nanocoating and SMT stencils

for quality results and a cleaner process

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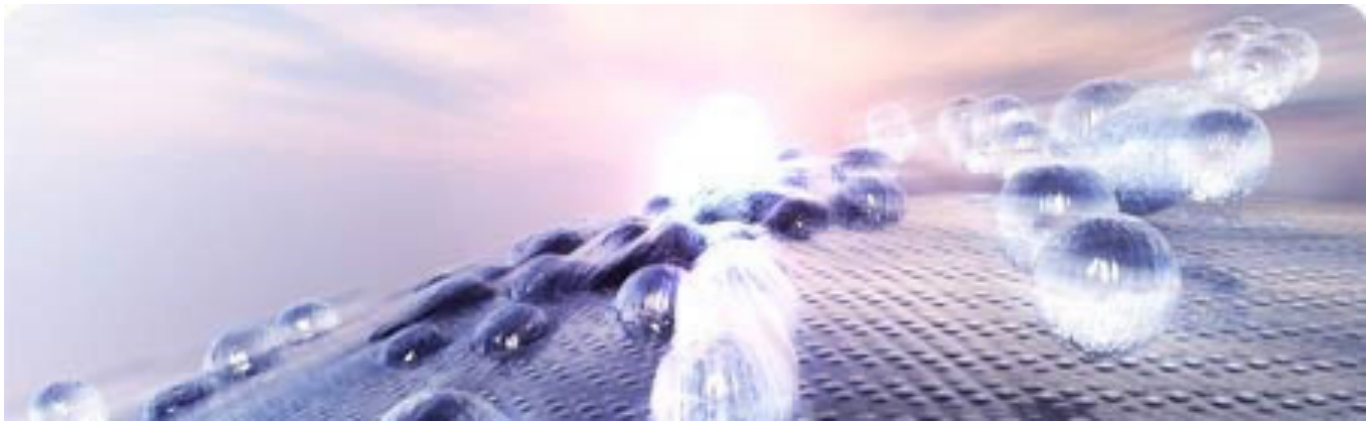
3.0 Nanocoatings

With a thickness of no more than 1-100 nanometers, nanocoatings are ultra-thin layers or chemical structures that are applied to surfaces by a variety of methods and applied to a wide range of substrates and chemically bond with non-porous surfaces. To put this in perspective, consider the thickness of paint used in the automotive industry of which is typically 125 microns or 125,000 nanometers.

While they can be one molecule thick, multiple molecular layers can be built up to deliver a particular chemical or physical property to a surface such as water-resistance (hydrophobic) and oil-resistance (oleophobic).

3.1 Nanocoating SMT stencils



The underside of solder paste stencils can be nanocoated at a typical thickness of ~5 nanometers to provide a non-stick surface which:

- reduces the number of cleaning cycles required during the paste printing process
- improves paste transfer efficiency for fine pitch apertures

Nanocoating SMT stencils delivers immediate and measurably improved results from the first print and can also be applied on the production line to previously used stencils.

3.2 When to use nanocoatings

There are a number of factors to take into account when considering whether to nanocoat a stencil:

1. What is the smallest aperture and pitch on the stencil and what is its thickness?
In the case of a large board with large appertures, the benefit of nanocoating is insignificant. On the other hand, stencil performance can be considerably improved in the case of a dense image with fine pitches and small apertures.

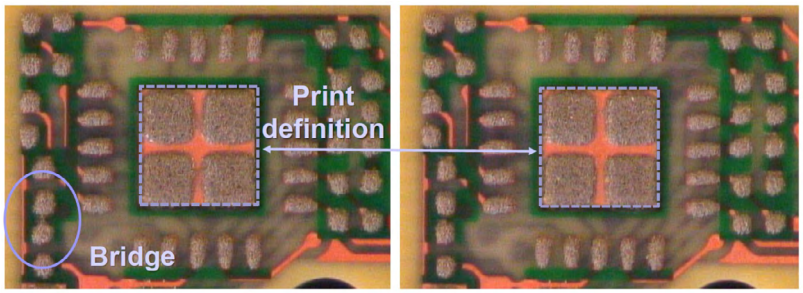
2. How many prints are you using the stencil for?
If you're simply printing a prototype, nanocoating is not necessary but where volume runs are concerned, nanocoating significantly reduces the frequency of cleaning cycles.

3. What paste are you using?
In the case of SMT stencils, the denser the paste you are using, the greater the benefit of nanocoating.

3.3 Nanocoating benefits

3.3.1 Better quality printing

Because the flux is repelled from the aperture walls by nanocoating, there is a reduction in bridging, resulting in better results. Figure 3.1 below shows the print definition improvements that can be achieved with a nanocoated stencil, highlighting QFN and 0201 devices after ten prints with no wipe using the same board, same stencil design and same print stroke.



