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Polyurethane Structural Adhesives Applied in Automotive Composite Joints

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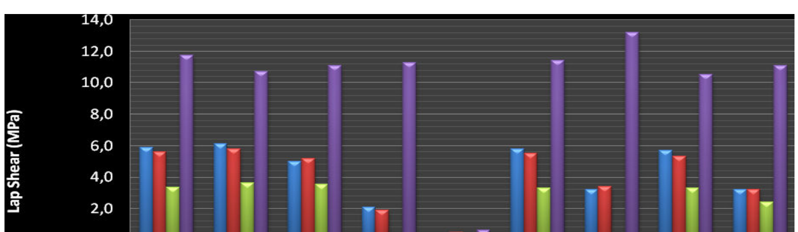
Abstract – Structural adhesives technology has changed the concept of joints bonding different materials in an unique solid assembly and becoming them part of the structures. These joints not only increase strength and stiffness but also reduce weight, so important, for instance, in vehicles and airplanes. The present study reports results of urethane structural adhesive in automotive components. The lap shear test in joints formed by polymeric composites like RTM and SMC, ABS thermoplastic and galvanized steel was evaluated. The results showed a very good adherence between the adhesive and the substrates in different temperature conditions and relative humidity.

The use of structural adhesives for vehicles has initiated by the need to bond metallic inserts and reinforcement in hood, grille and fender to components manufactured by the RTM and SMC process without mechanic fasteners. The successful of structural adhesives change the concept of structural bonding and nowadays almost all vehicles use structural adhesives like urethane, epoxy and acrylic [1]. Polymeric adhesives offer advantages over the metallic joints providing uniform distribution of static and dynamic stress, cost reduction in the production chain and also in the maintenance when compared with the traditional mechanical fasteners [2].

Specimens of RTM and SMC composites, ABS thermoplastic and galvanized carbon steel were machined in the dimensions of 25x70x2mm, degreased with trichloroethylene 99% before application of polyurethane adhesive Masterpur Estrutural 300 from Masterpol Adesivos, in agreement with ASTM D3163. The lap shear tests were performed in nine different conditions as follow: four in temperature, two in temperature and time and two in temperature-time and relative humidity.

The lap shear tests results at the temperature of -40, 25, 80, 120 and 177ºC are shown in FIG.1. Considering composites substrate, there was considerable reduction of lap shear strength at higher temperatures. All the failures occurred in the composites. In ABS thermoplastic substrate, due to the low thermal stability of the material, the tests were performed up to 80ºC and practically there were no variation in the lap shear at the temperatures of -40, 25 and 80ºC. The failure also occurred in the substrate. In metal joints, however, failure has occurred in cohesive mode. The urethane adhesive failure at its ultimate strength revealed that there was an excellent bonding. At temperature of 177ºC there was a significant decrease in the lap shear. Exposition at temperature, time and relative humidity in lap shear strength were also evaluated. The tests were performed at 500h/90ºC, 20min/177ºC and 500h/25ºC at 98% of relative humidity and 500h/38ºC at 98% of relative humidity. The results are shown graphically in FIG. 1. There was a decrease in lap shear joints in composite and thermoplastic substrate due to the failure in the substrate, while in metal joints, on the other hand, there was an increase in lap shear, followed by a cohesive failure mode.

The results take to conclude that the urethane structural adhesive have an excellent adherence in all the substrate performed in this study. In composites and thermoplastic joints, the lap shear was limited by the resistance of the substrate and in metal joints the failure was in the adhesive. Also there was evidence that the adhesive undergoes to a post cure at higher temperatures. It can be seen that in metal joint there was an cohesive failure.



	-40°C	25°C	80°C	120°C	177°C	500h of 90°C	20min of 177 °C	500h of 25°C and 98% R.H.	500h of 38°C and 98% R.H.
RTM	5,9	6,1	5,0	2,1	0,4	5,8	3,2	5,7	3,2
SMC	5,6	5,8	5,2	1,9	0,5	5,5	3,4	5,3	3,2
ABS	3,4	3,6	3,6			3,3		3,3	2,4
Carbon Steel	11,7	10,7	11,1	11,3	0,6	11,4	13,2	10,5	11,1

Figure 1: Lap shear in joints of RTM, SMC, ABS and galvanized carbon steel.

[1] PETRIE, E.W. ***Handbook of Adhesives and Sealants***, 1. ed. New York, N.Y., McGraw-Hill, 2000.
[2] SKEIST, I.; ***Handbook of Adhesives,*** 4.ed. New York, N.Y., Reinhold Publishing Corporation, 1965.