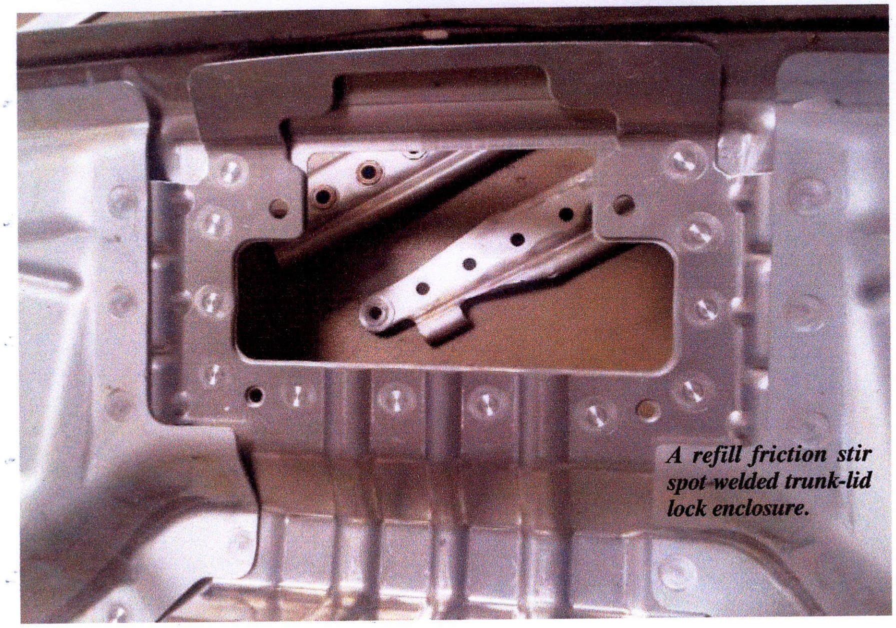

A refill friction stir spot-welded trunk-lid lock enclosure.

What's New for Welding Aluminum in the Auto Industry

Because of their flexibility and weld quality, friction stir spot welding and refill friction stir spot welding are expected to find increased use for building automobiles

BY NIGEL SCOTCHMER AND KEVIN CHAN

The new corporate average fuel economy (CAFE) standards, passed by the U.S. Congress in July 2011, require most automobiles to achieve an "averaged" 54.5 miles per gallon (mpg) by 2025. Indeed, even by 2017, the mandated fuel economy average will rise to 35.5 mpg, a significant increase from the current 27.5 mpg, where it has been pegged at the same level for the last 11 years (Ref. 1). While these targets are subject to the fine print and the vagaries of politics, automotive companies are looking at new ways to reduce the weight of their vehicles.

Resistance Spot Welding of Aluminum Alloys

Future vehicles will employ a wider range of materials to reach a lighter weight; therefore, advanced joining technologies will be required. One avenue has been to incorporate more aluminum alloy sheet into body-in-white construction. In North America, car companies have generally employed resistance spot welding (RSW) to join aluminum sheet, because it is a reasonably inexpensive joining process. In Europe, companies such as Jaguar have used self-piercing rivets, and Audi and Daimler Benz have used a variety of other processes in addition to RSW, including adhesive bonding (alone or combined with other joining techniques), bolts, laser brazing, clinching, and arc welding. The cost of these alternative processes is often high and they all possess some challenges. Not the least obstacle has been the considerable investment in spot welding equipment and knowledge in automotive plants worldwide, which has led to inertia in the adoption of new technologies.

In North America, RSW has had a checkered history as the process of choice for joining automotive sheet. Since aluminum is highly conductive, it is not easy to resistance weld. Resistance spot welding employs the materials' electrical resistance to generate heat to join the sheets, and since electricity flows easily through aluminum, it is hard to weld. In addition, the thick, hard oxide coating on aluminum proves troublesome to break through in resistance welding. Worse, the thickness of the aluminum oxide varies with the age of the alloy, increasing the care with which it must be resistance welded. These factors contribute to a short electrode life and a worryingly unpredictability in production weld quality. In addition, some aluminum alloys, such as the 7000 series — a strong, desirable family of alloys — cannot be effectively resistance welded because of their poor ductility. A number of initiatives have been introduced to deal with these issues, such as using coated electrodes in production plants throughout North America (Ref. 2), frequent electrode dressing and "polishing" (Ref. 3), and even pastes and liquids (Ref. 4).

Challenges for Joining Dissimilar Materials

The need for increased weight reductions in the future suggests that dissimilar materials will need to be joined, which will increase the problems regarding use of RSW. Some are suggesting that the increased use of magnesium is a requirement for large-scale weight reductions. The increased use of magnesium alloys and the inevitability of joining single components (whether in sheet, cast, or extrusion forms) to the subsystem level of the vehicle will also add technical complexity. This is because the different materials being joined may have various surface conditions, chemical compositions, microstructures, and physical properties.

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