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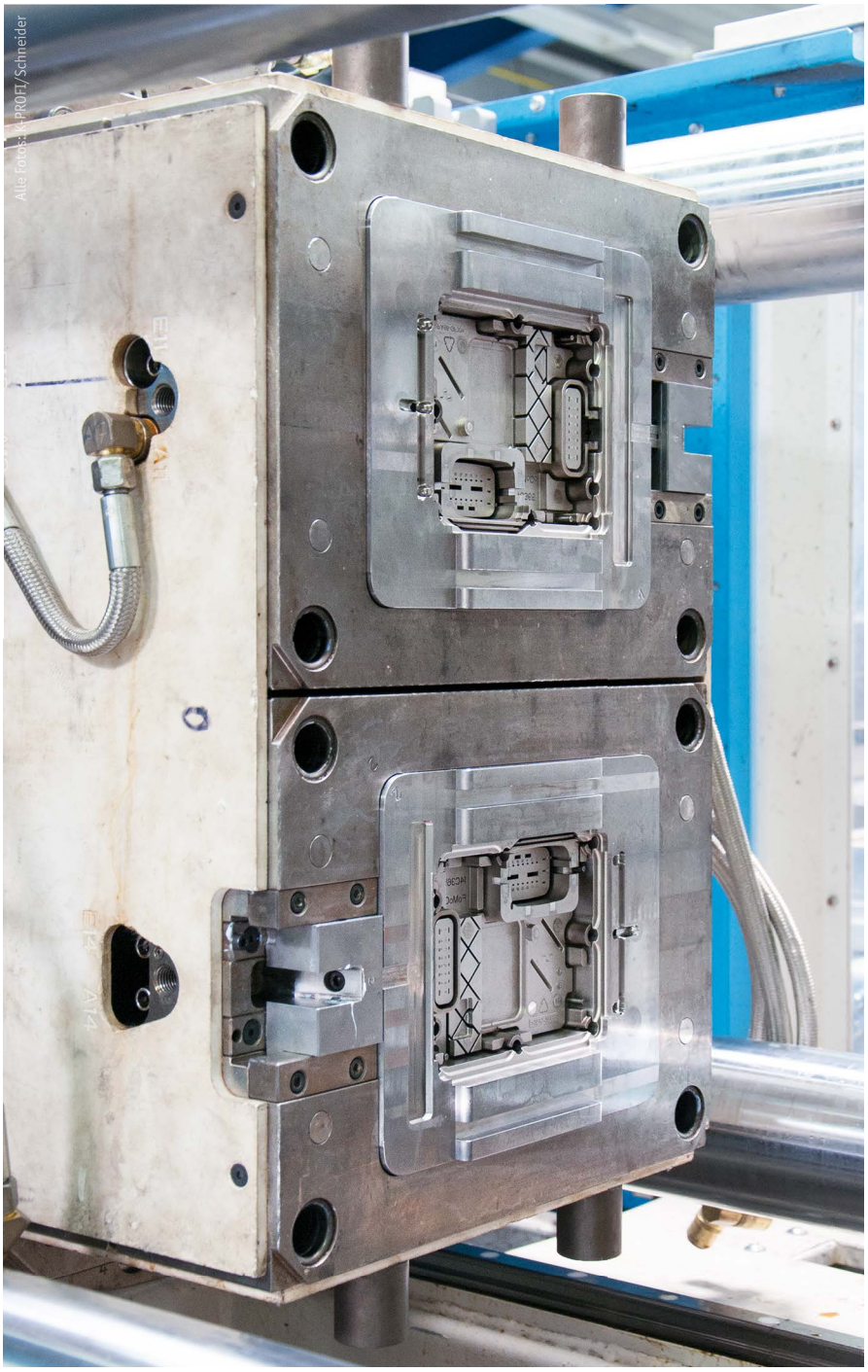


Rudi Göbel GmbH & Co. KG, Helmbrechts, embodies its slogan "We join materials" with exceptional variety. Its service portfolio includes insert molding of electronics parts and real glass insert molding, as well as complex parts with metal inserts and the coating of plastic parts with aluminum or nickel-plated copper parts. In addition to multi-component parts made from thermoplastics, the Upper Franconian company has also been manufacturing thermoplastic-silicone composites for several years. And here too the specialists faced complex challenges from the very beginning.

