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Development of Application of Friction Stir Spot Welding to Multi-material Components

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Towards decarbonization, transportation equipment such as automobiles is required to significantly reduce CO_2 emissions. Weight reduction, which directly contributes to the reduction of running energy, is an effective means. In addition, in automobiles, since weight reduction leads to improved vehicle performance, the development of joining technology, which is an important elemental technology for achieving weight reduction, has been promoted. To reduce weight, aluminum and fiber-reinforced composite plastics (CFRP) with high mass efficiency are used in the right place while balancing the performance and cost required for the vehicle body. There is a demand for joining technology development that considers friction stir spot welding uses a smaller electric current than general resistance spot welding and does not increase weight and cost due to auxiliary materials like machine fastening. development is underway.

In this report, the results were investigated on the joint strength when used with adhesives, which are issues in the practical use of multi-material components, and the suppression of thermal strain due to temperature changes in the manufacturing process and when used in the market. In addition, the results were reported of a trial production assuming a door as a specific multi-material component, with the door inner made of non-continuous fiber CFRP by injection molding, and the panel made of aluminum.

When bonding CFRP and aluminum with an adhesive, a shear tensile strength approximately 1.5 times higher than when no adhesive is used was obtained (Fig.1). Observing at the fracture surface after the tensile test, the adhesive was expelled to the outer part of the nugget where the CFRP and aluminum were bonded, and this was thought to have contributed to the improvement in bonding strength.

The thermal strain of a test piece bonded with a combination of CFRP and aluminum thermosetting adhesive was examined by actual measurement and CAE analysis at the actual use environment temperature of automobiles (-40℃ to +80℃). As a result of developing a thermal strain model technology, it was confirmed that the level is applicable to practical component.

Based on these research results, a prototype multi-material door was produced by joining CFRP (inner) and aluminum(outer). In addition to static strength and rigidity, it was confirmed that there was no problem with thermal strain (Fig.2). It was also confirmed by analysis that the collision performance was satisfactory. Next, it will be manufactured a door with an impact bar joined and examined the actual difference from the analysis results.

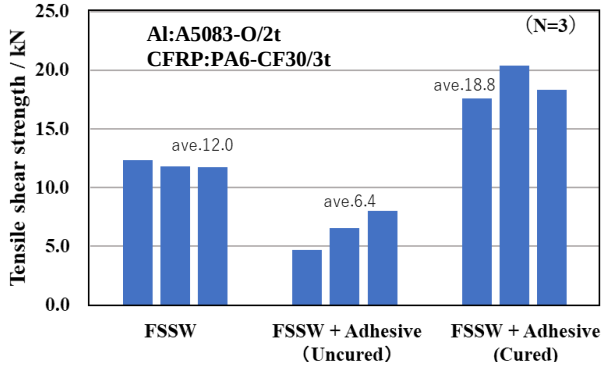

Fig.1 Effect on tensile shear strength with and without adhesive

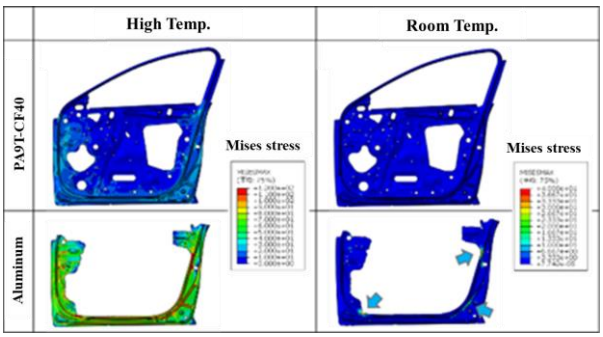

Fig.2 Result of thermal strain analysis