Results from stencil with no nanocoating ***Results from nanocoated stencil***

Figure 3.1: Print definition improvements with nanocoated stencil. Source: "Fine Tuning the Stencil, Manufacturing Process and Other Stencil Printing Experiments", Shea C. and Whittier R., Proceedings of SMTA International.

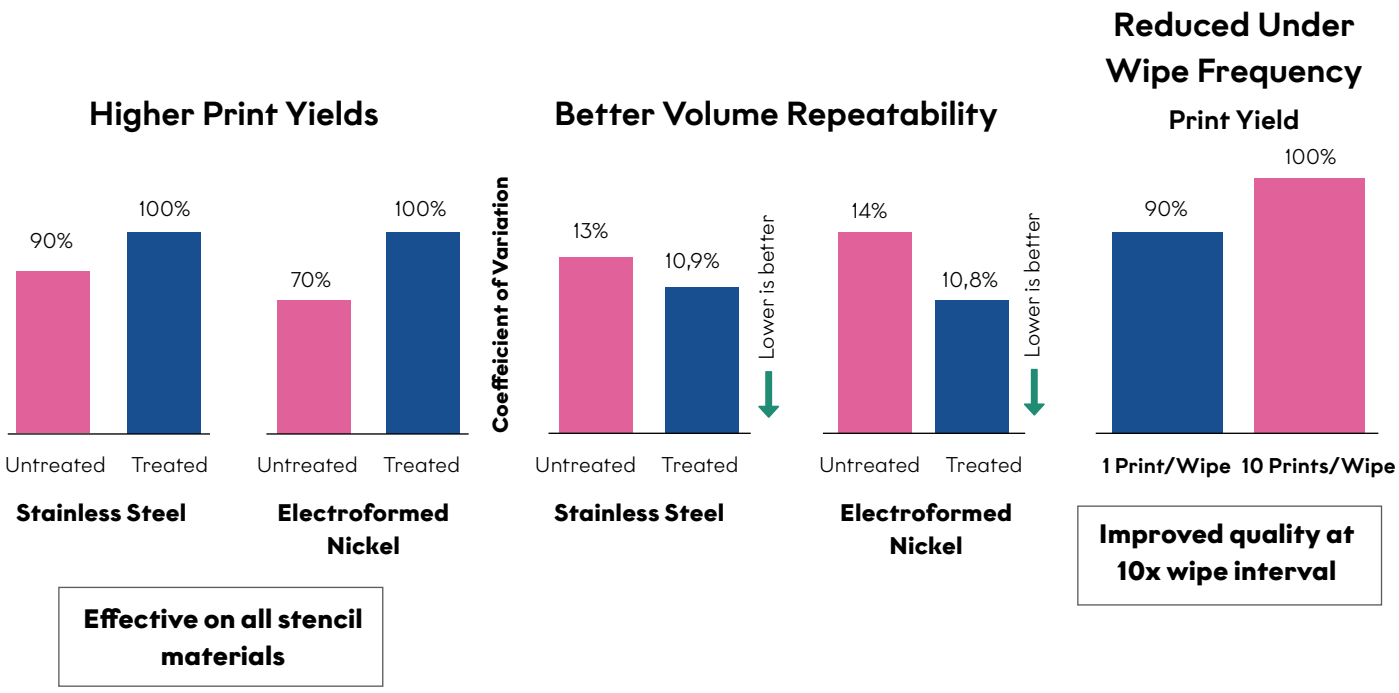


Figure 3.2: Results of 10-print test in large DOE. Source: "Fine Tuning the Stencil, Manufacturing Process and Other Stencil Printing Experiments", Shea C. and Whittier R., Proceedings of SMTA International.

3.3.2 Improved productivity, reduced costs

Flux-resistant nanocoating applied to the underside of the stencil and stencil aperture walls can boost productivity and reduce costs for volume runs:

- less underwiping is required
- less downtime for paper changes
- there is less damage to stencil mountings, particularly for meshed stencils, from exposure to aggressive cleaning solvents.
- lower paper and solvent consumption

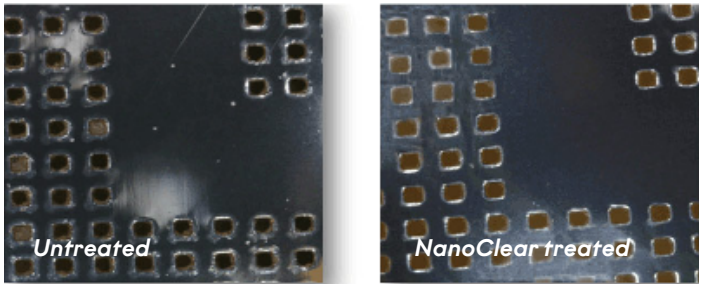


Figure 3.3: Comparison of untreated and NanoClear treated stencil.
Source: https://www.aculon.com/nanoclear-stencil-wipes/

3.4 SMT nanocoatings available from Tecan

A choice of nanocoatings are available for all Tecan stencils both of which create a robust, abrasion resistant surface that stands up to repeated cleaning.