Text: Dipl.-Chem. Toralf Gabler, Editor of K-PROFI

Although Rudi Göbel started metal processing exactly 60 years ago, as a supplier for the TV equipment manufacturer Metz and Loewe, among others, it also operated an injection molding machine at the time. When the plastics expert Franz Pichler took over the running of the company in 1986 following the death of the company founder, this business area was continuously expanded, without neglecting metal processing however. Today the company – now led by the next generation with Frank Pichler at the helm – offers its renowned clients from power electronics, car manufacturing, as well as industrial technology, a complete service for many different materials.

European market leader for copper platens

"With us the customer receives everything from a single source", proudly states Manager Reinhard Schneider. "We develop manufacturing processes for drawing parts, punch metals and inject plastic parts with metal inserts, build corresponding molds, process components from

both materials using diverse technologies and install complete assemblies." And like that Rudi Göbel made a name for itself not only as a plastics processor, but it is also a European market leader for copper base platens for power electronics. Chips are later soldered onto the punched and galvanically nickel-plated platens. Absolute evenness is required for this. "The deflections of the copper base platens have a tolerance of maximum 20 to 30 µm", highlights Schneider. And this is with a mass-produced product of many millions of items per year. These platens from Helmbrechts can be found in almost all areas of power electronics, including in wind turbines.

70 of the 400 local employees are employed in tool making, which has all necessary technologies in-house. The injection molding, punching and progressive tools that are developed here are intended almost exclusively for in-house production. Manifolds are also built for a large hot runner manufacturer.

