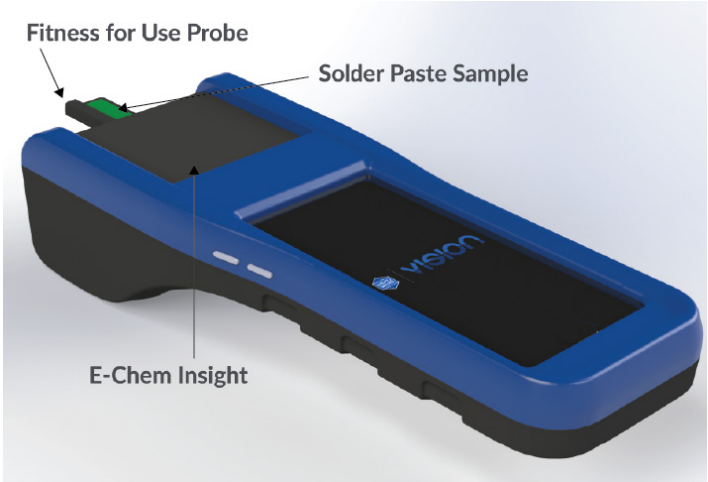

Fig. 1 *Vision MARK-1 with the Fitness for Use Probe inserted in the attached E-Chem Insight*

Solder paste is comprised of a metal powder suspended in a flux that contains an activator. The role of the activator is to remove the metal oxides from the metal powder during reflow. While not often discussed, even below the activation temperature of a solder paste, the oxide layer on the metal powder and activator slowly reacts to form a metal-activator reaction product (MARP). This reaction heavily influences the rheologic behavior of the solder paste and consequently, the printing properties of the solder paste. The rate of this reaction is referred to as the Powder Reactivity Coefficient (PRC).

Electrochemical impedance spectroscopy is a standard technique within the field of electrochemistry where a small sinusoidal AC signal is applied to a sample, and the complex impedance is measured over a range of frequencies. In a single measurement, EIS can determine the rate at which the activator reacts with the oxide layer represented by the flux-powder reaction rate of the PRC.

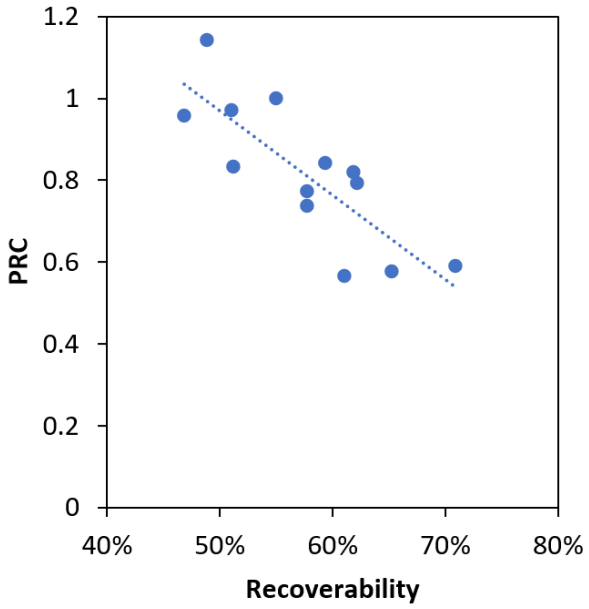

Fig. 2 *Correlation between the time constants and % recoverability of solder paste*

As a solder paste ages, either through time or accelerated by storage at elevated temperatures, the reaction rate between the activator and metal powder oxide layer (PRC) decreases. This slower reaction appears as an increase in the flux-powder reaction rate (PRC), and consequently alters the solder paste's recoverability, resulting in potential skips during printing anomalies.

Figure 2 shows the correlation between the PRC and the recoverability, which is a rheologic measure of the solder paste's ability to recover in viscosity after being shear thinned from the printing process.

As the PRC increases, the solder paste gradually loses its ability to recover which can be an indicator of potential printing anomalies such as skips and slumping.

Applications and Expected Results

The Vision MARK-1 can be used for a variety of solder paste applications within the manufacturing environment including:

Application	Recommended Measurement
Inspection of incoming solder paste	After brought to room temperature and stirred, sample and measure solder paste.
Process control of solder paste in use	At recurring time periods, sample and measure solder paste from stencil printer.
Eliminate solder paste as the root cause of printing defects	When printing defects are observed, sample and measure solder paste prior to usual troubleshooting steps.

After measuring the sample of solder paste, the Vision MARK-1 displays the EIS spectra as well as the PRC. Additionally, the Vision MARK-1 can be configured to display which region of the SPC control chart the measurement fell into based on user configurable control limits.

