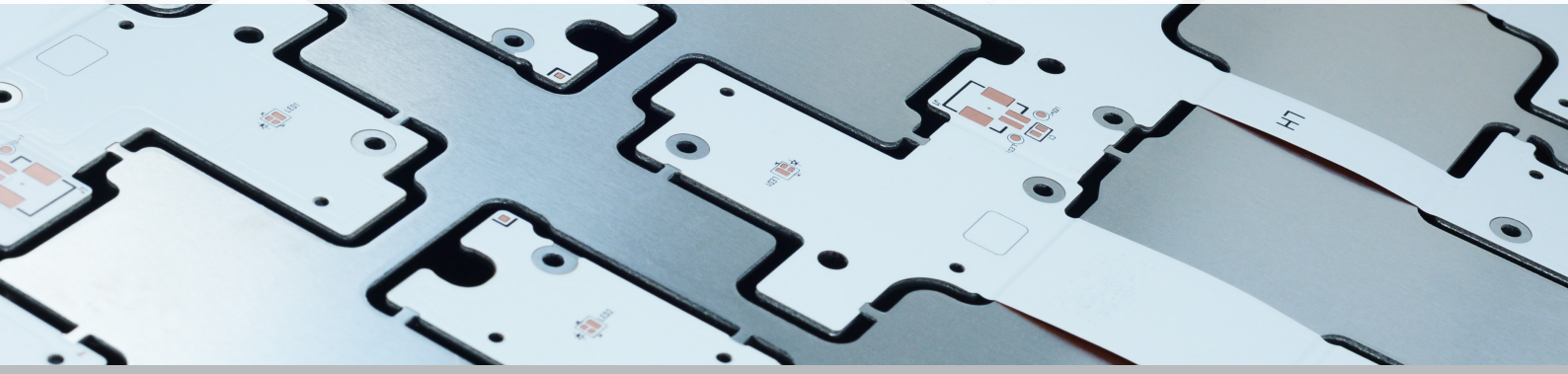
PCB SURFACE FINISHES AND HOW TO SELECT THEM



INTRODUCTION

"Surfaces … What is the best choice?" This question is very often asked by customers. The answer is "None!" In general, there is no best surface. It is the same question as "What's the best car?" Some would say "Ferrari", some would say "Porsche", but what if the driver is a father of 5 kids? The choice would be very different. It is the same for surface finishes: it depends on the application.

Let us look at the tasks that surfaces in the PCBA world have to fulfill.

1) ASSEMBLY METHODS

There are different approaches for attaching components to the PCB:

1. Wave soldering
2. Reflow soldering
3. Selective wave soldering
4. Press-fit pins
5. COB Bonding

Ensuring a good connection between the components and the PCB is the major task of a surface.

In the old days, all components had wires which were mounted in an assembly hole. The first SMD components were big and easier to physically position, thus hot air leveling surfaces were sufficient.

Nowadays components are becoming smaller. Additionally, the size of the landing pad is also becoming smaller and narrower – often referred to as fine pitch. If such components are used, a surface with a high planarity is necessary. Only chemical or electrically deposited surfaces are good enough for this.

Normally in PCB assembly, at least two solder processes are necessary. Wave soldering is used for wired components. Reflow soldering is for SMD components. If there is a double-sided SMD assembly, a third soldering process is necessary. All common surfaces are able to withstand three solder processes.

Today, very often the only remaining wired components are connectors. To omit wave soldering, press-fit connectors have replaced the through hole components. These connectors are pressed into the assembly hole, so no soldering is necessary. Not every surface can withstand this harsh procedure. Immersion Ni/Au is only allowed for certain pin designs.

If a chip on board component is used, a bondable surface is necessary. Only immersion Ni/Au can suffice.

2) CONNECTING STRATEGY TO OTHER DEVICES

We have three main methods for contacting the circuitry to other devices

1. Edge contact
2. Sliding contact
3. Touch contact

In former times, turning knobs or contact sliders that were mounted on the PCB, made the contact. To save and omit these components, the PCB took over the function of touchpads or sliders.

Only surfaces with high protection against oxidation and abrasion can handle this. So gold is the most desired. For sliding systems with high abrasion, only hard-gold is permitted. For edge connectors, HASL and HASL LF are also a viable option.

3) PROTECT THE UNDERLYING COPPER AGAINST CORROSION DURING PCBA LIFETIME

There are some surfaces which age during their lifetime. This means that the underlying copper comes in contact with humidity or air during the life cycle of the PCBA. The result is that the surface becomes passive and non-conducting. Corrosion is also a possibility. Only gold and HASL surfaces are final surfaces which do not change behavior during life cycle.

4) FOLLOW THE REGULATION 2011/95/EG RESTRICTION OF HAZARDOUS SUBSTANCES „ROHS“

Considering this HASL SnPb is out of the game.

5) RESPECT LOGISTICAL AND STORAGE CONDITIONS

If there is a long supply chain between PCB production and soldering, you must respect that immersion tin has 9 months and silver has 6 months shelf life. If you are likely to exceed the shelf life, be aware that not every surface can be refreshed.

6) LAST BUT NOT LEAST, COST SAVING IS OFTEN THE MOST IMPORTANT TASK

That's why you should choose the surface very cautiously. Rule of thumb estimation on the worth of different surfaces is as follows:

- OSP : 0.95
- HASL LF: 1
- HASL SnPb: 1
- Immersion tin: 1.2
- Immersion silver: 1.25
- Immersion Ni/Au: 1.35 - 1.5
- Electrolytic Gold: is an adder to the surfaces before + 0.5 up to 2 depending on the gold area.

SURFACE OVERVIEW

As you can imagine, no single surface can fulfill all requirements. One has to be aware of the tradeoff between pros and cons of all final surfaces.

You may select the suitable surface for your project from the table below:

SURFACE	SURFACE THICKNESS	ADVANTAGE	DISADVANTAGE
Immersion Nickel / Gold	Ni 3.5 - 5µm Au > 0.025µm	Perfect solderability, high planarity, Aluminum wire bondable, multiply solderable, long shelf life, contact surface	Most expensive surface, limited for press-fit
Electrolytic Nickel / Gold 0,5% Cobalt (Hard Gold)	Ni 3.5 - 5µm Au 1µm	Perfect contact surface, sliding contact, edge contact	Expensive, not solderable, needs additional solderable surface, no press-fit
Immersion Tin	Sn > 1.0µm	Temperature sensitive surface, no final surface, short shelf life	Temperature sensitive surface, no final surface, short shelf life
Immersion Silver	Ag > 0,15µm	Good solderability, high planarity, multiply solderable	Most sensible surface, perfect handling necessary, no final surface, short shelf life
Hot Air Leveling	SnPb > 0.5µm	Cheap, perfect solderability, long shelf life, multiply solderable, perfect for press-fit, edge contact	Not conformal to RoHS, low planarity, not usable for fine pitch assembly
Hot Air Leveling Lead-free	Sn 0.7 Cu > 1.0µm	Cheap, perfect solderability, long shelf life, multiply solderable, perfect for press-fit, edge contact	Low planarity, not usable for fine pitch assembly, high soldering temperature
OSP	> 0.2µm	Most cost effective surface, high planarity, multiply solderable	No final surface, limited shelf life, no contact surface

THE BOTTOM LINE

There is no perfect surface. If you define a certain surface, please take care not to over-specify it. The expensive surfaces are not always necessary. With the aid of our table, you will be in a better position to select the best surface for your project.