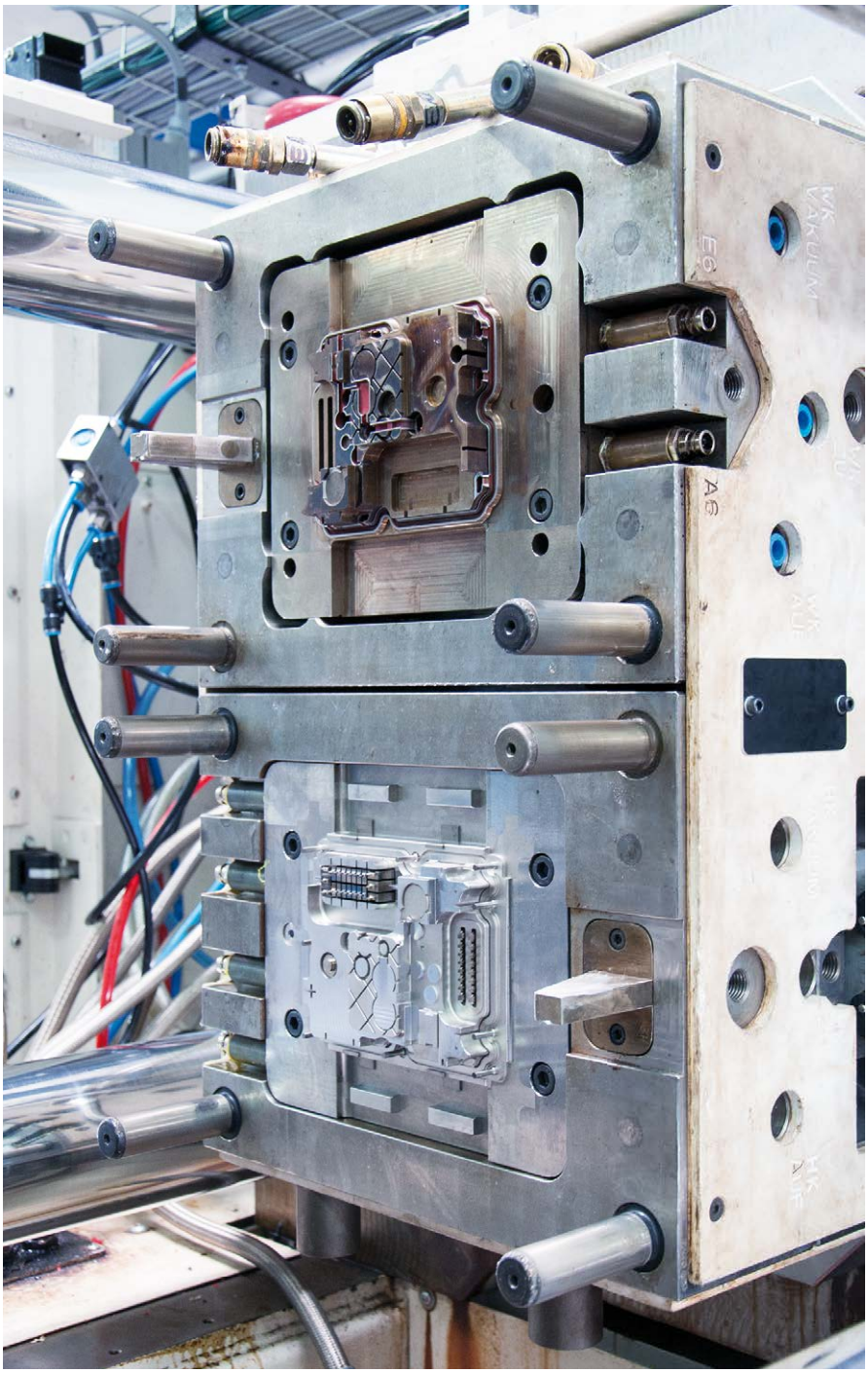
400 cores adapted empirically

Tricky challenges are also solved with the existing tool making know-how. Schneider shows a PBT housing as an example that is used in control cabinets or manifolds in the power grid. "The one hundred identical shafts in the components are all designed slightly differently to offset the distortion in the mold", explains the manager. 400 cores have to be empirically adapted for the 4-cavity mold used. "Simulation does not help for such fine details, only experience", highlights Schneider. And the shafts have to be individually adapted for each identical mold. "The mold can be scanned", he explains, "but I can never recreate a scan with hundreds of thousands of areas exactly."

On request the company also gets involved in the entire component development, for which there are cooperative ventures in place with two engineering firms. The meticulous work on promising concepts and new methods has long been part of day-to-day business at Rudi Göbel. For instance, in 1991 the Upper Franconian company revolutionized the shielding of electronic equipment. Whereas up to this point costly and heavy metal cages protected their electromagnetic compatibility (EMC), plastic parts could now be vaporized with aluminum in the thick layer process for this purpose. The technology for this was further developed at Rudi Göbel and made ready for series production. Four high vacuum evaporation systems are available today in Helmbrechts for this purpose.

Entry to LSR processing

As there was always problems with the quality of the purchased printing pads when processing plastic parts with pad printing, in 2006 Rudi Göbel entered into silicone processing and started manufacturing its own pads. Today these pads are no longer only produced for in-house requirements, but are also sold under the PSD brand through several dealers and its own online shop.



Rotary table molds are used for the 2-component injection molding of the P/LSR series – a 1+1-cavity version here.

Göbel Manager and Authorized Representative Reinhard Schneider: "It was a long learning process until everything ran smoothly."

In accordance with the company slogan, 2C processing of silicone and plastic was added to the manufacture of pure silicone parts five years ago. Today in the external factory in nearby Münchberg complex thermoplastics with metal inserts and LSR seals are built for the automotive industry in highly automated processes.

