NanoWork® stencil

Laser cut stainless steel stencil with anti-adhesion properties

1.1

Easy-to-clean surface

LaserJob's NanoWork® stencil is a specially-treated laser cut SMD stencil (see data sheet 1.0 SMD stencil).

The NanoWork® coating is applied to the bottom side (printed circuit board side, PCB) and inside every aperture. Before the coating is applied, a CNC brushing process removes all burrs on the laser exit side in order to provide optimal printing performance. The upper side (squeegee side) is left uncoated in order to ensure proper rolling of the solder paste. The coating layer thickness is ≤ 2 µm (see cross section, picture 1).

Advantages of NanoWork® coating

Due to the anti-adhesion properties of the NanoWork® coating, the solder paste is no longer able to stick to the stencil. The anti-adhesion coating in the apertures guarantees a significantly better contour definition of the solder paste as well as a more consistent solder paste volume. The NanoWork® coating's advantages are evident in the pick and place process as well as in the soldering process. Ultimately, a lower failure rate and a better yield can be achieved. The cleaning cycles on the bottom side of the PCB are reduced significantly due to the fact that solder paste is no longer able to adhere to the NanoWork® coated surface. The positive results: more printing cycles (higher production yields) and less cleaning materials (cost savings). The NanoWork® stencil from LaserJob allows for smaller print structures (fine pitch) without negatively influencing the printing results.

LaserJob makes many valuable contributions in helping you to fulfill the increased requirements of miniaturization:

- optimized aspect ratios and area ratios
- significantly fewer bottom-side cleaning cycles
- better contour definition
- excellent solder paste release
- consistent transferred solder volume
- less solder bridging

Layout guidelines and design proposals

Two key determining factors for applied solder paste volume are
1) size of the aperture and
2) the thickness of the stencil.
The solder paste release correlates to:

- aspect- and area ratios for the aperture design
- aperture side wall geometry
- aperture wall definition

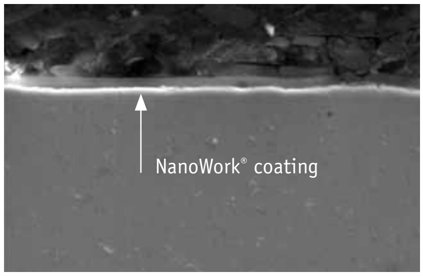
Area ratio and aspect ratio are both illustrated in picture 2.

A general design guide for complete paste release is:

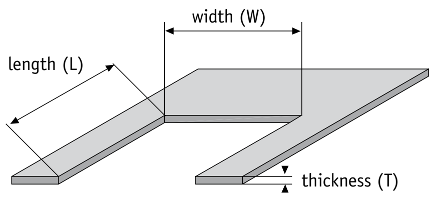
Area ratio: > 0.66
Aspect ratio: > 1.5

For more information on SMD stencil guidelines, see IPC-7525-A.

For more information to help optimize area and aspect ratios, please see further details inside this data sheet.



Picture 1: Cross section NanoWork® stencil



$$\text{Aspect ratio} = \frac{\text{width of aperture}}{\text{stencil thickness}} = \frac{W}{T}$$

$$\text{Area ratio} = \frac{\text{area of aperture}}{\text{area of aperture walls}} = \frac{L \times W}{2 \times (L+W) \times T}$$

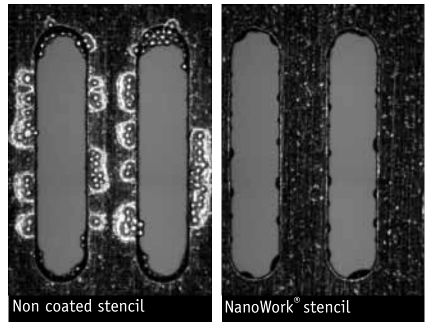
Picture 2: Cross section of an aperture

LaserJob Inc.
55 Fleming Drive, Unit 24
Cambridge, ON N1T 2A9, Canada
phone +1 (0) 519 620-1221
info@laserjob.ca
www.laserjob.com

