Solder balling in wave and selective soldering

Solder balls are created by different factors. The most important one is the solder resist. What happens during the wave solder process is that the solder resist gets weak in the wave and acts like an adhesive for the solder alloy. Especially the Tg (Glass transition temperature) of the solder resist is the most important factor. Using a solder resist with a high Tg will decrease and possibly eliminate solder balls. The curing time and curing temperature of the solder resist are also of influence on the solder balling effect of the resist. All these facts make that there is a huge difference in solder balling between different solder resists.
Other items that can create solder balls are equipment (wave formers, maintenance), flux, alloy (surface tension, impurities), temperature (viscosity) etc. but all of these will have a minor impact on the solder balling (see presentation slide below) compared with the solder resist.

Below is a slide included out of one of our presentations that is related to solder balling (see figure 2)

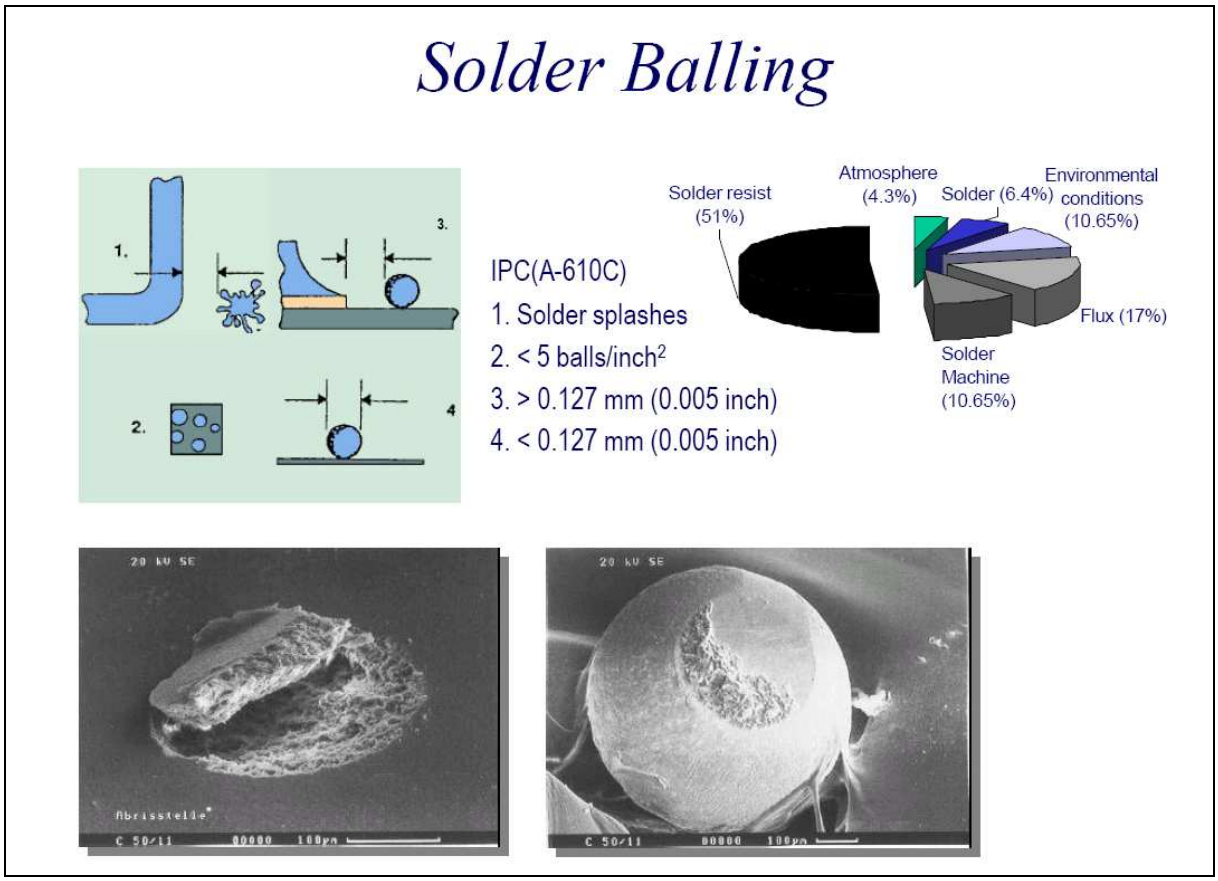

Figure 2

The main problem at the moment is that the small solder balls between two adjacent leads of the IC's or connectors can create shorts. The cause of these shorts are related to the distance between the two pads. This distance is very small and the solder ball bridges this gap which creates a short. As is illustrated in figure 2 a small solder ball can create a short in the current situation, even if there is a silkscreen between the pads to reduce solder balling. Important for the silkscreen is however the Tg. If the Tg

of the silkscreen is lower as the Tg of the solder resist, the silkscreen between the pads will increase solder balling instead of reducing it in this case it would be better to remove it. Also if the difference of Tg between solder resist and silkscreen is very low, the silk screen has no effect on the reduction of solder balling.
There are materials available, used as silk screen, with a very high Tg and a very high hardness. On these materials the solder has very low attach properties and solder balling will be eliminated.

