Joining Aluminum with Focus on Adhesive Bonding

The techniques used to join aluminum are summarized below (Barnes & Pashby, 2000):

* Welding, including resistance spot-welding, arc welding, laser welding, friction stir welding
* Brazing
* Mechanical fasteners
* Adhesive bonding

Adhesive bonding is more common in high-performance vehicles and has many advantages over the other methods. For example, unlike welding, the parts that are bonded do not distort and have up to a 20% increase in stiffness (Fays, 2003). Adhesive bonding also has higher stiffness than mechanical fasteners or spot welding since it creates a continuous bond and therefore has a more uniform stress distribution (Barnes & Pashby, Joining techniques for aluminium spaceframes used in automobiles: Part II — adhesive bonding and mechanical fasteners, 2000), which leads to more uniform work and therefore higher fatigue strength (Fays, 2003). Adhesive bonding also absorbs energy well, has good noise and damping properties, provides a continuous seal against moisture and debris and provides the opportunity to join dissimilar materials that could lead to galvanic corrosion or other problems (Barnes & Pashby, Joining techniques for aluminium spaceframes used in automobiles: Part II — adhesive bonding and mechanical fasteners, 2000).

Some disadvantages of adhesive bonding include manufacturing difficulties as well as some performance difficulties. Adhesive bonds are weak in peel strength, but this can be overcome by using lap shear joints (Barnes & Pashby, Joining techniques for aluminium spaceframes used in automobiles: Part II — adhesive bonding and mechanical fasteners, 2000) or by using hybrid joints which combine two of the joining techniques, like spot welding and adhesive bonding (Fays, 2003). Other disadvantages include the environmental, and health and safety concerns since most high-performance adhesive are toxic and require energy to cure (Barnes & Pashby, Joining techniques for aluminium spaceframes used in automobiles: Part II — adhesive bonding and mechanical fasteners, 2000). They also have a limited shelf-life, which makes mass production more difficult since their viscosity increases and therefore the robotic dispensers require regular maintenance and cleaning (Barnes & Pashby, Joining techniques for aluminium spaceframes used in automobiles: Part II — adhesive bonding and mechanical fasteners, 2000). Furthermore, while the adhesive is curing, the joints must be supported to ensure the parts bond correctly. This can be done by using mechanical fasteners or by having interlocking details such as in the Lotus Elise (Barnes & Pashby, Joining techniques for aluminium spaceframes used in automobiles: Part II — adhesive bonding and mechanical fasteners, 2000). The surface of the parts being bonded must also be pre-treated to remove contaminants, and in the case of aluminum, to modify or remove the oxide layer. There is also no reliable non-destructive evaluation to test the adhesively bonded parts, which makes ensuring standards are met for crashworthiness of vehicles more difficult (Barnes & Pashby, Joining techniques for aluminium spaceframes used in automobiles: Part II — adhesive bonding and mechanical fasteners, 2000).