LaserJob GmbH
Liebigstraße 14
82256 Fürstenfeldbruck, Germany
phone +49 (0) 8141 52778-0
fax +49 (0) 8141 52778-69
info@laserjob.de
www.laserjob.de

NanoWork® stencil

Laser cut stainless steel stencil with anti-adhesion properties



Picture 5: Visual inspection of the stencil bottom side, after 5 prints without cleaning (QFP 500 µm)

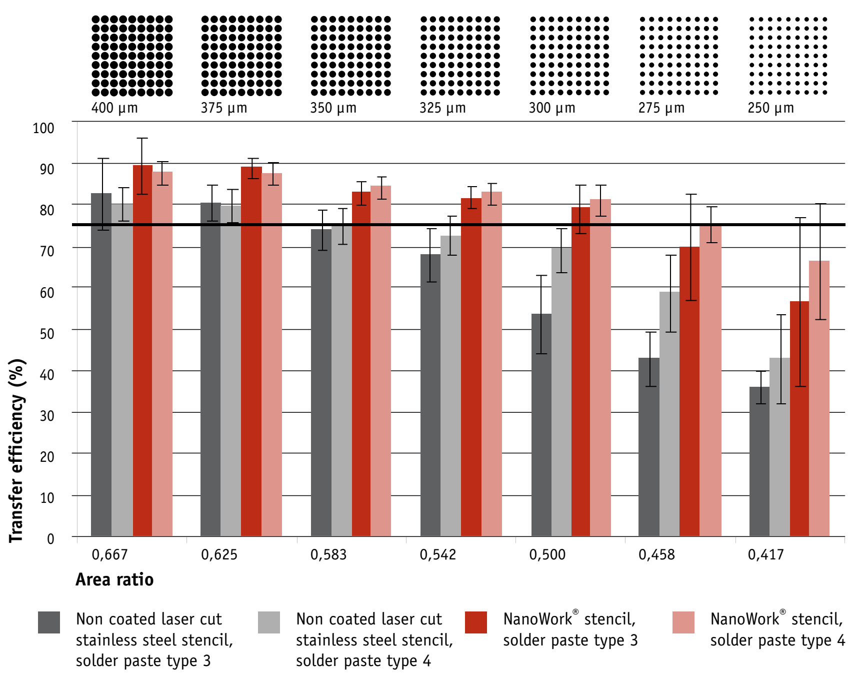
Release characteristics and transfer efficiency

Picture 3 illustrates the release characteristics of a NanoWork® stencil in comparison to a non-coated laser-cut stainless steel stencil. The graph illustrates the transfer efficiency % of an 81-pin BGA with aperture sizes ranging from 400 µm to 250 µm and corresponding area ratios ranging from 0.667 down to 0.417. With an area ratio of 0.5, the NanoWork® stencil shows a transfer efficiency greater than 77 % on both type 3 (25 µm – 40 µm) and type 4 (20 µm – 38µm) solder paste. A non-coated laser-cut stainless steel stencil allows only 50 % of the type 3 and 70 % of the type 4 solder paste to transfer. The NanoWork® stencil allows significantly greater transfer efficiency and yield improvement over non-coated stencils, regardless of aperture size and area ratio. The transfer efficiency between NanoWork® stencils and non-coated laser-cut stencils is demonstrated in the QFP (400 µm) example in picture 4. In this example, 16 printing cycles were executed without bottom side cleaning of the PCB and, afterward, the transferred solder paste volume was measured. The diagram shows that the NanoWork® stencil transfers between 100 % and 110 % of the solder volume during the whole printing cycle. A non-coated laser-cut stainless steel stencil, in contrast, shows a clear increase in transfer efficiency of between 120 % and 130 %. The dangerously- high transfer efficiency with the non-coated stencil is caused by permanent contamination of solder paste on the bottom side of the stencil. The flux and solder balls, over time, begin to migrate to the underside of the stencil. The accumulating paste on the underside of the stencil causes a »gasket« effect which, by creating a gap between the stencil and the board, compromises the perfect seal between the stencil and substrate. The ultimate result: over-printing of the paste which leads to solder bridging and compromised yields. The NanoWork® stencil from LaserJob minimizes the risk of solder bridging by promoting more efficient paste and flux release from the stencil to the PCB (see picture 5).