From 1C to 2C technology

"The impetus came in 2010 from a customer who manufactures control boards for BMW headlights", remembers Reinhard Schneider. The mounting of the control boards made from glassfiber-reinforced PA 6 should have a silicone seal made from several lips. "As we have already been working successfully with KraussMaffei since 2004 in the area of thermoplastic-thermoplastic composites", adds Purchasing Manager Peter Baumann, "we also made contact with Munich for the new topic." It was also the first project in this area for the machine builder. "After the initial discussions we agreed to take on the challenge, and a mutual learning process began."

Problems with adhesion

The production was initially tested on two 1C machines. In Helmbrechts sample parts of hard components were injected. The engineers from Rudi Göbel traveled to Munich with these parts and in the KraussMaffei TechCenter sprayed a seal made from an adhesion-modified LSR. Cordula Wieland, who is responsible for Product & Technology Management at KraussMaffei, explains: "This method was very common at the time for demonstrable reasons. If a processor has an existing silicone machine, he understandably wants to inject the LSR components using this machine. However, this is often critical from a technical point of view due to different temperatures and the difficult adhesion build-up."

Like in this case. "The adhesion step was so problematic that we were happy if we had one good part after eight hours", adds the manager. "We were always the first ones there in the morning and the last to leave the TechCenter in the evening – we were well acquainted with the local security team", he adds grinning. On top of all the difficulties there was also time pressure from the customer, who even brought forward the product. An alternative solution had to be found.

2-component process with rotary table leads to a breakthrough

This was reflected in the 2-component process on one machine. "Here one can use the high temperature of the thermoplastic, which has a positive effect on the adhesion and the LSR cross-linking, and the risk for contamination is only minimal", is how Wieland explains the benefits. "Today this is standard – either with conversion in a machine or with a space-saving rotary table."

As the specialists at Rudi Göbel already had experience with the conversion technology in hard-hard injection molding and wanted to steer clear of the associated distortion problems, in the end it was decided to use rotary table technology. "The rotary table is often the better solution", Cordula Wieland is convinced. As the part remains in the cavity, the shrinkage is lower, the exact part positioning during the conversion is omitted, a simpler gripper design is possible and the cycle times are also shorter. "But", states the KraussMaffei expert, "many processors do not trust rotary table molds, because technically they are much more complex than the conversion. And with the combination of thermoplastic and silicone the thermal separation is also complicated."

Heat and cold as a challenge

While the thermoplastic cavity is cooled to around 120 to 140 °C, the mold temperature during injection of the LSR component is over 200 °C. "In order to specifically control the heat balance, considerable know-how in the rotary table design is required", states Purchasing Manager Baumann. This is where KraussMaffei played a significant role. Wieland explains: "A big challenge with the rotary table is the media routing. Media distributors must pass through the rotary table with cold and hot media beside each other. This requires very high sealing layers. There is also the massive thermal stress from the opposite expansion of the different temperature ranges. This was also a challenging task."

Significant reduction of LSR cross-linking time

Despite all the benefits of the 2-component process on one machine, with the material combination of thermoplastic and LSR there is the disadvantage of the extremely different cycle times for the two components, as the silicone must cross-link. In order to achieve an efficient

Göbel Purchasing Manager Peter Baumann: "We managed to significantly reduce the LSR cross-linking time."

Cordula Wieland from KraussMaffei: "Many processors do not trust rotary table molds."

process, the two cycle times have to be adapted to each other. "According to the specification from the manufacturer Wacker, the minimum cross-linking time of the LSR used by us Elastosil with a hardness of 50 Shore A for the wall thicknesses of our products is 120 to 180 seconds", explains Baumann. With special mold designs and technologies, however, the parts can be manufactured with a cycle time of 50 to 60 seconds. "To be on the safe side, we had the products examined by Wacker and received the confirmation that the cross-linking is optimal", proudly states the Purchasing Manager.

