Resource Efficiency in Electronics Manufacturing

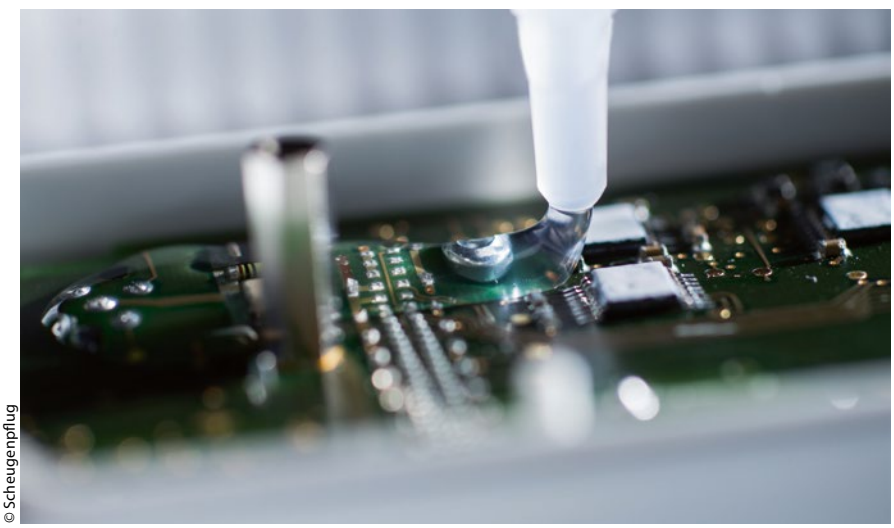
Saving resources in electronics manufacturing is not an end in itself. It is closely linked with reducing costs and gaining a competitive advantage. However, innovative adhesion and potting technologies in combination with highly functional adhesives and potting media make a significant contribution to the ideal union between economic performance and a reduced ecological footprint.

Karin Steinmetzer, Sebastian Piller, Sebastian Schmitt

The main driving forces behind this development are the high costs of energy and raw materials and the legal and social demands for the economic activity to be based on the principles of sustainability. These are expressed in legal requirements, such as the EU's REACH regulations governing the use of chemicals or the Battery Directive, which guarantees the sustainable manufacture of safe batteries. We've all heard the saying "If it ain't broke, don't fix it". It's a sentiment that still prevails in many areas of production, but it gets us nowhere. Sustainable economic activity calls for fresh trails through less familiar but more promising terrain. Many aspects of the adhesion and potting process have an impact on the efficient use of energy, raw materials, adhesives, sealants and, last but not least, available space.

Guiding principles

As part of the Atlas Copco Group, Scheugenpflug itself is in the middle of this transformation with regard to reducing CO_2 and increasing energy and material efficiency, and is committed to actively supporting its customers' CO_2 targets. The guiding principles here involve saving energy, raw materials and space as well as reducing waste. If these requirements are to be met it is crucial to optimize workpiece design, increase plant availability and safeguard process reliability. In addition to optimizing the dispensing and potting processes themselves, prevention of waste is an important factor. The safety, reliability and longevity of electronic components depend to a large extent on potting quality.



© Scheugenpflug

Figure 1 > Only electronic equipment that is well protected will be safe and durable.

Long-term protection of sensitive electronic components

Each electronic component places special demands on suitably adapted dispensing solutions, and this is especially the case in the automotive sector where different dispensing tasks have to be completed, often several at a time, for such components as displays, sensors, power electronics and chargers. Only electronic components that are perfectly encapsulated, in other words fully protected against environmental influences, will have long service lives and will therefore save on resources. Electronic equipment installed in a vehicle is exposed to a variety of influences, such as high temperatures, humidity, vibrations and abrasive media. Sensitive electron-