To prevent solder balling there are a few options.

Option 1

A major improvement can be made by changing the silk-screen material to a material with a high Tg.
This Tg should be as high as possible. Also it could be good to evaluate the manufacturing conditions of the PCB and check the curing time and temperature of the solder resist and the silkscreen (see figure 3). For Daewoo this would have the least impact, it is only a chance of material choice in order to prevent solder balling leading to higher yields in production and better quality of the final products.

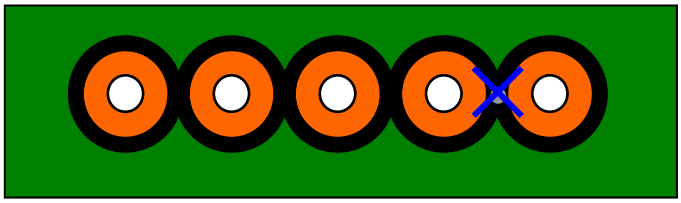

Figure 3

Option 2

Choose a solder resist material that has proven to be solder ball resistant is another option. There are materials available that will not attach any solder and therefore eliminate solder balling. These are solder resists with a high Tg and a high hardness (see figure 4).

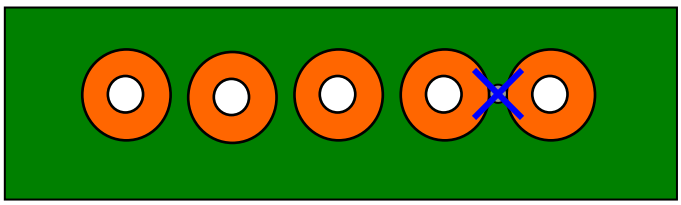

Figure 4

Option 3

Since the solder resist is the main factor to create solder balling a third option could be to remove the solder resist in the problem areas (see figure 5). In this case there is no solder resist between the pads and the solder can not create a solder ball on the resist. The solder will not attach to the base material, thus there will be no solder balls in these specific areas. This principle is used often to avoid solder balling and it is called the “envelope principle”

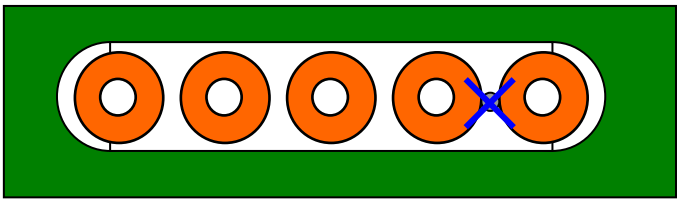

Figure 5

If the options above to avoid solder balling are not possible then there are some options to prevent shorts but the phenomenon solder balls has to be accepted as long as they don't create shorts.
There are different ways to prevent the phenomenon of shorts.

Option 1

Add a silkscreen between the pads of the problem area. The silkscreen will be placed over the pads in order to increase the distance between the adjacent pads. In normal circumstances the silkscreen does not promote solder balling (depending on Tg and curing conditions). In the case that there will be an incidental solder ball, this will not be a big concern because this solder ball will not create a short. (see figure 6).

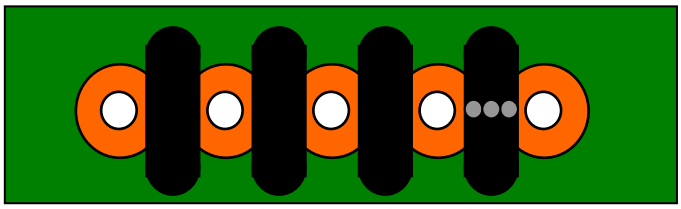

Figure 6

Option 2

Increase the distance between two adjacent pads by changing the pad design from round to oval shape. (see figure 7). By increasing the distance the solder will have less chance to attach to the solder resist resulting in the fact that solder balling will be reduced (depending on Tg and curing conditions). In the case that there will be an incidental solder ball this will not be a big concern because this solder ball will not create a short. Especially in the consumer electronics industry this design is rather popular.

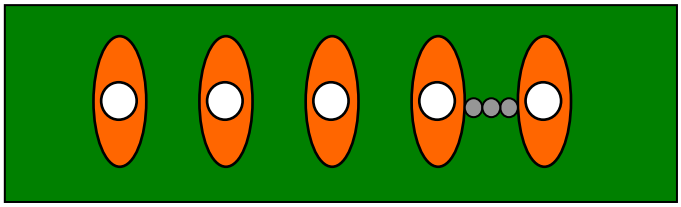

Figure 7

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