But Manager Schneider is not revealing the details of the secret of success. In his words the special heat-balancing and also mold technology serve as a basis for this. In contrast to many other silicone processors, heat-balancing is effected here with a liquid medium instead of electrically. In order to fully utilize this potential, the molds are equipped with near-surface heat-balancing. This way the heat can be introduced to the material faster and more selectively. The tool maker works together with a partner who in some instances also builds the corresponding mold structures using additive technologies.

BMW places huge trust in Rudi Göbel

"It was a long process until everything ran smoothly", sums up Schneider. "The hard component is not a problem, but to

This board holder made from PA/LSR was the starting point for the hard-soft injection molding at Rudi Göbel.

establish the adhesion of the silicone and the specified intricate sealing geometry error-free, we had to try out many things and learn the hard way." Furthermore, the adhesion is also affected by material fluctuations of the polyamide. Unfortunately, this could not be determined in advance through the incoming inspections of material parameters. "Either it holds or it doesn't", adds Schneider. Many can be offset by changing the process parameters. "We have to play around a little with each new batch. We now have vast experience in which tiny screws one has to turn", adds Baumann.

Annual quantities of 720,000 are expected of the transmission control housing which is produced in six variants.

After the experience in Rudi Göbel, no batch fluctuations occur with LSR. Having said that, minimal deviations in the dye metering could lead to significant changes in the viscosity. "There are no problems here however with the timed metering we use by Elmet. It is very stable", highlights Schneider.

The result of the complex development satisfied all sides in the end to the extent that contrary to its usual two-supplier strategy BMW allowed only Rudi Göbel to build the series molds and remain the sole manufacturer of the part.

10,000 parts a day in peak times

Parts were produced in a 2+2 cavity mold. A hydraulic CXZ 160-750/55 with 1600 kN clamping force from KraussMaffei was used as a series production machine. The LSR injection unit sits above the main thermoplastic injection unit in a space-saving piggyback configuration. Particular demands are placed on the insulation and heat-balancing so that the hot polyamide is conveyed at the bottom and the cold LSR at the top. Only this can ensure that no premature cross-linking occurs. "Those who have already cleaned a silicone dispenser know why this is so important", grins the manager.

"The start of the series production in 2011/2012 was difficult", admits Schneider. Only around 400 good parts could be manufactured per shift. "But since 2013 it has been running perfectly", states the manager happily. In peak times three similar machines produced around 10,000 parts a day, occasionally in four shifts on seven days, this equates to several million parts a year. The product is now being discontinued and only reduced requirements are currently needed.

Hydraulic multi-component injection molding machines from KraussMaffei with two injection units in piggyback configuration are used for the hard-soft injection molding.

The experience gained in the course of the development and production encourages the Helmbrecht specialists to venture on even more complex processes.

Now it is even more complex

A housing for the transmission control in all-terrain vehicles is currently being produced for an automotive manufacturer made from PA 66 with 30% fiberglass and LSR with a hardness of 50 Shore A. The complex part is also equipped with two metal inserts and a membrane.

The demanding geometry of the silicone component with intricate seals and thick domes posed challenges for the mold manufacture. "The specified component-related location of the injection point is not optimal" explains, "from a procedural point of view another location would have been better." A lot of things had to be tried so that the meeting point is not effected at a delicate point.

A machine now produces around 1,200 parts per shift – fully automatically in a clever process which was developed together with the automation technology of KraussMaffei.

Clever fully automatic process

Equipment which was already tried-and-tested for the 2-component part is used with a similar injection molding machine from KraussMaffei, as well as a 2+2 rotary table mold. After the mold is opened, the rotary table turns the two finished parts down. A multi-gripper removes them and then inserts two metal bushes each in the two lower cavities for the next shot. The mold closes, thermoplastic is injected into the lower cavities, sprayed onto the hard component in the upper LSR.

