The process tape: principle of operation, and details
With its process tape, the innovative DeltaSpot process opens up some new and interesting perspectives. The principle is based on a process tape running between the electrode and the base metal, in the same rhythm as the spot-welding operations. Unlike fixed electrodes which always present the same contact surfaces, in this case the aluminum alloys to the process tape, which is then wound on a few mm after each spot-weld. In other words, the 'used' length of process tape is moved out of the contact zone every time. This means that for every weld-spot, exactly the same conditions obtain as for the previous one and the next one.

The process tapes perform several very different functions. First, they prevent any direct contact between the electrode and the workpiece, protecting the electrodes from soiling or other influences emanating from the surface of the workpiece. This stabilizes the weld process and greatly prolongs the electrode service life. Secondly, they improve the contact situation: for every single spot, the process tape creates a new electrode contact surface to the workpiece. This prevents surface spatter and widens the process window.
Compared to a conventional sequence of 20 to 30 spot-welded joints (of not very satisfactory quality), DeltaSpot achieves around 10,000 top-quality spots with just one process tape. This corresponds to a 70 m long tape and a 7 mm interval between weld-spots. When the tape is used up, it is simply replaced by a new one for the next series.

Influence on the heat balance in the join
A third and very significant advantage of the process tape is the scope that it gives for directly and selectively influencing the heat balance in the workpiece. This is because the existing contact resistances and material resistances are now augmented by the material- and contact resistance of the process tape. When the current is switched on, this resistance generates additional heat which 'shields' the join against electrode cooling, thereby increasing heat-generation in the join. This acts as additional heat input into the base metal from the outside.
The result is more heat in the workpiece at the same time as lower electrical input power. By using process tapes made of different materials and with different coatings, the user can modify and 'fine tune' the overall balance and distribution of heat in the workpiece.

The process tape can be used as a flexible tool for creating optimum conditions in each case, e.g. for joining materials of different compositions and thicknesses, or multi-sheet joints. The extra resistances bring with them a further advantage: by focusing the added heat input onto the point being joined, they reduce the shunt effect. Because of this, unwanted current transfer at other positions on the workpieces hardly ever occurs. This is especially relevant for light-gauge sheets.

The standard electrode has a convex shape. Thanks to the slightly elastic process tapes, this results in an optimally shaped circular contact area. However, a concave electrode with a ring-shaped contact area can also bring a number of alternative advantages, leading to higher current density on the 'ring' compared to a flat electrode and resulting in higher process reliability. Another benefit of this 'Expo electrode' is that the surfaces of aluminum sheets are barely marked by any 'stamping' indentations at the weld-spots.

Unlike in the conventional process, in which the weld-pool almost only ever takes a nugget shape, DeltaSpot will also create a cylindrical weld shape if the boundary conditions allow. This is mainly due to the insulation against electrode cooling, and to the extra thermal input.

Examples from practice
Some noted European and Asian automobile and engineering firms have tested DeltaSpot

welding systems and decided to introduce them for series production. One example is the Georg Fischer company from Austria, which is spot-welding the aluminum die-cast doors for the new Porsche Panamera. Here, a 1.5 mm thick stiffening plate has to be spot-welded onto the 2 mm thick aluminum die-cast door-frame.

On Hyundai's new luxury models Equus and Genesis, subcontractors Sungwoo Hightech are using DeltaSpot to manufacture the engine bonnet (hood) from aluminum. The critical criteria for Hyundai were the high quality, process reliability and enhanced corrosion resistance which it made possible, and its cost advantage over punch riveting.

A pilot application in the field of railed-vehicle construction is underway with the Oslo Metro, which now has a 5-year 'track' record with DeltaSpot-welded electronics control cubicles on its trains. DeltaSpot welds around 120 spots, of diam. 7 mm, on each set of four control-cubicle doors. These spot-welds join two 2 mm thick AlMg3 sheets. The contract from the manufacturer of the trains, Siemens, is being fulfilled by the Austrian system partner Gebr. Bach with great success in terms of both quality, cost-effectiveness and technical proficiency. The flawless technical quality of this work is confirmed by the testers from TÜV Bavaria SZA, who have inspected the intersheet joints in accordance with the relevant railway standards.

DeltaSpot has also established itself in the general mechanical engineering and apparatus construction sectors. The Irish company C&F Tooling manufactures aluminum and steel housings for truckborne refrigerating sets. Steel and aluminum housings have to be welded alternately, with identical electrode and process-tape configurations. One steel and one aluminum housing are then installed for each refrigerating set.

Rittal, a leading German manufacturer of control-cubicle systems, insists on uncompromisingly cost-efficient high-tech production. Following intensive testing and trials, the company integrated a DeltaSpot installation into its series production operations early in 2011. The machine welds hinges and guidepieces to the doors of aluminum control cubicles.

Important technical details and data on these applications will be found in the table below!

Conclusion and outlook

DeltaSpot means that a technically and economically attractive spot-welding process is now available for aluminum. Compared to conventional resistance spot welding, the differentiated process parameters open up new possibilities with regard to different materials, workpiece thicknesses and multisheet joints. From the point of view of lightweight construction, the system's ability to reliably join aluminum sheets, and aluminum to steel sheets, makes it highly relevant. Its greatest advantage is that it minimizes the costs for consumables.