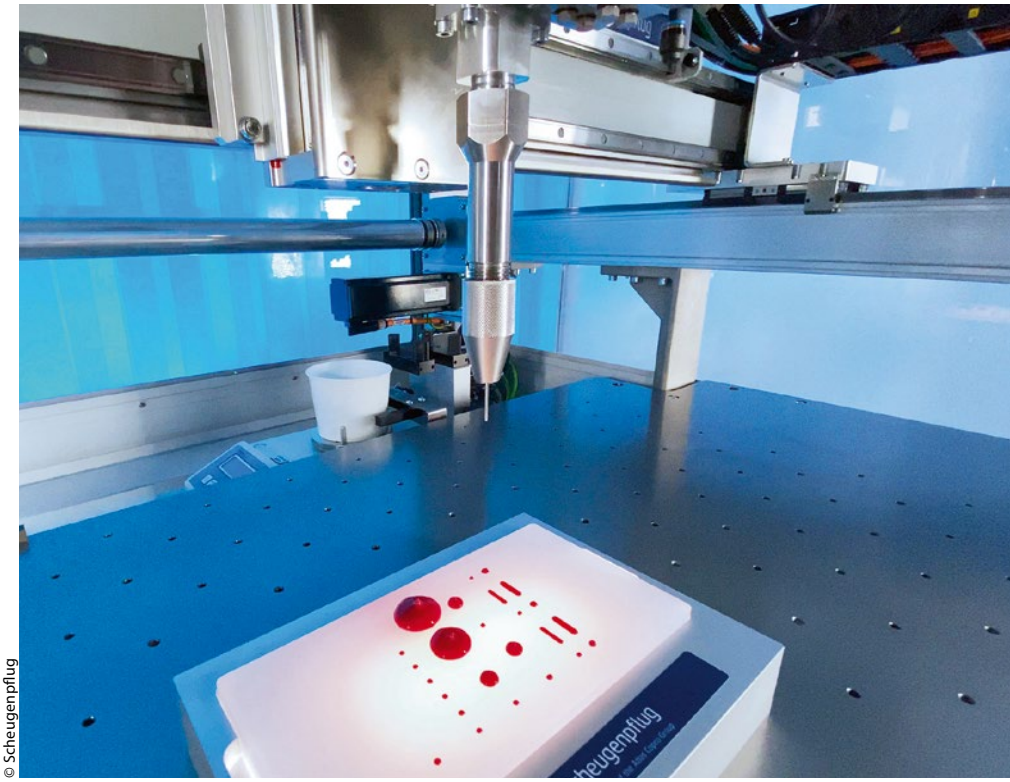
ic components must be protected against chemical and mechanical factors. If the sealing and potting media are precisely matched to the particular application (*Figure 1*) they will provide reliable protection for the electronics installed in enclosures. Adhesive bonds, protection against environmental influences and effective heat dissipation are essential for ensuring functionality throughout the entire product life cycle, especially in safety-relevant areas, such as ADAS (Autonomous Drive Assistance System). Maximum precision in combination with reliable quality assurance in dispensing, positioning and material preparation is absolutely vital.

Component design as the starting point

It all starts with component design. The megatrend of electrification is a driving force for economic growth and goes hand in hand with the miniaturization of electronic components in the automotive, industrial, medical and consumer sectors. The crucial challenge is to ensure that they are precisely bonded, sealed or potted. A perfect match between the component and the dispensing process means that the process can be completed more quickly, thereby reducing cycle times. In combination with precise dispensing and advanced residual quantity management, this saves on valuable material, expensive reworking and ultimately replacement of entire plants. Overall, it therefore reduces the footprint. In recent years in particular, adhesive bonding has become increasingly established as an application area of dispensing technology because it has numerous advantages, such as weight savings and simplified handling, over conventional joining techniques such as welding or screwing. What's more, peak mechanical stresses can be completely avoided with force applied uniformly over the entire surface. This has a positive effect on the life of the joints.