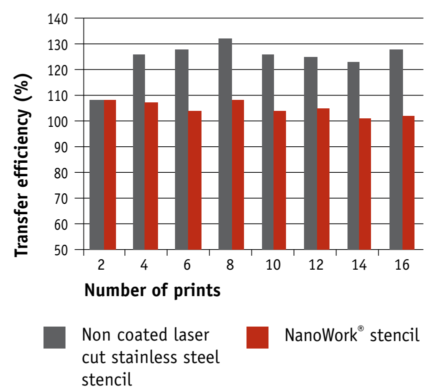
Picture 6 graphically illustrates the printing performance of solder paste, on both non-coated and NanoWork® laser-cut stainless steel stencils, over multiple cycles without cleaning. The NanoWork® stencil from LaserJob provides constant solder paste deposit heights between 100 µm and 110 µm during 16 print cycles without stencil cleaning. The non-coated laser-cut stainless steel stencil possesses dramatically higher paste deposit heights between 120 µm and 130 µm. The cause, again, is the progressive increase in contamination on the bottom-side of the stencil.

The NanoWork® coating process

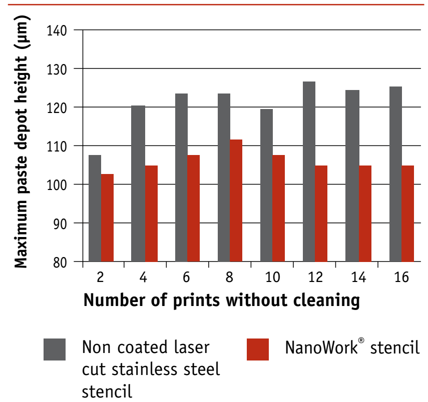
LaserJob's proprietary NanoWork® coating is derived from a Sol-Gel process. This chemistry combines organic and inorganic molecules to a »hybrid« molecule suspended in a solvent. Specific chemicals are then added to start a hydrolytic reaction. A controlled temperature process evaporates the solvents and the Sol-Gel begins to initiate a multistep polymerization. During this reaction, a chemical is added to provide the anti-adhesion properties. The reaction layer (the resultant coating) provides an extremely high chemical and mechanical resistance.



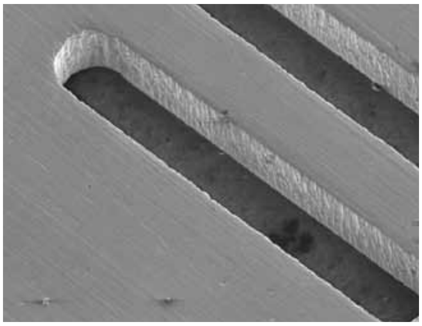
Picture 3: Solder paste release behavior of BGA structures after 5 prints without cleaning



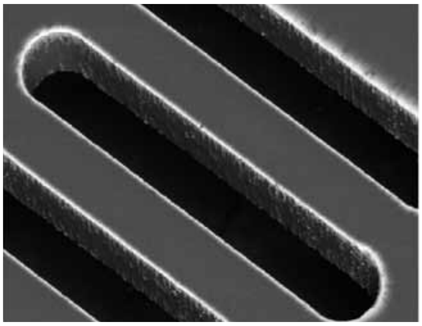
Picture 4: Transfer efficiency of a QFP structure (400 µm)



