Reducing the environmental impact in the PCB / IC-Substrate industry

AT&S experts ***Gernot Schulz*** and ***Christof Wernbacher*** together with Evatec's ***Roland Rettenmeier*** explain how the CO_2 footprint of PCB manufacturing can be reduced by reducing raw materials and wet processes, optimizing product build ups and introducing dry processes.

AT&S – Playing its part

The Electronics industry as well as the PCB industry are undergoing a massive change in manufacturing. Governments, OEMs and customers all require a reduction of the CO_2 footprint and a resource-efficient use of raw materials, support materials, energy and water throughout the entire value/supply chain. The "Green Deal" is the European Union's response to this major global challenge for the future. Manufacturing companies are among the key players in the environmentally friendly economic development of tomorrow and are called upon to contribute to solving these challenges with their ideas and innovations. Various measures are available for this purpose: Switching to renewable energy, climate-friendly mobility, resource-conserving value chains, material innovations and intelligent product developments that are designed entirely for recycling.

Product Carbon Footprint – Wet chemical processes are the main contributor

The production process of printed circuit boards generally consisting of mainly wet chemical processes such as etching, galvanic or cleaning. Figure 1 gives an overview on how different production processes from classic PCB production contribute to the overall Product Carbon Footprint of PCB (PCF). Therefore, a sample product consisting of a 10-layer PCB with PTH and Laser Drills manufactured in AT&S production facility in HTB was chosen for this study. Several Energy and Chemical consumptions along the production chain were measured and broken down on product level. The contribution of the different process steps is highly dependent on PCB design such as number of layer, complexity and advanced technologies used. In general a significant amount of emissions are related to the energy and chemical intensive galvanic and etching process steps. Both are standard processes within the PCB production landscape and form the basis of a subtractive manufacturing approach. Since sustainability is in addition to costs and technology becoming a further focus point, additive manufacturing approaches which do not rely on wet chemical processes are becoming of greater interest.

One important part and door opener into additive manufacturing is the sputtering / PVD process. On one hand it improves PCB manufacturing from a technology point of view, on the other hand it allows us to reduce the amount of subtractive production processes.

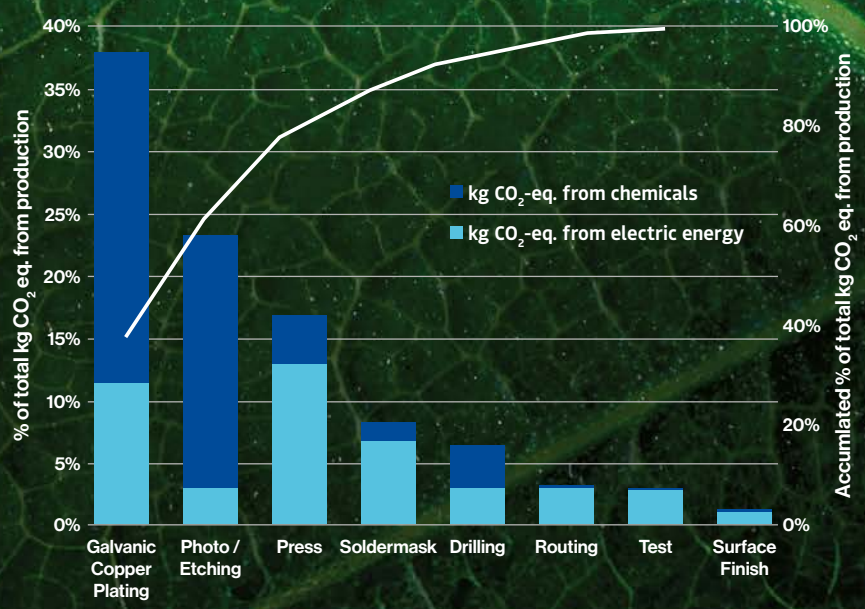


Figure 1: Carbon Footprint of different production processes

Novel technologies as a key to more sustainable products

To further substantiate this correlation, a study was initiated which allowed direct comparison of the environmental footprint between a PCB produced with Sputtering/PVD processes on Evatec's CLUSTERLINE® 600 versus a PCB produced with standard technology. This study was done as part of AT&S' initiative to better understand the environmental impact of different technology platforms and process groups. Therefore, the boundaries of the study were set around processes dedicated to a specific technology. The focus of the study was so called embedding technology, which allows the embedding of ICs as well as active and passive components directly into the PCB which gives numerous advantages especially from a technological point of view. Different technology levels are available with Center Core Embedding (CCE) being the current standard technology. The more sophisticated technology which is currently under development uses a Sputtering/PVD process.