Right on the dot

The miniaturization of electronic components means that tiny quantities of potting compound or adhesive have to be applied to areas of extremely small dimensions. This requirement is met by Scheugenpflug with its DosPL DPL2001 piston dispenser for dispensing ever smaller



© Scheugenpflug

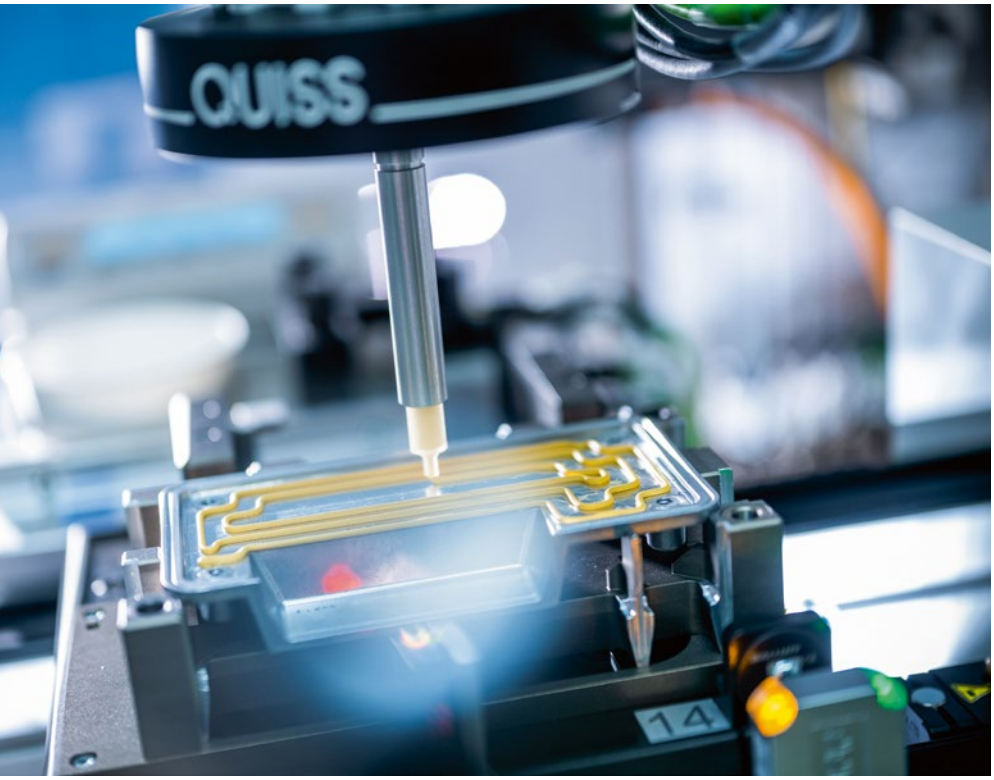
Figure 2 > The DosPL DPL2001 low-volume dispenser can position both small and large dots with high precision.

quantities and volumes (*Figure 2*). Dots smaller than a pin head can be applied quickly, reliably and with maximum repeatability. Single-component materials can be applied in quantities as small as 3 µl. Quantities of two-component media can be as small as 6 µl. High dispensing accuracy and fast cycle times are made possible by a new zero-displacement valve system which is also robust enough to be used for abrasive materials. This dispensing unit has a relatively large working range of more than 2 ml so it can handle complex dispensing tasks involving different volumes in a single operation. For many modern applications the number of machines required can therefore be reduced to just one system. It also opens up new options, such as adapting the mixing ratios to product-specific properties, leading to greater flexibility and thus an extended range of applications. In close consultation with adhesive manufacturers, it is thus possible to influence, among other things, the mechanical end properties and curing behavior of the material. This single dispensing system does the job of several conventional dispensing units and represents a safe long-term investment as it can be adapted to any subsequent changes to processes.

The mixing process itself has an environmental benefit. 2C material has to be mixed and the dynamic processes that perform this mixing often use environmentally critical cleaning solutions. The mixture of material components and cleaning agent is hazardous waste and requires appropriate disposal. Static mixing is different altogether. In this case, the two components are combined and homogeneously mixed in a plastic tube that contains several mixing coils, each at an angle of 90° to the preceding one. The two components are perfectly mixed together thanks to the screw-shaped baffles arranged one behind the other. The material remaining in the mixing tube is usually easier to handle after curing and is non-critical so disposal is also straightforward.

