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ANALISYS AND INVESTIGATION OF ADVANCED SOLDERING TECHNOLOGIES: A SHORT REVIEW[10]

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Abstract: *Current trends are for Restriction of Hazardous Substances (RoHS) and corresponding RoHS Compliant Technology. Soldering alloys and fluxes must be used in the manufacture of electronic products. The paper reviews existing methods of advanced soldering technologies and alloys. They are classified according to the melting temperature and their percentage of Sn. It has been studied that SnAgCu type alloys are suitable for surface mounting (SMD), but they are not particularly suitable for "wave type soldering" and manual soldering, as cavities may appear. Three- and four-component alloys with Bi are particularly promising. It is recommended to use the so-called matte tin (Matte Sn, Pure Sn) when soldering, as it does not show the appearance of "whiskers" in the solder under certain conditions. In the manufacture of electronic devices, they grow on the surface of light tin (Bright Sn) and its alloys deposited on copper as intermetallic compounds are formed Cu6Sn5). They are due to vibration, electric field and moisture. Cleaning after soldering is one of the essential stages in the technological process of soldering electronic components with the help of Water Soluble Paste.*

The main methods for soldering with RoHS pastes ensure their melting by blowing with hot air (Convection Reflow) CR or superheated steam (Vapor Phase Reflow) - VPR. In them, the temperature of the board on which the elements will be soldered must be changed in a specific way, called a soldering profile (Reflow Profile). It consists of four mandatory stages: Reheat Stage, Thermal Soak Stage, Soldering Stage and Cool Down Stage. To speed up the technological process, the boards should be cooled to room temperature as quickly as possible, but the rate of temperature reduction is important for the strength of the solders in case of repeated mechanical influences (Fatigue Resistance) and should not be higher from 10 °C/s.

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Relatively high soldering temperatures are a prerequisite for the occurrence of defects in the finished products, the most significant of which are: damage to elements sensitive to elevated temperature, the effect of "popcorn" (Popcorn Effect) in integrated circuits. peeling of tracks on the board, appearance of "whiskers", distortion and even peeling (Tomb-stonning) of soldered SMD devices, etc.

Keywords: *Soldering Material and Alloy, Soldering Technologies, Electronic Board.*

INTRODUCTION

Soldering may be defined as a joining process that's used for connecting or joining various types of metals together by melting solder. Solder is a metal alloy that's created of lead and can be melted it utilizing a hot iron. Soldering is used in plumbing, electronics, and etc.

To solder two materials, you need to hold a hot soldering iron to the joint in your circuit where you want to make an electrical connection (Bunea R., Svasta P., Illyefalvi-Vitez Z., Batorfi R. and Geczy A. 2011). Also, you can remove the electrical joints using a resoldering tool (fig. 1).

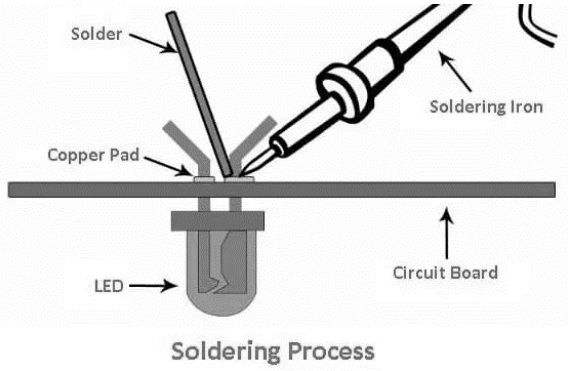

Fig. 1. Main elements of soldering process

The oldest evidence showed us that soldering was used 5000 years ago in Mesopotamia. In that time soldering was used to make cooking tools, jewellery and assembling stained glass for architecture.

The ideal solder joint for through-hole components should resemble the Fig. 2.

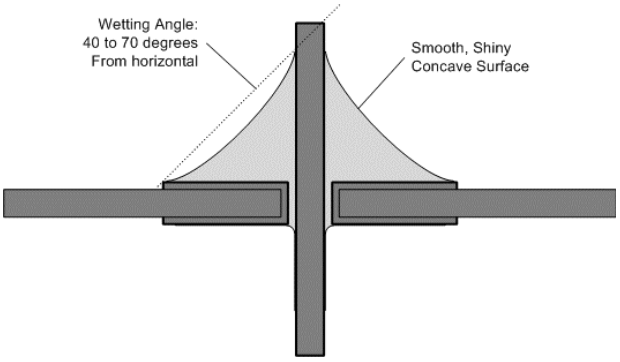

Fig. 2. Ideal Solder Joint
(source: https://learn.adafruit.com/assets/2029)

The regular solder is a fusible metal alloy. It is used to create a permanent bond between some workpieces (Geczy A. et al. 2013). In the beginning, we melt a solder to connect it to various pieces and after this, we cool it down. We need a suitable alloy to be used as solder and has a low melting point compared to the workpieces we use.