Picture 6: Analysis of the maximum solder paste depot height



Picture 7: Laser cut stainless steel stencil



Picture 8: Laser cut stainless steel stencil with NanoWork® coating

Quality control

Quality assurance is paramount at LaserJob. Effective quality control starts with incoming inspection of stainless steel sheets and stencil frames. A thickness measurement instrument controls every stainless steel sheet with an accuracy of $\pm 0.5\,\mu m$. From each screen printing frame the screen tension is measured. Directly after the laser cutting process aperture size and aperture geometry are measured.
An OKM measurement system, which inspects the position of the apertures in an area of 400 mm x 200 mm with a precision of $0.5\,\mu m + L/400$ the position of the apertures. The contour of apertures is controlled with an accuracy of $0.5\,\mu m$ utilizing with a CCD camera with back light. ScanCheckI+ compares the new stencil with the origin data in order to validate the congruency.

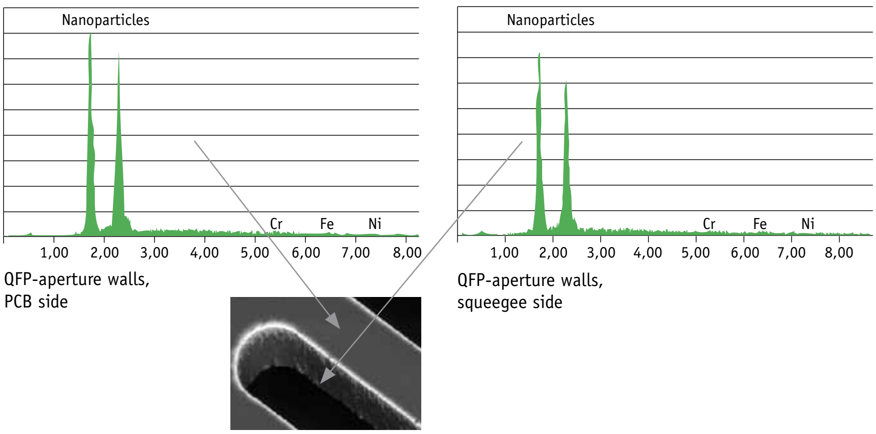
Quality verification of the NanoWork® coating

In order to scientifically prove the uniformity of the NanoWork® coating on both the underside of the stencil as well as in each aperture, SEM pictures (scanning electron microscopy) were produced. Pictures 7 and 8 show SEM images of uncoated and coated apertures on a stainless steel stencil. EDX (energy disperse x-ray) images were also taken and the data logged to further prove the uniform distribution of the NanoWork® coating throughout the entirety of the aperture (see picture 9).

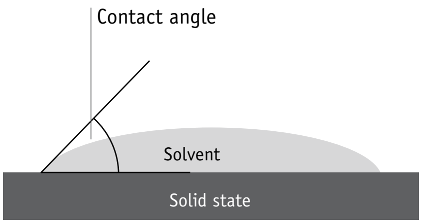
Quality control for validating the anti-adhesion coating for every stencil

A NanoWork® coated stencil's anti-adhesion properties will exhibit a different surface tension than an uncoated stencil. The contact angle of a specific liquid used for measurements allows for a measurable and repeatable process in helping to determine whether-or-not the surface is attracting or repelling the liquid.

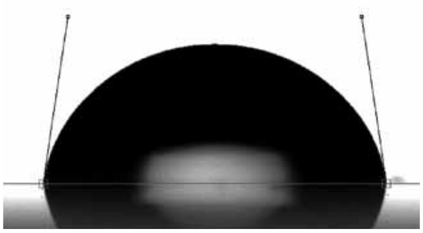
A large contact angle indicates perfect anti-adhesion properties and a small contact angle stands for good wetting (see pictures 10 and 11). Contact angle measurements are tested and documented from each NanoWork® stencil produced, assuring that every NanoWork® stencil produced by LaserJob exhibits anti-adhesion (hydrophobic) properties (see picture 12).