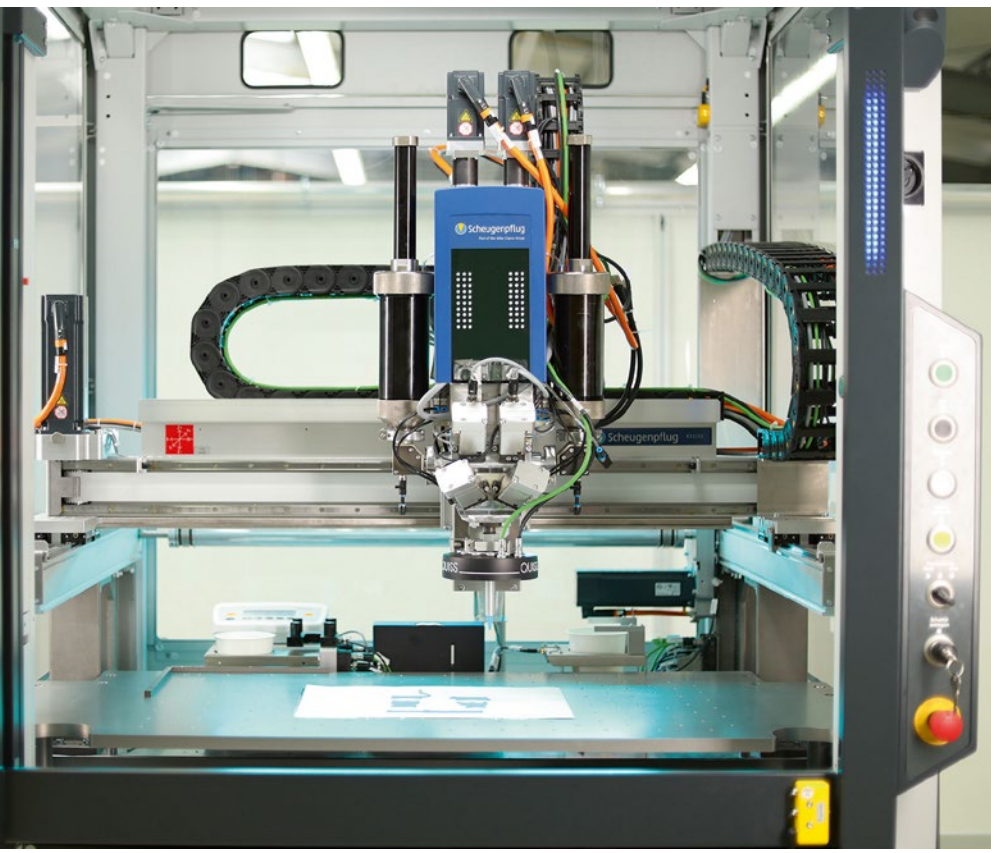
Quality control that saves space and material

Savings on material can be made by integrating the RTVision.t and RTVision.3d industrial image processing systems which are primarily designed for quality control. Practical experience shows that



© Scheugenpflug

Figure 3 > In addition to their main task of providing traceable documentation for quality levels, the vision systems prevent material waste.



© Scheugenpflug

Figure 4 > The high-performance DosP DP2001 dispenser operates up to ten times faster than conventional systems.

the application of adhesive and sealant is not always successful for every component the first time. The primary function of the RTVision.t and RTVision.3d image processing systems is therefore to ensure optimum product quality that is both demonstrable and traceable. The systems integrated in the dispensing cell detect interruptions in the dispensing process as well as deviations in width, height and position. In-process testing provides an immediate overview of the quality of the application, even at high application speeds of 600 mm/s and more. Any NOK workpieces can be rejected right away. In contrast to testing exclusively with a seal tester, faults are detected inline immediately before any further value-added steps take place. This means that no further resources flow into the product. In addition to its main task of providing traceable documentation for process quality, the integrated vision system avoids unnecessary waste (*Figure 3*) – without any additional cycle time or a separate cell.

