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Cleaning as a necessary production step Faster, more efficient, qualitatively superior!

The cleanliness especially of complex high grade components in the electronics production is a decisive factor for a high quality end result with minimal failure rates. Thus, the cleaning is increasingly becoming a necessary and thus a fully valid production step. A recent example: In a newly established process for cost-effective DCB production, developed by Siemens company in Amberg, Germany, cleaning technology is a key success factor.

Article

The technology department at Siemens in Amberg developed in a partnership-cooperation with the manufacturer kolb Cleaning Technology a world first in the field of DCB power module cleaning, which works highly efficient with high throughput. This process has been implemented in a kolb PSB600 V85 4-slot custom system from the Willich, Germany, based company, specifically developed on the current requirements of Siemens and as a successor to the existing cleaning machine. The system cleans on the same footprint four times the amount spending only one quarter of the previous operating costs. For Siemens this new development seems to be a decisive milestone on the road away from costly inline concepts.

The new kolb system proves again that today rational and flexible DCB Module cleaning is technically and economically feasible in space saving batch systems and thus contributes to Germany being a competitive production location.

The department DF CP MF GWA of Siemens in Amberg develops and manufactures fully electronic solid-state switching devices - both relays, and semiconductor contactors - including the latest switch generation of Sirius SC series. These components are extremely variable concerning the connection technology, its highly compact design, saves space and the possible stacked mounting of the elements allows safe operation to an ambient temperature of 60 ° Celsius! The heart of these high-performance elements are assembled DCB (Direct Copper Bonding) substrates.

To develop a process-reliable, cost-effective concept for the complex technology requirements for the cleaning of these modules, including the matching of the high environmental standards of Siemens was the object of the questions for the project leaders.

A completely new development

Since such cleaning process are a closely guarded secret of the respective module manufacturers, the project team could in fact learn from the experience with the previous system, but on the other hand, had to take in account the technical progress of the past eight years. Which meant in other words: start from scratch as all researched and to date used processes were no longer economically or technically appropriate for the earlier mentioned requirements.



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Picture: Project management: from left: Karl-Heinz Schaller, Thomas Schulz, in the foreground the PSB 600-V85 with open lock window loaded with four washing frames

For this reason, Siemens project manager Karl-Heinz Schaller grabbed back on an experienced specialist team, proven in cleaning in electronics manufacturing in general and with correspondingly high skills and already long-term experience in the DCB cleaning, and which had developed in a similar composition the predecessor system: kolb Cleaning Technology: Georg Pollmann, Markus Smolenaers (Systems engineering and processes), Christian Smits (Construction management), Christian Linker (Cleaning chemistry), Siemens: Karl-Heinz Schaller (Project leader), Thomas Schulz (Project analysis). This team went to work in July 2013.

Development dynamics by competition

The individual tasks were always distributed at least two independent partners of the team. This should lead to a cross-check and assurance of possible implementation concerning time and costs in controllable project feasibility stages. The side effect: The work was thus not less, and also not necessarily more transparent, but innovation discovery by healthy competition gained an amazing and extremely fertile momentum.

The project team completed basic research and the associated reliability tests systematically and meticulously. Over a period of about 1.5 years - from the intentional task to final reliability tests - all conceivable possible process influences were excluded or analyzed e.g. in over 1000 hours of climate chamber tests as well as in various other test methods. The tolerance limits of materials, plant capacity and the special cleaning chemicals were determined procedurally or adapted to the tasks repeatedly. Completely new insights were won and new limits partly defined completely new. The results today define the basis for the reliable process window and the documentation of processes; because with the high volumes to be produced, the production process must be safely controlled to avoid losses. Only in this way a stable quality with large quantities and reasonable costs is possible and the quality assurance of each process step comprehensible.

Target: A new benchmark in module cleaning

Accordingly the definition of objectives for the cleaning system was made: the new system technology, the cleaning chemicals, and thus the overall process should be environmentally sound, technically ahead, cost saving and as compact as possible - in short: The new benchmark in the field of module cleaning.

The focus was first and foremost the high quality requirement the cleaning goods are rated after. Furthermore it must be processed very efficiently and effectively. Accordingly, the system works with a process window that is calculable and verifiable not only at the elementary level, but also in threshold range - on the one hand, of course, for optimum results but also to control and improve the process in any given situation. Nothing is impossible - the project team took the never before achieved targets sporty.

Already with the first alternative solutions it became clear that they were perhaps feasible, albeit with the risk to achieve only partial success or setbacks - especially within the predetermined time window. The result however was bull's eye. Finally a very intensive development ended in a future-oriented, highly efficient cleaning method for DCB modules.

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For project manager Karl-Heinz Schaller this successful development is more than just a new and promising process: "With such innovations we work in a pioneering kind on maintaining a competitive edge and deliver a further contribution to active environmental protection."

Picture: kolb PSB600V85-DCB custom batch system with one of four possible washing frames

Picture: Cleaned DCB-modules in a composite panel

Picture: 3D- construction of kolb PSB600 V85

Less process stages, more automation

The cleaning of the DCB modules happens after soldering and prior to wire bonding. Researching systems and processes made clear that conventional methods and the corresponding equipment technology need more process steps due to the cleaning chemicals used, compared to the now newly developed process scheme. With the appropriate machine technology, intelligent software management and the kolb TernarySequence detergent MultiEx 3D-A3 reduced the process stages and therefore the cleaning time to a not yet achieved minimum.

Process reference values

Product to be cleaned:

DCB substrates on composite panels, ceramics as basic material, copper electro plating, soldered chips per single circuit. Critical material is especially the copper and aluminum surface, on which the wire-bonding happens, after the cleaning process.

Contamination:

- Rosin from XY used soldering support materials
- Oxides on the metal surfaces of aluminum and CU

Reliability check:

- Evaluation of cleaning results
- Climate room storage
- Shear forces
- Detection of activators such as flux
- Detection of ionic contaminations
- Climate room storage 100 hours
- Climate room storage 1000 hours
- Functional test
- ESCA, REM, IR Spectroscopy, for example, the monitoring of residues from cleaners
- Dual test (analytical method for monitoring the process window of the cleaning fluid)

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Process cycle:

- Cleaning – three dimensional sequence
 - a) Removal of rosin
 - b) Deoxidizing the metal surfaces
 - c) Passivation by converting the metal grid structure
- Rinsing (in numerous stages and qualities)
- Drying (multidimensional controlled special process)

Cleaning medium:

Detergent: kolb MultiEx 3D-A3, with patented TernarySequence technology, managing all dimensions of the cleaning process in a single, aqueous alkaline solution

Environmentally friendly supply and disposal:

- Rinsing water is produced by reverse osmosis
- Wastewater is processed to be fed into the local wastewater net
- The processes are threshold monitored

Picture: Siemens semiconductor contactors - Sirius SC series