Picture 9: EDX scans of an aperture wall coated with NanoWork®



Picture 10: Definition of the contact angle



Picture 11: Example of a high contact angle

Picture 12: Computer-controlled contact angle measure equipment

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Fulfillment

The stainless steel material, which is utilized for the stencils, has an optimal hardness and tensile strength. Only stainless steel sheets with a nominal thickness variance are utilized.

Material

Stainless steel: 1.4301
Hardness (Hv): min 370
Tensile strength (N/mm²): > 1100
Thickness of stainless steel sheet: ± 3%

Dimensions of stainless steel materials

SMD stencils are available in metal sheet thicknesses of (µm):
20, 30, 50, 70, 80, 90, 100, 120, 130, 140, 150, 180, 200, 250, 300, 400
SMD stencils in VectorGuard® tensioning systems are available in metal sheet thicknesses of (µm):
80, 100, 120, 130, 150, 180, 200, 250
Maximum thickness of metal sheets: 2 mm
Maximum machine surface: 800 mm x 600 mm

Variances

- NanoWork®-stencil
- PatchWork®-stencil (Step stencil)
- 3D PatchWork®-stencil
- combination PatchWork®-stencil with NanoWork®-coating
- stencil in screen printing frame glued over stainless steel mesh
- in tensioning system LJ 745
- in Quattroflex tensioning system
- in VectorGuard® tensioning system
- in Alpha Tetra/Micromount/Vector tensioning system
- in Zelflex tensioning system
- in Stencilman tensioning system
- in customer-specific tensioning system

Frames

- aluminum frames
- cast aluminum frames
- stainless steel frames

For more information on the sizes and types of available frames, please refer to data sheet 1.4 Frames and Tensioning systems

The stainless steel screen cloth, composed of 0.1 mm diameter wire woven into an 80 mesh array, is strong, durable, heat-resistant and resilient. Optional screen filler can be applied after tensioning in order to avoid contamination of the screen cloth and printer.

Service

LaserJob offers a full range of consulting services for layout and design. Our team generates, from your CAD-CAM data, automatic cutting instructions for the laser. Our highly focused laser systems cut with high positioning accuracy the apertures.

We offer additional

- scaling apertures up and down
- changing aperture design, e.g. home plates and rounding sharp corners
- optimizing apertures (anti tombstone design)
- rotating or mirroring of the whole design or sub-areas
- control of aspect and area ratios
- generation of stencils with multiple panels
- generating layouts from existing PCBs
- generating stencil layouts for adhesive applications
- customer-specific storage for used frames. The frames will be cleaned, re-strung and provided for new orders. Your actual inventory is always retrievable.
- data storage
- test certificates (as well as customer's specifications)
- data for solder paste inspection systems
- Data Matrix Code
- measuring of printed circuit boards
- production of stencils from provided PCBs, stencils, or films

Shipping conditions

Shipping time

Standard shipment time ex works is 4 work days
Order entry before 5 p.m. (= first work day)

48 hour express shipment –
Confirmed orders will be shipped the second day
Order entry before 5 p.m.

24 hour express shipment –
Confirmed orders will be shipped the next day
Order entry before 5 p.m.

Common carrier: UPS, DHL, GO, FedEX (any shipping service) as well as direct shipments with courier delivery with partner companies.

Packaging

All LaserJob stencils are shipped in reusable packaging. To avoid damage of stencils, proven packaging materials are used. We deliver stencils in specialty packaging as well as per customer request.
For stencils in tensioning systems, a special storage bag is recommended.

Order process

For complete processing, we need the drawing of the component with tolerances. We can read drawings in DXF-format or Gerber files.
To guarantee fast handling of your order, send the purchase order via

- e-Mail: **mail@laserjob.ca**
- post

Please send the gerber files for the stencils via e-mail to: **mail@laserjob.ca**

LaserJob data sheets

Auch in Deutsch erhältlich.

As of 03/2013