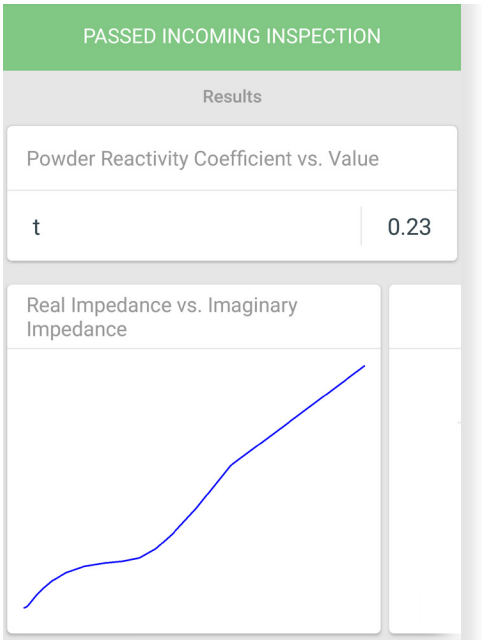

Fig. 3 *Screenshot of a passing incoming inspection on the Vision MARK-1*

Figure 3 shows a screenshot of the measurement results from a typical solder paste on the Vision MARK-1.

Application 1: Inspection of Incoming Solder Paste

Before use, the Vision MARK-1 can measure electrochemical variation of the solder paste to prevent defects in the stencil printing process. Many factors can alter both the rheologic and electrochemical properties of a solder paste such as improper storage or other mishandling.

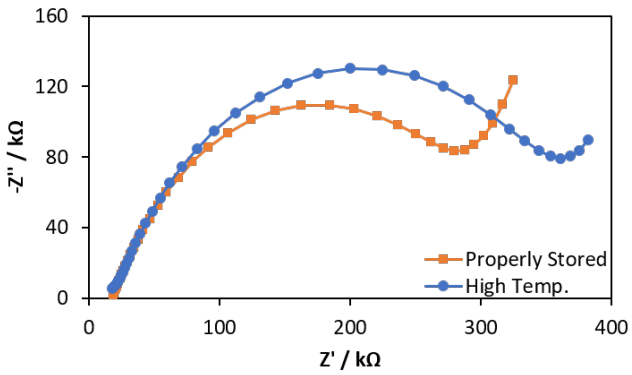

Fig. 4 *EIS spectra for solder pastes properly stored vs. stored at high temperature*

Figure 4 displays the results of a new sample of solder paste that was properly stored since it was manufactured, and a paste exposed to high temperatures during shipment. The solder paste that was exposed to high temperatures during shipment had a higher PRC of 8.1 msec compared to the PRC of the properly stored solder paste of 5 msec. With the Vision MARK-1, the user can quickly determine if the solder paste is fit for use based on the PRC.

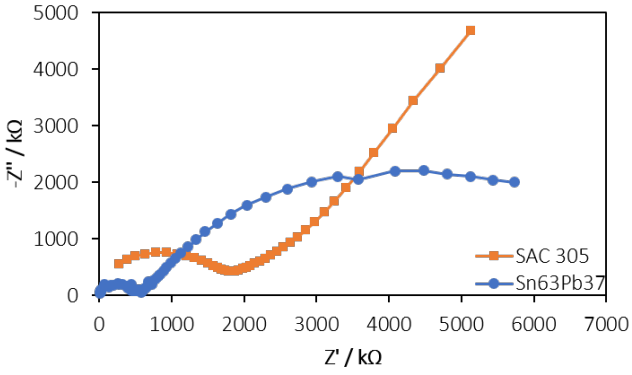

Fig. 5 *EIS spectra for two solder pastes with different alloys: SAC305 and Sn63Pb37*

Application 2: Process Control of Solder Paste in Use

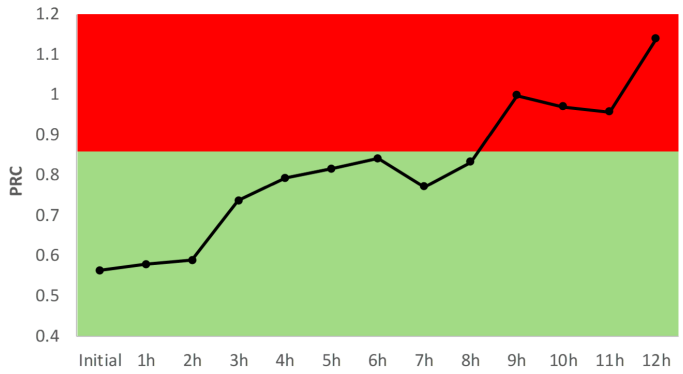

Fig. 6 *Control chart displaying the pass/fail limits of the fitness for use experiment*

During use, the rheologic and electrochemical properties of a solder paste change until an increase in printing defects results in the solder paste being unworkable. Figure 6 shows the PRC of a solder paste increasing as it is being used on a stencil printer. Control limits can be set to ensure that the solder paste is replaced prior to the onset of printing problems.

Application 3: Eliminate Solder Paste as the Root Cause of Printing Defects

When printing problems occur during use, the ability to quickly determine the root cause of the defects is vital as production lines must be stopped until the root cause is determined. If the measured PRCs are higher than typically observed through inspection or process control of the solder paste, it is likely that the material is the root cause of the defects. The Vision MARK-1 can be used to quickly eliminate the solder paste as the root cause of printing problems.

Conclusion

The Vision MARK-1 is an innovative tool for the non-destructive inspection and process control of solder pastes. It can be used to ensure the quality of the solder paste prior to use, monitor solder paste in use, or aid in determining the root cause of printing problems.

Contact Insituware's Technical Support Engineers at info@insituware.com to discuss how to better control materials in your process.

Contact our engineers today: **info@insituware.com**
Learn more: **www.insituware.com**
Phone: **856.324.6776**