One step ahead

A significant increase in dispensing speed creates even more savings in series production – at least one cell fewer and possibly an entire line fewer in the best-case scenario. But how are speed and resource savings related? Demands for ever shorter cycle times are based essentially on economic reasons. That may sound contradictory but is easily explained. An up to tenfold increase in speed with the new high-performance dispenser from Scheugenpflug can save on an entire production line (*Figure 4*). The performance of this latest development exceeds that of comparable solutions on the market, even with highly viscous materials. The DosP DP2001 dispenses 1C materials from 0,06 to 20 ml and 2C materials from 0,1 to 40 ml. The high dispensing rates are achieved thanks to high-power servo drives and high dispensing pressures. With its extremely short switching times the new valve system is capable of handling the highest pressures and significantly reducing process downtimes. The robust construction of the dispensing head is optimized for filled and abrasive materials. It therefore has an exceptionally long service life, and maintenance downtime is kept to a minimum, thereby increasing profitability per square meter of production area.

High performance with multiple potting

If, for example in automotive series production, top performance is required in terms of quantity and cycle time, multiple piston metering systems are used. They are therefore highly resource-efficient as filling and positioning times are distributed among a large number of components. Multi-piston dispensing systems comprise several functionally interconnected single dispenser units, each of which has its own inlet/outlet valves and its own monitoring sensors. The single dispenser units share a common servo motor which saves on acquisition costs and also reduces power consumption. The systems achieve excellent dispensing accuracy and long service life irrespective of the number of single dispenser units.

These multi-nozzle dispensing units, originally developed in combination with a vacuum chamber to save on the then-customary long downtimes, can pot several workpieces (including small ones) per unit of time. They enable dispensing for up to 24 workpieces simultaneously, not only under vacuum but also in atmospheric pressure. Multiple potting is quick, efficient, saves on downtime and ensures optimum use of materials.

Economical material management

To safeguard the functional properties of the adhesive and potting materials it is important that they possess and maintain the desired homogeneity, are optimally tempered and protected against moisture ingress. The necessary agitators, heaters and vacuum pumps are automatically shut down during downtimes in the liquiprep material processing system, for example, to prevent unnecessary stress on the material and to save energy. Full utilization of the material (with no residual material) is also important. Solutions for almost complete emptying as well as monitoring solutions for continually optimizing consumption save on valuable resources. The key here is to have dispensing, feeding and preparation processes from a single source. A good example of a trusted performer and still a state-of-the-art solution is the A90 CV cartridge expulsion unit which reduces material waste per cartridge and workpiece by 90 % and not only ensures safe and trouble-free material feed to the dispensing unit but also enables automated ventilation when cartridges are replaced thanks to its vacuum docking function (*Figure 5*). This ensures absolutely bubble-free docking of the material cartridge to the dispensing system. Previously, the freshly mounted cartridge was

© Scheugenpflug

Figure 5 > Up to 90 % reduction in material waste each time a cartridge is changed thanks to the innovative docking sleeve

© Scheugenpflug

Figure 6 > Chemical and analytical expertise is required to ensure optimum material utilization.