The linear robot uses the injection and cross-linking time to set down the two removed parts and equip them with membranes, which are then welded one after the other and automatically checked for tightness with positive pressure and underpressure. Meanwhile the robot grabs the bushes from the manually equipped magazines for the next shot and then places the inspected parts on a conveyor. The cycle is fully exhausted with the complex and clever sequence of handling steps, adds Schneider.

This housing for the transmission control made from PA/LSR with metal inserts and welded membrane is manufactured in a fully automated process.

PBT housing for power electronics: The identical shafts in the mold are all different to offset material distortion.

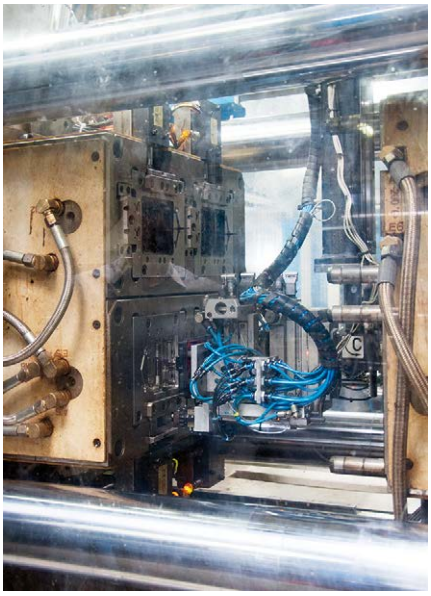
Handling process further refined

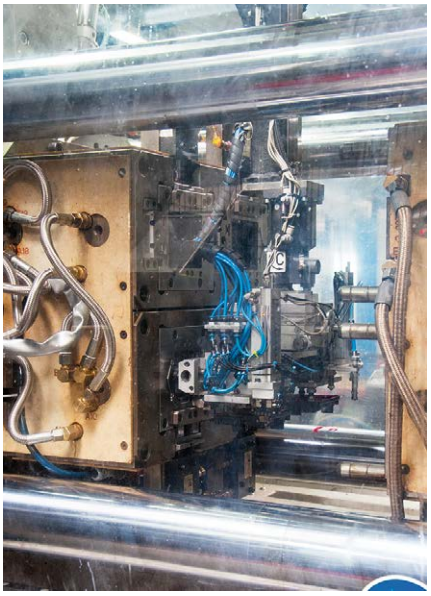
The handling process was further refined for the subsequent machines. For the second machine, which is already in operation, the magazines for the metal bushes are now no longer manually equipped, but this is done automatically. In the latest machine, which is currently being introduced, the handling robot does not position the membranes on the components. This is done directly via the membrane dispenser, which leads to an even higher precision fit.

Up to 720,000 parts are to be manufactured per year in peak times. This is why since Septe mber a four-shift system has been in operation in Münchberg. The six 2-component machines which are currently producing parts here are supplied with thermoplastic granules via a central material feed. Further consideration was also given to a central LSR feed. "But this was too critical for us", adds the manager. "If something began to vulcanize, this affects all machines", he points out. It is for this reason each injection molding machine is equipped with a separate metering station from Elmet.

2-component process also for power electronics

The specialists at Rudi Göbel now want to introduce the know-how gained in the hard-soft injection molding to other production areas. "In addition to electric mobility, we also see a future market for this in the area of power electronics in particular", Schneider is convinced. Several housings with seals would be required here. Up to now these are generally manufactured separately and then assembled manually. Automatic assembly is often not possible.





Top to button:

After the rotation of the mold the PA components are located in the two upper cavities. The robot removes the 2-component parts from the lower cavities.

