

PAPER REF: 6920

## **ANALYSIS OF STRUCTURAL ADHESIVES FOR AUTOMOTIVE APPLICATIONS**

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### **ABSTRACT**

Structural adhesives technology has changed the concept of joints bonding different materials in a unique solid assembly and making them part of the structures. These joints not only increase strength and stiffness but also reduce weight, which is important, for instance, for vehicles and airplanes. The present study reports the results of applying urethane structural adhesives in automotive components. Lap shear in joints formed by polymeric composites, such as RTM and SMC, ABS thermoplastic and galvanised steel, was evaluated. The results show very good adherence between the adhesive and the substrates under different temperature conditions and relative humidity.

**Keywords:** adhesion, mechanical tests, joints.

### **INTRODUCTION**

In recent years, the structural adhesives technology has shown great potential application because of its ability to transform complex structures into solid, monolithic units using different materials. Therefore, joints become part of these structures, providing, in addition to weight reduction, a considerable increase in mechanical strength and stiffness (Baldan, 2004).

The adhesives for such applications have attractive chemical and mechanical properties, which have not been sufficiently studied or understood, perhaps because of the complex interactions existing between the substrate and adhesives (Kinloch, 2000). Theories based on adsorption, diffusion, mechanical lock, chemical interactions and electrostatic forces and secondary adhesive interface - substrate are available (Petrie, 2000).

The use of structural adhesives in vehicles arose from the need to bond metallic inserts and reinforcements in hoods, grilles and fenders to components manufactured by the RTM and SMC processes without mechanical fasteners. The success of structural adhesives has changed the concept of structural bonding, and today, almost all vehicles use structural adhesives such as urethane, epoxy and acrylic. Polymeric adhesives offer several advantages over metallic joints, providing uniform distribution of static and dynamic stress and cost reduction in the production chain and in maintenance, as compared with traditional mechanical fasteners (Quini, 2005].

### **RESULTS AND CONCLUSIONS**

For all samples using polymeric substrates, SMC, RTM and ABS, a reduction in the shear strength was identified, always with failure in the substrate, when compared with that obtained at baseline (25 °C). For the SMC substrate tested under condition 1, there was a reduction in shear strength of 8.6%, with rupture of the specimen; under condition 2, a

reduction of 44.8% with delamination was observed. For RTM under condition 1, there was a decrease of 6.6%, with rupture of the specimen and under condition 2, a reduction of 47.5% with delamination. In the composite substrate, it was observed that not only the reduction behaviour of the shear strength was similar in shape to the rupture but also the percentage of reduction, and thus the combined effect of exposure to temperature and relative humidity significantly reduces the shear strength of the joint for these composite materials.

In ABS substrates subjected to condition 1, there was a reduction of 8.3% in the shear strength, while under condition 2 there was a reduction of 33.3%. The behaviour of ABS under these two conditions was similar to that observed in composite substrates.

The immersion of polymeric materials in water may initiate hydrolysis and corrosion and reduce the resistance of a joint, which may affect the substrate and the urethane adhesive. This condition may occur in a practical situations: for example, bonded parts of vehicles will be exposed to water in the form of rain or cleaning purposes. Therefore, the effect of water immersion on the joints of SMC, RTM, ABS and galvanised carbon steel was evaluated. The specimens were immersed in distilled water at 25 °C for 500 h, followed by manual drying with paper towels, and were tested to obtain the shear strength.

One of the most critical factors for promoting degradation of polymeric materials and corrosion of metallic materials, with consequent loss of material strength, is the exposure to salt spray. Because of the presence of minerals, salt spray can combine the corrosive effects of minerals with moisture, reducing the lifetimes of many materials. The effect of salt spray on the joints, previously mentioned in the exposure condition for 240 h, was evaluated.

Variations in temperature, humidity, time and salt spray can create unfavourable conditions when combined, which reduce the load capacity of the joint. The effect of these external conditions on specimens was evaluated together in two cycle: cycle 1, relative humidity, salt spray, high and low temperature plus salt spray; and cycle 2, relative humidity, high and low temperature.

The joints formed with the urethane adhesive had excellent performance in the different exposure conditions, such as humidity, salt spray, temperature accelerated aging, different temperature and exposure cycling tests combining different conditions. Such performance allows the urethane adhesives as suitable for use in bonding automotive components with the substrates studied in this work.

## **ACKNOWLEDGMENTS**

The authors acknowledge the technical support of the Masterpol Adhesives Technology and IPEN-Nuclear and Energetic Research Institute.

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