The following types of soldering are distinguished: laser soldering, Induction soldering, Fiber focus infrared soldering, Resistance soldering, Active soldering, Soldering vs. brazing, Silver soldering, Mechanical and aluminium soldering, Pipe soldering, Electronics soldering, Desoldering and resoldering, Wave soldering and reflow soldering, Environmental regulation and RoHS.

Silver solder is known as the strongest type of solder (Geczy A., Nagy A., Illes B., Gyorgy Z. and Busek D. 2017). You can use it to make joints by using lugs with solder. It is also known as the hardest solder which can be found in the market.

EXPOSITION

Used materials

Soldering iron: The soldering iron is the main tool used in soldering. A soldering iron is made from a heated metal tip and an insulated handle. It supplies sufficient heat to melt the solder so it can flow into the joint between two materials.

Flux: Flux is used to purify and also protects the metal surfaces from re-oxidation. There are three main types of flux used in soldering based on electronics industry, rosin flux, organic acid flux and inorganic acid flux.

The oldest and most popular is the rosin flux. It is suited for clean and easy to solder surfaces. It is hard, not conductive and general corrosion resistant.

Types of soldering

Soft soldering: Soft soldering is used in sheet-metal work for joining parts. These parts are not exposed to high temperatures (Hillen F., D. Pickart-Castillo, I.J. Rass, E. Lugscheider 2000). It is used also for small components or for joining wires together. In this situation, the soldering iron has a melting range of 150-350°C.

Hard soldering: Hard soldering employs a higher temperature than soft soldering and it is stronger. The temperatures vary from 300-450°C.

Brazing: In brazing, the melting point of the soldering tool is above 450°C. The high temperature helps to melt the base metals together. The only difference between brazing and soldering is the temperature. In soldering, we work with temperatures below 450°C despite the brazing which is working with temperatures above 450°C.

Heating methods:

For any specific application, it exists a different type of soldering tool. We can obtain the needed heat from burning fuel or with the help of an electrical tool (Hillen F., D. Pickart-Castillo, I.J. Rass, E. Lugscheider 2000). The most basic method is to put the soldering iron at the locations of joints to heat the entire object and melt the solder. We have 2 types of heating, electrical and chemical.

The Electrical methods are:

• laser soldering: Laser soldering is a non-contact process that eliminates the risk of marring or damaging sensitive components. The laser makes the possible ultrafine area and other types of soldering that are difficult using tip soldering, which drives enormous advantages.

• induction soldering: Induction heating is a fast, efficient, precise, repeatable, non-contact method for heating metals or other electrically-conductive materials. An induction heating system includes an induction power supply that converts line power to an alternating current, delivers it to a work head and work coil creating an electromagnetic field within the coil.

• fiber focus infrared soldering: Fiber focus infrared soldering is a technique where many infrared sources are led through fibers. And then focused on a single spot. Which will then solder the connection joint.

• resistance soldering: Resistance Soldering is the name applied to a technique where the heat to melt solder is instantaneously generated by passing through a high amperage electrical current through a resistive material.

• active soldering: Solders with active element content have been shown to provide excellent wettability. For mechanical activation, needed for active soldering, can be performed by brushing or ultrasonic vibration (20–60 kHz). The active elements, owing to mechanical activation, react with the surface of the materials generally considered difficult to solder without metalization.

Chemical methods are: flame contact, radiation and conduction.

Silver solder can be described as the brazing alloys because the basic principles are similar to brazing, the only difference is made by temperature requirements (Plotog I, et al. 2012). The design of silver solder is made in such a way as to work at a specific temperature range. Usually, the temperature is below the melting point of the used materials. We use this to join various types of metals or different grades and also, we get a level of strength of some specific operating temperature (Hsiao Y., Lin K. 2016).

Common soldering problems

Cold joints

In soldering the most common defect is "colder solder" and it appears when solder fails to melt properly to form a proper joint and it results in a cold solder joint. This defect can also result from a common cause of equipment that passes testing but in a few years of operating, it will fail.

