

Effects of Different Thermal Processing Routes and Their Parameters on the Formation of Voids in PA6 Bonded Aluminum Joints

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Abstract : Adhesively bonded aluminum joints are common in automotive and aircraft industries and are one of the enablers of lightweight construction to minimize the carbon emissions during transportation for a sustainable life. This study is focused on the effects of two thermal processing routes, i.e., by direct and induction heating, and their parameters on void formation in PA6 bonded aluminum EN-AW6082 joints. The joints were characterized microanalytically as well as by lap shear experiments. The aging resistance of the joints was studied by accelerated aging tests at 80°C hot water. It was found that the processing of single lap joints by direct heating in a convection oven causes the formation of a large number of voids in the bond line. The formation of voids in the convection oven was due to longer processing times and was independent of any surface pretreatments of the metal as well as the processing temperature. However, when processing at low temperatures, a large number of small-sized voids were observed under the optical microscope, and they were larger in size but reduced in numbers at higher temperatures. An induction heating process was developed, which not only successfully reduced or eliminated the voids in PA6 bonded joints but also reduced the processing times for joining significantly. Consistent with the trend in direct heating, longer processing times and higher temperatures in induction heating also led to an increased formation of voids in the bond line. Subsequent single lap shear tests revealed that the increasing void contents led to a 21% reduction in lap shear strengths (i.e., from ~47 MPa for induction heating to ~37 MPa for direct heating). Also, there was a 17% reduction in lap shear strengths when the consolidation temperature was raised from 220°C to 300°C during induction heating. However, below a certain threshold of void contents, there was no observable effect on the lap shear strengths as well as on hydrothermal aging resistance of the joints consolidated by the induction heating process.

Keywords : adhesive, aluminium, convection oven, induction heating, mechanical properties, nylon6 (PA6), pretreatment, void

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