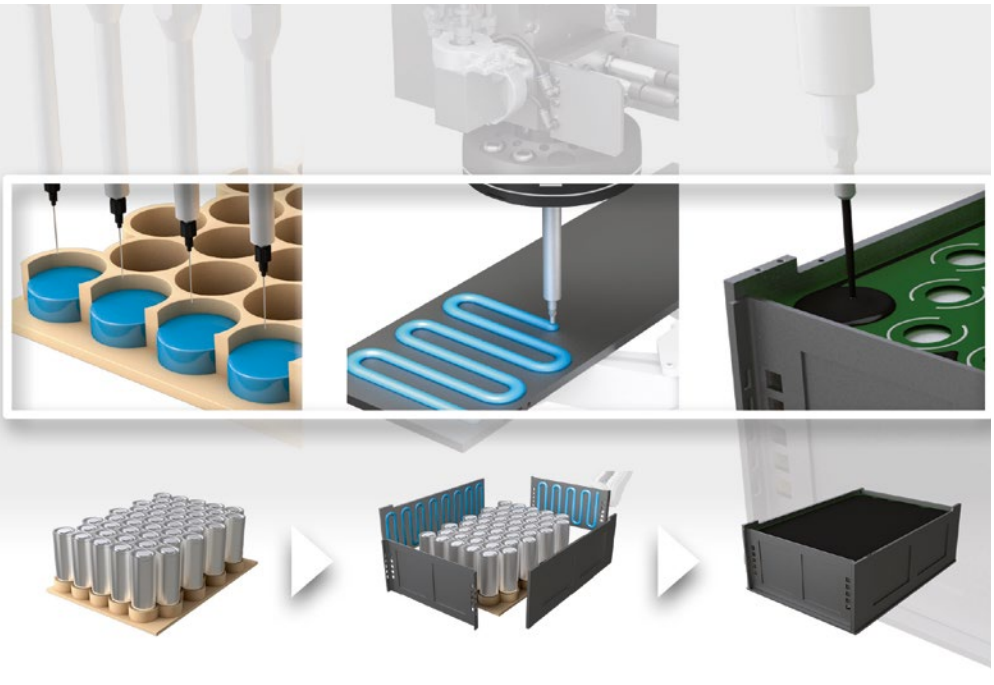


Figure 7 > Complex dispensing and potting applications for e-mobility battery production.

ventilated manually. The resulting material loss therefore depended on the experience and routine of the operator. With vacuum docking, this process is automated, fault-free and simple because of the innovative docking sleeve and filter insert. There is also the benefit of significant cost savings, especially considering the fact that the potting materials used are often very expensive. The operator is guided by software, which rules out the previous sources of error when changing cartridges.

Understanding and developing processes

In addition to maximum efficiency in the use of materials, material know-how is gaining in importance in the context of adhesive processes. Scheugenpflug has been actively investing in the development of in-house chemical and analytical expertise for more than 10 years to support process users and ensure optimum use of materials. It is important to test the interaction between the material and the workpiece at an early stage with regard, for example, to adhesion properties in order to save on resources throughout the entire process. Thermal management in particular is becoming increasingly important because temperature affects material properties and therefore also the process and the product quality. In the interests of sustainability, energy consumption should be as low as possible and product quality should be safeguarded through early testing. Resource efficiency is therefore a question not only of the plants and systems used but also of the parameters of the production process. In-depth chemical and analytical competence and close cooperation with material manufacturers form the basis for solution-oriented customer support (*Figure 6*). Experience shows that significant savings in terms of costs and time can be achieved through project integration and collaboration from a very early stage.

Application example: E-mobility

Market demand for a bonding and potting process that saves on resources and is economical at the same time is particularly strong right now in the electromobility sector. The requirements on xEV batteries in terms of range, weight and cost are high. Depending on the battery concept, a wide variety of applications and tasks have to be fulfilled in series production in order to meet ambitious market demands in the face of international competition. For example, battery cells need to be bonded, modules and sensors have to be thermally coupled, and side walls have to be sealed or structurally bonded. The materials used here have very different compositions and flow properties. As a result, different application technologies and procedures are employed.

For the production of battery modules with cylindrical cells in particular, complex dispensing tasks are required for honeycomb structures (*Figure 7*). Among other things, numerous dots and lines of a two-component, thermally conductive adhesive (TCA) are applied in a very short cycle time to make the mechanical and thermal connection. Since the demand here is for an efficient solution for highly precise dispensing of small volumes the Multi-Nozzle Dispenser described above can be used as it allows not only 1C and 2C materials but also liquid and paste-like materials to be applied in a very short time. Customers benefit from lower investment in plant and machinery, a smaller footprint and a high degree of flexibility.

Conclusions

To meet the economic challenges and comply with legal requirements, companies need to invest in solutions that reduce their environmental footprint. This will further boost the megatrend of electrification. At the same time, however, there is the need to optimize the use of raw materials across all industries. As a supplier of adhesive and potting technologies for electronics, Scheugenpflug is actively involved in this transformation. The company is not only committed to sustainability in the design of its products, but is also working together with innovative material manufacturers on economic solutions that will enable users to save both energy and material by increasing resource efficiency. //

The Authors

Dr. Karin Steinmetzer
– corresponding author –
(karin.steinmetzer@scheugenpflug-dispensing.com)
Sebastian Piller
Sebastian Schmitt
Scheugenpflug GmbH, Neustadt (Germany)