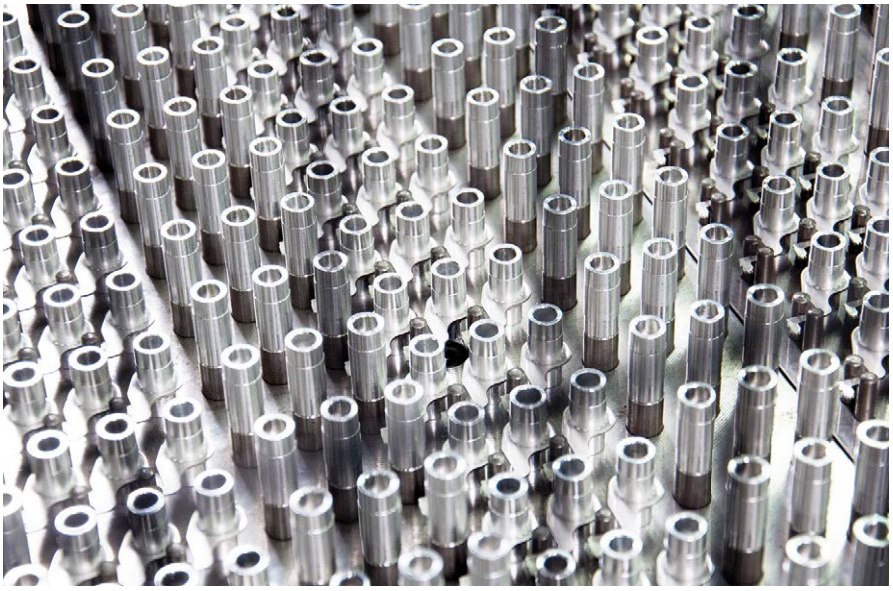
Directly after the demolding the robot swivels the parts down and equips the mold with the metal inserts for the next shot.

The robot sets down the parts removed from the mold and equips them with a membrane which is then welded and checked for tightness.

After the leak test the robot positions the finished parts on a conveyor belt.

As the slightest deviations in the dye metering can lead to significant changes in the viscosity for the LSR, the timed metering from Elmet ensures precision here.

While the magazines for the metal inserts (l.) are manually equipped for the first machine, the feed is automatically effected for the second machine (r.).



Successful teamwork (f.l.): Florian Eilhardt, Sales & Marketing, KraussMaffei, Reinhard Schneider, Manager, Rudi Göbel, and Cordula Wieland, Product & Technology Management, KraussMaffei.

"Besides the additional assembly, this also means: There is no adhesion and thus always a chance of leaks", states Schneider pointing out another disadvantage. The 2-component process also offers the benefit of introducing additional functions such as a buffer and spacer. Schneider sees silicone as the preferred material here for the sealing component: "Power electronics is open to silicone and interested in innovations." Silicone is also robust enough to meet the high service life expectation of the products. The TPEs which are easier to process are not an alternative due to the creep tendency. Moreover, the mold technology has developed to such an extent that even very complex parts can be manufactured from LSR today. And with the self-adhesive LSR types 2-component parts can be produced economically.

"But", notes Schneider, "the power electronics market is slightly slower than the automotive industry." One senses that many companies are currently addressing this topic. "We are often sitting down with the customers. Such topics come up and together we develop ideas." There are already initial requests for test series of existing products in 2-component technology. If this is successful, then things could happen very quickly. As there are many standardized modules in this segment, which are used for various purposes, one can also be fast even with high quantities. For instance, housings with up to 500,000 items per month are currently being produced.

Prepared for the breakthrough

The specialists at Rudi Göbel want to be prepared accordingly. "In power electronics generally PPS or PBT is used instead of PA", explains Schneider. "Internally we have already tested the adhesion of diverse materials for LSR and were unable to identify any problems."

In addition, the capacities of silicone processing are to be expanded significantly. "External production in Münchberg was a good solution for the start", states Schneider. "But we didn't anticipate that the business area would grow so quickly As the hall is full with the six machines, next year there will be a new building at the headquarters in Helmbrechts with around 1,500 m² where 2-component processing with silicone will relocate. There will also be a new logistics center with over 2,000 pallet bays as well as fully automated transport from production to the warehouse.

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