For the comparison the main process steps of both technologies were quantified regarding their consumption of energy, chemicals, process gas and water. The environmental impact of the different input streams was assessed with a combination of primary data from material and energy supplier as well as data from ecoinvent database.

Figure 2 shows the comparison of the Carbon footprint between both technologies. The new generation embedding technology shows a significant reduction, mainly due to a reduction of energy and chemical consumption. This reduction can be achieved because of the more efficient product design becoming feasible with new technology. The process gas which is only used in the new generation embedding technology does not have a serious impact on the overall result.

As an additional benefit, which is not considered in the assessment, the new generation embedding technology also increases the utilization of the panel according to the die to package ratio, which basically indicates how densly the Integrated Circuits (IC) can be placed onto the Package. Considering this improvement, the advantage of the new technology is even more significant.

In addition to embedding technology, Sputtering/PVD processing has the potential to increase the opportunities in PCB design not only in terms of technological aspects, but also in terms of more sustainable design. Different Life Cycle Assessments of PCBs have shown that reducing layer counts as well as reducing the size of a single PCB for better utilization of the production panel leads in most cases to a significant improvement of the Product Carbon footprint.

Improvement beyond carbon footprint

The focus of the industry and branch in Europe is definitely on reduction of the carbon footprint due to the several large initiatives such as the EU Green Deal or the Paris Agreement which are focusing on Greenhouse gas reduction. But to gain a holistic picture of environmental impact it is also necessary to take a look on further influences (for example environmental impact categories according to CML-2016). For all these categories beyond the carbon footprint AT&S plans to extend these assessments to create a more complete picture. But especially for PVD/Sputtering process and the opportunities coming with this technology an even larger improvement is expected than for the carbon footprint, since the reduction of wet chemical processes and therefore chemistry usage is highly connected to other benefits e.g. reduction human toxic substances, acidification potential or nutrification potential. Due to the fact that Sputtering/PVD is also considered as one key technology for miniaturization of electronic components such as PCB or IC Substrates, it can also make its contribution to reducing the global e-waste problem. With miniaturization approaches the relative amount of e-waste can be reduced by simply reducing the volume and mass of the electronic components. Overall more dry process steps in PCB production will lead to less impact on the environment from the industry sector.