Dry joints

Dry joints often occur because the joint will move when the soldering iron is removed from the joint. They are mechanically weak and are poor electrical conductors. The problem with the dry joint is that it seems to work, it does work for many years, but it will eventually fail.

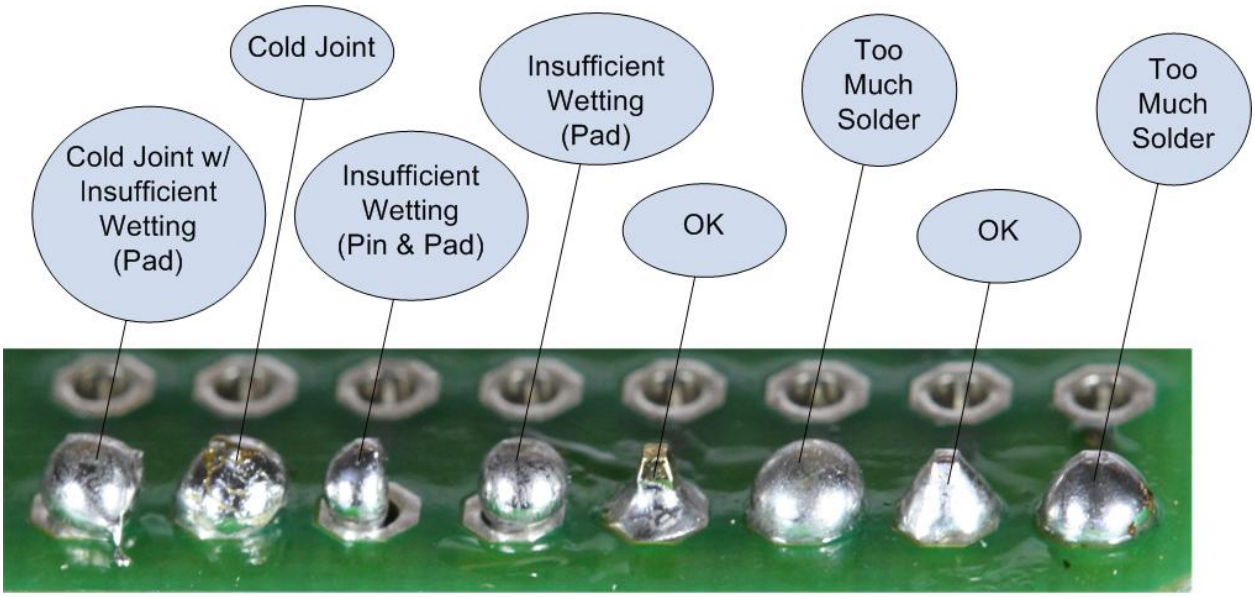

Fig. 3. Common soldering problems
(source: https://learn.adafruit.com/assets/1978)

Disturbed Joint

A Disturbed joint is one that has been subjected to movement as the solder was solidifying. The surface of the joint may appear frosted, crystalline or rough.

Often called a 'Cold Joint'. They can look similar to a true cold joint, but the cause is different.

Repair: This joint can be repaired by reheating and allowing it to cool undisturbed.

Prevention: Proper preparation, including immobilizing the joint and stabilizing the work in a vise can prevent disturbed joints.

Overheated Joint

At the other extreme, we have the overheated joint. The solder has not yet flowed well and the residue of burnt flux will make fixing this joint difficult.

Repair: An overheated joint can usually be repaired after cleaning. Careful scraping with the tip of a knife, or little isopropyl alcohol & a toothbrush will remove the burnt flux.

Prevention: A clean, hot soldering iron, proper preparation and cleaning of the joint will help prevent overheated joints (Chiu Y., Liu C., Lin K. and Lai Y. 2011).

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Desoldering and resoldering

Desoldering wick is a common method of using flux and braided copper wire to remove unwanted solder. It is often used to help remove defective components, correct solder bridges, or for any other reason that requires solder removal.

We can resolder bad connections and old oxidized solder joints.

CONCLUSION

Solders as joining materials need to be able to react with the contact metals like lead frame and the metallization on-chip or substrate. The solidified solder joint provides the strength needed for holding the component. The materials properties of soldiers need to fulfill the requirements. For electronic applications, the solder must have acceptable electrical properties and mechanical impact. The reliability of solder joints relies on the endurance of solder to these environmental impacts.

The solder materials properties that need to consider include melting temperature, materials reaction, phase transformation, mechanical strength, creep resistance, ductility, and etc. In conclusion, we use soldering for repairing or building some electronic devices, pipes, wires.

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