- **MicroShield** is a two-part coating that is applied by Tecan prior to stencil dispatch
- **NanoClear®** coating from Aculon is supplied in a pouch containing both the primer and nanocoating to be applied on the production line.

3.4.1 MicroShield

This on-contact coating has a unique chemistry. Upon contact, it forms a self-assembling monolayer that is highly hydrophobic and oleophobic. It is applied to Tecan's solder paste stencils after they are cut and prior to dispatch. MicroShield demonstrates both the printing and cleaning benefits of nanocoating.

MicroShield does not "cure" like a traditional polymer coating but instantly transforms the surface on-contact. Performance typically improves with time.

Physical Properties	Values
Appearance	Clear
Specific Gravity @ 23 °C	0.80 g/cm^3
Viscosity @ 23 °C	2.1 cP
Nonvolatile content	1 %
Static contact angle, water	103 Degrees
Static contact angle, n-hexadecane	69 Degrees
Abrasion resistance, ASTM D2486, Isopropyl Alcohol	>2000
Abrasion resistance, ASTM D2486, IPA Based Flux	>2000
Pencil hardness	N/A

Figure 3.4: MicroShield test results

3.4.2 NanoClear®

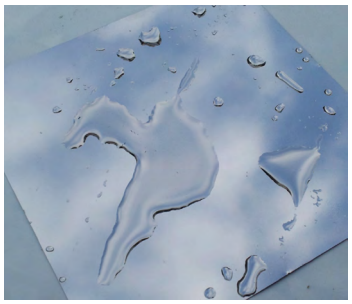
NanoClear is a SAMP Coating (Self-Assembling Monolayer Phosphonate) supplied in a two-part pouch and can be applied by SMT operators to a new stencil on the production line or to an existing stencil to improve performance.

Aculon NanoClear repels flux which improves print quality, increases efficiency, lowers total costs and enhances printing with small apertures.

Application of NanoClear® is very simple. With a NanoClear® dual wipe, a water source, and just five minutes of time you can have an SMT stencil that has been properly treated with a robust and high performing coating.

Figure 3.5 NanoClear SMT Stencil Nanocoating"

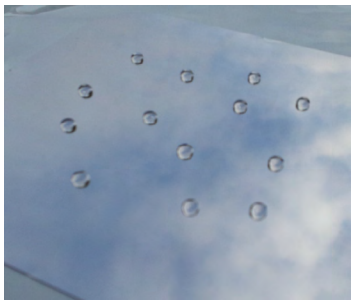
3.4.2.1 Applying NanoClear



Step one (unprimed stencil)
Take the clean stencil and hold under running water for a few seconds, if the water does not wet out evenly onto the stencil (see figure 3.6), then the stencil still has surface contaminants and needs to be primed with Aculon Primer (Part A).

Figure 3.6: Uneven wetting

Step two (primed stencil):
After using Aculon Part A rinse the stencil under running distilled or deionised water for at least 60 seconds. Please note a primed stencil will have an unbroken film of water that should remain on the surface without beading up for 30 seconds. If the stencil looks like this, then completely dry with a cleanroom wipe and proceed to the application of Part B.



Step three (treated stencil):
Upon opening, immediately apply Aculon Nanoclear Part B by wiping it on the stencil for one minute. Wipe off excess coating with a cleanroom wipe. You can test a stencil's performance by evaluating if water droplets bead tightly on the surface (as shown in figure 3.7) and shed from the stencil easily when tilted.

Figure 3.7: Tight beading on stencil surface

3.5 How long does a nanocoating last?

Aculon states that users typically report **25K print cycles**, although durability depends on many factors, including:

- Abrasiveness of wiper paper/fabric
- Wipe frequency
- Solvent or dry wipe
- pH of under wipe and off-line cleaning solvents
- Solder paste chemistry

In order to maximise durability, Aculon suggests:

- Use soft, non-abrasive understencil wiper paper such as Eco Roll SCER360 or Hyperclean PP4200
- Use a solvent wipe rather than a dry wipe – engineered solvents are best for lead-free no-clean pastes
- Use pH neutral cleaners
- Reduce understencil wipe frequency