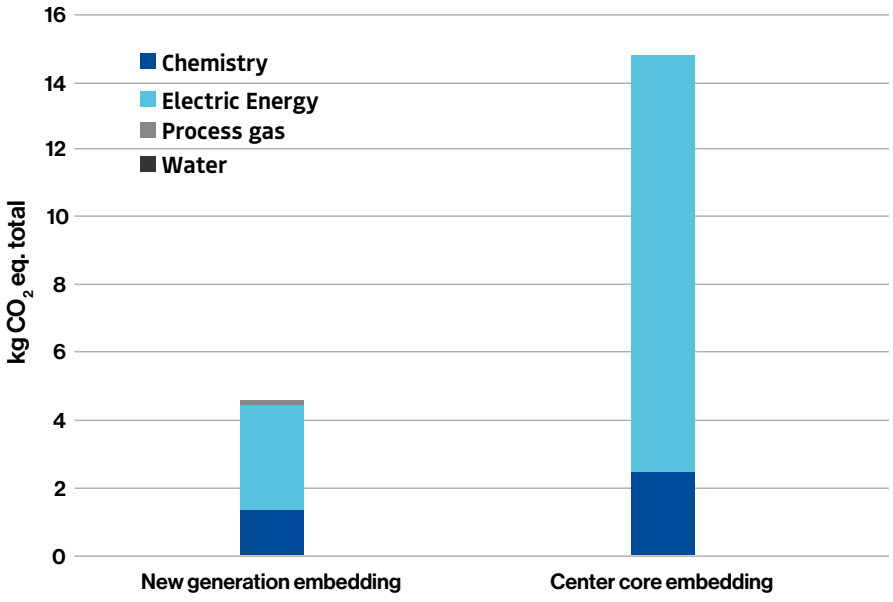
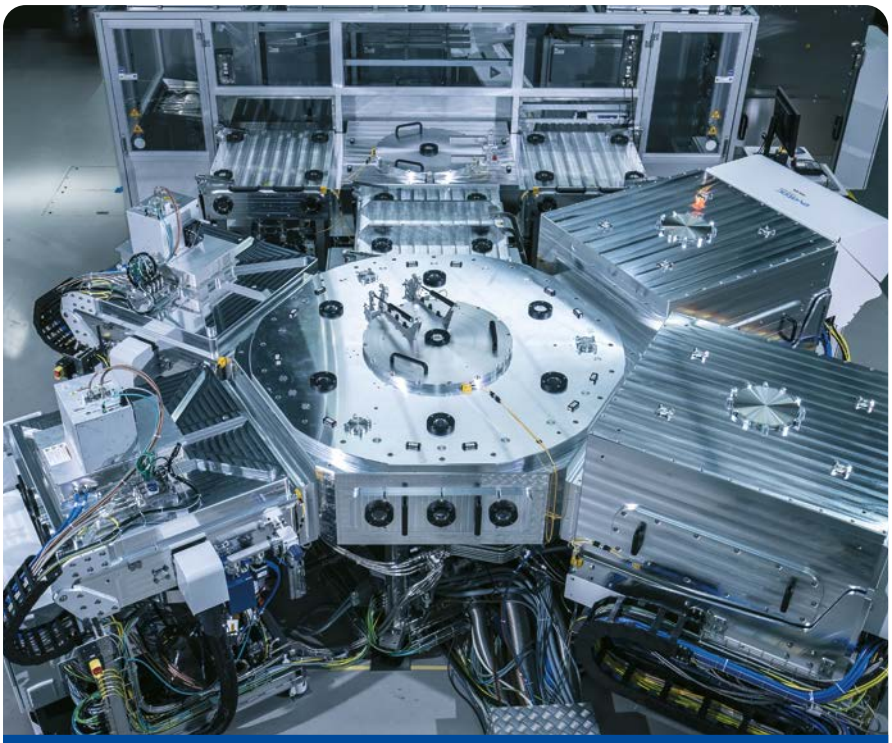


Figure 2: Carbon Footprint of new generation embedding technology compared to standard embedding technology

Heading in the right direction

The PCB industry has been trying to find novel technologies and processes to reduce the amount of wet chemical subtractive processes within the manufacturing landscape since many years. The internal and external pressure to reduce the environmental footprint of PCB production is now bringing an additional argument to go in this direction. Sputtering/PVD process technology now seems to be the most promising approach. Direct comparison with conventional technology shows a significant improvement from both sides – ecologically and technologically. Currently the technology is used for special use high end cases, but when it finds its way to more commodity use cases also high volume applications can profit from the environmental impact reducing processes.



CLUSTERLINE® 600

To read about Evatec's CLUSTERLINE® 600 sputter platform and some of the most recent technological developments go to page 40 or visit **evatecnet.com/products/clusterline-family/clusterline-600**

A view of AT&S*

Technology and digitalization are having an ever-growing impact on our lives and are increasingly shaping our daily routines at home and at work. The advances achieved in these fields in recent years are truly breathtaking and have created crucial momentum for growth in every sector of the economy. As a global technology enterprise, AT&S is actively involved in these developments and plays a decisive role in shaping the digital world of tomorrow. This also represents an enormous responsibility, which AT&S has always accepted and fulfilled through its forward-looking vision, pioneering investments in research and development, and responsible use of resources. The high-end PCBs and IC substrates AT&S supplies influence future industry standards, products and applications in a number of key industries.

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